

**YIELD MAXIMIZATION IN DIRECT SEEDED RICE
(*Oryza sativa* L.) UNDER TUNGABHADRA PROJECT
IRRIGATION COMMAND**

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RAICHUR – 584 104**

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(*Oryza sativa* L.) UNDER TUNGABHADRA PROJECT
IRRIGATION COMMAND**

**Thesis submitted to the
University of Agricultural Sciences, Raichur
in partial fulfilment of the requirement for the
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in

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By

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AUGUST, 2017

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CERTIFICATE

This is to certify that the thesis entitled “Yield maximization in direct seeded rice (*Oryza sativa* L.) under Tunga Bhadra Project Irrigation Command” submitted by Mrs. SHUBHA, G.V. in partial fulfilment of the requirement for the degree of **DOCTOR OF PHILOSOPHY** in **AGRONOMY**, College of Agriculture, Raichur, University of Agricultural Sciences, Raichur, is a record of research work done by her during the period of her study in this University under my guidance and supervision and the thesis has not previously formed the basis for award of any degree, diploma, associateship, fellowship or other similar titles.

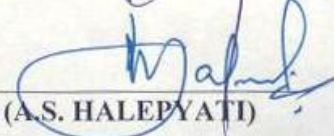
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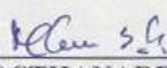
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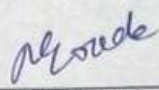

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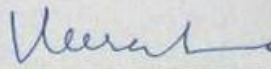

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*Dedicated
To
Beloved Parents
Smt. Meenakshi & Sri. Veerabhadrappa
My Better half Chandrashekara
and Respected Teachers
Brothers Yogesh, Krishnaswamy and Manjunath
God Gifted Sisters Geetha and Thanuja
My Besties Vidya and Shruthi Kharvi*



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“Every time we remember to say ‘thank you’, we experience nothing less than heaven on earth.”

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LIST OF ABBREVIATIONS

Abbreviation	Expansion
%	: Per cent
B:C	: Benefit Cost ratio
C. D.	: Critical Difference
cm	: Centimeter
DAS	: Days After Sowing
DSR	: Direct Seeded Rice
dS	: deci Siemens
Fig.	: Figure
FP	: Farmers' practice
G	: Gram
Ha	: Hectare
IFS	: Integrated Farming System
K	: Potassium
K ₂ O	: Potassium oxide
kg	: Kilogram
LAI	: Leaf area index
LSD	: Least Significant Difference
M	: Meter
MARS	: Main Agricultural Research Station
mg	: milligram
mm	: Millimeter
MOP	: Muriate of potash
N	: Nitrogen
NS	: Not Significant

°C	:	Degree Celsius
P	:	Phosphorus
P ₂ O ₅	:	Phosphorus pentoxide
Q	:	Quintal
RH	:	Relative Humidity
₹	:	Rupees
S. Em.	:	Standard Error of Mean
SSP	:	Single super phosphate
SR	:	State recommendation
T	:	Tonnes
TBP	:	Tunga Bhadra Project
TPR	:	Transplanted rice
Viz.,	:	Namely

I. INTRODUCTION

Today, the world needs more grain for food. This has to be achieved even with diminishing arable lands, water scarcity, and rising costs of cultivation. In addition, climate change is adding further complexity. The world population of 7.3 billion in 2015 is projected to grow to 8.5 billion in 2030, 9.7 billion in 2050 and to 11.2 billion in 2100. Average per capita food consumption in developing countries, which rose from 2,110 kcal person⁻¹ day⁻¹ over three decades ago to 2,650 kcal person⁻¹ day⁻¹ at present, may rise further to 2,960 kcal person⁻¹ day⁻¹ in the next 30 years and to 3,070 kcal person⁻¹ day⁻¹ by 2050. Achieving it should not be taken for granted as land and water resources are now more stretched than in the past and the potential for continued growth of yield is more limited (FAO 2006a). Already, declining trend in crop yield and an increasing water shortage are apparent in many nations including India (Rosegrant and Cline, 2003 and NAAS, 2006).

Rice is one of the most important staple food crops of the world and India, and hundreds of millions in Asia, Africa and Latin America living in the tropics and subtropics depend on it. In these areas, population growth rate is rapid and will likely to remain high at least for the next decade. In the world, rice is grown on 158.0 m ha⁻¹ with a production of 746.9 m t and productivity of 3889 kg ha⁻¹ (FAO, 2014). In India, rice continues to hold the key to sustain food production by contributing 20-25% and assures food security for more than half of the total population. Rice accounts for 55% of total cereal production in the country. The per capita food intake in India is 2234 kcal person⁻¹ day⁻¹ of which 30% comes from rice. With an estimated population of 1.4 billion by 2020, the country will require 300 m t of grain compared with the approximately 272 m t at present.

Since the beginning of the 1960s, the large increase in the demand for food has been met largely by improved agricultural productivity, which required more inputs *viz*, fertilizers, pesticides, and improved seeds and more water for irrigation. Our country is proud of spectacular achievements during Green revolution and there is no denying the fact that fertilizer has played a major role in this endeavor. Nevertheless, the average annual increase in fertilizer consumption from 1960-61 to this day revealed that the partial factor productivity of fertilizers has been continuously declining. For instance in

the heartland of rice-wheat (especially, Punjab, Haryana, and western Uttar Pradesh) in the north, farmers are forced to apply more and more fertilizers to obtain the same crop yield of the preceding years (NAAS, 2006). It is estimated that 70–80% of future increases in crop production in developing countries will have to come from intensification, that is, higher yields (FAO, 2006b). Since there is no possibility of any further increase in the area under cultivation over the present 142 million ha, much of the desired increase in grain production has to be achieved by enhancing productivity per unit area. The productivity of milled rice has to be increased from the present 2370 kg ha⁻¹ to 2895 kg ha⁻¹ by 2020, with an average increase of 5% per annum (Gujja and Thiyagarajan, 2013).

In India, rice is grown in an area of 43.95 m ha with an annual production of about 106.54 m t and the productivity is about 2.37 t ha⁻¹ (Anon., 2015). In Karnataka, rice is cultivated in command areas of Cauvery, Tunga Bhadra and Upper Krishna, where conventional puddling and transplanting (PuTPR) is the major system of cultivation. The total area under rice in Karnataka is 1.42 m ha with an annual production of 3.5 m t and the productivity is 2.63 t ha⁻¹ (Anon., 2015). It is not enough to meet the needs of burgeoning population and the country has to produce 40% more rice by 2025 to satisfy the growing demand without adversely affecting the resource base.

To meet the challenge of producing more rice from suitable lands, it is necessary to use rice varieties with higher yield potential and greater yield stability (Khush, 2004). Therefore, evolving new cultivars and their testing for adaptability and productivity would be a continuous job. Generation of suitable production practices is another necessity and addressing the water issue takes the precedence. World Water Council (2000) observed a decade back that ‘There is a water crisis today. But the crisis is not about having too little water to satisfy our needs. It is a crisis of managing water. In most of the cases leading to poor water efficiency lies with management, rather than its availability as such’. Nevertheless, in the next two decades, water scarcity will increase dramatically in many parts of the world. Global grain harvests will be dented, and livelihood of many countries will be threatened (World Economic Forum, 2009). The water use should, therefore, aim at securing the maximum crop production per unit of water and sustaining soil health. It is estimated that rice uses 30 % of fresh water worldwide. In Asia, more than 80% of fresh water resources are used for irrigating rice. By 2025, it is estimated that 15-20 m ha of irrigated rice will suffer with some degree of

water scarcity. In the world's 'rice bowls', particularly China and India, the scarcity of water is acute, with competing demands of fresh water sources triggering conflicts. The declining freshwater availability will have its impact on agriculture in India.

Zeigler *et al.* (2008) listed seven challenges to be addressed in intensive irrigated rice systems. Two of these are (1) exploiting all options for raising the yield potential of rice and (2) closing 'yield gaps', increasing yield stability, and improving net returns through improved germplasm with multiple resistance to abiotic and biotic stresses and improved crop management. So far, the much-publicized strategies surrounding Genetically Modified (GM) rice have not had much success as seen by the limited spread of the 'New Plant Type' (NPT). There is clearly an urgent need to find ways to grow more food with less water and fewer inputs. Farm-based approaches, which used to be at the center of agricultural practices for centuries to improve productivity, need to be explored once again. Direct seeded rice (DSR) is one such farm-based approach which is relatively easy and the results are visible in a short period of time. The technology is gaining popularity in the rice-wheat belt in the north apart from Karnataka and adjoining states of Telangana and Andhra Pradesh in the south. Basically grown in a watery ecosystem, with an average of 2500 mm water requirement, because of delayed and receding rainfall and consequent low water in reservoirs, delayed planting and also limited numbers of crops in a year are greatly affecting overall production.

DSR is not new in many areas of Karnataka. In Western Ghats (Belgaum, Dharwad and Karwar districts) farmers grow drill sown rice in upland situations. Recently due to severe water and labour shortages and high cost of production constraints; farmers even in irrigation commands are facing challenges of low productivity, profitability and even low cropping intensity. Water supplies are limited in the tail-end and in middle reaches and farmers do not get sufficient water at right time and are constrained with On-Off canal water supply. Erratic and insufficient monsoon have further aggravated conditions leading to insufficient water in barrages, delayed, erratic and untimely canal supplies leading to delayed transplanting (beyond August) ultimately resulting in poor harvests. Therefore, a participatory intervention on DSR in the Upper Krishna Project (UKP) and Tunga Bhadra Project (TBP) to address such predicaments was initiated (Anon., 2013). Response to early dry seeding or taking advantage of early rains received before canal supplies was met with imminent success of farmers. Kasabe camp, a small village near Raichur city is often called as a DSR

village having > 90% of the rice area in that village under DSR. Farmers of these villages are getting equal yield with less water, energy, labour, fertilizer and ultimately higher net profit per unit area compared to conventional puddled transplanted rice (PuTPR). Today the technology has covered nearly 95,000 acres in TBP and UKP irrigation commands.

The results revealed that the rice productivity across sites under DSR and PuTPR was statistically on par but the cost of production of DSR was significantly less than conventional puddle transplanted rice. This resulted in an overall increase in net returns. In addition to increase in net income of farmers, the other benefits recorded in the DSR are; timely sowing, reduced seed rate by half, reduced fuel consumption by 40-50 l ha⁻¹, reduced water use by 25-35% facilitating an additional area under irrigation with other associated benefits of reduced waterlogging/salinity and reduced GHGs, increased NUE due to fertilizer placement (Chittapur, 2016).

Thus, DSR appears to be potential, though, current high yielding rice varieties are bred only for transplanting conditions and little is known about their response under DSR. Cultivar suitable for DSR should possess intermediate plant height, high specific leaf area during vegetative stage and low specific leaf area during the reproductive phase with high chlorophyll content, lodging resistance and high yield. In addition, panicles should be placed within the plant's canopy, which increases lodging tolerance. Early maturing and photoperiod-insensitive rice varieties with better drought tolerance are suited for DSR. At Bulandshahar in Uttar Pradesh, under DSR conditions, with irrigation around field capacity, rice varieties like Pusa Sugandha 3, Pusa Sugandha 4, Pusa Rice Hybrid 10, and Pusa Sugandha 5 yielded 4.75 - 5.75 t ha⁻¹ of grains (**Anandan *et al.*, 2015**).

In flooded rice with saturated anaerobic soils, ammonium is the dominant form of available N. In aerobic systems, on the other hand, the dominant form of N is nitrate. The application of irrigation water will create soil moisture conditions close to saturation immediately following irrigation and below field capacity a few days later. These alternate moist-dry soil conditions may stimulate nitrification - denitrification process, resulting in a loss of nitrogen through N₂ and N₂O (Prasad, 2004). The differences in soil N dynamics and pathway of N losses between flooded and aerobic systems may result in different fertilizer-N recoveries. With high nitrogen applications in aerobic rice, grain filling may be limited by a low contribution of post-anthesis assimilates (Zhang

et al., 2009). Of late, many studies indicated the response of high-yielding rice varieties to nitrogen above the recommended dose under flooded condition as well (Saoji *et al.*, 2008, Ganga and Sumathi, 2011 and Rao *et al.*, 2011). The other limitation in DSR is occurrence of widespread micro nutrient deficiencies particularly of zinc and iron due to aerobic condition prevailing during establishment. Farmers often apply these nutrients randomly but specific recommendations are yet to be made so also the redefining the requirement of major nutrients that not just be able to rise the levels but would be able to realize the crop potential by bridging the gap between soil supply and crop need for a pre-set yield target. Already, under ICAR-STCR scheme yield equations are developed but these have not been tested for DSR situation (Anon., 2007). Recently, International Plant Nutrition Research has come out with Site Specific Nutrient Management (SSNM) with a software (Nutrient Expert) for transplanted rice nutrition (Anon., 2011). This also needs to be evaluated for DSR conditions. In all, to realize the maximum possible benefits of rice crop under DSR, a climate smart and emerging technology in irrigation command, and to obtain higher yield, developing optimum package of agronomic practices for successful cultivation assumes importance. Among the various cultural practices seed rate and selection of variety are most important for yield maximization. Improved high yielding and hybrid varieties contribute one of the major components of modern rice production technology (Prasad, 2004). The seed rate in DSR used presently across rice zones vary a lot. Suitable rice variety with optimum seed rate is desirable to utilize the available natural resources efficiently to get maximum yield. Keeping all these points in view the present investigation ‘Yield maximization in direct seeded rice under Tungabhadra project irrigation command’ was envisaged during rainy and summer seasons of 2014-15 and 2015-16 with following the objectives.

- To evaluate the response of cultivars to seed rate and micronutrient supply under drill sown situation.
- To evaluate the potential of achieving the yield targets in rice using different decision support system and micronutrients under DSR.
- To work out the economics of drill sown rice due to different agronomic practices

II. REVIEW OF LITERATURE

Rice is the world's prime food crop supporting a great number of people over a long period of time than any other crop and will continue to do so. Rice, called 'stuff of life', constitutes the staple food for more people in the world than other cereals. However, the great challenge today is to ensure that rice production keeps pace with the burgeoning population under changing climate and water shortage. The recent study jointly carried out by NASA and the German Aerospace Center (DLR) in N-W IGP (north-west Indo-Gangetic Plains), indicated a groundwater table decline rate of 0.33 m per year (Rodell *et al.*, 2009). The alarming crisis of water and rate of climate change are forcing researchers and farmers to consider the dry direct-seeded rice (DSR) as an alternate production system. Therefore, Direct seeded rice, of late like elsewhere, is an emerging rice culture gaining popularity and momentum in mid to tail end regions in Tunga Bhadra Project (TBP) and Upper Krishna Project irrigation commands of Karnataka due to inadequacy of water and untimely release in to the canals confounded by chaotic monsoon. Therefore, investigations were carried out for two consecutive seasons during 2015-16 and 2016-17 to optimize production practices for 'Yield maximization of dry-direct seeded rice in Tunga Bhadra Project irrigation command'. As conceptual frame work for the study based on the ideas and concepts gathered from review work of existing literature of both theoretical and empirical nature will facilitate planning such a study in a systematic manner, a brief research work carried out on genotype, seed rate, use of micronutrients, and different decision support systems for nutrient management for targeted yields mainly under DSR has been presented in this chapter.

2.1 Direct Seeded Rice

The direct seeded rice is characterized by sowing of dry seed on the receipt of monsoon rains or in dry soil. Thus, sowing of seeds in dry unsaturated soils is called direct seeding. Seeds can be broadcasted or dibbled or drilled. Irrigation is given subsequently to keep the soil sufficiently moist by using tank, canal and/or ground water. Direct-seeded rice offers the advantage of faster and easier sowing, ensures proper plant population, reduces labour and drudgery, enables 10-12 days earlier crop maturity, more efficient water use and higher tolerance to water-deficiency, and often ensures high profit in areas with assured water supply (De Datta, 1986).

Dry seeded rice also enables advanced crop establishment to make use of early season rain water (Tuong, 1999). Tuong *et al.* (2000) also emphasized that typically, DSR is established earlier than transplanted rice (TPR) without growth delays from transplanting injury, which hastens physiological maturity and reduces vulnerability to late-season drought. Direct seeding reduces labour requirement, shortens the crop duration by 7 – 10 days and can produce as much grain yield as that of a transplanted crop. It is reported that direct seeded rice needs only 34% of the total labour requirement and saves 29% of the total cost over transplanted crop (Ho and Romil, 2000). Kumar (2000) studied the effect of different tillage system on growth and yield of rice and reported that transplanting manually under puddled condition produced more number of effective tillers ($277 \text{ tillers m}^{-2}$) than that from line sowing of sprouted seeds without puddling ($269 \text{ tillers m}^{-2}$).

Aerobic rice management eliminates water required for puddling and reduces water losses due to evaporation and percolation and thereby reduces the total irrigation requirements by 30 – 50% (Castaneda *et al.*, 2004). Direct seeding of rice also allows early planting of succeeding crop due to decreased crop duration. Higher profit with short duration varieties under direct seeding can be achieved with assured water supply and efficient weed management (Balasubramanian and Hill, 2002).

Gangwar *et al.* (2005) revealed that effective tillers and panicle weight were significantly higher in drum-seeding and mechanical transplanting (unpuddled), however, manual transplanting (puddled) gave significantly lower effective tillers m^{-2} and panicle weight. Similarly, 1000-grain weight and grain yield were significantly higher in drum seeding but were at par with direct-seeding and mechanical transplanting (puddled). Mechanical transplanting (unpuddled) and manual transplanting (puddled) gave lower 1000-grain weight and grain yield in comparison to direct seeded rice which produced 50.87 % higher yield than transplanted rice. This was due to higher number of panicles m^{-2} , more tillers m^{-2} and dry matter production and taller plants in direct seeded rice.

Gill (2008) reported that the transplanted rice on the day of direct sowing produced significantly more effective tillers (320 m^{-2}) than the crop transplanted after 25 days of sowing (276.9 m^{-2}). Kumar (2008) revealed that the direct seeding of sprouted seeds under puddled condition recorded higher growth attributes than other systems of cultivation.

Sharma *et al.* (2005) examined the effect of rice establishment methods on the performance of rice. They reported that direct seeding of rice results in early maturity and shortens the crop duration than transplanted rice. Singh (2005) observed significantly higher number of panicles per unit area in wet seeded rice (429 m^{-2}) than in transplanted rice (248 m^{-2}). Farooq *et al.* (2006) observed that direct seeded rice crop generally flowers earlier leading to shorter crop duration and matures 7–10 days earlier and have less methane (a green house gas) emissions than TPR (transplanted puddled rice). Ali *et al.* (2006) mentioned that shortage of labour and water are forcing farmers to explore the alternatives to transplanting. Further, they also concluded that direct-seeded rice had shorter crop duration.

Of the problems, Gao *et al.* (2006) reported that micronutrient deficiencies such as Zn and Fe, due to imbalanced N fertilization and higher infiltration rates in DSR, are major concerns. In fact, yield in DSR is sometimes lower than transplanted rice (TPR) principally owing to poor crop stand and high weed infestation. Moreover, cost for weed control is usually higher than in TPR. Therefore, high weed infestation is a major constraint for wider adoption of DSR (Rao *et al.*, 2007).

However, the advantage in the direct-seeded method, about 30 per cent less water was needed for land preparation compared to the transplanting technique of crop establishment (Xu *et al.*, 2007). That apart, direct seeding methods have several other advantages over transplanting. In addition to higher economic returns, DSR crops are faster and easier to plant, less labour intensive and consume less water (Bhushan *et al.*, 2007). Bhushan *et al.* (2007) also opined that since economic profitability in terms of net returns is high with no-tillage and DSR on raised beds, it can easily replace TPR.

Farooq *et al.* (2006) revealed that direct seeding also offers the option to resolve edaphic conflicts (between rice and the subsequent non-rice crop) and enhance sustainability of both the rice–wheat cropping system and/ succeeding winter crops, particularly that of early sown wheat. Hugar (2009) noticed significantly taller plants with normal transplanting which was followed by SRI on silty clay loam soil.

Halepyati (2016) while reviewing the challenges to DSR in the present changing climate scenario opined that among different rice cultures, DSR has received much attention because of its low-input demand. It involves sowing pre-germinated seed into a puddled soil surface (wet seeding), standing water (water seeding) or dry seeding into a

prepared seedbed (dry seeding). The development of early-maturing varieties and improved nutrient management techniques along with increased availability of chemical weed control methods has encouraged many farmers in India to switch from transplanted rice to DSR culture.

In view of the above advantages offered by DSR it is essential to optimize different production practices to overcome the limitations and maximize rice production and productivity. Following review deals with the genotypic performance, response to planting geometry and crop nutrition under DSR.

2.2 Performance of Genotypes

Almost no varietal selection and breeding efforts have been made for developing rice cultivars suitable for alternate tillage and establishment methods, especially in unpuddled or zero-tillage soil conditions with direct seeding (Dry-DSR) in Asia (Fukai, 2002; Lafitte *et al.*, 2002). Currently, no varieties are available that are targeted for this environment though there have been successful breeding programmes for direct-seeded rice in puddle conditions (Wet-DSR) (Wah and Cheong Ah, 1998; Weerakoon *et al.*, 2011).

On-station and on-farm trials involving the evaluation of Dry-DSR cultivation have used rice varieties/hybrids that are primarily bred for puddled transplanting. Therefore, one can argue that comparisons of crop performances of rice in Dry-DSR with Conservation Tillage-TPR varieties have been biased. Based on the constraint analysis discussed in the preceding section, a plant type for Dry-DSR should be different from the one for Conservation Tillage -TPR. An ideal plant type should have traits to deal with problems associated with early CE (crop emergence), weed competition, spikelet sterility, and lodging.

2.2.1 Growth parameters

Patnaik (1988) studied the growth habit of medium and late maturing varieties of rice released by CRRI, Cuttack under drill sowing condition and found that cvs. Savithri, Anamika, Gayathri, Moti and Utkalprabha varieties had deeper root system with more drought tolerance. In Karnataka, while working with coarse cultivars, Purushotham *et al.* (1988) reported that the mean duration of all the varieties (Jaya, KMP 41 and KMP 57) was 150 days. The plant height and the number of productive tillers m^{-1} were more

in KMP 57 than those of other varieties. Among all, KMP 41 had the lowest test weight (16.5 g). Further, Shashidhar and Reddy (1990) reported that local variety such as Doddinellu, Devamallige, Byrnellu and Kesaradoddi had long and voluminous roots than Jaya, IR 20, KRH 1 and Rasi. While, Sheela (1995) observed that varieties like Jaya, Rasi and Tulasi performed better than the other varieties in terms of growth parameters and yield under rainfed condition. In the northern parts of Karnataka at Agricultural Research Station, Mugad, Karnataka, Mohan Kumar *et al.* (1997) reported that cv. Amruth (IET-7991-11-2) was more promising and high yielding rice variety for drill sown upland condition than cv. Rasi (IET 1444).

Experiments conducted at Directorate of Rice Research (DRR), Hyderabad revealed that cvs. IET 14793, IET 14807, IET 15327, IET 15032 and IET 14867 were found to give consistent performance under rainfed upland conditions (Anon., 1998). Reddy (1998) found that cv. Byrnellu, a local tall growing and long duration variety, was more suitable for *punaji* cultivation than cv. Jaya or KRH 1 and it out yielded both cultivars. Early seedling vigour coupled with long hypocotyl region of cv. Byrnellu helped in early and proper establishment. Besides, it had longer, deeper and denser root system than Jaya and KRH 1.

Singh *et al.* (1998) rated performance of cv. Rajashree to be better compared to IET 8002, which was most popular in Bihar. In the south, Valarmathi and Leenakumary (1998) carried out a field experiment in Kerala, India to evaluate the suitability of *aman* rice cultivars under direct sown conditions because of scarcity of labour for transplanting. Shorter duration in time to maturity was observed in all the cultivars under direct sowing, upland situation than under lowland transplanted conditions.

Goel and Verma (2000) compared direct sowing and transplanting methods of crop establishment on the yield and yield components of two rice cultivars. They observed higher plant height (104.8 cm) in transplanting. No significant interactions were observed between the cultivars and sowing methods in Karnal. Mishra and Singh (2008) identified morpho-physiological traits such as rapid and uniform germination, faster growth at seedling stage, early prolific root growth, good vegetative vigour, height and larger canopies, especially during the early stages of crop growth are useful traits as these provide better competitive ability.

Sarkar *et al.* (2002) investigated the effect of row arrangement, and time of tiller separation on growth of transplanted *aman* rice (cv. BR 23). Results revealed that in single row tillers could be separated at 25 DAT without hampering tiller reduction hill⁻¹. Further, Tabbal *et al.* (2002) while studying on-farm strategies for reducing water input in irrigated rice, recorded higher number of tillers in cvs. HD 502 and HD 297 over other genotypes.

Kondo *et al.* (2003) reported that the plant morphological features such as tillering capacity, leaf area expansion, shoot and root biomass production, nitrogen accumulation and the rooting patterns likely to differ between the upland and lowland cultivars and even between upland and lowland condition. Further, they suggested that such of the differences may be associated with abilities in resource acquisition and also the dry matter production under varied environments. In Assam, Rautaray (2004) studied the tillering behavior and yield of rice varieties and reported that cv. Tapaswini recorded significantly more number of effective tillers (442 tillers m⁻²) compared to cv. RCPLI 27 (221 tillers m⁻²). Akbar (2004) reported that cv. Sonarbangla 1 ranked first in respect of total tillers hill⁻¹ among the varieties studied in Bangladesh. Cultivation of *boro* rice by direct seeding using the drum seeder had created a sensation among farmers now wherever it was tested (Anon., 2004). Srilaxmi *et al.* (2005) studied the varietal response under direct seeding at Bapatla, Andhra Pradesh. They reported that growth and yield were significantly affected due to variety. Maximum dry matter production (1116 g m⁻²) and productive tillers m⁻² (315.3) were noticed in cv. Krishnaveni than in other varieties. Earlier harvest could result in another crop being accommodated. Therefore, they opined that the choice of appropriate variety and cropping system would be important.

At IRRI, the Philippines, Atlin *et al.* (2004) revealed that aerobic rice cultivars yielded better (3.89 t ha⁻¹) under favorable upland environment and outperformed improved upland and irrigated varieties. Aerobic cultivars maintained harvest index of about one third higher than other cultivar types. From the same institute, Lafitte *et al.* (2006) reported that genotype IR 64 performed better under aerobic condition and attained more number of tillers (49 plant⁻¹) and had wide range of tolerance to stress conditions. Uphoff and Randriamiharison (2007) studied the behaviour of aerobic rice genotypes and reported that genotypes developed very strong root system under dry seeded condition with more root length (23.5 cm) and thicker roots. In China, Wang Huaqui *et al.* (2007) revealed that cvs. HD 207 and HD 502 had better performance under aerobic condition with high

number of productive tillers (45 tillers plant⁻¹). They also reported that high tillering was due to the early initiation of tillers at the nodal region.

Santoshi *et al.* (2007) evaluated 14 rice genotypes for grain yield with different phenology under four growing conditions: transplanting (TP) or direct-seeding (DS) in a toposequentially lower and upper field. Genotypic differences in grain yield were significant in a combined analysis of all four growing conditions. High ripened grain percentages were found to be associated with high yield. It was observed that cv. IR 24 did not out-yield the rainfed-lowland genotypes and its yield was particularly low in DS. In the lower field, the interaction between cultivation method and genotype was also significant wherein the late maturity genotypes produced higher shoot dry weight at maturity in TP than in DS. High shoot dry matter production and higher spikelet number per panicle were found to be associated with high grain yield in DS genotypes in the lower field. Further, they also found that varieties differed in their response to levels of N applied.

Feng *et al.* (2010) reported that nitrogen is one of the most important nutrients for aerobic rice production. Under low nitrogen conditions physiological parameters like chlorophyll content and total biomass were more affected. Results revealed that genotypes with lower biomass had higher relative values of the traits. Mahajan and Timsina (2011) opined that leaf area index (LAI) and relative water content (RWC) at flowering period in rice are important traits for selecting direct seeded rice cultivars with high agronomic efficiency and crop productivity. The results indicated that cv. IR 64 had RWC (78.9%) and hence caused reduction in yield compared to other cultivars at all N levels.

Christopher and Akinbile (2010) evaluated two upland rice varieties, NERICA 2 and NERICA 4, under different water application. They observed significant differences in biomass and grain yield, LAI, plant height and root depth among treatments. On the other hand, Ginigaddara and Ranamukhaarachchi (2011) emphasized the significance of age of seedling. They reported that the number of tillers, leaf area hill⁻¹, plant height and above ground non-grain biomass did not differ between direct-seeded rice (DSR) and transplanted rice (TPR) with 4-12 days old seedlings. Maximum tillering occurred between five and six weeks after establishment in all age groups of seedlings. Age of seedlings at transplanting had a significant effect on number of productive tillers hill⁻¹,

filled grains panicle⁻¹, panicle length, 1000-grain weight, grain yield and panicle setting rate.

Singh (2013) reported that amongst cultivars, Sarjoo 52 had better performance of growth and yield attributes compared to BPT 5204 and PRH 10. Rice cultivars BPT 5204 and PRH 10 were at par with each other with respect to dry matter accumulation, RGR, CGR and leaf area index. Sarjoo 52 was found to be the most competitive than other cultivars in terms of grain yield and economics. Gill *et al.* (2014) reported that the grain yield was higher under direct seeded rice than under transplanting due to more dry matter production, leaf area index and effective tillers per meter.

2.2.2 Yield performances

In India working with a Sri Lankan cultivar, Subramanian *et al.* (1986) reported that short duration rice variety BG 367-4 yielded 6.5 t ha⁻¹ surpassing all the varieties. In a Suwram, Korea, Experimental station, the two rice hybrids V 20A/Milgand 46R and IR 54756A/Suwram 287R yielded significantly higher than the best inbred cultivar Suwram 287 (Anon., 1987). At IRRI, studies revealed that hybrids in general yielded 1000-1800 kg ha⁻¹ higher than the inbred cultivar at three locations (Anon., 1988).

Rao and Moorthy (1997) reported that among 10 varieties tested cvs. IR 3, RR 151-3 and RR 50-5 were superior in yield than others giving 81.9 per cent increased yield than the control. At DRR, Hyderabad, studies revealed that cvs. IET 15169, IET 15170 and IET 15254 were suitable for direct seeding which recorded 1760 kg ha⁻¹ compared to transplanted rice varieties IET 15296, 15297 and IET 15299 (2516 kg ha⁻¹) (Anon., 1999). In hilly region of Karnataka, Ganajaxi and Rajkumara (2000) studied the performance of various methods of sowing with different agronomic practices for growing direct seeded rice. They recorded significantly higher yield with seeding in 8 row using DRR drum seeder than that with broadcasting of sprouted seeds (3083 and 2433 kg ha⁻¹, respectively).

At Karnal, Haryana, Goel and Verma (2000) investigated the effects of two sowing methods, direct sowing and transplanting, on the yield and yield components of two rice cultivars, Pusa 33 and HKR 120/HKR 126, during *khariif* (rainy season). Grain yields in both sowing methods were at par during 1992 and 1993, but were 15.2 and 9.1 per cent less in direct sowing than in transplanting, respectively, during 1994 and 1996. This reduction in yield was attributed to the heavy infestation of weeds in direct sowing

in subsequent years and the delay in first manual weeding beyond 20 days after sowing. Mean grain yield was higher in transplanting than in direct sowing, with values of 5460 and 5160 kg ha⁻¹, respectively.

At Changping Experimental Station, Beijing, China, Bouman *et al.* (2002) reported that aerobic rice recorded lower yields (4.7-6.6 t ha⁻¹) compared to lowland rice (8 - 8.8 t ha⁻¹) and cv. Han Dao 205 was more promising variety under aerobic production. Further, Tao-Hong Bin *et al.* (2002) noticed that aerobic rice varieties recorded higher harvest index, yield and water use efficiency compared to lowland varieties at Beijing, North China. Castaneda *et al.* (2002) reported that upland varieties under aerobic condition yielded 2.4 to 4.4 t ha⁻¹ which was 14 to 40 per cent lower than under flooded conditions. The total water input from transplanting to harvest was 650 to 830 mm under aerobic conditions and about 1350 mm under flooded condition and water productivity under aerobic condition increased by 20-40 per cent over that under flooded conditions.

At IRRI, the Philippines, Wang *et al.* (2002) reported that aerobic rice cultivars grown in aerobic soil produced double yield than traditional upland cultivars, but registered 20 - 30 per cent lower yield than those of lowland cultivars grown under flooded condition. Ogura (2002) conducted an experiment using direct sowing in plots without ploughing and with fertilizer applied in the slots or by transplanting from long mats of seedlings grown hydroponically. Yields with transplanting were 470 g m⁻² compared with 451 g m⁻² with direct sowing.

Nagappa and Biradar (2002) conducted an economic analysis on employing drum seeding and transplanting of two rice varieties (BPT 5204 and ES 18) at a farmer's field in Siruguppa, Karnataka, India. A substantial difference in yield was noted between the two methods of planting during summer 1999-2000. During 2000-2001, similar yields were noted between drum seeding and transplanting during *kharif* and marginally higher yield was observed in drum seeding during summer. They suggested that drum seeder sowing gave yields similar to those achieved with transplanting and hence drum seeding would help improve the profitability of rice farming in the Tunga Bhadra project area under wet-direct seeding.

At Bapatla, Andhra Pradesh, Priyadarshini and Prasad (2003) opined that highest grain yield was recorded with variety Pusa Sugandha 5 (43.89 q ha⁻¹) which was found

significantly superior to other varieties. Lowest grain yield was found with cv. Taraori Basmati (26.67 q ha^{-1}). The highest yield with Pusa Sugandha 5 was owing to more panicles m^2 . The variation in grain yield among different varieties was due to differential efficiency of the varieties in converting dry matter into grain.

In another study, at Bapatla, Andhra Pradesh, Srilaxmi *et al.* (2003) reported that the varieties differed significantly in grain and straw yields. Cv. Krishnaveni recorded significantly higher yield (4310 kg ha^{-1}) compared to cv. Surya (3838 kg ha^{-1}). Further studies revealed varied varietal response under direct seeding (Srilaxmi *et al.*, 2005). Again, they recorded maximum grain yield (4310 kg ha^{-1}), straw yield (5338 kg ha^{-1}) and harvest index (44.5%) with cv. Krishnaveni among all other varieties. While at DRR, Hyderabad, Singh and Sridevi (2006) indicated that among the varieties, higher grain yield was recorded in cvs. IET 8887 (2.34 t ha^{-1}), Rasi (2.24 t ha^{-1}) and Vikas (2.22 t ha^{-1}), while the lowest yield was recorded in IET 9818 (1.8 t ha^{-1}).

At IRRI, the Philippines, in the non-stress upland environment, aerobic varieties significantly out yielded all other types, surpassing the irrigated HYVs by over 30 per cent and the traditional upland tropical *japonicas* by over 100 per cent (Atlin *et al.*, 2004). At Tamil Nadu in hybrid rice, Gobi *et al.* (2006) revealed that there was significant increase in growth and yield attributes and yield in cv. CORH in direct seeding and broadcasting with plant population of 40 hill m^{-1} . Aerobic types also out yielded HYVs and traditional *japonicas* under severe upland stress conditions, and were as productive as highly drought-tolerant, short-duration varieties. Ravishankar *et al.* (2008) reported that cv. Quing Livan 1 registered significantly higher number of panicles (201 m^{-2}), followed by cvs. Zen Gui AT 1 (192 m^{-2}) and C 14-8 (142 m^{-2}). Similar trend was observed for filled grains per panicle and 1000-grain weight. At Rasht, Iran, Hassan Akhgari and Behzad Kaviani (2011) opined that effects of cultivars on all yield components (panicle m^{-2} , seeds panicle $^{-1}$, and 1000-grain weight), plant height, panicle length, and total tiller were significant, while the effect of cultivation method was significant on the rest of the traits except for grain weight.

In the south Karnataka, Veeresh *et al.* (2011) studied the response of rice varieties to different planting methods under aerobic method of rice cultivation and revealed that among varieties, MAS 26 recorded significantly higher grain (3978 kg ha^{-1}) and straw (4978 kg ha^{-1}) yields, but it was on par with that of MAS 946-1 and both

cultivars were superior to other varieties. Among the methods of planting, sowing of sprouted seeds produced significantly higher grain yield (3978 kg ha^{-1}). While at Hyderabad amongst cultivars, Sarjoo 52 recorded better growth and yield attributes compared to BPT 5204 and PRH 10 (Singh, 2013). Rice cultivars BPT 5204 and PRH 10 were at par with each other with respect to dry matter accumulation, RGR, CGR and leaf area index. Sarjoo-52 was found to be most competitive than other cultivars in terms of grain yield and economics.

In dry seasons, a recent dual-adapted rice variety yielded 25% lower in aerobic condition due to modifications and adjustments in plant architecture (Clerget *et al.*, 2014). Leaf appearance rates was altered from 8th leaf in aerobic instead of the 11th leaf. As a result, two fewer leaves were produced by main tillers in aerobic crops. Further, plant nitrogen content was about 1 per cent lower in the aerobic crop than in the flooded crop during the entire crop duration. Biomass accumulation of the variety used was biphasic in both the environments.

Shukla *et al.* (2015) reported that variety Dantesavar produced highest number of tillers and filled grains panicle⁻¹, grain yield and straw yield over the rest of the varieties viz., IET 21288, IET 21296, IET 21278, Jaididhan, Varalu, and Aditaya.

Yadav *et al.* (2017) obtained the highest plant dry matter in variety DRRH 3 (929 g m^{-2}) which was significantly higher than all other varieties while lowest dry matter accumulation was with variety PD 16 (900 g m^{-2}). Hybrid varieties DRRH 3 and PAC 837 performed better with the grain yields of 4620 kg ha^{-1} and 4554 kg ha^{-1} respectively compared to high yielding variety PD 16 (4408 kg ha^{-1}) at Uttarakhand.

All these reviews reveal that rice genotypes responded differently under different growing conditions and hence there is need for location specific studies for any pragmatic recommendation.

2.3 Optimum Seed Rate

It is not cultivar alone but the competitive seed rate/seedling density at which it is planted is equally important. Traditionally, high seed rates are used mostly in areas where seed is broadcast with an aim to suppress weeds or when water-seeded (Moody, 1977). However, it is not clearly known whether a high seed rate is primarily used to control weeds or is really a requirement to raise a good crop of DSR. Farmers also use

high seed rate when conditions for germination are poor due to damage by birds, insects, rats, etc. or the germination per cent of seed itself is low. However, the benefits of a higher panicle number associated with a higher seed rate are offset by a reduction in panicle length and grain weight per panicle (Bhattacharjee, 1978). High seed rates can result in large yield losses also due to excessive vegetative growth before anthesis followed by a reduced rate of dry matter accumulation after anthesis (Wells and Faw, 1978).

Much research on plant spacing is done for optimizing transplanting (De Datta, 1986). He pointed that, if we follow this lead, then plant spacing in direct seeding should be similar to that in transplanting, if weed control is good. The published literature reveals a wide range of seed rates of up to 200 kg ha⁻¹ to grow a DSR crop (Guyer and Quadranti, 1985). Generally, an increase in yield would be possible only in weedy plots and not in weed-free or weeded plots with increases in seed rate (Castin and Moody, 1989). Therefore, higher seedling rates can be beneficial only in conditions with no or partial weed control. Besides, Mithrasena and Adikari, (1986) cautioned that dense plant populations at high seed rates can create favorable conditions for diseases (e.g., sheath blight) and insects (e.g., brown plant hoppers). A high seed rate also increases establishment costs. Thus, optimum plant spacing is critical for good crop yields.

Huan *et al.* (1999) observed that, as the seed rate increases, tillering decreases and panicle density is more dependent on primary than on secondary or tertiary tillers. Since panicles from primary tillers are more productive than those from secondary and tertiary tillers, one should target an optimal spacing to have more panicles from primary tillers by minimizing interplant competition.

At Ludiana, Panjab, Gill *et al.* (2006) reported that maximum grains panicle⁻¹ were observed with seed rate of 25 kg ha⁻¹ irrespective of the methods of sowing followed by those of 50 and 75 kg ha⁻¹. More grains panicle⁻¹ at lower seed rate was due to less competition among the plants for light, moisture and nutrients compared with those at higher seed rate. They obtained, high yield level of direct-seeded rice, using seed rate of 50 kg ha⁻¹ at 20 cm row spacing in compacted or puddled field by drilling or broadcasting of pre-sprouted seeds in loamy sand soils under irrigated condition. Further, a seeding density of 75 kg ha⁻¹ was found optimum for direct seeded fine and coarse rice cultivars in terms of better growth and higher yield, however, kernel quality was found to

be lowered due to increasing the seeding density (Gill *et al.*, 2006). Similarly, Zhao *et al.* (2007) reported that raising seeding rate from 100 to 300 viable seeds m⁻² resulted in a significant increase in yield and a decrease in weed biomass, whereas a further increase from 300 to 500 viable seeds m⁻² did not result in further improvement in yield and weed suppression.

A very few on-station studies have been conducted evaluating the effects of seed rate to assess the performance of Dry-DSR. Sudhir-Yadav *et al.* (2007) evaluated seed rates of 30, 40 and 50 kg ha⁻¹ for cv. Basmati rice in Punjab, India, and found that a seed rate of 30 kg ha⁻¹ yielded the highest. Besides, Islam *et al.* (2008) cautioned against dense plant populations as high seed rates can make plants more prone to lodging.

In China, Wu *et al.* (2008) found a seed rate of 20–25 kg ha⁻¹ as optimum for DSR, including under zero-till conditions (ZT-dry-DSR). However, others found no difference in yield with a range of seed rates. Similarly, Gopal *et al.* (2010) revealed that using a drill for seeding, the seed rate can be decreased drastically without causing any adverse effect on yield if weeds are controlled effectively. Based on recent experience with on-farm farmer participatory trials in the IGP, a seed rate of 20–25 kg ha⁻¹ has been found optimum for medium-fine-grain rice cultivars with a spacing of 20 cm between rows and 5 cm within rows. Further, it is suggested that for cultivars with medium fine grain, seed rates of 15–20 kg ha⁻¹ are optimum using planters that have precise seed metering systems (Ravi Gopal *et al.*, 2010).

Mahajan *et al.* (2010) reported that use of 15 kg seed rate under weed-free conditions was the only option to achieve higher productivity under direct seeded rice. Optimum seed rate enables better space for leaf growth for better light interception and higher dry matter accumulation which might result in higher grain yield. This was also supported by (Ling *et al.* 2011).

In *boro* rice also a low seed rate of 15 kg ha⁻¹ with 140 kg N ha⁻¹ was found adequate to produce the maximum yield of direct seeded hybrid rice (Anisuzzaman *et al.*, 2010). However, In Bangladesh, Chauhan *et al.* (2011) suggested seeding rates of 48–80 kg ha⁻¹ for the inbred varieties and 47–67 kg ha⁻¹ for the hybrid varieties to achieve maximum grain yield when grown in the absence of weeds, while rates of 95–125 kg ha⁻¹ seed for the inbred varieties and 83–92 kg ha⁻¹ seed for the hybrid varieties were needed to achieve maximum yields in competition with weeds. Asif

Ameen *et al.* (2014) concluded that using higher seeding density (75 kg ha^{-1}) for direct seeded fine and coarse rice cultivars is beneficial in terms of better growth and higher yield but kernel quality is reduced by increasing the seeding density.

At Bangladesh, Sharif Ahmed *et al.* (2016) reported that under weed-free conditions, higher crop yields (5.1 and 5.2 t ha^{-1} in the 2012 and 2013 seasons, respectively) were obtained at the seeding rate of 40 kg ha^{-1} and thereafter, yield decreased slightly beyond 40 kg ha^{-1} seed.

Harris and Vijayaragavan (2015) revealed that seed rate of 143.5 kg ha^{-1} significantly increased the LAI, the number of panicles and spikelets m^{-2} , 1000-grain weight and yield. The lowest and the highest yields were obtained at the seed rate of 61.5 and 143.5 kg ha^{-1} respectively. Therefore, yield could be improved by 57% by increasing seed rate from 61.5 to 143.5 kg ha^{-1} . A further increase of seed rate from 143.5 to 205 kg ha^{-1} reduced the yield by 35%.

Yadav *et al.* (2017) tested different seed rates. Numbers of shoots m^{-2} were increased with increasing the seed rates up to 35 kg ha^{-1} . Varieties with seed rate 35 kg ha^{-1} recorded maximum numbers of shoot m^{-2} at maturity (321). Increase in number of tillers from 15 kg to 35 kg seed rate might be attributed to achievement of optimum plant population under higher seed rates. Significantly higher plant dry matter was produced with seed rate of 35 kg ha^{-1} (956 g m^{-1}) which was at par with seed rate of 45 kg ha^{-1} (933 g m^{-2}), however, lowest dry matter accumulation was recorded with seed rate 15 kg ha^{-1} (860 g m^{-2}). The dry matter accumulation increased with increasing seed rate up to 35 kg ha^{-1} and thereafter declined at 45 kg ha^{-1} . Seed rate of 35 kg ha^{-1} also yielded more (4829 kg ha^{-1}) compared to other seed rates. Therefore, they concluded that higher yield and profit from direct seeded aerobic rice could be obtained from hybrid rice cultivars with seed rate of 35 kg ha^{-1} under *tarai* condition of Uttarakhand.

2.4 Nitrogen Nutrition

Nitrogen is the most critical input in paddy production as positive responses to N application have been reported. As N is important in development and growth of plant it is also expected to increase the demand for other essential soil nutrients. However, above the optimum levels of N, application may create imbalanced nutrition of crop resulting in poor yields, besides there could be continuous mining of nutrients from soil. Since N is an important nutrient and is a significant component of soil test crop response studies

and site specific nutrient management approaches (Nutrient seeker) a brief account of N on growth and yield of rice is presented here.

2.4.1 Growth parameters

Kumari *et al.* (2000) conducted a field experiment to study the effect of different levels of nitrogen on growth of rice. They observed taller plants at higher level of nitrogen application *i.e.* 120 kg ha⁻¹. Dry matter production also increased with increased level of nitrogen. Response to N may also vary with cultivars and seasons. For instance, Om *et al.* (2000) conducted an experiment to study the response of two rice hybrids (PHB 71 and PMS 2A/IR 31802) to graded levels of N (0, 50, 100, 150 and 200 kg ha⁻¹). The results revealed that the yield improvement was significant with each additional application of N from 0 to 200 kg ha⁻¹ during 1993. While in 1994, the increasing N doses from 150 to 200 kg ha⁻¹ could not register significant increase. This may be due to increased seedling vigour in the hybrid 'PHB 71' over PMS 2A/ IR 31802. The hybrid 'PHB 71' gave 0.75 and 0.95 t ha⁻¹, respectively higher yield than other hybrid during both the years.

Rammohan *et al.* (2000) studied the influence of different levels of nitrogen on growth and yield of rice in coastal saline soils and reported that increase in nitrogen level increased the growth parameters and yield of rice. In transplanted rice, Chander and Pandey (2001) recorded the maximum dry matter accumulation with nitrogen application, which was significantly higher than under direct seeded rice. Somasundaram *et al.* (2002) reported a significant increase in plant height, number of leaves, leaf area index and dry matter accumulation with every successive increase in N level from 0 to 150 kg ha⁻¹. Addition of N from 100 to 150 kg ha⁻¹ did not significantly improve these parameters. However, maximum values for growth parameters were recorded at 125 kg N ha⁻¹.

Similarly, Prasad *et al.* (2003) observed that the level of N had significant effect on the plant height, number of tiller per m², leaf area index (LAI) and dry matter accumulation in early rice. Crop growth rate was also increased with the increasing levels of N. Increasing levels of N significantly increased the grain and straw yields up to 80 kg N ha⁻¹ compared with lower doses of 40 and 60 kg N ha⁻¹ but it was at par with 100 kg N ha⁻¹. At Faizabad, Uttar Pradesh, Singh and Tripathi (2007) found that increasing levels of N increased plant height, effective tillers m⁻² and grains panicle⁻¹ significantly

up to 120 kg ha⁻¹ N, whereas length of panicle and 1000-grain weight increased only up to 80 kg ha⁻¹ N.

At Tamil Nadu, Sathiya *et al.* (2008) reported that the application of 175 kg N ha⁻¹ resulted in higher growth attributes, yield attributes and grain yield compared to 100 and 125 kg N ha⁻¹. Crop growth rate also increased with the increasing N level. Similarly in China, Huang *et al.* (2008) reported that increase in N level increased plant height, and maximum plant height (104.6 cm) was recorded in plots supplemented with 60 kg N ha⁻¹, which was at par with plant height at 40 kg N ha⁻¹ while, the minimum plant height (94.4 cm) was observed in the unfertilized plots.

Tabar (2012) reported that plant height, number of tillers, stem dry matter and total dry matter at 3 stages viz., tillering, flowering and harvesting stages were increased by increasing the levels of N fertilizer (50, 100 and 150 kg ha⁻¹). That apart, increasing of N levels also increased 1000-grain weight, filled grain and yield significantly.

Singh *et al.* (2015) observed that variable nitrogen doses and scheduling had significant effect on grain yield of rice. Grain yield increased with the increase of nitrogen doses. Highest grain yield of rice (4652 kg ha⁻¹) was obtained with 150 kg N ha⁻¹ which was at par with 120 kg N ha⁻¹ of (4533 kg ha⁻¹). The increase in grain yield with N @ 150 kg ha⁻¹ was 2.63% over 120 kg ha⁻¹ and 7.34% over 90 kg N ha⁻¹ treatments.

2.4.2 Yield parameters

Datta *et al.* (1988) evaluated DSR and TP rice under similar 'N' management practices and found that plant recovery of N was greater for DSR than in TP rice. Without applied N, grain yield of transplanted rice was lower than that of DSR. These results suggest that considerable potential exists to increase N use efficiency and grain yield in DSR by manipulating N fertilizer management practices.

Ehsnullah *et al.* (2001) reported that 125 kg N ha⁻¹ in fine rice produced significantly higher number of grains panicle⁻¹, 1000-grain weight and grain yield than that of 100 kg N ha⁻¹. However, panicles m⁻¹ and straw yield were statistically at par with 125 and 100 kg N ha⁻¹. In a trial to find out response of different rice (*Oryza sativa* L.) hybrids and varieties to graded levels of N (0, 50, 100, 150 kg N ha⁻¹ and 0, 40, 80, 120 kg N ha⁻¹, respectively) during wet and dry seasons at Cuttack, Rao and Moorthy (2002) observed that irrespective of hybrids or varieties, grain yield increased significantly with

N application up to 120 kg ha⁻¹ and there was decline in yield with further higher N level, *i.e.*, 200 kg ha⁻¹. Crop responded better to nitrogen during dry season than during wet season because of higher solar radiation and greater difference in day-light temperature in the former situation. The hybrids and varieties responded significantly up to 100 kg N ha⁻¹ during wet season and 120 kg N ha⁻¹ during dry season.

Umashankar *et al.* (2005) reported that application of enriched FYM + neem cake treated urea + K along with seed soaking of *Penshibao* and *Azospirillum* produced better growth and yield attributes which in turn increased the grain and straw yields of wet seeded direct seeded rice. Ramana *et al.* (2005) reported the N, P and K uptake by rice crop was found to be the highest with cv. Pushkala sown during second fortnight of June and supplied with 90 kg N ha⁻¹, however, responses due to 90 kg N ha⁻¹ were on par with 60 kg N ha⁻¹.

Singh *et al.* (2005) reported that yield and yield attributing characters, *i.e.* grains panicle⁻¹ (84), panicles m⁻² (368), and straw yield (6.9 t ha⁻¹) were higher with treatment 200 N + 100 P₂O₅ + 50 K₂O kg ha⁻¹ in the rice cultivation. Khan *et al.* (2006) reported linear increase in grain yield up to 180 kg N ha⁻¹. N dose of 180 kg ha⁻¹ resulted in significantly higher grain yield of rice compared to lower doses of 60, 120 and 150 kg N ha⁻¹. This was mainly attributed to the higher number of panicles m⁻² and grains panicle⁻¹. They also noticed that higher N dose of 240 kg ha⁻¹ resulted in lodging of crop at maturity which declined the grain yield of rice.

In Kaveri irrigation command of Karnataka, application of 200 kg N ha⁻¹ recorded maximum number of effective tillers hill⁻¹, panicle length (23.67 cm), 1000-grain weight (24.93 g) and number of filled grains panicle⁻¹ (132.73) and it was on par with weed-free check (Thimmegowda, 2006). At Mohanpur, West Bengal, Maiti *et al.* (2006) recorded higher plant height (101.25 cm), dry-matter accumulation (891.3 g m⁻²), leaf-area index (5.13), uptake of nutrients (98.9, 29.4 and 52.9 kg N, P and K ha⁻¹, respectively), number of panicles m⁻² (245.0), number of filled grains panicle⁻¹ (165.4), 1000-grain weight (23.4 g), and grain (5.32 t ha⁻¹) and straw yields (5.33 t ha⁻¹) with 125% RDF along with 5 t FYM ha⁻¹.

Manzoor *et al.* (2006) working with cv. Basmati using graded levels of N observed that plant height, number of tillers hill⁻¹, panicle length, 1000-grain weight and paddy yield increased from 0 to 175 kg N ha⁻¹. The yield parameters including paddy

yield and 1000-grain weight declined at 200 kg N ha⁻¹ level and above. Maximum paddy yield (4.24 t ha⁻¹) was obtained from 175 kg ha⁻¹ N application due to higher number of grains panicle⁻¹ (130.2) alongwith maximum 1000-grain weight (22.92 g). El-Refaei *et al.* (2007) emphasized application of N in splits for higher productivity as it helps in efficient mobilization of reserved and current photosynthates for the purpose of grain filling. They concluded that increasing grain yield and yield attributes by splitting N application could be attributed to reduction in N losses as well as increase of N recovery and N uptake compared to single dose application.

Singh *et al.* (2007) obtained response up to 120 kg N ha⁻¹, where applied N fertilizer increased grain yield of direct seeded rice by 62 per cent compared to control. Beyond 120 kg N ha⁻¹, no further increase in grain yield was observed but its application resulted in more production of rice straw. In Basmati rice, Laroo *et al.* (2007) reported 49.5 and 48.5 per cent increase in grain yield with the application of 100 and 150 kg N ha⁻¹, respectively over control. Similarly, Naw *et al.* (2007) reported the effect of N on the productivity of aromatic rice with the application of 100 and 150 kg N ha⁻¹ (2.0 and 1.95 t ha⁻¹, respectively). They opined that beneficial effect of N application on various yield attributing characters viz. number of panicles hill⁻¹, panicle weight, panicle length, number of filled grains panicle⁻¹ and 1000-grain weight led to increased grain yield with increasing levels of N. Significantly higher yield at the higher level of N obtained owing to the better N uptake which resulted in greater dry matter production.

Jacqueline *et al.* (2008) conducted a field experiment to determine the effect of different levels of N (0, 60, 90 and 120 kg ha⁻¹) on yield and yield components of *japonica* (Hatsuboshi) and *indica* (IR-13) rice varieties. Results revealed an increasing trend in the rice yield, panicle number and tiller number with increasing amount of applied N fertilizer.

Ramesh *et al.* (2009) revealed that application of 150 kg N ha⁻¹ registered significantly higher number of tillers, panicles, filled grains panicle⁻¹, 1000-grain weight and grain yield than 100 kg N ha⁻¹. While, Lal *et al.* (2009) studied the effect of graded levels (30, 60 and 90 kg ha⁻¹) of N on yield attributes of rice varieties (viz. IET 17566, Badshahbhog, Kalanamak and Kanakjeer as local check). The results revealed that IET 17566 produced significantly higher grain yield (3.64 t ha⁻¹). In hybrid rice, Yadav *et al.* (2011) observed that application of N at 200 kg ha⁻¹ significantly increased all the

growth characters viz., dry matter accumulation, number of panicle m^{-2} , panicle weight and 1000-grain weight and also recorded significantly higher grain yield (7.72 t ha^{-1}) over 0, 50, 100 and 150 kg N ha^{-1} but it was at par with 150 kg N ha^{-1} in case of straw yield. They attributed increased grain yield due to N fertilization directly to significant improvement in the yield attributes.

At Ludhiana, Punjab, the mean N fertilizer response was the highest at 40 kg N ha^{-1} compared to other N levels (0, 20, and 60 kg N ha^{-1}), indicating that further increase in N level had no effect on crop response to fertilizer (Mahajan *et al.*, 2011). The grain yield was increased by 64.2 per cent when plots were supplemented with 40 kg N ha^{-1} compared with control. However, Mannan *et al.* (2010) reported that N level of 75 kg ha^{-1} was found superior as regards to grain and straw yields, grains panicle $^{-1}$ and panicles m^{-2} than in other treatments. While, Ethan *et al.* (2011) revealed that yields generally increased with increasing levels of N and declined from 80 kg ha^{-1} onwards.

Awan *et al.* (2011) while working with newly evolved medium grain rice variety at Kala Shah Kaku (Pakistan) using different N levels (110 , 133 and 156 kg ha^{-1}) found that 156 kg N ha^{-1} resulted in maximum values of plant height (79.07 cm), tiller m^{-2} (594), panicle length (25.4 cm), grain (5461 kg ha^{-1}) and straw (9662 kg ha^{-1}) yields. They attributed increase in plant height with increased N application to enhanced vegetative growth with more N supply to plant. Increase in grain weight was due to increase in chlorophyll content of leaves which led to higher photosynthetic rate, and ultimately plenty of photosynthates were available during grain development. They attributed enhanced tillering to improved/more nitrogen supply to plant at active tillering stage.

Hirzel *et al.* (2011) revealed that the N rates significantly increased the grain yield up to 140 kg N ha^{-1} compared with lower doses of N of 80 and 100 kg ha^{-1} but yields were at par with 160 kg N ha^{-1} . At Coimbatore, Tamil Nadu, Alagesan and Babu (2011) revealed that the application of graded levels of nitrogen significantly increased the grain yield and yield attributing characters viz., number of filled grains panicle $^{-1}$, total number of tillers m^{-2} and productive tillers m^{-2} . Application of N in four equal splits at seedling, active tillering (AT), panicle initiation (PI) and flowering enhanced the growth and yield attributes compared to the recommended practice of three equal splits of $1/3^{\text{rd}}$ each at seedling, AT and PI in dry as well as SWM seasons.

Vipin Kumar *et al.* (2011) while working on integrated nutrient management reported higher grain yield (4.37 t ha^{-1}) with 150% RDF with $10 \text{ kg Zn} + 10 \text{ t FYM ha}^{-1}$ compared to control ($192.7, 229.5$ and $249.5 \text{ kg N, P}_2\text{O}_5$ and $\text{K}_2\text{O ha}^{-1}$, respectively). The available nutrients viz., organic carbon, N, P_2O_5 and K_2O in soil increased with increasing fertility levels. Similarly, Yoseftabar (2012) revealed that number of effective tillers, total grain, 1000-grain weight and yield increased significantly with increase in application of nitrogen and P fertilizer. Interestingly, in comparison to 50 and 100 kg ha^{-1} level, application of higher N-fertilizer 150 kg ha^{-1} resulted in a positive response to application of high N for Taroom Hashemi cultivar. Effect of different levels of P-fertilizer also had significant influence on these parameters; increased application of P improved these parameters.

Song *et al.* (2012) opined that low panicle N might benefit dry-matter accumulation but lead to yield decline. Grains m^{-2} was quadratically correlated with stem dry matter at the heading stage, which suggests that over-accumulated dry matter in the stem before grain filling plays a negative role in grain yield. Grain filling percentage and grain m^{-2} were found to be linearly correlated with leaf dry matter at the heading stage, which suggests that leaf growth at panicle initiation and heading stages had critical influence on yield performance.

Uddin *et al.* (2013) studied the effect of nitrogen and potassium on yield of dry direct seeded rice cv. NERICA 1 and revealed that interaction of nitrogen and potassium have significant effect on all the parameters except 1000-grain weight. Simultaneous application of 80 kg N ha^{-1} and $40 \text{ kg K}_2\text{O ha}^{-1}$ produced the highest grain yield in NERICA 1 rice. A functional positive relationship was observed between effective tillers and grains panicle $^{-1}$ with grain yield of NERICA 1 rice and it was linear.

Graded levels of nitrogen had marked effect on grain and straw yields (Meena *et al.*, 2014). Grain and straw yields increased with increase in N levels, however the differences in grain yield between 160 kg N ha^{-1} (4468 kg ha^{-1}) and 120 kg N ha^{-1} (4353 kg ha^{-1}) were statistically at par. Straw yield increased significantly with an increase of nitrogen level up to 160 kg N ha^{-1} . Highest yield with higher nitrogen level might be due to better N uptake leading to greater dry matter accumulation and its translocation to their sink.

Dakshina Murthy *et al.* (2015) observed that grain yield was increased by 11.5% and 6.3% due to increase in recommended dose of N from 100% (120 kg ha^{-1}) to 125%

and 150%. Increase in P and K doses from 100 to 125% (P from 60 to 75 and K from 40 to 50 kg ha⁻¹) also improved grain yield significantly. In TBP, Kiran *et al* (2015) reported that variety JKPH 3333 recorded highest grain yield under direct seeded field (5221 kg ha⁻¹) with the least yield reduction (16.79%) compared to transplanted method, followed by cvs. Gangavathi Sona and BPT 5204.

Application of N dose in two –three split doses, followed by corrective N dose guided by Green seeker at panicle initiation stage resulted higher rice yield than general recommendations and with lower nitrogen application (Ali *et al.*, 2015).

2.4.3 Availability and uptake of nutrients

Uptake of nutrients is one important aspect of expression of plant potential and it depends on the availability of nutrients in the rhizosphere, the optimum soil air and water continuum, the health and ability of roots besides crop husbandry practices. The air and water situation differs among different rice cultures and hence the nutrient uptake and plant expression in these situation. For instance, Pal *et al.* (2000) reported significant differences in K uptake by rice grain due to splitting of K levels over basal and these followed the same trend in the case of rice yield.

Thai and Rerkasem (2003) conducted experiment to study the effect of N (0, 60 and 120 kg ha⁻¹) on Fe concentration in rice grain in five genotypes (KDML 105, IR 68144, Ubon 2, Basmathi 370 and RD 6) and found that N fertilizer generally increased N content of rice. The Fe concentration in unhusked KDML 105, IR 68144, Ubon 2, Basmathi 370 and RD 6 also increased with the application of 120 kg N ha⁻¹. Kumar *et al.* (2007) while studying the effect of levels of N (0, 50, 100 and 150 kg ha⁻¹) on NPK concentration and uptake by high yielding variety and a hybrid of rice revealed that though the N, P and K concentration increased non-significantly, while their uptake increased significantly with increase in N levels which was attributed to maintenance of relatively large amounts of N in the ammonium form for longer period and the increased yield of dry matter at higher levels of N.

Hao *et al.* (2007) revealed that the concentrations of Fe, Mn, Cu and Zn in most parts of rice shoot increased with increasing level of N fertilizer compared with control (no N fertilizer application). This indicated that the transportation ability of microelements from root to shoot in rice was improved with N fertilizer application.

Further, Hao *et al.* (2007) reported that the concentrations of microelements (Fe, Mn, Cu and Zn) in brown rice increased at first and then decreased with increasing N fertilizer application, reaching the highest at 160 kg ha⁻¹, at which the Fe, Mn, Cu and Zn concentrations in brown rice increased by 28.96, 41.34, 58.31 and 16.0 per cent for cv. IR-64, and by 22.16, 13.75, 8.75 and 20.21 per cent for cv. IR-68144 compared with control, respectively. These results indicated that appropriate N fertilizer management could increase micronutrient contents in grain and improve nutritional quality of rice.

Marlar *et al.* (2007) observed that increasing levels of N increased the N uptake significantly. This was also true for grain, straw and total N uptake. With each successive increase in the level of N, P uptake increased significantly up to 100 kg ha⁻¹. Application of 50 kg N ha⁻¹ significantly increased the K uptake by grain over control. However, it remained statistically on par with 100 and 150 kg N ha⁻¹. Similarly, Wijebandara (2007) observed significantly higher concentration and uptake of plant N, P, K and Zn and residual available N, P and Zn in soil in treatment receiving 75 % RDF + biofertilizer with 25 kg ZnSO₄ ha⁻¹ particularly with SRI method of cultivation. Increased Zn uptake and concentration were observed with 400 mg N kg⁻¹ compared to 50 and 100 mg N kg⁻¹ and control treatments regardless of N sources (Hosseiny and Maftoun, 2008). They attributed this improvement to increased root growth and absorption capacity when 400 mg N kg⁻¹ was applied.

In aromatic rice, Sikdar *et al.* (2008) revealed that N content increased with increasing level of N from 40 kg ha⁻¹ to 80 kg ha⁻¹. Further, soil pH, organic matter, available P and exchangeable K in post harvest soils also increased with increasing level of N from 40 to 80 kg ha⁻¹. Chandel *et al.* (2010) also studied response of 32 genotypes at three different locations each under 80 and 120 kg hm⁻² N fertilizer applications. The results revealed that the brown rice grain protein content (GPC) increased significantly (1.1% to 7.0%) under higher N fertilizer application (120 kg hm⁻²). Faraji *et al.* (2013) reported that among three lower N fertilizer levels (10, 20 and 30 kg ha⁻¹) maximum grain protein content (9.46%) was observed at 30 kg ha⁻¹.

In a study on integrated nutrient management, Satisha *et al.* (2011) observed significantly higher growth and yield attributes with 150% N + compost + ZnSO₄ 20 kg ha⁻¹ followed by 150% N + Zn-enriched compost @ 15 kg ha⁻¹. Grain and straw yields were also higher in these treatments. The same trend was noticed for uptake of nitrogen,

phosphorus, potassium, sulphur and zinc. In Karnataka, Siddram *et al.* (2011) while working on organic sources in irrigated aerobic rice recorded significantly higher dry matter production and nutrient uptake with recommended dose of fertilizer (100:50:50 kg NPK ha⁻¹) + 10 tones FYM ha⁻¹. However, it was on par with 200 per cent recommended dose of nitrogen (RDN) equivalent through FYM ha⁻¹, 100 per cent RDN equivalent through vermicompost ha⁻¹ and 100 per cent RDN equivalent through manure ha⁻¹.

Devi *et al.* (2012) again while working with aerobic rice revealed that uptake of P, K and post harvest soil available N of rice were significantly higher with the application of 150 kg N ha⁻¹, whereas highest N uptake by rice was recorded in 175 kg N ha⁻¹. At Agriculture College farm, Naira (Telangana) in semi-dry rice, Jansi *et al.* (2013) found that application of 120 kg N ha⁻¹ resulted in highest grain yield and nutrient uptake. The highest nutrient uptake, yield and returns were recorded at harvesting stage with the application of nitrogen in four splits $\frac{1}{4}$ each at basal, conversion to wet panicle initiation and flowering leading to higher productivity. At Agricultural Research Station, Gangavati, TBP, Karnataka, grain yield increased with increasing levels of N (RDF + 40% additional N) and the increase in grain yield (53.46 q ha⁻¹) was 5.7% higher over control (RDF) (50.56 q ha⁻¹) (Sankalpa, 2013). The straw yield increased significantly with RDF + 80% additional N. The macro and micro nutrient contents and uptake values increased with increasing levels of N while at harvest of the crop, except N and Zn, residual macro and micro nutrient contents in soil decreased with increasing levels of N.

Faraji *et al.* (2013) observed that nitrogen fertilizer levels had significant effect on grain Fe content and they observed maximum Fe content (12.43 mg kg⁻¹) with 30 kg N ha⁻¹. Yu *et al.* (2013) while working with rice cultivar Zheyong 12 revealed that uptake of N, P and K in rice plants indicated increasing trend with increasing N application levels from 0 to 270 kg hm⁻², but decreased at N application levels exceeding 270 kg hm⁻².

Dakshina Murthy *et al.* (2015) reported that incremental doses of N, P and K over the recommended dose recorded significant improvement in uptake of respective nutrients. Application of NPK of 180-90-60 kg ha⁻¹ appears to be the most optimum dose for *rabi* rice in deltaic alluvial soils of Andhra Pradesh. While in Karnataka, Kiran *et al.* (2015) reported that variety JKPH 3333 recorded maximum leaf nitrogen content

(1.16%) followed by Gangavathi Sona (1.1%) whereas lower leaf nitrogen was noticed in BPT-5204 (0.77%).

Thus, being cereal rice responds positively to nitrogen irrespective of method of establishment or culture of production. However, the maximum optima for achieving yield potential or pre set yield target varies for cultivars and rice cultures and method of real time N management and hence location specific studies are needed.

2.5 Response to Micronutrients

Much work on fertilizer management in rice has been carried out for CT-TPR but very limited work has been conducted in Dry-DSR, including Zero Tillage-dry-DSR. In Dry-drill-DSR, because of more aerobic conditions and alternate wetting/drying cycles, the availability of several nutrients including N and micronutrients such as Zn and Fe, is likely to be a constraint (Ponnamperuma, 1972).

Basal application of zinc to the soil is found to be the best and to avoid its deficiency, application of 25–50 kg ha⁻¹ zinc sulphate heptahydrate is recommended. However, if a basal application is missed, the deficiency can be corrected by topdressing up to 45 days. For foliar application, spray of 0.5% zinc sulphate two to three times at intervals of 7-15 days just after the appearance of deficiency symptoms is recommended. A pH below neutral in the rhizosphere increases solubility of P and Zn and hence their availability (Kim and Bajita, 1995). The timing and source of Zn application may influence Zn uptake in DSR (Giordano and Mortvedt, 1972). Some experiments revealed that both soil and foliar spray of Fe conjointly results in better yield compared to their sole application. Application of 50 kg ha⁻¹ + 2 foliar spray of 2% FeSO₄·7H₂O results in higher grain yield, returns and benefit cost ratio and was comparable to sole soil application of 100 kg FeSO₄·7H₂O ha⁻¹ and 3 foliar spray of 2% FeSO₄·7H₂O.

Lakshmanan *et al.*, (2005) observed that medium duration rice varieties produce more grain and straw yields and result in higher uptake of micronutrients Zn, Fe, Mn and Cu than short duration rice varieties. Nitrogen fertilization increases grain and straw yield and uptake of micronutrients Zn, Fe, Mn and Cu in rice

Zinc can be supplied by foliar application of 0.5% zinc sulfate two to three times at intervals of 7–15 days just after the appearance of deficiency symptoms. For iron, it has been observed that foliar application is superior to soil application (Datta *et al.*,

2003). Foliar-applied Fe is easily translocated acropetally and even retranslocated basipetally. A total of 9 kg Fe ha⁻¹ in three splits (40, 60, and 75 DAS) as foliar application (3% of FeSO₄ 7H₂O solution) was found to be effective (Pal *et al.*, 2008)

Deficiencies of Zn and Fe are more common in aerobic/non-flooded rice systems than in flooded rice systems (Hongbin *et al.*, 2006; Choudhury *et al.*, 2007; Pal *et al.*, 2008 and Yadvinder-Singh *et al.*, 2008). Therefore, micronutrient management is critical in Dry-DSR. Cheema *et al.* (2006) revealed that application of 10 kg ZnSO₄ ha⁻¹ produced more paddy grain due more number of spikelet and lesser spikelet sterility. Nevertheless, to avoid zinc deficiency, 25–50 kg ha⁻¹ zinc sulfate is recommended (Anon., 2008, 2010). Basal application of zinc to the soil is found to be the best. However, if a basal application is missed, the deficiency can be corrected by topdressing up to 45 days (Anon., 2010).

In general, foliar applications of nutrients (major) result in maximum number of panicles m⁻², grains panicle⁻¹, 1000- grain weight and biological yield. Shaygany *et al.* (2010) concluded that five foliar applications of balanced amounts of fertilizers at the seedling stage (two sprays), tillering (single spray) and at panicle initiation and panicle differentiation (two sprays) helped in enhancing yield and yield components of rice.

The crop quickly oxidizes iron sulphate applied under aerobic condition into ferric forms (Fe³⁺) that is not taken up (Yadav *et al.*, 2011). After 30-35 days of sowing, libmix @ 2 g per litre of water is sprayed to overcome the deficiencies of zinc and iron. Zinc content in whole grains increased significantly in all the cultivars with Zn-application and the magnitude of increase was higher when Zn was applied as soil + foliar application (118%) than soil application only (30%).

Yadav *et al.* (2013) reported that grain yield of rice increased by 23.1% and 19.8% due to application of 5 kg Zn ha⁻¹ and 5 t poultry manure ha⁻¹, respectively whereas maximum response of 31.2% was obtained with the combined application of 5 kg Zn + 5 t poultry manure ha⁻¹. Increasing levels of Zn contributed to the Zn content in various fractions in soil. Basal application of zinc and iron or foliar application of 0.5% zinc sulphate and iron sulphate two to three times intervals of 7-15 days just after the appearance of symptoms were corrected the zinc deficiency. Similar evidence was provided by Joshi *et al.* (2013).

Jadhav *et al.* (2014) revealed that significantly higher rice seed yield was obtained when recommended dose of N-P-K (80 - 50 - 50 kg ha⁻¹) and farm yard manure @ 5 t ha⁻¹ with soil application of both the micronutrients *i.e.* FeSO₄ and ZnSO₄ @ 10 kg ha⁻¹ was followed, however, it was at par with recommended dose of fertilizer and farm yard manure with two foliar applications of both the micronutrients on rice under aerobic condition.

Gill and Walia (2015) also indicated that plant growth and yield attributes were significantly higher with foliar sprays of micronutrients. With the application of MnSO₄ 0.5% and FeSO₄ 1.0% at 70, 60 and 50 DAS significantly increased grain (~28 and 21%) and straw yields (~ 26 and 20%) compared to control.

2.6 Nutrient management for Pre-set Yield Targets

Plant nutrient management, among various production practices, plays a pivotal role in enhancing productivity and quality of farm produce. Nitrogen being a dominant nutrient particularly in cereals, the main staple for majority, occupies central role in crop nutrition to enhance productivity, but when used in excess N pollutes precious ground as well as surface water. Various state of the art techniques in nitrogen nutrient recommendation aim to reduce fertilizer dose or tailor the supply of nutrient for the target yield besides enhancing use efficiency of applied fertilizers to address cost effectiveness and environmental concerns. Decision support tools, therefore, focus on real time plant nutrient supply as per crop needs.

2.6.1 Site specific nutrient management

Site specific nutrient management (SSNM) is a widely used term in all parts of the world, generally with reference to addressing nutrient deficiencies which exist within fields, and making adjustments in nutrient application to match these location or soil differences. The novel approach of SSNM involves science-based principles for guiding the judicious and efficient application of fertilizers as and when needed by crops. It recognizes the inherent spatial variability associated with fields during crop production and provides guidelines for optimal use of indigenous nutrients originating from soil, plant residues, manures and irrigation water. Thus, SSNM considers indigenous nutrient supply of the soil and productivity targets capable of sustaining higher yields on one hand, and assured restoration of soil fertility on the other.

Singh and Singh (2000) compared SSNM in rice and wheat with farmer's fertilizer management practice and found average increases of 0.56 t ha⁻¹ in rice and 0.58 t ha⁻¹ in wheat yields. Similarly, Wang guaunhuo *et al.* (2007) also reported that SSNM practice consistently improved grain yield by 10-15 per cent compared to the farmer's fertilizer practice. Yield levels of 7.5 t ha⁻¹ or more seem achievable and sustainable through introduction of SSNM.

Abdulrahman *et al.* (2002) reported an increased fertilizer efficiency of N (12 to 36%), P (8 to 13%), K (>100%) and higher rice yield with the SSNM (5.6 to 6.4 t ha⁻¹) over farmers' practice. The yield goal achieved with SSNM approach was 78 to 83 per cent of the set target. The fertilizer dose based on soil test values for attaining a yield target of 60 q ha⁻¹ were found to be ranging from 120 to 214, 27 to 126 and 20 to 35 kg⁻¹ N, P₂O₅ and K₂O, respectively (Srinivas *et al.*, 2003). Gill *et al* (2008) opined that with the implementation of SSNM, the present food grain production could be achieved from half of the current irrigated area and rest could be better utilized in crop diversification efforts.

Results from on-farm experiments comparing soil test-based SSNM with other fertilizer practices in pearl millet-wheat and pearl millet-mustard cropping systems also revealed large yield and economic advantages with the adoption of SSNM (Dwivedi *et al.*, 2009). Working with fruit crop sweet orange at Nagpur, Maharashtra, Srivastava *et al* (2009) reported that SSNM increased the yield and improved the fruit quality compared to state nutrient recommendations and farmer fertilizer practice. Thus, high net economic returns realized with implementation of SSNM calls for large scale adoption of this technology to help reduce the gap between actual and potential yields.

In the soil test based SSNM approach, both the macro and secondary nutrients need to be applied at rates that are required to meet the crop yield removal and for micronutrients blanket recommendations could be followed when the soil testing shows to be marginal or deficient. This allows complete yield expression of crop in the absence of any nutrient deficiency, and once the yield potential of a site was determined, the next step is to refine nutrient application rates with further field trials.

Satyanarayana *et al.* (2011) reported that SSNM is not only a potential to increase profits but also revealed increasing evidence of environmental friendliness owing to its balanced and crop need based nutrient application. Mahajan and Timsina (2011) at

Ludhiana observed that DSR required more N than TPR. Besides, it is observed that the rate and timing of N application is an equally important crop management practice for improving N use efficiency and crop yields.

The reviews indicated that fertilizer application based on SSNM for a target yield enhances growth, yield and quality of crops. In addition it also enhances nutrient status in the soil for succeeding crop.

2.6.2 Soil test based crop response approach

Bera *et al.* (2006) reported that application of fertilizers based on soil test based crop response (STCR) approach for a target yield of 8 t ha⁻¹ recorded higher grain yield of rice compared to farmer's practice and general recommended dose. It was also economically viable within the agro-ecological zone with relatively uniform cropping practices and socio-economic conditions. Srinivasan and Angayarkanni (2008) also opined that STCR recommendation plays a vital role in ensuring balanced nutrition to crops. Further, Srinivasan and Angayarkanni (2010) revealed that when the initial soil available NPK status were 200, 10 and 250 kg ha⁻¹, the FN, FP₂O₅, FK₂O recommendations to get 6.0 t ha⁻¹ were 233:100:107 kg ha⁻¹ for fertilizers alone application. The fertilizer recommendations for the application of fertilizers + FYM + Azospirillum, for the same yield target were 185:86:82 kg ha⁻¹ due to balanced fertilization.

Similarly, Keram *et al.* (2012) revealed that inorganic fertilizer application based on targeted yield alongwith organic manure (FYM) *i.e.*, integrated plant nutrient system (IPNS) approach, that consisted of application of 98 N: 103 P₂O₅: 27 K₂O kg ha⁻¹ through chemical fertilizers + 46 N: 36 P₂O₅: 45 K₂O kg ha⁻¹ through 5 t FYM ha⁻¹ as organic manure, resulted in higher grain yield (4.04 t ha⁻¹) of rice. Besides, they opined that the practice of fertilizing a crop on the basis of yield target is precise, meaningful and ecofriendly which needs to be adopted by farmers to increase the yields sustainably while maintaining soil productivity.

Deshmukh *et al.* (2012) revealed that targeted yields of paddy (40 q ha⁻¹) could be achieved by using the plant nutrients on the basis of targeted yield concept. The per cent increase in yield was 38.24% over local check which was 30.02 q ha⁻¹. Similarly, Singh *et al.* (2014) revealed that targeted yield 45 and 50 q ha⁻¹ were achieved by using the

plant nutrients on the basis of targeted yield concept. The per cent increase in yield was 46.2% in first location, 46.5% in second location, 45.9% third location and 46.6% in fourth location over farmers' practice.

Kanhaiya and Singh (2014) reported that the nutrient requirements of N, P₂O₅ and K₂O for producing one quintal of rice yield in *Inceptisol* were 2.56, 0.56 and 2.21 kg ha⁻¹ respectively. The per cent contributions of nutrient from soil, fertilizers and FYM were 26.35, 51.17 and 26.14; 54.03, 36.35 and 75.68; and 18.59, 3.10 and 8.56 of N, P and K nutrients, respectively. Based on these they developed the fertilizer adjustment equations and a ready reckoner of optimum fertilizer doses at varying soil test values for attaining yield target of 40 and 50 q ha⁻¹ of rice yield.

2.6.3 Nutrient Expert

Web based ready reckoners are nutrient management decision support systems developed to provide a fertilizer management strategy to attain the yield goal. Nutrient Expert (NE) is one such decision tool for nutrient management in hybrid maize, rice and wheat (Satyanarayana *et al.*, 2011, 2013). This helps farmers increase their crop yield and profit by suggesting a meaningful yield goal for specific site. The guidelines provided by this software are in line with the scientific principles of site specific nutrient management (SSNM). It provides field-specific nutrient recommendation to individual farmer for improved yields and farm profits (Kumar *et al.*, 2012). Walker *et al.* (2009) documented adoption of farm and regional level economic impact of a decision aid. As agriculture in developing countries expands with increasing food prices and other demands such as bioenergy production, farmers will need better decision tools such as the NuMaSS (Nutrient management decision support system) to manage crop production on problem soils and marginal sites. Similarly, Patil (2009) also established variable-rate N application utilizing site specific management zones based upon a variable yield goal.

Although various on-the-go soil sensors are under development, but only electrical and electromagnetic sensors have been widely used in precision agriculture and the Sim Corn software was developed in Thailand used on- hand held computer and desktop for extension officers and interested people for fertilizer recommendation of each soil series. Further, Setiyono *et al.* (2011) found Hybrid-Maize model to be robust in estimating maize yield potential across a wide range of environments. Attainable yields at the validation sites were site specific and influenced by climate, agronomic management, and water supply.

Limin *et al.* (2013) indicated that principles of nutrient recommendations were formed and incorporated as part of the Nutrient Expert for wheat decision support system. Field validation based on yield response and agronomic efficiency revealed an increasing trend in both grain yield and gross profit, besides improvement in agronomic efficiency, recovery efficiency and partial factor productivity of nitrogen in most of the study sites. It was concluded that Nutrient Expert for wheat could be used as an alternative method of soil testing when making fertilizer recommendation.

Satyanarayana *et al.* (2011, 2013) opined that Nutrient Expert based field-specific fertilizer recommendations offered solutions to the farmers of southern India for better nutrient use in maize. Results from validation trials, comparing NE-based recommendations with farmer's practice (FP) and the state recommendation (SR) in 82 farmer fields of southern India, demonstrated the utility of the decision support system tool in improving the yield and profitability of maize farmers in the region. They also revealed that NE-based fertilizer recommendations generated on the principles of SSNM performed better than FP and SR for maize. Besides providing location-specific nutrient recommendations rapidly, the tool has options to tailor recommendations based on resource availability to the farmers.

Sapkota *et al.* (2014) reported that wheat production with NE-based recommendation supplemented with Green Seeker guided nutrient management under no tillage system can be carbon neutral. Thus, the combination of tillage and nutrient management strategy could be recommended for wheat production in northwest Indo-Gangetic plain to increase yield, efficiency and profitability as well as to reduce agriculture's contribution to climate change.

Xinpeng Xu *et al.* (2014) opined that fertilizer recommendation based on Nutrient expert method could maintain grain yield and profitability and improve nutrient use efficiency through 4R nutrient stewardship and it is proved to be a promising approach for fertilizer recommendation when soil testing is not timely or not available.

The research work carried out by using Nutrient Expert as a tool for fertilizer recommendation in prime cereals including rice revealed improved growth, yield and quality of grain. It also reduces quantity of fertilizers without compromising yield potential, and hence it definitely has a role in DSR in the irrigation commands where excess fertilization is a rule rather than an exception.

2.6.4 A Comparison of decision support systems

Agronomic efficiency of nitrogen was high due to higher grain yield with lesser N application in the SPAD-N and LCC-N plots with a saving of 10-20 kg ha⁻¹ of fertilizer N (Kenchiah *et al.* 2000). Besides, agronomic efficiency of applied N (AEN), partial factor productivity of applied N (PFPN) was also higher in SPAD based N management (Balasubramanian *et al.*, 2000). In HYV's and hybrids also SPAD based N application resulted in significantly higher agronomic efficiency of rice (Mahendra *et al.*, 2001).

Maiti *et al.* (2004) reported that the SPAD- and LCC-based N application showed higher NUE over fixed-scheduling N treatment in rice. The results further revealed that SPAD value of 37 and LCC value of 5 proved to be superior treatments over SPAD (35) and LCC (4) for application of N in rice in *Inceptisols*.

Biradar *et al.* (2005) observed that the values of agronomic efficiency of applied N (AEN) were higher at lower LCC threshold values. Alam *et al.* (2005) reported a further increase in NUE in rice in Bangladesh when the critical value for LCC was reduced from 4 to 3.5. For wheat, LCC threshold value 4 gave higher grain yield, N uptake and N use efficiency than with 120 N kg ha⁻¹ applied in 3 splits (Shukla *et al.*, 2006).

In Tamil Nadu, application of recommended dose of nitrogen at 20 kg N ha⁻¹ at LCC-3 value at bi-weekly observations after 21 days after rice emergence was found to be a better method of nitrogen management in rainfed rice (Jayanthi *et al.*, 2007). Srinivasan and Angayarkanni (2008) reported that integrated application of chemical fertilizers, FYM and Azospirillum increased the yield and N, P and K uptake of rice in STCR experiment

Mahajan *et al.* (2010) reported that the SPAD value at higher seed rates of 60, 120, and 240 kg ha⁻¹ was significantly lower than that for seed rates of 15 and 30 kg ha⁻¹ at flowering stage, which confirmed earlier perception that higher seed rate caused dilution and resulted in lower yield because the crop always suffered from hidden hunger of N due to more intra-specific competition offered by the crop at higher seed rate (60, 120, and 240 kg ha⁻¹) resulting in less supply of nutrients. NDVI values when recorded at panicle initiation stage explained to a large extent the variability in rice at maturity (Ali *et al.*, 2015)

Ali *et al.* (2012) obtained increased grain yield with LCC-based N management with the lower N fertilizer input. On the other hand, Kumar *et al.* (2012) revealed that application of Nutrient Expert (NE)-recommended N rates in three equal splits performed better than applying 80 per cent of the recommended N rate as a basal application. Further, it was also revealed that Nutrient expert (NE) based fertilizer recommendations reduced N, P₂O₅ and K₂O use by 32, 50 and 66 kg ha⁻¹ indicating 17, 56, and 58 %, respectively reductions in fertilizer use over farmers' practice (Jat *et al.*, 2013).

Satyanarayana *et al.* (2013) observed seasonal variations in nutrient requirement and recommended slightly higher N, P₂O₅ and K₂O rates during *rabi* in comparison to the *kharif* season. This is due to the fact that nutrient rates generated through NE are based on the estimated yield response to NPK application and NE estimated relatively high yield responses in *rabi* season over the *kharif* season. Sharma and Singhal (2014) reported that STCR based fertilizer recommendations were found more economically viable within the agro- ecological zone and achieved more than 95% of targeted yield of rice, wheat and mustard.

Vikram *et al* (2015) found that application of fertilizer based on SSNM target 10 t ha⁻¹ recorded higher grain yield (9532 kg ha⁻¹), stover yield (11497 kg ha⁻¹), grain rows per cob (18.4), grains per row (41.8), cob weight per plant (216.7 g) and grain yield per plant (136.5 g) in maize. Total dry matter production (349.20 g plant⁻¹), leaf area per plant (2774 cm² plant⁻¹), leaf area index (2.31) and plant height (204.0 cm) were also higher with SSNM based nutrition for a target 10 t ha⁻¹. Nutrient Expert target (NE), LCC, SPAD threshold based fertilizer application also enhanced the yield. In spite of higher fertilizer cost, SSNM and STCR approaches recorded higher net return of ` 86,727 ha<sup>-1</sup> and ` 84,601 ha⁻¹, respectively. However, B: C ratio and returns per rupee invested on fertilizers were higher in NE based target of 10 t ha⁻¹ and LCC threshold 5.

Therefore, it is necessary to optimize the use of these decision support systems for N management in DSR, the emerging rice culture in the irrigation commands.

2.7 Economics of DSR

Irrespective of cultures/production practices including various state-of-the-art gadgets/techniques used, it is the economics or the margin of profit that is more

important and the ecological services/benefits that a practice provides are of secondary importance to the growers. Therefore, the economic aspect rice establishment techniques is briefed hereunder.

Thakur (1993) while comparing DSR and TPR found that cost of cultivation was 8.87 per cent lower in DSR but cost: benefit ratio was 3.96 per cent higher in DSR than in transplanted rice. At DRR, Hyderabad Singh *et al.* (1999) revealed that wet seeding of sprouted seeds in lines recorded maximum grain yield (5.17 t ha^{-1}) and net return ($\text{₹ } 10,095 \text{ ha}^{-1}$) followed by transplanting. Further, they recorded greater economic returns with direct seeding of sprouted seeds in lines in varieties like IET 9994, IET 9978 and Vikas compared to transplanting method.

On red sandy loam soil at TNAU, Paiyur, Budhar and Tamil Selvan (2002) while assessing feasibility of different stand establishment techniques revealed that wet seeding by manual broadcasting (57.22 q ha^{-1}) and wet seeding by drum seeder (56.57 q ha^{-1}) recorded higher yield and it was on par with traditional transplanting method (55.76 q ha^{-1}) while, direct seeded rice registered maximum net income of $\text{₹ } 19,039$ with a benefit: cost ratio of 2.33.

Biradar *et al.* (2005) revealed that the RDN was inadequate in achieving higher yields of irrigated rice in the TBP area whereas, economics indicated a higher benefit-cost ratio for LCC 5 than with RDN. In China, fertilization of maize based on SSNM for targeted yield enhanced the grain yield of maize by 5 to 15 per cent with an average yield increase of 1025 kg ha^{-1} and net income improved by 1 to 23 per cent and the average being US\$ 100 ha^{-1} (Wang *et al.*, 2005). As far SPAD and LCC-based N application in rice is concerned, higher grain yield, N-use efficiency and benefit: cost ratio (1.91) were obtained when N was applied based on SPAD value of 37, with basal N at 20 kg ha^{-1} (Maiti and Das, 2006).

Bera *et al.* (2006) indicated that soil test based fertilizer recommendation approach was economically viable within the agro-ecological zone with relatively uniform cropping practices and socio-economic conditions. However, in *Typic haplustalf* soils of Punjab, Milpchand *et al.* (2006) working on targeted yield approach, obtained higher value of additional yield, B: C ratio with 1.8 t ha^{-1} target compared to soil test based fertilizer recommendation and farmers' practice under mustard and rapeseed cropping system at 5 locations.

Shukla *et al.* (2006) made comparisons of splitting similar recommended quantity of fertilizer N and found that the LCC treatment combinations (LCC 3 for Basmati-370 and LCC 4 for wheat) gave 20 and 23 per cent higher net returns (NR), respectively. Further, in hybrid rice-wheat (HD-2687) combination, they observed that N application based on LCC 5 for rice and 4 for wheat produced additional NR of 28 and 31 per cent, respectively over recommended N splits.

Among different rice establishment techniques, Sanjay (2006) obtained significantly higher gross income (₹ 31,158 ha⁻¹) with line transplanting compared to drum seeding (₹ 30,829 ha⁻¹) and broadcast seeding (₹ 22,032 ha⁻¹) techniques. Further, he recorded significantly higher net returns (₹ 37,086 ha⁻¹) and B: C (2.03) ratio under SRI method compared to aerobic and conventional method of rice establishment.

In a study on integrated nutrient management, Vinay Singh (2006) reported that the net monetary return was the highest at 100 per cent NPK + 10 t ha⁻¹ cut rice straw followed by 100 per cent NPK + 10 t ha⁻¹ *dhaincha* and 100 per cent NPK + 10 t ha⁻¹ FYM compared with that of 150 per cent NPK to both rice and wheat (₹ 33,729/ha). The highest benefit: cost ratio was observed at 100 per cent NPK + 10 t ha⁻¹ FYM and 100 per cent NPK + 10 t ha⁻¹ *dhaincha*. In rice-wheat systems, Sharma *et al.* (2006) obtained higher net returns and B: C ratio with cv. Jaya-wheat and cv. DRRH 1 - wheat systems than the other rice-wheat systems.

In nutrient cum weed management study with different rice establishment methods, Parmeet Singh and Singh (2006) recorded the maximum net return in direct-seeded rice treated with 120: 60: 60 kg ha⁻¹ N: P₂O₅: K₂O with two hand-weedings. However, higher net profit was observed in transplanted rice treated with 120: 60: 60 kg ha⁻¹ N: P₂O₅ and K₂O with anilofos @ 0.4 a.i. ha⁻¹.

Significantly better net returns and benefit cost ratio were observed with wet seeded rice + *S. rostrata* compared to intercropping of green manures under transplanted conditions as the cost of cultivation was more under transplanting compared to wet seeded rice (Ravishankar *et al.*, 2007). Though gross returns were more under transplanted rice, it was not significantly different from wet seeded rice. Benefit: cost ratio also reflected similar trend. Further, Ravishankar *et al.* (2007) also noticed that anaerobic seeding was better in terms of net returns and B: C ratio, compared to line transplanting. Levels of nitrogen progressively enhanced the gross and net returns and B:

C ratio up to 120 kg nitrogen ha⁻¹ and were significantly higher with 100 kg ha⁻¹ than with rest of nitrogen levels.

In southern Karnataka in Kaveri irrigation command, Jayadeva and Prabhakara Shetty (2008) revealed that the B: C ratio was higher with SRI establishment technique (2.84) than those with transplanting (2.77) and aerobic technique (2.20). Among the sources of nutrients, incorporation of *in-situ* green manure alongwith application of recommended NPK recorded significantly higher B: C ratio (2.79), followed by paddy straw manuring with application of recommended NPK (2.72) compared to other sources of nutrients. This might be due to reduced cost of cultivation and slightly higher grain and straw yields compared to application of recommended NPK only. In another study, Mallareddy and Padmaja (2013) obtained higher net returns with flooded rice than under aerobic condition, however, no significant differences were noticed in benefit: cost ratio due to high cost of cultivation in the former method. The interaction between the water management and variety revealed significantly higher net returns with cv. MTU 1001 in flooded and with cv. WGL 32100 in aerobic method over other varieties. Similar trend was visible in benefit: cost ratio. Of N levels, higher dose of nitrogen, *i.e.* 240 kg ha⁻¹ resulted in significant increase in net returns and benefit: cost ratio over the rest of the N levels.

In the TBP irrigation command of Karnataka in the north, Biradar *et al.* (2012) obtained relatively better agronomic efficiency of nitrogen (30.7) and return on investment (17.7) with N application in three splits. Further, they suggested that LCC indicated the right time of N application in maize-wheat cropping system.

Mirasol *et al.* (2012) reported that Nutrient Expert for hybrid maize (cv.NEHM) increased yield and profit of farmers in Indonesia and the Philippines. In Indonesia, cv. NEHM increased yield by 0.9 t ha⁻¹, which increased profit by US\$ 270 ha⁻¹ over farmer's fertilizer practice (FFP). In the Philippines, NEHM increased yield by 1.6 t ha⁻¹ and profit by US\$ 379 ha⁻¹ compared with FFP.

Jagjot and Sohan (2013) observed that direct-seeding of Basmati rice and machine transplanting of Basmati rice in zero-tilled plots resulted in the maximum benefit: cost ratio and net return, and hence proved more remunerative than machine transplanting after puddling and conventional practice. This was owing to lower input cost in direct seeding of Basmati rice and machine transplanting of Basmati rice in zero tilled plots.

Jat *et al.* (2013) reported that Nutrient Expert (NE) in maize increased yield and economic benefit over farmers' practice (FP) and state recommendation (SR). Compared to FP; it increased yield by 1.06 t ha^{-1} and general recommendation of fertilizers (GRF) by $12,902 \text{ kg ha}^{-1}$ with a significant reduction in fertilizer cost of $\text{₹ } 3,239 \text{ ha}^{-1}$. Recommendations from NE-Maize also increased yield (0.9 t ha^{-1}) and GRF ($\text{₹ } 8,033 \text{ ha}^{-1}$) over SR with a moderate reduction in fertilizer cost ($\text{₹ } -1,041 \text{ ha}^{-1}$). This indicates that NE, in addition to suggesting the right rate of nutrients sufficient to meet the attainable yield targets, also helps in optimizing nutrient use through appropriate reductions in fertilizer application.

In Tunga Bhadra Project irrigation command, Umesh *et al.* (2014) reported that SSNM based nutrient application resulted in improvement of economic returns of corn production. The net income obtained from corn production under SSNM was $28.94 \times 100 \text{ ₹ ha}^{-1}$ which was much higher over RDF except N200: P75: K50 level.

Thus, the foregoing review reveals that DSR is an important rice culture needs popularization in irrigation commands owing to its high water productivity and climate smartness. At the same time it is also important to optimize production technologies such as genotypes, seed rate and micronutrients for maximization of yield. Besides, identifying suitable farmer friendly decision support system and a realizable target is equally important in rice production in peninsular region.

III. MATERIAL AND METHODS

Field experiments were conducted on ‘Yield maximization of direct seeded rice (DSR) under Tunga Bhadra Project Irrigation Command’ at Agricultural Research Station, Dhadesugur, University of Agricultural Sciences, Raichur during rainy seasons of 2015 and 2016 as well as during summer of 2016. Details of materials used, procedure followed and techniques adopted during the course of investigation are described in this chapter.

3.1 Characteristics of experimental site

The experiment was conducted under protective irrigation to maintain soil under saturation condition at Agricultural Research Station, Dhadesugur, University of Agricultural Sciences (UAS), Raichur, Karnataka, India. It is situated on the latitude of 15° 6' North, longitude of 76° 8' East and at an elevation of 358 meters above mean sea level and is located in North Eastern Dry Zone of Karnataka.

3.2 Climatic conditions of the experimental site

The monthly meteorological data for the years 2014-15 and 2015-16 recorded at meteorological observatory, Agricultural Research Station, Sirguppa (12 km away from Dhadesuguru), and the mean data of previous 10 years (2004-2014) (data was available for only this period) on climatic parameters like rainfall (585.2 mm), maximum and minimum temperature (43.0°C and 20.0 °C) are presented in Table 1 and depicted in Fig. 1. Data on relative humidity was not available.

3.2.1 Climatic conditions during the crop growth period

An amount of 603.0, 15.0 and 497.9 mm rainfall was received during crop growth period (June to December in rainy season (*kharif*) 2015, January to May 2016 and 2016 rainy season. During *kharif* 2015 and 2016 due to high rainfall in the month of September, and prevalence of cloudy and humid weather, incidence of brown plant hopper, leaf folder and stem borer were noticed. Maximum temperature (37 °C- June '15, 44.8 °C-May'15 and 38.4 °C-June '15) and minimum temperature (20.0°C- December '14, 20°C –January '15 and 22.6°C-December '15) were recorded during *kharif* 2015, summer and *kharif* 2016, respectively (Table 1 and Fig. 1). No much temperature deviation from normal maximum temperature (35.0 °C- June, 43.0 °C-May and

35.0 °C- June) and minimum temperature (20.0 °C- December, 24.0 °C –January and 20.0 °C-December) were recorded during *kharif*-2015, summer and *kharif* 2016, respectively (Table 1 and Fig. 1).

3.3 Soil properties of the experimental site

The soil of the experimental site was medium black and clay loam in texture. Composite soil sample was collected from the experimental site before initiation of the experiment and the soil was air-dried, powdered and allowed to pass through 2 mm sieve and was analyzed for physical and chemical properties (Table 2).

In Experiment I, the soil was neutral in reaction (pH 7.20, 7.04 and 7.21) and relatively high in soluble salts (1.13, 1.08 and 1.07 dS m⁻¹). The soil was high in organic carbon (0.86, 0.84 and 0.62%), medium in available nitrogen (286.0, 280.0 and 285.1 kg ha⁻¹) and available P₂O₅ (22.2, 27.2 and 23.4 kg ha⁻¹), while it was high in K₂O (427.0, 438.5 and 440.9 kg ha⁻¹). The soil was medium in exchangeable calcium (1330.0, 1151.0 and 1124 mg kg⁻¹) and high in magnesium content (243.0, 288.0 and 216.0 mg kg⁻¹). The DTPA extractable micronutrient content revealed deficient zinc (0.63, 0.61 and 0.49 mg kg⁻¹), deficient iron (4.41, 4.40 and 4.41), high copper (3.32, 3.10 and 3.34 mg kg⁻¹) and manganese (3.32, 3.10 and 3.34 mg kg⁻¹) during rainy season-2015, rainy season -2016 and summer season respectively.

In Experiment II, the soil was neutral in reaction (pH 7.31, 7.43 and 7.30) and again high in soluble salts (1.12, 1.10 and 1.08 dS m⁻¹). The soil was medium to high in organic carbon (0.66, 0.79 and 0.75%), medium in available nitrogen (290.1, 285.6 and 286.2 kg ha⁻¹) and available P₂O₅ (24.5, 26.1 and 25.4 kg ha⁻¹), while it was high in K₂O (459.2, 442.3 and 440.1 kg ha⁻¹). It was medium in exchangeable calcium (1054, 1219 and 1209 mg kg⁻¹) and high in magnesium content of soil (310, 320 and 289 mg kg⁻¹). The DTPA extractable micronutrient content viz., deficient zinc (0.52, 0.51 and 0.51 mg kg⁻¹), deficient iron (4.9, 4.2 and 4.8), high copper (3.20, 3.41 and 3.21mg kg⁻¹) and manganese (3.2, 3.4 and 3.2 mg kg⁻¹) during *kharif*-2015, *kharif*-2016 and summer season respectively.

3.4 Past history of the experimental site

During the previous year, general direct seeded rice was grown in the experimental site area and the land was left fallow during summer season.

3.5 Experimental details

The details of the field experiments conducted are given below.

3.5.1 Treatment details

Experiment-1: Response of genotypes to seed rates and micro nutrients application under direct seeded rice

There were three main plot treatments, three sub plot treatments and four sub-sub plot treatments comprising of three varieties, three seed rates and four micro nutrient levels as detailed below.

Main plot treatments: Genotypes (V)

V₁- Gangavathi sona (GGV 05 01)

V₂- MTU 1010 (rainy season)/ RNR 15048 (summer season)

V₃- BPT -5204

Sub plot treatments: Seed rate (S)

S₁- 25 kg ha⁻¹

S₂- 30 kg ha⁻¹

S₃- 35 kg ha⁻¹

Sub-Sub plot treatments: Micronutrients (M)

M₁- Control (no micronutrients)

M₂- FeSO₄ (Soil application @ 25 kg ha⁻¹+ foliar application @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil application @ 25 kg ha⁻¹ + foliar application @ 0.5% twice at 15 and 30 DAS)

M₄- M₂ + M₃

Design : Split-Split Plot

Replication : Three

Plot size : **Gross plot** : 6 m x 3 m

Net plot : 5.2 m x 2.6 m

Spacing : 20 cm x 10 cm

Location : ARS, Dhadesugur

Experiment 2. Response of Direct Seeded Rice to Nutrient Management for Varied Yield Targets

Treatment details

Variety : Gangavathi sona (GGV 05 01)

Factor I: Nutritional approaches (N)

N₁- Nutrient Expert (NE)

N₂- Soil Test Crop Response (STCR)

Factor II: Yield target (T)

T₁- 6.0 t ha⁻¹

T₂- 7.0 t ha⁻¹

T₃- 8.0 t ha⁻¹

Factor III: Micronutrient and organics (M)

M₁- Control (no micronutrients or organics)

M₂- ZnSO₄ + FeSO₄ + Organic manure

Treatment Combinations

- N₁ T₁M₁ - Nutrient expert + 6.0 t ha⁻¹ yield target + No micronutrient/organics
- N₁ T₁M₂ - Nutrient expert + 6.0 t ha⁻¹ yield target + *micronutrient and organic manure
- N₂ T₁M₁ - STCR + 6.0 t ha⁻¹ yield target + No micronutrient/organics
- N₂ T₁M₂ - STCR + 6.0 t ha⁻¹ yield target + micronutrient and organic manure
- N₁ T₂M₁ - Nutrient expert + 7.0 t ha⁻¹ yield target + No micronutrient/organics
- N₁ T₂M₂ - Nutrient expert + 7.0 t ha⁻¹ yield target + micronutrient and organic manure
- N₂ T₂M₁ - STCR + 7.0 t ha⁻¹ yield target + No micronutrient/organics
- N₂ T₂M₂ - STCR + 7.0 t ha⁻¹ yield target + micronutrient and organic manure
- N₁ T₃M₁ - Nutrient expert + 8.0 t ha⁻¹ yield target + No micronutrient/organics
- N₁ T₃M₂ - Nutrient expert + 8.0 t ha⁻¹ yield target + micronutrient and organic manure
- N₂ T₃M₁ - STCR + 8.0 t ha⁻¹ yield target + No micronutrient/organics
- N₂ T₃M₂ - STCR + 8.0 t ha⁻¹ yield target + micronutrient and organic manure
- C - Control (RDF 150: 75: 75 kg ha⁻¹ N, P₂O₅ and K₂O, respectively)

(NOTE: * ZnSO₄ @ 25 kg ha⁻¹ + FeSO₄ @ 25 kg ha⁻¹ + organic manure 10 t ha⁻¹ to soil before sowing and Zn SO₄ and FeSO₄ @ 0.5% to foliage at 15 and 30 DAS)

Table 1. Monthly meteorological data for the experimental years 2015-16, 2016-17 and mean of the previous 10 years (2004-2014) at Agricultural Research Station, Siruguppa, University of Agricultural Sciences, Raichur

Month	Rainfall (mm)		Temperature (°C)			
			Maximum		Minimum	
	Average of 10 years (2004-14)	2015-16	Average of 10 years (2004-14)	2015-16	Average of 10 years (2004-14)	2015-16
June 2015	94.0	60.0	35.0	37.0	24.0	26.0
July 2015	69.3	41.2	33.0	34.0	25.0	24.0
August 2015	151.2	133.5	34.0	34.0	23.0	25.0
September 2015	156.8	298.3	32.0	35.0	23.0	24.0
October 2015	69.8	62.0	32.0	35.0	23.0	23.0
November 2015	2.9	3.0	33.0	32.0	21.0	20.0
December 2015	2.7	5.0	31.0	34.0	20.0	18.0
January 2016	2.9	0.0	35.0	32.0	24.0	20.0
February 2016	1.9	0.0	35.0	35.8	24.0	25.2
March 2016	13.2	0.0	38.0	38.7	24.0	24.5
April 2016	13.2	0.0	41.0	43.4	29.0	30.2
May 2016	42.9	15.0	43.0	44.8	31.0	28.7
June 2016	105.3	220.6	35.0	38.4	24.0	26.1
July 2016	73.1	124.8	33.0	34.0	25.0	25.2
August 2016	147.0	42.2	34.0	33.5	23.0	26.0
September 2016	151.5	101.2	32.0	34.0	23.0	24.0
October 2016	67.1	4.0	32.0	34.1	23.0	24.5
November 2016	3.0	3.3	33.0	32.9	21.0	23.4
December 2016	2.6	1.8	31.0	30.5	20.0	22.6
*Total	1170	1116				

* 2015 June to December and 2016 January to December

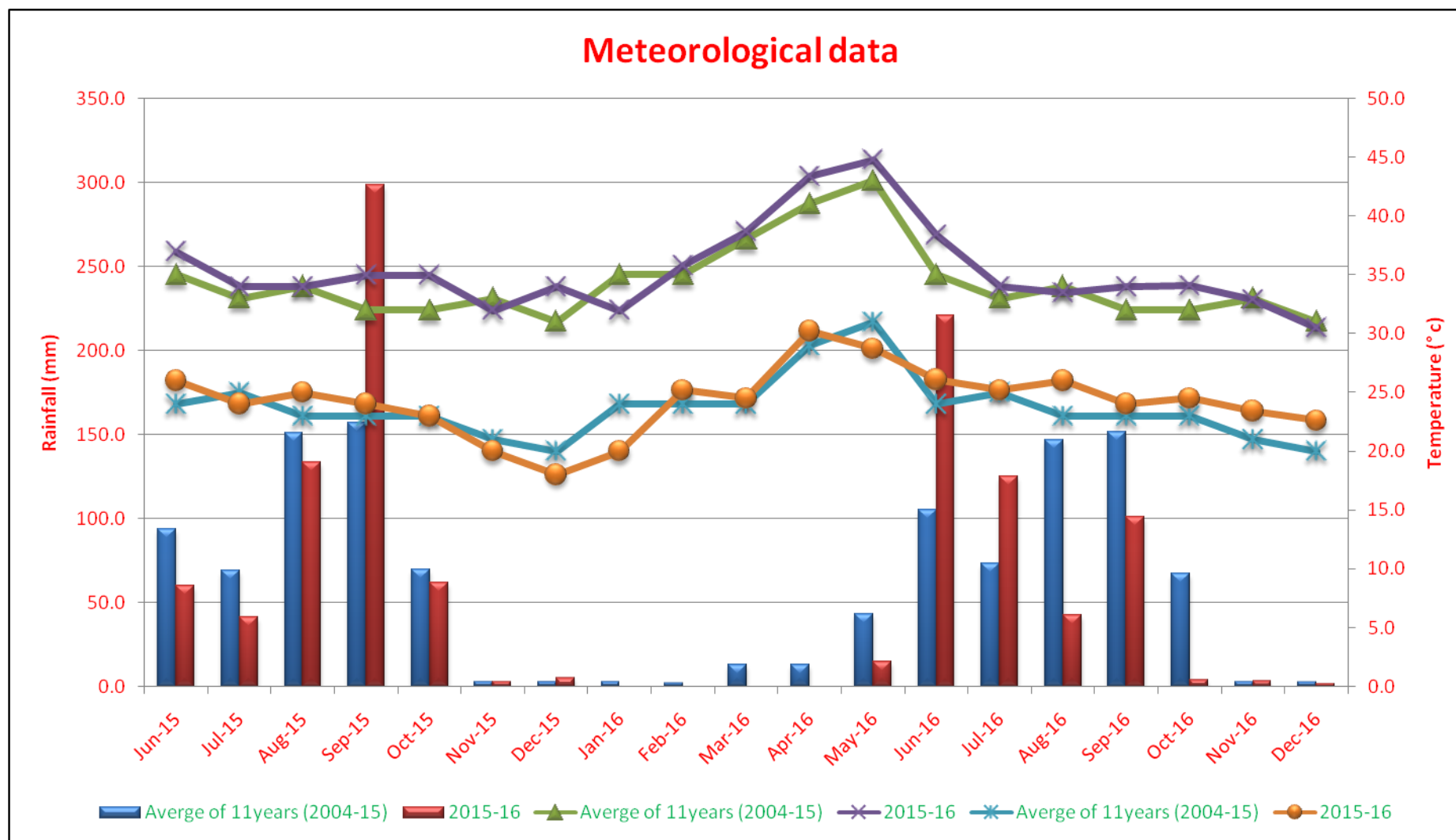


Fig. 1. Monthly meteorological data for the year 2015 -2016 at Agricultural Research Station, Siruguppa

Table 2. Initial physico-chemical properties of soil from the experimental site

Sl. No.	Parameter	Experiment I			Experiment II			Ratings	Methodology
		2015	2016	Summer	2015	2016	Summer		
Physical Properties									
1	Sand%	21.50	21.5	21.5	21.50	21.5	21.5	Clayey texture	International pipette method (Piper, 1966)
2	Silt%	24.54	24.54	24.54	24.54	24.54	24.54		
3	Clay%	53.96	53.96	53.96	53.96	53.96	53.96		
4	Bulk density(kg m ⁻³)	1.45	1.44	1.45	1.45	1.44	1.45		Core sampler method (Dastane, 1967)
Chemical properties									
1	pH _(1:2.5)	7.20	7.04	7.21	7.31	7.43	7.3	Neutral	pH meter (Piper, 1966)
2	EC _(1:2.5) (dSm ⁻¹)	1.13	1.08	1.07	1.12	1.10	1.08	High	Conductivity bridge (Jackson, 1967)
3	Organic carbon (%)	0.86	0.84	0.62	0.66	0.79	0.75	High	Wet oxidation method (Jackson, 1967)
4	Available N (kg ha ⁻¹)	286	280	285.1	290.1	285.6	286.2	Medium	Alkaline permanganate method (Subbaiah and Asija, 1956
5	Available P ₂ O ₅ (kg ha ⁻¹)	22.2	27.2	23.4	24.5	26.1	25.4	Medium	Olsen’s method (Jackson, 1967)
6	Available K ₂ O(kgha ⁻¹)	427	438.5	440.9	459.2	442.3	440.1	High	Flame photometry method (Jackson, 1967)
9	DTPA Fe (mg kg ⁻¹)	4.41	4.40	4.41	4.9	4.2	4.82	Deficient	DTPA extractable micronutrients method (Lindsay and Norvell, 1978)
10	DTPA Zn (mg kg ⁻¹)	0.63	0.61	0.49	0.52	0.51	0.51	Deficient	-do-
11	DTPA Mn (mg kg ⁻¹)	8.48	9.44	8.72	8.28	8.31	8.0	High	-do-
12	DTPA Cu (mg kg ⁻¹)	3.32	3.10	3.34	3.20	3.41	3.21	High	-do-

Design : Factorial RCBD

Replication : Three

Plot size : **Gross plot size** : 5.0 m x 4.0 m

Net plot size : 4.0 m x 3.6 m

Spacing : 20 cm x 10 cm

3.5.2 Design and layout

The first experiment was laid out using split-split plot design (Fig. 3) with three main plots, three sub plot treatments and four sub-sub plot treatments and replicated three times.

The second experiment was laid out in randomized block design (Fig. 4) with thirteen treatment combinations and replicated three times.

3.5.3 Description of varieties

3.5.3.1 Gangavathi sona (GGV 05 01)

Variety released from University of Agricultural Sciences, Raichur, has high yield potential, tolerant to sheath blight, neck blast and BLB during *kharif* and sheath blight and brown spot during summer, possesses resistance to shattering and lodging, withstand salinity. The yield potential is 32 – 35 q ac⁻¹. It has medium slender grain and recommended for agro climatic zones of 2 and 3 of Karnataka. Cultivar is presently popular in Karnataka and Andhra Pradesh.

3.5.3.2 MTU 1010

MTU 1010 (Cottondora Sannalu) was developed at Agricultural Research Station, Maruteru of West Godavari of Andhra Pradesh in the year 1999. It is a cross between MTU 2077 (Krishnaveni) and IR 64. It is a semi dwarf variety, medium tillering. green foliage, grain straw glumed, long slender and matures in 120 days with a yield potential of 6-6.5 t ha⁻¹ and matures in 110-125 days. It has medium slender grain with length of around 10.0 mm, breadth of 2.41 mm and thickness of 4.15 mm. It is a high yielding and BPH resistant variety. This variety is most suited for puffed rice in Karnataka and Andhra Pradesh.

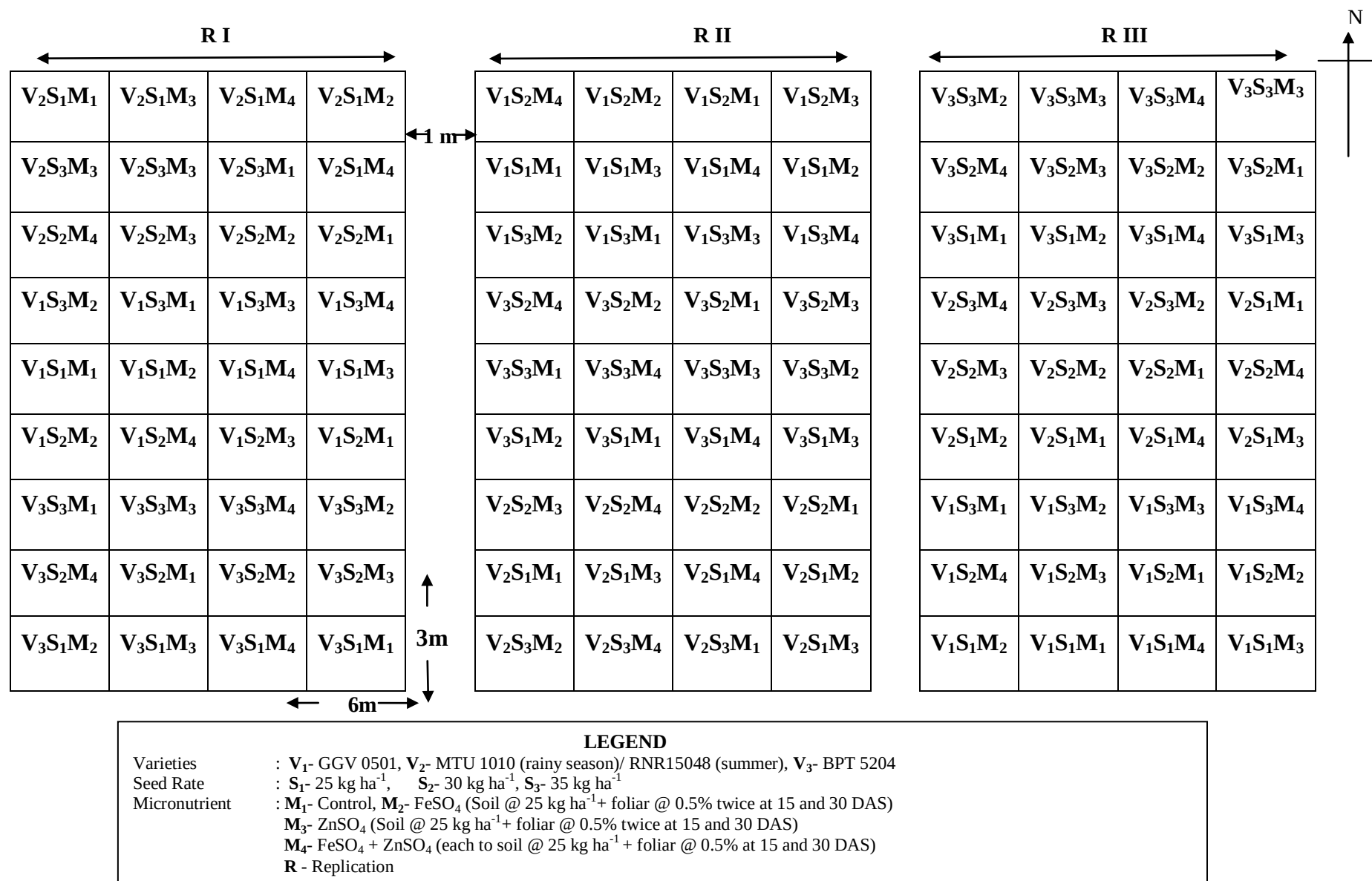
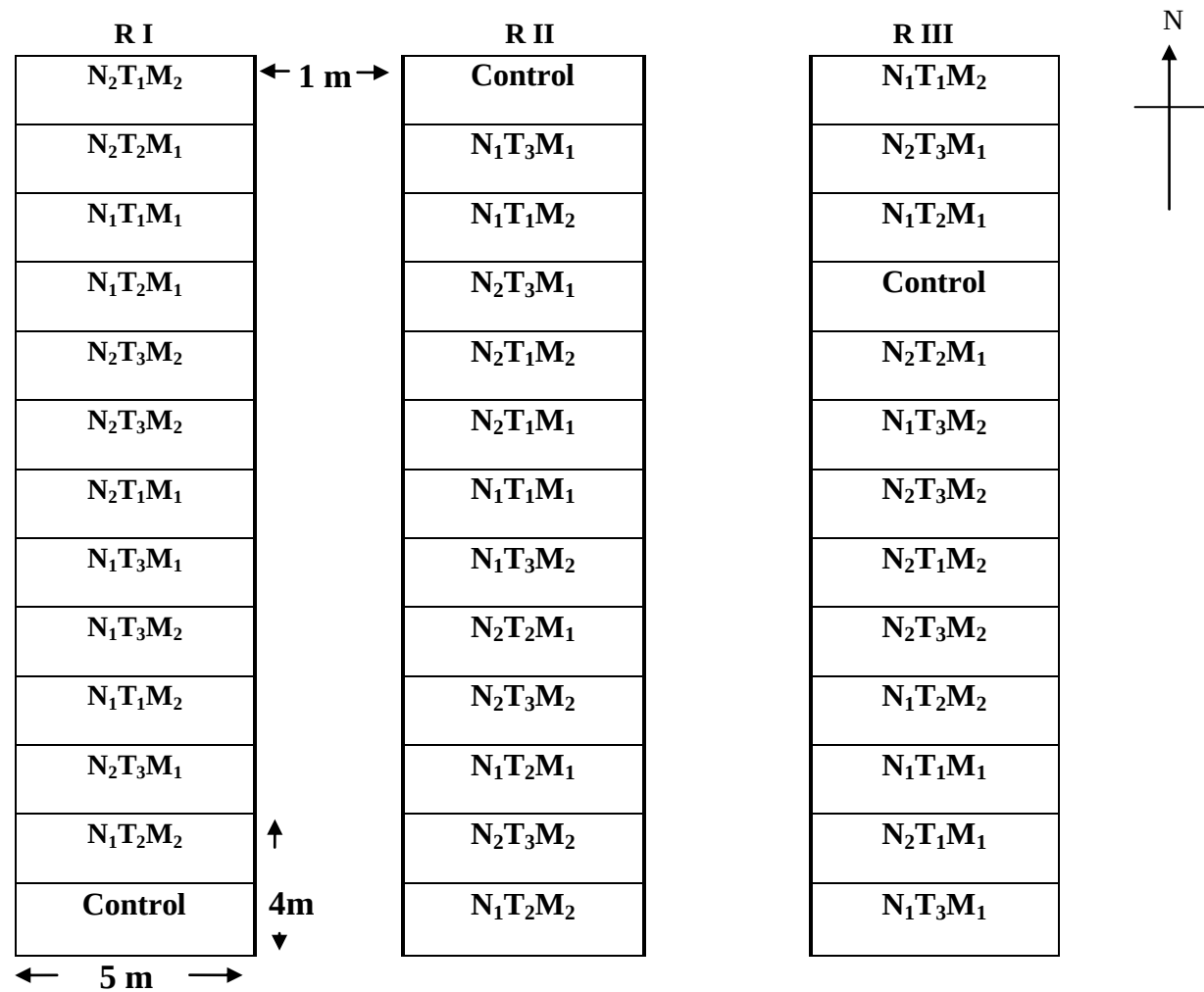


Fig. 2 Plan of layout of Experiment I



LEGEND

R – Replication

Nutrient approach (N) : N₁- Nutrient Expert N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹ T₂- 7 t ha⁻¹ T₃- 8 t ha⁻¹

Micronutrient and Organics (M): M₁ -Without FeSO₄ + ZnSO₄ + Organics, M₂ - With FeSO₄ + ZnSO₄ + Organics

Fig. 3 Plan of layout of Experiment II



Plate 1. Overview of the Experiment I at harvest during rainy season



Plate 2. Overview of the Experiment I at harvest during summer season



Plate 3. Overview of the Experiment II 110 DAS during summer season



Plate 4. Overview of the Experiment II at harvest during rainy season

3.5.3.3 BPT 5204

The original name of BPT 5204 is Swarna Masuri, grains are thin and medium size and grown largely in the south Indian states viz., Andhra Pradesh and Karnataka. In Telugu, Sona masuri rice is called *Bangaru Theegalu* (meaning Golden Ivy). Grains are light weight, aromatic and considered to be of premium quality. It matures in about 145-150 days.

3.5.3.4 RNR 15048

This rice variety has low glycemic index of 51 and 5% more protein compared to normal Sona masoori, which has glycemic Index of 72. It has unique grain size, short slender shape, high grain yield potential, good cooking quality and above all robust blast resistance characteristics. One of the striking qualities of this paddy variety is that it can be raised in both rainy and post rainy seasons in a short duration of about 125 days.

3.6 Cultural operations

3.6.1 Land preparation

The land was ploughed with bullock drawn mould board plough. Clods were crushed with the help of wooden clod crusher. The land was levelled and harrowed twice to attain a fine soil tilth. The soil surface was then compressed by passing wooden plank. Stubbles and weeds were removed. Plots were laid out as per the plan and bunds were raised all round each experimental unit leaving buffer strips between replications for direct seeded treatment.

3.6.2 Sowing

In direct seeded rice plot, the sowing was done (24-06-2015 and 16-06-2016) at spacing of 20 cm x 10 cm in opened furrows. During summer sowing was done on 02-01-2016. The seeds were sown at the depth of 2-3 cm.

3.6.3 Thinning

Thinning was attended in case of direct seeded treatment at seven days after emergence of seedling.

3.6.4 Weed management

Weeds in the experimental plots were controlled by application of Pendimethalin 30 EC @ 1.0 kg a.i. ha⁻¹ at 3 days after sowing as pre-emergent and Bispyribac

sodium 10% SL @ 25 g a.i. ha⁻¹ was sprayed at 20 days after sowing as early post-emergent with the help of hand operated knapsack sprayer. Besides, three hand weeding (25, 50 and 75 DAS) were carried out during the crop growth to keep plot weed free.

3.6.5 Water management

Crop was irrigated as and when the soil developed cracks by following alternate wetting and drying cycles in direct seeded treatments. Water was drained during top dressing and spraying of chemicals.

3.6.6 Fertilizer management

In Experiment I, recommended dose of fertilizers 150:75:75 kg ha⁻¹ (N: P₂O₅: K₂O) was applied to all the treatment combinations and nitrogen was applied in 3 splits (50% basally at sowing and remaining equally at 25, and 65 DAS). Micronutrients 25 kg ha⁻¹ FeSO₄, 25 kg ha⁻¹ ZnSO₄ and in a combination of FeSO₄ + ZnSO₄ to soil and these micronutrients were also applied to foliage at 15 and 30 DAS @ 0.5 per cent as per treatment.

In Experiment II as per the treatments, nitrogen was applied in 4 equal splits (25% each at sowing, 25, 45 and 65 DAS) and full dose of P and K were applied at sowing. Zinc sulphate and ferrous sulphate @ 25 kg ha⁻¹ each basally and foliar application @ 0.5 per cent (15 and 30 DAS) alongwith 10 t ha⁻¹ FYM was adopted as per the treatment, whereas in control (150:75:75 kg ha⁻¹ NPK 50 per cent N and full dose of P and K were applied basally and remaining 50 per cent N was applied at 25 and 65 DAS in two equal splits. Urea, Di-Ammonium Phosphate (DAP) and Muriate of Potash (MOP) were used to supply N, P and K, respectively.

3.6.6.1 Calculation of fertilizer

3.6.61.1 Calculation of fertilizer for STCR

The amount of fertilizer for STCR treatments was calculated by using standardized STCR equations developed for *Vertisols* of Siruguppa for rice cultivation (Anon., 2007) and is given below.

$$FN = 3.45 T - 0.029 SN \text{ (KMnO}_4 \text{ - N)}$$

$$FP_2O_5 = 2.82 T - 1.90 SP_2O_5 \text{ (Olsen's - P}_2O_5\text{)}$$

$$FK_2O = 2.00 T - 0.09 SK_2O \text{ (NH}_4\text{OAC - K}_2O\text{)}$$

Where,

T = Targeted yield ($q \text{ ha}^{-1}$)

FN = Nitrogen supplied through fertilizer (kg ha^{-1})

FP₂O₅ = Phosphorus supplied through fertilizer (kg ha^{-1})

FK₂O = Potassium supplied through fertilizer (kg ha^{-1})

SN, SP₂O₅ and SK₂O are initial soil test value for available N, P₂O₅ and K₂O, kg ha^{-1} respectively.

3.6.6.1.2 Calculation of fertilizer amount for nutrient expert (NE)

Nutrient Expert is a decision support tool for nutrient management in rice. The guidelines provided by this software are in consistent with the scientific principles of SSNM (Anon, 2011).

3.6.7 Plant protection schedule

In direct seeded rice at tillering stage, the crop was noticed with stem borer and bacterial leaf blight. They were controlled by spraying Monocrotophos (1000 ml ha^{-1}) and Copper oxychloride (3 g litre^{-1}) + Streptomycin sulphate (0.5 g litre^{-1}), respectively.

3.6.8 Harvesting and threshing

The crop was harvested at physiological maturity, threshed and cleaned manually in both the years and seasons. The plants in the net plot area were harvested treatment-wise and kept separately for sun drying. Hand threshing and winnowing was done to separate the grains after sun drying.

3.7 Collection of experimental data

Five plants from net plot were selected at random and tagged for the purpose of recording various observations. Observations on growth parameters at four distinct

Table 3. Quantity of fertilizer applied to different treatment (kg ha⁻¹) as per the different nutrient recommendation techniques during rainy season 2015 in Experiment II

Treatment	Basal			25 DAS			45 DAS			65 DAS			Total			CHANGE OVER RDF (+/-)		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
N ₁ T ₁ M ₁	29.5	37.0	62.0	29.5	-	-	29.5	-	-	29.5	-	-	118.0	37.0	62.0	-32.0	-38.0	-13.0
N ₁ T ₁ M ₂	29.5	37.0	62.0	29.5	-	-	29.5	-	-	29.5	-	-	118.0	37.0	62.0	-32.0	-38.0	-13.0
N ₂ T ₁ M ₁	30.7	131.5	81.5	30.7	-	-	30.7	-	-	30.7	-	-	122.9	131.5	81.5	-27.1	+56.5	+6.5
N ₂ T ₁ M ₂	30.7	131.5	81.5	30.7	-	-	30.7	-	-	30.7	-	-	122.9	131.5	81.5	-27.1	+56.5	+6.5
N ₁ T ₂ M ₁	31.3	41.0	69.0	31.3	-	-	31.3	-	-	31.3	-	-	125.0	41.0	69.0	-25.0	-34.0	-6.0
N ₁ T ₂ M ₂	31.3	41.0	69.0	31.3	-	-	31.3	-	-	31.3	-	-	125.0	41.0	69.0	-25.0	-34.0	-6.0
N ₂ T ₂ M ₁	39.4	159.7	101.5	39.4	-	-	39.4	-	-	39.4	-	-	157.4	159.7	101.5	+7.4	+84.7	+26.5
N ₂ T ₃ M ₂	39.4	159.7	101.5	39.4	-	-	39.4	-	-	39.4	-	-	157.4	159.7	101.5	+7.4	+84.7	+26.5
N ₁ T ₃ M ₁	35.3	50.0	85.0	35.3	-	-	35.3	-	-	35.3	-	-	141.0	50.0	85.0	-9.0	-25.0	+10.0
N ₁ T ₃ M ₂	35.3	50.0	85.0	35.3	-	-	35.3	-	-	35.3	-	-	141.0	50.0	85.0	-9.0	-25.0	+10.0
N ₂ T ₃ M ₁	48.0	187.9	121.5	48.0	-	-	48.0	-	-	48.0	-	-	191.9	187.9	121.5	+41.9	+112.9	+46.5
N ₂ T ₃ M ₂	48.0	187.9	121.5	48.0	-	-	48.0	-	-	48.0	-	-	191.9	187.9	121.5	+41.9	+112.9	+46.5
Control-POP	75.5	75.0	75.0	37.5	-	-	-	-	-	37.5	-	-	150.0	75.0	75.0	-	-	-

POP – Nutrition as per the package of practices

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M): M₁ - Without FeSO₄ + ZnSO₄ + Organics, M₂ - With FeSO₄ + ZnSO₄ + Organics

Table 4. Quantity of fertilizer applied to different treatment (kg ha⁻¹) as per the different nutrient recommendation techniques during rainy season 2016 in Experiment II

Treatment	Basal			25 DAS			45 DAS			65 DAS			Total			CHANGE OVER RDF (+/-)		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
N ₁ T ₁ M ₁	29.5	37.0	62.0	29.5	-	-	29.5	-	-	29.5	-	-	118.0	37.0	62.0	-32.0	-38.0	-13.0
N ₁ T ₁ M ₂	29.5	37.0	62.0	29.5	-	-	29.5	-	-	29.5	-	-	118.0	37.0	62.0	-32.0	-38.0	+62.0
N ₂ T ₁ M ₁	31.0	125.0	80.0	31.0	-	-	31.0	-	-	31.0	-	-	124.0	125.0	80.0	-26.0	+50.0	+5.0
N ₂ T ₁ M ₂	31.0	125.0	80.0	31.0	-	-	31.0	-	-	31.0	-	-	124.0	125.0	80.0	-26.0	+50.0	+5.0
N ₁ T ₂ M ₁	31.3	41.0	69.0	31.3	-	-	31.3	-	-	31.3	-	-	125.0	41.0	69.0	-25.0	-34.0	-6.0
N ₁ T ₂ M ₂	31.3	41.0	69.0	31.3	-	-	31.3	-	-	31.3	-	-	125.0	41.0	69.0	-25.0	-34.0	-6.0
N ₂ T ₂ M ₁	39.8	153.0	100.0	39.8	-	-	39.8	-	-	39.8	-	-	159.0	153.0	100.0	+9.0	+78.0	+25
N ₂ T ₃ M ₂	39.8	153.0	100.0	39.8	-	-	39.8	-	-	39.8	-	-	159.0	153.0	100.0	+9.0	+78.0	+25
N ₁ T ₃ M ₁	35.3	50.0	85.0	35.3	-	-	35.3	-	-	35.3	-	-	141.0	50.0	85.0	-9.0	-25.0	+10.0
N ₁ T ₃ M ₂	35.3	50.0	85.0	35.3	-	-	35.3	-	-	35.3	-	-	141.0	50.0	85.0	-9.0	-25.0	+10.0
N ₂ T ₃ M ₁	48.3	181.0	120.0	48.3	-	-	48.3	-	-	48.3	-	-	193.0	181.0	120.0	+43.0	+106.0	+45.0
N ₂ T ₃ M ₂	48.3	181.0	120.0	48.3	-	-	48.3	-	-	48.3	-	-	193.0	181.0	120.0	+43.0	+106.0	+45.0
Control-POP	75.5	75.0	75.0	37.5	-	-	-	-	-	37.5	-	-	150.0	75.0	75.0	-	-	-

POP – Nutrition as per the package of practices

Nutrient approach (**N**) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (**T**) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (**M**): M₁ - Without FeSO₄ + ZnSO₄ + Organics, M₂ - With FeSO₄ + ZnSO₄ + Organics

Table 5. Quantity of fertilizer applied to different treatment (kg ha⁻¹) as per the different nutrient recommendation techniques during summer season 2016 in Experiment II

Treatment	Basal			25 DAS			45 DAS			65 DAS			Total			CHANGE OVER RDF (+/-)		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
N ₁ T ₁ M ₁	29.0	37.0	62.0	29.3	-	-	29.3	-	-	29.3	-	-	117.0	37.0	62.0	-33.0	-38.0	-13.0
N ₁ T ₁ M ₂	29.0	37.0	62.0	29.3	-	-	29.3	-	-	29.3	-	-	117.0	37.0	62.0	-33.0	-38.0	-13.0
N ₂ T ₁ M ₁	31.0	125.8	80.4	31.0	-	-	31.0	-	-	31.0	-	-	124.0	125.8	80.4	-26.0	+50.8	+5.4
N ₂ T ₁ M ₂	31.0	125.8	80.4	31.0	-	-	31.0	-	-	31.0	-	-	124.0	125.8	80.4	-26.0	+50.0	+5.4
N ₁ T ₂ M ₁	31.3	41.0	69.0	24.6	-	-	24.6	-	-	24.6	-	-	125.0	41.0	69.0	-25.0	-34.0	-6.0
N ₁ T ₂ M ₂	31.3	41.0	69.0	24.5	-	-	24.5	-	-	24.5	-	-	125.0	41.0	69.0	-25.0	-34.0	-6.0
N ₂ T ₂ M ₁	39.6	154.1	101.0	39.6	-	-	39.6	-	-	39.6	-	-	158.5	154.1	101.0	+8.5	+79.1	+26.0
N ₂ T ₃ M ₂	39.6	154.1	101.0	39.6	-	-	39.6	-	-	39.6	-	-	158.5	154.1	101.0	+8.5	+78.0	+26.0
N ₁ T ₃ M ₁	35.3	50.0	85.0	26.3	-	-	26.3	-	-	26.3	-	-	141.0	50.0	85.0	-9.0	-25.0	+10.0
N ₁ T ₃ M ₂	35.3	50.0	85.0	26.3	-	-	26.3	-	-	26.3	-	-	141.0	50.0	85.0	-9.0	-25.0	+10.0
N ₂ T ₃ M ₁	48.3	182.0	121.0	48.3	-	-	48.3	-	-	48.3	-	-	193.0	182.0	121.0	+43.0	+107.0	+46.0
N ₂ T ₃ M ₂	48.3	182.0	121.0	48.3	-	-	48.3	-	-	48.3	-	-	193.0	182.0	121.0	+43.0	+107.0	+45.0
Control-POP	75.5	75.0	75.0	37.5	-	-	-	-	-	37.5	-	-	150.0	75.0	75.0	-	-	-

POP – Nutrition as per the package of practices

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M): M₁ - Without FeSO₄ + ZnSO₄ + Organics, M₂ - With FeSO₄ + ZnSO₄ + Organics

stages of crop growth viz., 45 days after sowing (DAS), 67 DAS, 90 DAS, and at harvest during rainy season and at 45 DAS, 90 DAS, and at harvest during summer were recorded on observation plants. Data on yield parameters were recorded at harvest. Based on observations recorded on five tagged plants, average per plant was calculated.

3.7.1 Growth parameters

3.7.1.1 Plant height (cm)

Plant height was recorded at 45 and 90 DAS and at harvest during both the seasons and also at 67 DAS during rainy season from base of the plant up to the base of last sheath of main shoot in direct seeded treatments. Five plants were randomly selected, tagged and mean values of height was expressed in centimeter.

3.7.1.2 Number of tillers (No. m⁻¹ length)

Number of tillers per meter length of two rows were counted at randomly selected row area and expressed as tillers per meter length.

3.7.1.3 . Leaf area per plant (cm²)

For measuring leaf area, number of leaves per plant was counted. The length and maximum width of each leaf on the middle tiller was measured and leaf area of each leaf was computed as follows.

$$\text{Leaf area} = K \times L \times W$$

Where,

K = Constant factor

L = Length of leaf (cm)

W = Maximum width of leaf (cm)

The value of constant K was taken as 0.75 up to 90 days and 0.67 during maturity stage (Gomez, 1972). The leaf area per plant was then calculated as follows.

Leaf area per plant = Total leaf area of middle tiller x Total number of tillers per plant.

It was recorded for five plants separately and averaged to get leaf area in cm² plant⁻¹.

3.7.1.4 Leaf area index (LAI)

Leaf area index is defined as the leaf area per unit land area, and was worked out by the formula given by Watson (1952).

$$LAI = \frac{A}{P}$$

Where,

LAI = Leaf area index

A = Leaf area (cm²)

P = Land area (cm²)

3.7.1.5 Dry matter production and distribution (g plant⁻¹)

Five plants were uprooted at random from the adjacent to net plot area excluding two border rows in the field. Leaves and stem portions were separated and root portion was discarded. The samples were dried in hot air oven at 65° C for 72 hours until the constant weight was reached. The completely dried samples were weighed and the dry weight of different plant parts was expressed in g per plant.

3.7.1.6 Days to fifty per cent flowering

Number of days taken from the date of sowing to the initiation of flowering in fifty per cent of the total plants in entire plot was considered as days to fifty per cent flowering and expressed in days.

3.7.1.7 SPAD and Green seeker readings

The SPAD-502 (Soil and plant analysis development) chlorophyll meter developed from Minolta (Minolta Ltd., Tokyo, Japan) was used for recording leaf chlorophyll content. The SPAD readings were recorded at middle lamina of the third leaf from the top of plant at 45 days interval. The third fully expanded leaf from top of rice plant was selected for leaf colour measurement.

General guidelines followed for using SPAD were as follows.

Five youngest fully expanded and healthy leaves (third leaf from the top) were selected from 10 randomly selected rice plants in an area of uniform population for leaf colour measurement. The chlorophyll of each selected leaf was measured by holding the SPAD and placing the middle part of the leaf (the leaf was neither detached nor destroyed). The SPAD measurements were taken between 12.00 noon and 2.00 PM. The average of the 10 SPAD readings was calculated.

Green Seeker is an integrated optical sensing and application system that measures crop status and its variability in the crop's nitrogen. The sensor uses light emitting diodes (LED) to generate red and near infrared (NIR) light. Yield potential for a crop is identified using a vegetative index known as NDVI (normalized difference vegetative index) and an environmental factor. Normalized Difference Vegetative Index is commonly used to measure plant health and vigour. The NDVI was calculated using the equation (Rouse *et al.*, 1974).

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

The light generated is reflected off of the crop and measured by a photodiode located at the front of the sensor head. Optimal sensing height is 2-3 feet above the plant.

3.7.1.8 Growing degree days

This is usually done by taking the maximum and minimum temperatures for the day, adding them together and dividing by 2. The base temperature is then subtracted from the mean temperature to give a daily GDD. T_{base} used for rice is 10°C.

$$GDD = \frac{T_{max} + T_{min}}{2} - T_{base}$$

Accumulated GDD (heat units) for different cultivars

Variety	GDD (⁰ days)			
	2015	2016	Pooled	summer
Gangavathi sona (GGV 0501)	3431	2855	3143	3002
MTU-1010	3311	2936	3123	-
BPT-5204	3646	3115	3380	3265
RNR 15048	-	-	-	2677

3.7.1.9 Heat use efficiency

The data on GGDs accumulation was further used to calculate heat use efficiency index (Rajput, 1980) as under,

$$\text{Heat use efficiency (kg ha}^{-1} \text{ }^{\circ}\text{C}^{-1}\text{day)} = \frac{\text{Grain yield or Total dry matter (kg ha}^{-1}\text{)}}{\text{Accumulated heat units (}^{\circ}\text{C day)}}$$

3.7.2 Observation on yield parameters and yield

3.7.2.1 Number of productive tillers per square meter

Number of panicles per square meter were counted at harvest from each treatment at random and expressed as number of panicles per square meter.

3.7.2.2 Number of tillers per square meter

Number of tillers per square meter were counted at harvest from each treatment at random and expressed as number of tillers per square meter.

3.7.2.3 Number of unproductive tillers per square meter

Numbers of unproductive tillers per square meter were counted at harvest from each treatment at random and expressed barren tillers per square meter.

3.7.2.4 Panicle length (cm)

Length of panicle from five panicles selected at random in each plot was recorded from base to tip of panicles and the mean was computed and expressed in centimetres.

3.7.2.5 Number of filled, unfilled and total grains per panicle

Filled, unfilled and total number of grains panicle⁻¹ was determined by counting the grains in five panicles of randomly selected plants and mean was calculated.

3.7.2.6 Sterility percentage

It is the proportion of number of unfilled spikelets per panicle to the total number of grains per panicle and expressed in percentage.

$$\text{Sterility percentage} = \frac{\text{Number of filled grains per panicle}}{\text{Total number of grains per panicle}} \times 100$$

3.7.2.7 Test weight (g 1000⁻¹ seed)

From the seed yield of each net plot, 1000 seeds were randomly counted and weight was recorded and expressed in grams.

3.7.2.8 Grain yield plant⁻¹

The selected five plants in the net plot was harvested, threshed and dried in sun. The grains were cleaned and weight was recorded and converted into g plant⁻¹.

3.7.2.9 Grain yield (kg ha⁻¹)

The crop in the net plot was harvested, threshed and dried in sun. The grains were cleaned and weight was recorded and converted into kg per hectare.

3.7.2.10 Straw yield (kg ha⁻¹)

The straw from net plot after threshing was dried in sun, weighed and converted into kg per hectare.

3.7.2.11 Harvest index

Harvest index was calculated by the formula as outlined by Donald (1962).

$$\text{Harvest index} = \frac{\text{Grain yield (kg ha}^{-1}\text{)}}{\text{Grain yield (kg ha}^{-1}\text{)} + \text{Straw yield (kg ha}^{-1}\text{)}}$$

3.8 Chemical analysis of soil samples

During the field experimentation, a composite soil sample was collected from experimental plot before sowing and after harvest from each net plot. The collected soil samples were air dried under shade, powdered using pestle and mortar and passed through 2 mm sieve and preserved for analysis. For organic carbon analysis, the 2 mm sieved soil samples were subjected for further grinding and passed through 0.2 mm sieve.

The samples were analysed for pH, electrical conductivity (EC), organic carbon, available nutrient status (N, P, K, Fe, Mn, Cu and Zn). The procedure adopted for analysis of soil samples are detailed below.

3.8.1 Soil texture

Texture of soil was determined by International pipette method (Piper, 1966). The textural class was determined using textural triangle.

3.8.2 pH

The pH of soil before sowing and after harvest was analyzed by using potentiometer (Jackson, 1973).

3.8.3 Electrical conductivity (d Sm^{-1})

The soil samples of the experimental site, before sowing and after harvest were analyzed for EC by conductivity method using conductometer (EC Bridge) (Jackson, 1973).

3.8.4 Organic carbon (%)

A known weight (0.5 g) of 0.2 mm sieved soil was treated with a known excess volume of chromic acid ($\text{K}_2\text{Cr}_2\text{O}_7 + \text{H}_2\text{SO}_4$). After oxidation of organic carbon, the un-reacted $\text{K}_2\text{Cr}_2\text{O}_7$ left in the contents was back titrated against standard ferrous ammonium sulphate solution using diphenylamine indicator (Walkley and Black, 1934).

3.8.5 Available nitrogen

Available nitrogen in soil was determined by alkaline potassium permanganate method as described by Subbaiah and Asija (1956).

3.8.6 Available phosphorus

Available phosphorus was extracted from soil using Olsen extractant and the concentration of phosphorus present in the extract was determined by stannous chloride reduced molybdophosphoric blue colour method in HCl system (Jackson, 1973).

3.8.7 Available potassium

Available potassium was extracted from soil using neutral normal ammonium acetate (NH₄OAc) (at 1:5 soil: NH₄OAc ratio) and the concentration of potassium present in the extract was determined by flame photometry as described by Jackson (1973).

3.8.8 DTPA extractable Cu, Fe, Mn and Zn (mg kg⁻¹)

Cationic micronutrients viz., copper, iron, manganese and zinc were extracted by DTPA (Diethylene Triamine Penta Acetic Acid) extractant method (Lindsay and Norvell, 1978).

3.9 Analysis of plant sample

3.9.1 Collection and preparation of plant samples

The collected plant samples at the time of harvest by uprooting were dried at 60° C in a hot air oven till constant weight was reached, then powdered using a grinder fitted with stainless steel blades and preserved in polythene covers for further analysis. The straw N, P, K, Zn, Fe, Cu and Mn are presented in Appendix I while those of grain contents were presented in Experimental results chapter

3.9.2 Nitrogen

Total nitrogen in plant samples was determined by Kjeldhal's method as described by Jackson (1973). In this method, a powdered sample of 0.5 g was digested with concentrated H₂SO₄ in presence of digestion mixture (K₂SO₄:CuSO₄.5H₂O: Se in the proportion of 100:20:1) and distilled under alkaline medium. The liberated NH₃ was trapped in boric acid containing mixed indicator and titrated against standard H₂SO₄.

Digestion of plant samples with di-acid mixture

A powdered sample of 0.5 g was pre-digested with 5 ml of concentrated HNO₃ and again digested with a di-acid mixture (HNO₃: HClO₄ in 10:4 ratio). Volume of the

digest was made up to 100 ml with distilled water and preserved for P and K analysis (Jackson, 1973).

3.9.3 Phosphorus

The total phosphorus content in plant sample was determined by taking a known volume of the digested samples by adopting the Vanado molybdo phosphoric yellow colour method as described by Jackson (1973).

3.9.4 Potassium

The total potassium content of the di-acid digested plant samples were estimated by atomizing the digested and diluted sample to a calibrated flame photometer Jackson (1973).

3.9.5 Micronutrients (Cu, Fe, Zn and Mn)

Micronutrients (Cu, Fe, Zn and Mn) concentration in the di-acid extract was determined using Atomic Absorption Spectrophotometer (AAS) under suitable measuring conditions (Page *et al.*, 1982).

3.9.6 Grain protein content (%)

Protein content the protein content of foods has been determined on the basis of total nitrogen content, while the Kjeldahl (or similar) method has been almost universally applied to determine nitrogen content (AOAC, 2000). Nitrogen content is then multiplied by a factor to arrive at protein (FAO, 2003).

$$\text{Protein (\%)} = \text{N} \times 5.95$$

3.9.7 Uptake of nutrients by grain and straw of rice

The uptake of nutrients by different parts of rice plants was worked out by multiplying the nutrient content (%) and dry matter yield of the plant parts using the following formulae;

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (\%)}}{100} \times \text{Dry weight (kg ha}^{-1}\text{)}$$

3.10 Economic analysis

3.10.1 Cost of cultivation (₹ ha⁻¹)

The price of inputs that were prevailing at the time of their use was considered to work out the cost of cultivation. The cost of cultivation was worked out considering the material inputs like seed, manure, fertilizer, plant protection chemicals, *etc.* and labour input for all the operations. Treatment-wise cost of cultivation was worked out and prescribed in appendix III and IV.

3.10.2 Returns

Utility of adopting different practices were computed by working out economics. The price of the crop products prevailing in the market after the harvest was obtained from the Agriculture Produce Market Committee, Raichur and was used for the calculation of gross returns.

$$\begin{aligned}\text{Gross Returns (₹ ha}^{-1}\text{)} &= \text{Total values of the produce (both grain and straw)} \\ &= (\text{Grain yield X grain price, ₹}) + (\text{Straw yield X straw price, ₹})\end{aligned}$$

$$\text{Net returns (₹ ha}^{-1}\text{)} = \text{Gross returns (₹ ha}^{-1}\text{)} - \text{Cost of cultivation (₹ ha}^{-1}\text{)}$$

$$\text{Benefit cost ratio} = \frac{\text{Gross returns (₹ ha)}}{\text{Net returns (₹ ha)}}$$

3.11 Statistical analysis of data

The experimental data obtained were subjected to statistical analysis adopting Fisher's method of analysis of variance as outlined by Gomez and Gomez (1984). The level of significance used in F test was at 5 per cent. Critical Difference (CD) values are given for the data at 5 per cent level of significance, wherever the F test was significant. The means were subjected for DMRT to draw inference.

IV. EXPERIMENTAL RESULTS

The results of investigation on “Yield maximization of direct seeded rice (DSR) under Tunga Bhadra Project Irrigation Command” comprising of two field experiments conducted twice during rainy seasons and once in summer during the growing seasons of 2014-15 and 2015-16 at Agricultural Research Station, Dhadesugur, Ballari, Karnataka under irrigation are presented in this chapter. Overall, variations in pooled data were highlighted unless otherwise individual years behaved differently.

4.1. Experiment 1. Response of rice genotypes to seed rates and micronutrients under direct seeded condition

4.1.1 Rainy season

4.1.1.1 Growth parameters

The data on growth components of rice viz., plant height, number of tillers m⁻¹, number of tillers m⁻², leaf area, leaf area index, dry matter production and its accumulation in leaves, stem and panicles, SPAD and Green seeker values, heat use efficiency and days' to 50 per cent flowering as influenced by different treatments are presented here.

4.1.1.1.1 Plant height (cm) (c.f. Table 6-9)

Plant height varied significantly due to cultivars, seed rates (except at 45 days after sowing - DAS and 90 DAS) and use of micronutrients and their interactions (except seed rate X micronutrient interaction at 67 DAS and at harvest) during both the years and on pooled basis as well.

At 45, 67 and 90 DAS and at harvest, cv.MTU 1010 (V₂) recorded significantly higher plant height (32.7, 68.9, 92.0, and 98.0, respectively) followed by cvs. GGV 0501 (31.8, 66.9, 85.6 and 90.5, respectively) and BPT 5204 (27.4, 61.0, 74.0 and 76.6, respectively), and among the seed rates higher plant height (30.7, 66.2, 83.3 and 88.9 respectively) was recorded with the seed rate of 30 kg (S₂); plant height decreased both with lower or higher seed rates (S₁ and S₃) and both were at par. Similarly, use of micronutrients produced significant variations individually and with combined application wherein the latter (M₄ - FeSO₄ + ZnSO₄) resulted in higher plant height (32.0,

68.5, 86.7 and 90.0 respectively), while no application of micronutrient (M_1) recorded significantly lower plant height (29.3, 62.7, 80.9 and 86.3 respectively).

At 45 DAS, among variety and seed rate ($V \times S$), cv. MTU 1010 at 35 kg ha⁻¹ seed rate (V_2S_3) recorded higher plant height (32.7); MTU 1010 at all the seed rates (V_2S_{1-3}) was at par and so were V_1S_{1-3} , while lower plant height was recorded with cv. BPT 5204 irrespective of seed rates used particularly with lower seed rate of 25 kg ha⁻¹ (V_3S_1 -27.2). In variety $\times$ micronutrient ($V \times M$), cv. MTU 1010 with combined application of $FeSO_4 + ZnSO_4$ to soil and foliage (V_2M_4) rerecorded taller plants (34.5). In the absence of micronutrient application plant height decreased irrespective of cultivars used and recorded lower plant height with cv. BPT 5204 (V_3M_1 - 26.4). Similarly, among seed rates and micronutrients, 35 kg seed rate with application of $FeSO_4 + ZnSO_4$ (S_2M_4) recorded higher plant height (32.4) while 25 kg ha⁻¹ seed rate with no micronutrient (S_1M_1) recorded lower plant height (29.1).

The three way interaction revealed significantly higher plant height (35.2) with cv. MTU 1010 sown with 30 kg seed rate and supplied with both $FeSO_4 + ZnSO_4$ ($V_2S_2M_4$), while lower plant height (26.0) was recorded with cv. BPT 5204 sown using 25 kg ha⁻¹ seed rate and supplied with no micronutrient ($V_3S_1M_1$) among all.

At 67 DAS, cv. MTU 1010 at 30 kg ha⁻¹ seed rate (V_2S_2) recorded higher plant height (70.6), closely followed by same variety but with lower seed rate (V_2S_3 - 69.3); while the lowest plant height among all was recorded with cv. BPT 5204 irrespective of seed rates used particularly with higher seed rate of 35 kg ha⁻¹ (V_3S_1 - 59.7). Cv. MTU 1010 with combined application of $FeSO_4 + ZnSO_4$ (V_2M_4) rerecorded higher plant height (71.9) among variety $\times$ micronutrient. In the absence of micronutrient application, plant height decreased irrespective of cultivars used and recorded lower height with cv. BPT 5204 (V_3M_1 - 58.4).

Among all treatment combinations significantly taller plants (73.1) were recorded with cv. MTU 1010 sown using 30 kg seed rate and supplied with both $FeSO_4 + ZnSO_4$ ($V_2S_2M_4$), while lower plant height (57.2) was recorded with cv. BPT 5204 sown using 35 kg ha⁻¹ seed rate and supplied with no micronutrient ($V_3S_3M_1$).

At 90 DAS, two-way interactions due to variety and seed rate were significant and among all cv. MTU 1010 at 30 kg ha⁻¹ seed rate (V_2S_2) recorded taller plants (93.1),

Table 6. Effect of genotypes, seed rates and micronutrients on plant height (cm) at 45 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	30.5 ^{b-j}	33.9 ^{a-c}	27.2 ^j	30.5^c	28.7 ^{i-h}	29.4 ^{a-h}	24.8 ^{g-h}	27.6^b	29.6 ^{e-k}	31.6 ^{a-e}	26.0 ^l	29.1^d
	M ₂	32.3 ^{a-h}	34.1 ^{a-c}	28.6 ^{g-j}	31.7^{a-c}	29.6 ^{a-h}	30.2 ^{a-g}	25.3 ^{f-h}	28.4^{ab}	30.9 ^{c-h}	32.1 ^{a-d}	27.0 ^{i-l}	30.0^{cd}
	M ₃	34.4 ^{ab}	34.4 ^{ab}	30.1 ^{c-j}	33.0^{ab}	30.3 ^{a-g}	32.3 ^{a-c}	25.5 ^{f-h}	29.4^{ab}	32.4 ^{a-e}	33.4 ^{ab}	27.8 ^{hi}	31.2^{a-c}
	M ₄	35.3 ^a	34.9 ^a	30.6 ^{b-j}	33.6^a	32.8 ^{ab}	34.4 ^a	25.2 ^{f-h}	30.8^a	34.0 ^{a-c}	34.7 ^{d-i}	27.9 ^{hl}	32.2^{ab}
S ₂	M ₁	32.7 ^{a-g}	32.5 ^{a-h}	28.1 ^{ij}	31.1^{bc}	29.3 ^{a-h}	27.7 ^{b-h}	24.5 ^h	27.2^b	31.0 ^{a-h}	30.1 ^{a-e}	26.3 ^{kl}	29.1^d
	M ₂	33.9 ^{a-c}	33.9 ^{a-c}	29.6 ^{b-j}	32.5^{a-c}	30.6 ^{a-f}	30.0 ^{a-h}	25.4 ^{f-h}	28.7^{ab}	32.2 ^{a-c}	32.0 ^{a-e}	27.1 ^{i-l}	30.6^{b-d}
	M ₃	33.9 ^{a-c}	34.3 ^{ab}	30.1 ^{c-j}	32.8^{a-c}	30.1 ^{a-g}	30.6 ^{a-f}	25.9 ^{e-h}	28.9^{ab}	32.0 ^{a-j}	32.5 ^{a-e}	28.0 ^{h-l}	30.8^{a-d}
	M ₄	35.3 ^a	35.9 ^a	30.3 ^{b-j}	33.8^a	31.5 ^{a-d}	34.4 ^a	27.0 ^{e-h}	31.0^a	33.4 ^{c-i}	35.2 ^a	28.6 ^{f-l}	32.4^a
S ₃	M ₁	32.1 ^{a-i}	32.8 ^{a-f}	28.5 ^{h-j}	31.1^{a-c}	29.2 ^{a-h}	30.4 ^{a-f}	25.1 ^{f-h}	28.2^{ab}	30.6 ^{b-g}	31.6 ^{b-f}	26.8 ^{h-l}	29.7^{cd}
	M ₂	32.5 ^{a-h}	33.5 ^{a-d}	28.9 ^{f-j}	31.6^{a-c}	30.3 ^{a-g}	31.3 ^{a-e}	25.7 ^{f-h}	29.1^{ab}	31.4 ^{a-c}	32.3 ^{a-e}	27.3 ^{i-l}	30.3^{cd}
	M ₃	33.1 ^{a-e}	34.4 ^{ab}	29.3 ^{e-j}	32.3^{a-c}	32.1 ^{a-c}	31.9 ^{a-d}	25.8 ^{e-h}	29.9^{ab}	32.6 ^{b-f}	33.2 ^{a-d}	27.5 ^{i-l}	31.1^{a-c}
	M ₄	33.8 ^a	34.9 ^a	30.1 ^{c-j}	32.9^{a-c}	29.1 ^{a-h}	32.4 ^{a-c}	26.4 ^{d-h}	29.3^{ab}	31.5 ^{b-f}	33.7 ^{a-c}	28.2 ^{g-l}	31.1^{a-c}
Variety		33.3^a	34.1^a	29.3^b		30.3^a	30.3^a	31.3^a		31.8^a	32.7^a	27.4^b	
		Variety x Seed rate (V x S)			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	33.1 ^a	34.4 ^a	29.1 ^b	32.2^a	30.3 ^a	31.6 ^a	25.2 ^b	29.0^a	31.7 ^a	33.0 ^a	27.2 ^b	30.6^a
	S ₂	33.9 ^a	34.2 ^a	29.5 ^b	32.5^a	30.3 ^a	30.7 ^a	25.7 ^b	28.9^a	32.1 ^a	32.4 ^a	27.6 ^b	30.7^a
	S ₃	32.9 ^a	33.9 ^a	29.2 ^b	32.0^a	30.2 ^a	31.2 ^a	25.8 ^b	29.1^a	31.5 ^a	32.7 ^a	27.5 ^b	30.6^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	31.8 ^{cd}	33.1 ^{a-c}	27.9 ^f	30.9^c	29.0 ^b	29.2 ^b	24.8 ^c	27.7^c	30.4 ^d	31.1 ^{cd}	26.4 ^f	29.3^c
	M ₂	32.9 ^{bc}	33.9 ^{a-c}	29.0 ^{ef}	31.9^{bc}	30.1 ^b	30.4 ^b	25.5 ^c	28.7^{bc}	31.5 ^{b-d}	32.1 ^{b-d}	27.2 ^{ef}	30.3^b
	M ₃	33.8 ^{a-c}	34.4 ^{ab}	29.8 ^{a-f}	32.7^{ab}	30.8 ^b	31.6 ^{ab}	25.7 ^c	29.4^{ab}	32.3 ^{bc}	33.0 ^{ab}	27.8 ^{ef}	31.0^b
	M ₄	34.4 ^{ab}	35.3 ^a	30.3 ^{de}	33.3^a	31.1 ^{ab}	33.7 ^a	26.2 ^c	30.3^{ab}	33.0 ^{ab}	34.5 ^a	28.5 ^e	32.0^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.5				0.8				0.4			
Seed (S)		0.4				0.6				0.3			
Micro (M)		0.4				0.5				0.5			
V x S		0.7				1.1				0.5			
V x M		0.7				0.9				0.6			
S x M		0.7				0.9				0.6			
V x S x M		1.2				1.6				0.9			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 7. Effect of genotypes, seed rates and micronutrients on plant height (cm) at 67 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	62.7 ^{c-i}	63.8 ^{b-i}	58.9 ^{b-i}	61.8^d	66.5 ^{a-i}	67.1 ^{a-h}	59.9 ^{hi}	64.5^{a-d}	64.6 ^{e-m}	65.5 ^{c-l}	59.4 ^{h-m}	63.2^{cd}
	M ₂	64.0 ^{b-i}	67.9 ^{a-e}	60.7 ^{e-i}	64.2^{b-d}	69.6 ^{a-e}	69.1 ^{a-g}	61.8 ^{d-i}	66.8^{a-c}	66.8 ^{b-j}	68.5 ^{a-g}	61.3 ⁱ⁻ⁿ	65.5^{cd}
	M ₃	66.7 ^{a-g}	70.5 ^{a-c}	61.8 ^{d-i}	66.3^{a-c}	71.3 ^{a-c}	72.2 ^{ab}	62.2 ^{d-i}	68.6^{a-c}	69.00 ^{a-f}	71.4 ^{a-c}	62.00 ^{g-n}	67.5^d
	M ₄	67.7 ^{a-e}	71.3 ^{ab}	65.7 ^{a-h}	68.2^{ab}	71.5 ^{a-c}	72.5 ^a	63.8 ^{a-i}	69.3^a	69.6 ^{a-f}	72.00 ^{ab}	64.8 ^{d-m}	68.8^{bc}
S ₂	M ₁	68.3 ^{a-e}	67.2 ^{a-f}	57.2 ⁱ	64.2^{b-d}	60.4 ^{f-i}	69.00 ^{a-g}	60.2 ^{g-i}	63.2^{cd}	64.3 ^{f-m}	68.1 ^{a-h}	58.7 ^{mn}	63.7^{bc}
	M ₂	69.1 ^{a-d}	71.5 ^{a-c}	57.4 ⁱ	66.0^{a-d}	63.3 ^{b-i}	69.5 ^{a-g}	60.2 ^{g-i}	64.3^{b-d}	66.2 ^{b-j}	70.5 ^{a-f}	58.8 ^{mn}	65.2^{b-d}
	M ₃	70.1 ^{a-c}	71.7 ^{ab}	58.7 ^{hi}	66.8^{a-c}	64.5 ^{a-i}	70.1 ^{a-d}	62.8 ^{c-i}	65.8^{a-c}	67.3 ^{a-i}	70.9 ^{a-d}	60.7 ^{j-n}	66.3^{a-c}
	M ₄	70.3 ^{a-c}	73.7 ^a	66.0 ^{a-h}	70.0^a	65.3 ^{a-i}	72.5 ^a	68.3 ^{a-h}	68.7^{ab}	67.8 ^{a-h}	73.1 ^a	67.2 ^{a-h}	69.4^{a-c}
S ₃	M ₁	63.9 ^{b-i}	67.6 ^{a-e}	56.6 ⁷ⁱ	62.7^{cd}	60.7 ^{e-i}	61.7 ^{d-i}	57.8 ⁱ	60.1^d	62.3 ^{g-n}	64.4 ^{e-m}	57.2 ⁿ	61.3^{bc}
	M ₂	67.6 ^{a-e}	68.6 ^{a-e}	59.5 ^{f-i}	65.2^{b-d}	67.6 ^{a-i}	62.7 ^{c-i}	59.9 ^{ho}	63.4^{cd}	67.6 ^{a-h}	65.7 ^{c-k}	59.7 ^{k-n}	64.3^a
	M ₃	68.5 ^{a-e}	69.6 ^{ad}	59.9 ^{f-i}	66.0^{a-d}	68.2 ⁱ	62.7 ^{c-i}	59.4 ^{hi}	63.4^{cd}	68.3 ^{a-g}	66.2 ^{b-j}	59.7 ^{k-n}	64.7^a
	M ₄	68.5 ^{a-e}	71.9 ^{ab}	61.4 ^{d-i}	67.3^{ab}	70.1 ^{a-d}	69.3 ^{a-f}	63.3 ^{b-i}	67.6^{a-c}	69.3 ^{a-f}	70.6 ^{a-e}	62.4 ^{g-n}	67.4^a
Variety		67.3^a	69.6^a	60.3^b		66.6^a	68.2^a	61.6^b		66.9^b	68.9^a	61.0^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	65.3 ^a	68.4 ^a	61.8 ^{bc}	65.6^a	69.7 ^a	70.3 ^a	61.9 ^{bc}	67.0^a	67.5 ^{ab}	69.3 ^b	61.9 ^c	66.2^a
	S ₂	69.4 ^a	71.0 ^a	59.8 ^c	66.8^a	63.4 ^{bc}	70.3 ^a	62.9 ^{bc}	66.0^a	66.4 ^b	70.6 ^a	61.4 ^c	66.1^a
	S ₃	67.1 ^{ab}	69.3 ^a	59.4 ^c	65.3^a	66.6 ^{ab}	54.1 ^a	60.1 ^c	60.0^a	66.9 ^b	60.7 ^a	59.7 ^c	62.4^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	64.9 ^{de}	66.0 ^{c-e}	57.6 ^f	62.8^c	62.5 ^{bb-e}	65.9 ^{a-c}	59.3 ^e	62.6^b	63.7 ^{de}	66.0 ^{cd}	58.4 ^f	62.7^c
	M ₂	66.9 ^{b-e}	69.4 ^{a-c}	59.2 ^f	65.1^b	66.8 ^{ab}	67.1 ^{ab}	60.6 ^{de}	64.8^{ab}	66.9 ^{b-d}	68.0 ^{bc}	59.9 ^f	65.0^b
	M ₃	68.4 ^{a-e}	70.6 ^{ab}	60.1 ^f	66.4^{ab}	68.0 ^a	68.3 ^a	61.5 ^a	65.9^a	68.2 ^{bc}	69.5 ^{ab}	60.8 ^{ef}	66.1^b
	M ₄	68.8 ^{a-d}	72.3 ^a	64.4 ^e	68.5^a	68.9 ^a	61.5 ^{c-e}	65.1 ^a	65.2^a	68.9 ^{a-c}	71.9 ^a	64.8 ^d	68.5^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		1.0				0.5				0.7			
Seed (S)		1.0				0.9				0.6			
Micro (M)		0.8				0.8				0.6			
V x S		1.8				1.6				1.1			
V x M		1.3				1.5				1.0			
S x M		1.3				1.5				1.0			
V x S x M		2.3				2.6				1.8			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 8. Effect of genotypes, seed rates and micronutrients on plant height (cm) at 90 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	83.9 ^{de}	91.2 ^{a-c}	69.3 ^h	81.4^d	77.0 ^{h-n}	84.6 ^{b-h}	65.0 ^o	78.91^e	80.5 ^{g-i}	87.9 ^{b-f}	67.1 ^k	78.5^e
	M ₂	88.8 ^{cd}	92.3 ^{a-c}	73.3 ^{jh}	84.8^{cd}	78.1 ^{h-n}	88.0 ^{a-f}	70.6 ^{no}	82.26^{de}	83.5 ^{e-g}	90.1 ^{a-e}	71.9 ^{jk}	81.8^{c-e}
	M ₃	89.1 ^{cd}	95.3 ^{a-c}	73.4 ^{gh}	86.0^{bc}	76.1 ^{h-n}	90.1 ^{a-d}	71.3 ^{m-o}	83.04^{c-e}	82.6 ^{f-h}	92.7 ^{a-d}	72.4 ^{jk}	82.6^{cd}
	M ₄	90.3 ^{cd}	94.6 ^{a-c}	75.1 ^{f-h}	86.7^{bc}	82.4 ^{d-j}	91.5 ^{a-c}	74.3 ^{g-n}	84.98^{a-d}	86.3 ^{d-g}	93.0 ^{a-d}	74.7 ^{ij}	84.7^{a-d}
S ₂	M ₁	89.5 ^{cd}	90.7 ^{a-d}	74.8 ^{i-h}	85.0^{cd}	80.3 ^{e-l}	87.0 ^{a-g}	72.7 ^{k-o}	82.86^{b-e}	84.9 ^{e-g}	88.9 ^{b-f}	73.8 ^{ji}	82.5^{cd}
	M ₂	91.2 ^{a-c}	93.5 ^{a-c}	76.4 ^{fg}	87.0^{bc}	81.5 ^{d-k}	93.0 ^{ab}	72.9 ^{k-o}	85.07^{a-d}	86.3 ^{d-g}	93.2 ^{a-d}	74.0 ^{ij}	84.5^{a-d}
	M ₃	92.0 ^{a-c}	94.7 ^{a-c}	77.2 ^{fg}	88.0^{a-c}	82.7 ^{d-j}	93.3 ^{ab}	74.2 ^{j-n}	86.02^{a-c}	87.9 ^{b-f}	94.0 ^{ab}	75.7 ^{ij}	85.9^{a-c}
	M ₄	94.4 ^{a-c}	97.8 ^a	80.9 ^{ef}	91.0^a	83.5 ^{c-i}	94.8 ^a	79.1 ^{g-n}	88.78^a	88.9 ^{b-f}	96.3 ^a	80.0 ^{g-i}	88.4^a
S ₃	M ₁	90.5 ^{b-d}	90.4 ^{b-d}	72.7 ^{gh}	84.6^{cd}	79.7 ^{f-m}	85.0 ^{b-h}	71.4 ^{j-o}	82.04^{c-e}	85.1 ^{e-g}	87.7 ^{b-f}	72.1 ^{jk}	81.6^{de}
	M ₂	91.3 ^{a-c}	92.1 ^{a-c}	74.0 ^{gh}	85.8^{bc}	79.8 ^{f-m}	89.1 ^{a-e}	73.3 ^{k-o}	83.62^{b-d}	85.6 ^{e-g}	90.6 ^{a-c}	73.7 ^{ij}	83.3^{b-d}
	M ₃	92.0 ^{a-c}	94.9 ^{a-c}	75.1 ^{fh}	87.3^{a-c}	81.6 ^{d-k}	92.9 ^{ab}	75.3 ⁱ⁻ⁿ	85.59^{a-c}	86.8 ^{c-g}	93.8 ^{a-c}	75.5 ^{ij}	85.4^{a-d}
	M ₄	93.9 ^{a-c}	97.5 ^{ab}	77.2 ^{fg}	89.5^{ab}	82.6 ^{d-k}	94.5 ^a	76.1 ^{h-n}	87.33^{ab}	88.5 ^{b-f}	96.0 ^a	76.6 ^{k-j}	87.0^{ab}
Variety		90.6^a	93.8^a	75.0^a		80.4^b	90.3^a	73.0^c		85.6^b	92.0^a	74.0^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	88.0 ^b	93.6 ^a	72.8 ^d	84.8^b	78.4 ^{bc}	88.5 ^a	70.3 ^e	79.1 ^b	83.2 ^b	90.9 ^a	71.5 ^d	81.9^a
	S ₂	91.8 ^a	94.2 ^a	77.3 ^c	87.8^a	82.0 ^b	92.0 ^a	74.7 ^{cd}	82.9 ^a	80.9 ^b	93.1 ^a	76.0 ^c	83.3^a
	S ₃	91.9 ^a	93.7 ^a	74.9 ^{cd}	86.9^a	80.9 ^b	90.4 ^a	74.0 ^{de}	81.8 ^a	80.4 ^b	92.0 ^a	74.5 ^{cd}	82.3^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	88.0 ^d	90.8 ^{cd}	72.3 ^f	83.7^b	79.0 ^c	85.5 ^b	69.7 ^b	78.1 ^b	83.5 ^e	88.2 ^{cd}	71.0 ^f	80.9^c
	M ₂	90.4 ^{cd}	92.6 ^{bc}	74.6 ^{ef}	85.9^a	79.8 ^c	90 ^a	72.3 ^b	80.7 ^a	85.1 ^{de}	91.3 ^{bc}	73.4 ^f	83.3^b
	M ₃	91.0 ^{cd}	95.0 ^{ab}	75.4 ^{ef}	87.2^c	80.2 ^c	92.1 ^a	73.6 ^b	82.0 ^a	85.6 ^{de}	93.5 ^{ab}	74.5 ^{fg}	84.5^b
	M ₄	92.9 ^{bc}	96.6 ^a	77.7 ^c	89.1^c	82.8 ^{bc}	93.6 ^a	70.5 ^b	82.3 ^a	87.8 ^{cd}	95.1 ^a	77.1 ^f	86.7^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.9				2.7				1.2			
Seed (S)		0.7				0.6				0.6			
Micro (M)		0.8				1.0				0.6			
V x S		1.3				1.1				1.0			
V x M		1.5				1.8				1.2			
S x M		1.5				1.8				1.2			
V x S x M		2.6				3.2				2.1			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 9. Effect of genotypes, seed rates and micronutrients on plant height (cm) at harvest under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	93.7 ^{ef}	94.3 ^{c-f}	75.5 ^g	87.8^c	80.8 ^{i-k}	92.5 ^{a-f}	73.8 ^{kl}	82.4^a	87.3 ^{gh}	93.4 ^{c-f}	74.4 ⁱ	85.0^d
	M ₂	93.8 ^{ef}	96.9 ^{b-f}	76.7 ^g	89.1^{bc}	83.8 ^{h-j}	94.8 ^{a-c}	77.8 ^{j-l}	85.5^a	88.8 ^{f-h}	95.8 ^{b-e}	77.3 ⁱ	87.3^{ab-d}
	M ₃	95.4 ^{c-f}	101.8 ^{a-e}	76.2 ^g	91.1^{abc}	86.5 ^{e-i}	91.6 ^{b-g}	73.8 ^{kl}	84.0^a	91.0 ^{e-h}	96.7 ^{a-d}	76.0 ⁱ	87.9^{b-d}
	M ₄	93.4 ^{ef}	105.9 ^a	80.2 ^g	93.2^{ab}	81.0 ^{i-k}	94.2 ^{a-d}	73.8 ^{kl}	83.0^a	87.2 ^h	100.1 ^{ab}	77.0 ⁱ	88.1^{b-d}
S ₂	M ₁	94.4 ^{c-f}	94.1 ^{ad-f}	75.9 ^g	88.1^{bc}	84.5 ^{g-j}	92.8 ^{a-f}	74.5 ^{kl}	83.9^a	89.5 ^{f-h}	93.4 ^{c-f}	75.2 ⁱ	86.0^{cd}
	M ₂	96.0 ^{c-f}	103.0 ^{a-d}	76.7 ^g	91.9^{abc}	86.0 ^{f-i}	93.7 ^{a-e}	74.5 ^{kl}	84.7^a	91.0 ^{e-h}	98.4 ^{a-c}	75.4 ⁱ	88.2^{bc}
	M ₃	99.1 ^{a-f}	100.7 ^{a-f}	79.7 ^g	93.1^{ab}	85.8 ^{f-i}	95.3 ^{a-c}	75.7 ^{kl}	85.6^a	92.4 ^{d-h}	98.0 ^{a-d}	77.7 ⁱ	89.4^{ab}
	M ₄	99.4 ^{a-f}	107.6 ^a	81.3 ^g	96.1^a	87.7 ^{c-i}	96.3 ^{ab}	76.0 ^{kl}	86.7^a	93.5 ^{c-f}	102.0 ^a	78.7 ⁱ	91.4^a
S ₃	M ₁	91.9 ^f	101.4 ^{a-e}	81.8 ^g	91.4^{abc}	86.7 ^{d-i}	90.6 ^{b-h}	74.3 ^{kl}	83.8^a	89.3 ^{f-h}	96.0 ^{b-e}	77.7 ⁱ	87.7^{b-d}
	M ₂	94.0 ^{ef}	103.2 ^{a-c}	77.1 ^g	91.4^{abc}	91.8 ^{b-g}	94.9 ^{a-c}	72.8 ^l	86.5^a	92.9 ^{d-h}	99.1 ^{ab}	75.5 ⁱ	89.2^{a-c}
	M ₃	95.3 ^{c-f}	105.4 ^{ab}	76.5 ^g	93.4^{abc}	84.8 ^{g-j}	94.0 ^{a-e}	74.3 ^{kl}	84.3^a	90.0 ^{c-f}	99.7 ^{ab}	77.4 ⁱ	88.4^{a-c}
	M ₄	95.9 ^{c-f}	106.2 ^a	81.1 ^g	94.4^a	89.0 ^{b-h}	99.9 ^a	75.2 ^{kl}	88.0^a	92.5 ^{b-e}	101.1 ^{ab}	78.1 ⁱ	90.5^{ab}
Variety		95.2^a	101.7^a	78.4^b		85.7^b	94.2^a	74.7^c		90.5^b	98.0^a	76.6^c	
		Variety x Seed rate (V x S)			S	Variety x Seed rate(V x S)			S	Variety x Seed rate(V x S)			S
S	S ₁	94.1 ^c	99.74 ^{ab}	77.6 ^d	90.5^a	83.0 ^b	93.3 ^a	74.8 ^c	83.7^a	88.6 ^b	96.5 ^a	76.2 ^c	87.1^b
	S ₂	97.2 ^{bc}	101.4 ^{ab}	78.3 ^d	92.3^a	86.0 ^b	94.5 ^a	75.2 ^c	85.2^a	91.6 ^b	98.8 ^a	76.7 ^c	88.8^a
	S ₃	94.3 ^c	104.0 ^a	78.9 ^d	92.4^a	88.1 ^b	93.9 ^a	74.2 ^c	85.4^a	91.2 ^b	99.0 ^a	76.6 ^c	88.9^a
		Variety x Micro(V x M)			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	93.3 ^c	96.6 ^c	77.5 ^c	89.2^b	84.0 ^b	91.9 ^a	74.2 ^c	83.4^a	88.7 ^d	94.3 ^c	75.9 ^e	86.3^c
	M ₂	94.6 ^c	101.0 ^a	78.3 ^c	91.3^{ab}	87.2 ^b	94.4 ^a	75.1 ^c	85.6^a	90.0 ^d	97.8 ^b	75.9 ^e	88.2^b
	M ₃	96.6 ^c	102.6 ^a	76.7 ^c	91.9^a	85.7 ^b	93.6 ^a	74.6 ^c	84.6^a	91.1 ^d	98.1 ^b	76.4 ^e	88.6^{ab}
	M ₄	96.2 ^c	102.6 ^a	78.1 ^c	92.3^a	85.9 ^b	95.5 ^a	75.0 ^c	85.5^a	91.1 ^d	101.1 ^a	77.9 ^e	90.0^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		1.8				0.8				1.3			
Seed (S)		0.8				0.9				0.5			
Micro (M)		0.9				0.7				0.6			
V x S		1.5				1.5				0.9			
V x M		1.5				1.3				0.9			
S x M		1.5				1.3				0.9			
V x S x M		2.6				2.3				1.6			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

closely followed by $V_2S_{1\&3}$; while the lower plant height was recorded with cv.BPT 5204 with seed rate of 25 kg ha^{-1} (V_3S_1 - 71.5). Variety X micronutrient revealed significant variations, in that cv. MTU 1010 with $\text{FeSO}_4 + \text{ZnSO}_4$ (V_2M_4) recorded higher plant height (95.1). In the absence of micronutrient application the plant height decreased irrespective of cultivars, in that lower plant height was recorded with cv.BPT 5204 (V_3M_1 - 71.0). Similarly, among seed rates and micronutrients 30 kg seed rate with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) recorded higher plant height (88.4) while 25 kg ha^{-1} seed rate with no supplementation of micronutrient (S_3M_1) recorded lower plant height (78.5).

Overall, the three way interaction at 90 DAS revealed significantly higher plant height (96.3) with cv. MTU 1010 sown with 30 kg seed rate and applied with both $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_2S_2M_4$), while lower plant height (67.1) was recorded with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and not supplied with micronutrient ($V_3S_1M_1$).

At harvest, among variety and seed rate cv. MTU 1010 at 35 kg ha^{-1} seed rate (V_2S_3) recorded higher plant height (99.0), closely followed by V_2S_2 ; while lower plant height was recorded with cv. BPT 5204 with 25 kg ha^{-1} seed rate (V_3S_1 - 76.2) and $V_3S_{1\&3}$ were at par with it. In variety X micronutrient cv. MTU 1010 with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_2M_4) recorded higher plant height (101.1). Among variety X micronutrient lower plant height was recorded with cv. BPT 5204 (V_3M_{1-4}).

Of the third order interactions, significantly higher plant height (102.0) was recorded with cv.MTU 1010 sown using 30 kg ha^{-1} seed rate and supplied with $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_2S_2M_4$), while the lower plant height (74.4) was recorded with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate but not supplied with micronutrient ($V_3S_1M_1$).

4.1.1.1.2 Tiller count (no. m^{-1} length) (c.f. Table 10-12)

Variations in tillers count differed significantly due to cultivars, seed rates and use of micronutrients and their interactions at different stages of crop growth except at harvest during both the years and on pooled basis as well.

At 45, 67, and 90 DAS, among the varieties, cv.MTU 1010 (V_2) (72.0, 100.9 and 134.6, respectively) recorded significantly higher number of tillers followed by cvs. GGV 0501 (V_1 - 58.2, 98.1 and 131.0, respectively) and BPT 5204(V_3 - 44.5, 85.41 and 117.56, respectively); among seed rates significantly higher number of tillers (59.80 ,

102.10 and 128.8, respectively) were recorded with 30 kg ha⁻¹ (S₂) and it was at par with 35 kg ha⁻¹ (S₃) at 45 and 90DAS (58.34 and 128.2, respectively), while lower tiller count (55.97, 88.20 and 126.3, respectively) was observed with lower seed rate (S₁). Similarly, among micronutrients M₄ (FeSO₄+ZnSO₄ to soil and to the foliage) resulted in higher tiller count (65.80, 108.2 and 130.4, respectively); M₃ receiving ZnSO₄ only was at par at 90 DAS, while no micronutrient (M₁) recorded significantly lower count (50.14, 82.50 and 124.8, respectively).

At 45 DAS, cv. MTU 1010 at 35 kg ha⁻¹ seed rate (V₂S₃) among variety and seed rate recorded higher number of tillers (74.9), closely followed by 30 kg ha⁻¹ seed rate (V₂S₂)¹ (72.2); while lower number of tillers among all was recorded with cv. BPT 5204 irrespective of seed rates used particularly with lower seed rate of 25 kg ha⁻¹ (V₃S₁-40.3). Variety X micronutrient revealed significant variations, in that cv. MTU 1010 combined with application of FeSO₄ + ZnSO₄ (V₂M₄) rerecorded higher tiller count (80.6); in the absence of micronutrient tillers decreased irrespective of cultivars used and recorded lower number with cv. BPT 5204 (V₃M₁- 37.8). Similarly, 30 kg seed rate with application of FeSO₄ + ZnSO₄ (S₂M₄) among seed rates and micronutrient recorded higher number of tillers (70.3) among and micronutrients, while no micronutrient recorded lower number of tillers (S₁₋₃M₁) particularly with S₃M₁ (49.8).

At 67 DAS, interaction due to variety and seed rate varied significantly, and cv. GGV 0501 at 30 kg ha⁻¹ seed rate (V₁S₂) recorded higher number of tillers (107.0) followed by V₂S₁ and V₂S₃ (105.7 and 103.0, respectively), while lower number of tillers was recorded with cv. BPT with lower seed rate of 25 kg ha⁻¹ (V₃S₁- 79.5). Interactions due to variety X micronutrients resulted in significant variations, in that cv. MTU 1010 combined with of FeSO₄ + ZnSO₄ (V₂M₄) rerecorded higher number of tillers (113.5); in the absence of micronutrient application number of tillers across cultivars recorded lower number of tillers (75.9) with cv. BPT 5204 (V₃M₁). Similarly, among seed rates and micronutrients 30 kg seed rate with application of FeSO₄ + ZnSO₄ (S₂ M₄) recorded higher number of tillers (119.7), while no supplementation of micronutrient recorded lower number of tillers particularly with S_{1&3}M₁ (75.9 each).

At 90 DAS, in variety and seed rate combinations cv. MTU 1010 at 35 kg ha⁻¹ seed rate (V₂S₃) and 30 kg ha⁻¹ seed rate (V₂S₂) recorded higher number (135.1 and 134.8, respectively), while lower number of tillers among all was recorded with cv. BPT

Table 10. Effect of genotypes, seed rates and micronutrients on number of tillers m⁻¹ at 45 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	59.7 ^{g-j}	66.7 ^{d-h}	35.7 ^o	54.0^{fg}	54.0 ^{g-m}	53.0 ^{h-m}	34.3 ^s	47.1^{fg}	56.8 ^{ij}	59.8 ^{h-j}	35.0 ^o	50.5^g
	M ₂	60.0 ^{g-j}	74.0 ^{c-e}	38.3 ^{no}	57.4^{e-g}	55.7 ^{g-m}	63.8 ^{d-g}	36.0 ^{rs}	51.8^{ef}	57.8 ^{h-j}	68.9 ^{e-g}	37.2 ^{no}	54.6^f
	M ₃	60.3 ^{g-j}	76.0 ^{b-d}	42.7 ^{m-o}	59.7^{d-f}	57.5 ^{f-l}	69.7 ^{b-e}	38.5	55.2^e	58.9 ^{h-j}	72.8 ^{de}	40.6 ^{m-o}	57.4^{a-f}
	M ₄	62.3 ^{g-i}	77.0 ^{a-c}	51.0 ^{j-m}	63.4^{b-d}	59.7 ^{e-j}	72.0 ^{b-d}	45.5 ^{m-r}	59.0^{cd}	61.0 ^{hi}	74.5 ^{c-e}	48.3 ^{k-l}	61.2^{cd}
S ₂	M ₁	58.0 ^{h-k}	65.0 ^{e-i}	40.0 ^{no}	54.3^{fg}	48.2 ^{k-o}	58.1 ^{f-k}	35.3 ^{rs}	47.1^{fg}	53.1 ^{jk}	61.5 ^{hi}	37.6	50.7^g
	M ₂	60.0 ^{g-j}	77.3 ^{c-c}	44.3 ^{j-o}	60.5^{de}	57.5 ^{f-l}	62.7 ^{d-i}	41.0 ^{n-s}	53.7^{de}	58.8 ^{h-j}	70.0 ^{ef}	42.7 ⁿ	57.1^{ef}
	M ₃	65.0 ^{e-i}	72.0 ^{c-f}	46.7 ^{j-n}	61.2^{c-e}	64.3 ^{d-g}	71.5 ^{b-d}	46.3 ^{m-r}	60.7^{bc}	64.7 ^{f-h}	71.8 ^{de}	46.5 ^{ak-m}	60.9^{c-e}
	M ₄	72.7 ^{c-e}	86.7 ^a	54.7 ^{i-l}	71.3^a	71.7 ^{b-d}	84.0 ^a	52.3 ^{t-m}	69.3	78.2 ^{b-d}	85.3 ^a	53.5 ^{j-k}	72.3^a
S ₃	M ₁	47.0 ^{j-n}	69.3 ^{c-g}	43.3 ^{m-o}	53.2^g	37.3 ^{p-s}	59.3 ^{e-j}	38.3 ^{o-s}	45.0	42.2 ^{j-n}	64.3 ^{f-i}	40.8 ^{m-o}	49.1^g
	M ₂	48.3 ^{k-n}	79.3 ^{a-c}	46.7 ^{j-n}	58.1^{d-g}	47.0 ^{l-p}	67.2 ^{c-f}	46.0 ^{m-r}	53.3	47.7 ^{k-m}	73.2 ^{de}	46.3 ^{k-m}	55.7^f
	M ₃	60.3 ^{g-i}	84.3 ^{ab}	54.3 ^{i-j}	66.3^{a-c}	50.5 ^{j-n}	76.0 ^{a-c}	50.5 ^{j-n}	59.0	57.4 ^{h-j}	80.2 ^{a-c}	52.4 ^{jk}	63.3^{bc}
	M ₄	61.3 ^{g-i}	85.0 ^{ab}	54.3 ^{i-j}	66.9^{ab}	63.5 ^{d-n}	78.8 ^{ab}	52.0 ^{j-m}	64.7	62.4 ^{g-i}	81.9 ^{ab}	53.2 ^{jk}	65.8^b
Variety		59.6^b	76.1^a	46.0^c		55.6^b	68.0^a	43.0^c		58.2^b	72.0^a	44.5^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	60.6 ^c	73.4 ^b	41.9 ^f	58.6^a	56.7 ^d	64.6 ^b	38.6 ^f	53.3^c	58.7 ^c	69.0 ^b	40.3 ^f	55.9^b
	S ₂	63.9 ^c	75.3 ^{ab}	46.4 ^{ef}	61.8^a	60.4 ^{cd}	69.1 ^a	63.8 ^{bc}	64.4^a	62.2 ^d	72.2 ^{ab}	45.1 ^e	59.8^a
	S ₃	54.3 ^d	79.5 ^a	49.6 ^{de}	61.1^a	49.6 ^e	70.3 ^a	46.7 ^e	55.5^b	51.9 ^d	74.9 ^a	48.2 ^e	58.3^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	54.9 ^d	67.0 ^c	39.7 ^f	53.8^d	46.5 ^f	58.8 ^d	36.0 ^h	47.1^d	50.7 ^g	61.9 ^{de}	37.8 ^j	50.1^d
	M ₂	56.1 ^d	76.9 ^b	43.1 ^{ef}	58.7^c	53.4 ^{de}	64.6 ^c	41.0 ^{gh}	52.9^c	54.8 ^f	70.7 ^c	42.1 ⁱ	55.8^c
	M ₃	61.9 ^c	77.4 ^b	47.9 ^e	62.4^b	57.4 ^d	72.4 ^b	45.1 ^{fg}	58.3^b	59.7 ^e	74.9 ^b	46.5 ^h	60.3^b
	M ₄	65.4 ^c	82.9 ^a	53.3 ^b	67.2^a	64.8 ^c	78.3 ^a	49.9 ^{ef}	64.3^a	65.2 ^d	80.6 ^a	51.6 ^{fg}	65.8^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		1.0				1.4				0.9			
Seed (S)		1.0				0.7				0.6			
Micro (M)		1.0				1.0				0.7			
V x S		1.8				1.2				1.1			
V x M		1.8				1.8				1.3			
S x M		1.8				1.8				1.3			
V x S x M		3.2				3.7				2.3			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 11. Effect of genotypes, seed rates and micronutrients on number of tillers m⁻¹ at 67 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	87.4 ⁱ⁻ⁿ	82.6 ^{a-n}	77.8 ^{mn}	82.6^e	83.3 ^{e-i}	79.7 ^{f-j}	66.3 ⁱ	76.4^{cd}	85.4 ^{i-o}	81.2 ^{l-o}	72.1 ^o	79.5^f
	M ₂	88.2 ⁱ⁻ⁿ	104.4 ^{d-i}	80.7 ^{l-n}	91.1^d	90.0 ^{d-i}	91.7 ^{d-i}	72.7 ^{hi}	84.8^{bc}	89.1 ^{g-o}	98.0 ^{b-l}	76.7 ^{m-o}	87.9^e
	M ₃	90.8 ^{h-m}	99.33 ^{e-k}	96.4 ^{f-l}	95.5^d	91.0 ^{d-i}	95.0 ^{a-h}	74.7 ^{g-i}	86.9^{bc}	90.9 ^{g-m}	97.2 ^{e-l}	81.6 ^{k-o}	89.9^e
	M ₄	99.1 ^{e-k}	104.6 ^{d-i}	89.8 ^{h-n}	97.8^{cd}	97.0 ^{b-h}	96.3 ^{b-h}	85.0 ^{e-i}	92.7^b	98.1 ^{d-k}	100.5 ^{d-i}	87.4 ^{h-o}	95.3^{de}
S ₂	M ₁	94.8 ^{g-m}	92.0 ^{g-m}	87.7 ⁱ⁻ⁿ	91.5^d	87.0 ^{d-i}	89.0 ^{d-i}	79.7 ^{f-i}	85.2^{bc}	90.9 ^{g-m}	90.5 ^{g-m}	83.5 ^{j-o}	88.3^e
	M ₂	99.9 ^{e-j}	94.8 ^{g-m}	91.6 ^{f-l}	95.4^{cd}	97.0 ^{b-h}	94.7 ^{c-h}	86.3 ^{d-i}	92.6^b	98.5 ^{d-j}	94.8 ^{e-l}	89.0 ^{g-n}	94.1^{de}
	M ₃	115.5 ^{a-e}	108.9	96.4 ^{f-l}	106.9^b	112.7 ^{a-d}	108.7 ^{a-e}	96.0 ^{b-h}	105.8^a	114.1 ^{a-d}	108.8 ^{b-f}	96.2 ^{e-j}	106.7^{bc}
	M ₄	126.4 ^{ab}	130.4 ^a	106.8 ^{c-h}	121.2^a	122.3 ^{ab}	127.3 ^a	104.7 ^{a-f}	118.1^a	124.4 ^{ab}	128.9 ^a	105.7 ^{d-g}	119.7^a
S ₃	M ₁	73.3 ⁿ	98.7 ^{e-k}	73.3 ⁿ	81.8^e	73.0 ^{hi}	88.0 ⁱ	70.7 ^{hi}	77.2^{cd}	73.2 ^{no}	93.4 ^{e-l}	72.0 ^o	79.5^f
	M ₂	90.6 ^{h-m}	102.6 ^{e-i}	82.9 ^o	92.0^d	74.3 ^{g-i}	102.3 ^{a-f}	80.0 ^{f-i}	85.5^{bc}	82.5 ^{j-o}	102.5 ^{d-h}	81k-o5 ^a	88.8^e
	M ₃	119.5 ^{a-d}	106.8 ^{c-h}	84.2 ^{j-n}	103.5^{bc}	97.7 ^{b-h}	103.0 ^{a-f}	83.0 ^{e-i}	94.5^d	108.4 ^{c-f}	104.9 ^{d-g}	83.6 ^{j-o}	98.9^{cd}
	M ₄	122.4 ^{a-c}	112.5 ^{b-f}	90.2 ^{h-m}	108.3^b	121.3 ^{ab}	109.7 ^{a-e}	101.0 ^{b-g}	110.6^a	121.9 ^{a-c}	111.1 ^{b-e}	95.6 ^{e-l}	109.5^b
Variety		100.6^a	103.1^a	88.1^b		95.5^a	98.2^a	83.3^b		98.1^a	100.9^a	85.4^b	
Variety x Seed rate					S	Variety x Seed rate				S	Variety x Seed rate		
S	S ₁	91.4 ^{cd}	97.76 ^{bc}	84.2 ^d	91.1^b	90.3 ^{bc}	90.7 ^{bc}	74.7 ^{ad}	85.2^c	90.87 ^b	94.22 ^b	79.5 ^c	88.2^c
	S ₂	109.2 ^a	106.5 ^{ab}	95.5 ^{bc}	103.7^a	104.8 ^a	104. ^a	91.7 ^{bc}	100.7^a	107.0 ^a	105.7 ^a	93.6 ^b	102.1^a
	S ₃	101.3 ^{a-c}	105.2 ^{ab}	82.6 ^d	96.39^b	91.6 ^{bc}	100.8 ^{ab}	83.7 ^{cd}	92.0^b	96.5 ^b	103.0 ^a	83.2 ^c	94.2^b
Variety x Micro					M	Variety x Micro				M	Variety x Micro		
M	M ₁	85.2 ^{ef}	91.15 ^{de}	79.5 ^f	85.2^d	81.1 ^{ef}	85.6 ^{d-f}	72.2 ^f	79.6^d	83.2 ^{de}	88.4 ^{cd}	75.9 ^e	82.5^d
	M ₂	92.9 ^{c-e}	100.6 ^{bc}	85.1 ^{ef}	92.8^c	87.1 ^{c-e}	96.2 ^{b-d}	79.7 ^{ef}	87.6^c	90.0 ^{cd}	98.4 ^b	82.4 ^{de}	90.2^c
	M ₃	108.5 ^{ab}	105.0 ^b	89.7 ^{de}	101.0^b	100.4 ^{a-c}	102.2 ^{ab}	84.6 ^{d-f}	95.7^b	104.5 ^b	103.6 ^b	87.1 ^d	98.4^b
	M ₄	116.0 ^a	115.8 ^a	95.63 ^{cd}	109.1^a	113.6 ^a	111.1 ^a	96.9 ^{b-d}	107.2^a	114.8 ^a	113.5 ^a	96.3 ^{bc}	108.2^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		1.4				2.6				1.6			
Seed (S)		1.9				1.9				1.0			
Micro (M)		1.7				2.6				1.6			
V x S		3.4				3.2				1.8			
V x M		2.9				4.5				2.8			
S x M		2.9				4.5				2.8			
V x S x M		5.0				7.8				4.8			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 12. Effect of genotypes, seed rates and micronutrients on number of tillers m⁻¹ at 90 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	125.5 ^{b-d}	132.1 ^{a-c}	114.0 ^e	123.8^b	120.2 ^{a-f}	131.1 ^d	110.1 ^{ef}	120.4^a	122.9 ^{c-h}	131.6 ^{a-c}	112.1 ⁱ	122.2^d
	M ₂	132.5 ^{ab}	134.4 ^{ab}	117.8 ^{de}	128.2^{ab}	129.9 ^{a-d}	132.3 ^d	113.8 ^{d-f}	125.3^a	131.2 ^{a-c}	133.3 ^{a-c}	115.5 ^{hi}	126.7^{a-d}
	M ₃	134.6 ^{ab}	136.6 ^a	117.5 ^{de}	129.5^{ab}	130.7 ^{a-d}	134.8 ^{a-c}	115.5 ^{c-f}	127.0^a	132.7 ^{a-c}	135.7 ^{ab}	116.5 ^{hi}	128.3^{a-c}
	M ₄	131.9 ^{a-c}	138.5 ^a	117.4 ^{de}	129.2^{ab}	130.1 ^{a-d}	134.3 ^{a-c}	115.7 ^{b-f}	126.7^a	131.0 ^{a-c}	136.4 ^{ab}	116.5 ^{hi}	127.9^{a-d}
S ₂	M ₁	133.2 ^{ab}	132.1 ^{a-c}	116.3 ^{de}	127.2^{ab}	126.8 ^{a-e}	128.6 ^{a-e}	116.3 ^{b-f}	123.9^a	130.0 ^{a-c}	133.3 ^{a-c}	116.3 ^{hi}	126.5^{bd}
	M ₂	131.7 ^{a-c}	136.8 ^a	118.9 ^{de}	129.1^{ab}	129.4 ^{a-e}	129.2 ^{a-e}	118.5 ^{b-f}	125.7^a	132.1 ^{a-c}	133.0 ^{a-c}	118.7 ^{g-i}	127.9^{a-d}
	M ₃	133.8 ^{ab}	137.2 ^a	120.1 ^{de}	130.3^a	133.7 ^{a-c}	135.6 ^{ab}	119.7 ^{a-f}	129.6^a	133.7 ^{ab}	136.4 ^{ab}	119.9 ^{e-i}	130.0^{ab}
	M ₄	135.9 ^{ab}	140.2 ^a	120.7 ^{de}	132.2^a	135.3 ^{a-c}	138.6 ^a	120.3 ^{a-f}	131.4^a	135.6 ^{ab}	139.4 ^a	120.5 ^{e-i}	131.8^a
S ₃	M ₁	132.6 ^{ab}	133.1 ^{ab}	115.4 ^{de}	127.0^{ab}	121.8 ^{a-e}	128.1 ^{a-e}	101.9 ^f	117.2^a	127.2 ^{a-g}	130.6 ^{ab}	113.7 ^{hi}	123.8^{cd}
	M ₂	131.0 ^{a-c}	135.6 ^{ab}	122.0 ^{c-e}	129.5^{ab}	124.8 ^{a-e}	131.6 ^{a-d}	119.7 ^{a-f}	125.3^a	129.4 ^{a-f}	133.6 ^{ab}	120.9 ^{d-i}	127.9^{a-d}
	M ₃	134.0 ^{ab}	139.6 ^a	119.1 ^{de}	130.9^{ab}	130.7 ^{a-d}	131.0 ^{a-d}	119.7 ^{a-f}	127.1^a	132.3 ^{a-c}	135.3 ^{ab}	119.4 ^{f-i}	129.0^{a-c}
	M ₄	135.9 ^{ab}	139.8 ^a	120.1 ^{de}	131.9^a	132.3 ^{a-d}	133.8 ^{a-c}	120.7 ^{a-f}	128.9^a	134.1 ^{ab}	136.8 ^{ab}	120.4 ^{e-i}	130.4^{ab}
Variety		132.7^b	136.3^a	118.2^c		128.8^a	132.42^a	115.9^b		131.0^a	134.6^a	117.5^b	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	131.1 ^b	135.4 ^a	116.7 ^c	127.7^b	127.7 ^a	133.1 ^a	113.8 ^b	124.9^a	129.4 ^c	134.2 ^{ab}	115.2 ^e	126.3^b
	S ₂	134.4 ^a	136.6 ^a	119.0 ^c	130.0^a	131.3 ^a	133.0 ^a	118.7 ^b	127.7^a	132.8 ^{a-c}	134.8 ^a	118.9 ^d	128.8^a
	S ₃	134.1 ^a	137.0 ^a	119.2 ^c	130.1^a	127.4 ^a	131.1 ^a	118.0 ^b	125.5^a	130.8 ^{bc}	135.1 ^a	118.6 ^{de}	128.2^{ab}
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	130.4 ^c	132.4 ^{bc}	115.2 ^d	126.0^d	123.0 ^{b-d}	129.3 ^{ab}	112.8 ^d	121.7^b	126.7 ^c	133.8 ^{ab}	114.0 ^d	124.8^b
	M ₂	133.7 ^{a-c}	135.6 ^{a-c}	119.6 ^d	129.6^{ab}	128.0 ^{a-c}	131.0 ^{ab}	117.3 ^d	125.4^{ab}	130.9 ^{bc}	133.3 ^{ab}	118.5 ^d	127.6^{ab}
	M ₃	134.1 ^{a-c}	137.8 ^{ab}	118.9 ^d	130.3^a	131.7 ^{ab}	133.8 ^a	118.3 ^{cd}	127.9^a	132.9 ^{ab}	135.8 ^{ab}	118.6 ^d	129.1^a
	M ₄	134.5 ^{a-c}	139.4 ^a	119.4 ^d	131.1^a	132.6 ^{ab}	135.6 ^a	118.9 ^{cd}	129.0^a	133.6 ^{ab}	137.5 ^a	119.1 ^d	130.1^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.8				2.9				1.7			
Seed (S)		0.5				1.4				0.6			
Micro (M)		1.0				1.9				1.0			
V x S		0.9				2.4				1.1			
V x M		1.8				3.8				1.8			
S x M		1.8				3.8				1.8			
V x S x M		3.1				5.7				3.1			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

5204 irrespective of seed rates used particularly with lower seed rate of 25 kg ha⁻¹ (V₃S₁-115.2). Cv. MTU 1010 combined with FeSO₄ + ZnSO₄ (V₂M₄) among variety X micronutrient rerecorded higher number of tillers (137.5) and in the absence of micronutrient application number of tillers decreased particularly with cv. BPT 5204 (V₃M₁). Similarly, among seed rates and micronutrients medium rate of 30 kg seed with application of FeSO₄+ZnSO₄ (S₂M₄) recorded higher number of tillers (131.8) while no supplementation of micronutrient recorded lower number of tillers particularly with S₁M₁ (122.2).

Among the three way interaction significantly higher number of tillers (120.5) were observed with cv. MTU 1010 sown using with 30 kg seed rate and supplied with both FeSO₄ + ZnSO₄ (V₂S₂M₄), while the lower number of tillers (112.1) was recorded with cv. BPT 5204 sown using 25 kg ha⁻¹ seed rate and supplied with no micronutrient (V₃S₁M₁).

Interestingly, at harvest the number of tillers among treatment combinations though ranged from 327.0 (V₁S₁M₁) to 540.2 (V₂S₂M₄) all the variations observed at earlier stages were moderated and treatment combinations fared at par particularly in pooled data except main effects due to cultivars wherein cv. MTU 1010 had more number of tillers (442.5) compared to other two cultivars which were at par with each other (80.7 and 380.2 with cvs. GGV 0501 and BPT 5204, respectively). Medium seed rate (S₂ - 418.9) and supply of micronutrients (M₂ - 427.3) maintained numerical superiority over others.

4.1.1.1.3. Leaf area (cm² plant⁻¹) (c.f. Table 13-16)

Leaf area (LA) varied significantly due to cultivars, seed rates (except at harvest) and use of micronutrients and their interactions at different stages of crop growth during both the years and on pooled basis as well.

Among the varieties, cv. MTU 1010 (V₂) recorded significantly higher LA (505.9,) followed by cvs. GGV 0501 and BPT 5204 (495.0 and 451.0, respectively); among seed rates higher LA (498.9) was recorded with the seed rate of 30 kg ha⁻¹ and 35 kg ha⁻¹ was at par ; LA decreased with lower seed rate (S₁ – 474.2). Similarly, use of micronutrients produced significant variations individually and with combined application wherein M₄ receiving combined application of FeSO₄ + ZnSO₄ to soil and to

the foliage resulted in higher LA (494.7), M_3 and M_2 receiving $ZnSO_4$ and $FeSO_4$, respectively were at par, while no application of micronutrient (M_1) recorded significantly lower LA (472.3).

Of the two factor interactions, variety and seed rates revealed recorded significantly higher LA (512.2) with cv. MTU 1010 sown at 35 kg ha^{-1} (V_2S_3); MTU 1010 with other seed rates were on par with it while lower LA (437.5) was recorded with cv. BPT 5204 at 25 kg seed rate (V_3S_1). Among variety X micronutrient higher LA (516.8) was recorded with cv. MTU 1010 with application of $FeSO_4 + ZnSO_4$ (V_2M_4); other levels in the variety (V_2M_{1-3}) fared at par and lower LA (438.9) was observed with cv. BPT 5204 particularly with no supplementation of micronutrients (V_3M_1). Similarly, among seed rates and micronutrients medium seed rate of 30 kg with the application of $FeSO_4 + ZnSO_4$ (S_2M_4) recorded higher LA (507.7) and was on par with $S_{1-3}M_4$, $S_{2-3}M_{3-4}$, and S_3M_1 ; while 25 kg ha^{-1} seed rate without supplementation of micronutrient (S_1M_1) recorded lower LA (461.5).

Overall, the three way interaction revealed significantly higher LA (523.5) with cv. MTU 1010 sown with 30 kg seed rate and applied with $FeSO_4 + ZnSO_4$ ($V_2S_2M_4$), closely followed by $V_1S_2M_4$ (520.4), while lower LA (425.2) was recorded with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient ($V_3S_1M_1$) among all.

At 67 DAS, among the varieties, cv. MTU 1010 (V_2) recorded significantly higher LA followed by cvs. GGV 0501 and BPT 5204 (804.4, 753.1 and 622.5, respectively); among seed rates higher LA (743.7) was recorded with the seed rate of 30 kg ha^{-1} and 35 kg ha^{-1} was at par; LA decreased with lower seed rate (S_1). Similarly, use of micronutrients produced significant variations individually and with combined application wherein combined application $FeSO_4 + ZnSO_4$ to soil and to the foliage (M_4) resulted in higher LA (747.7); M_3 receiving $ZnSO_4$ only was at par, while no application of micronutrients (M_1) recorded significantly lower LA (707.9).

Among two way interactions, cv. MTU 1010 at 30 kg ha^{-1} seed rate (V_2S_2) recorded higher leaf area (825.0); cv. MTU 1010 with other the seed rates (V_2S_{1-3}) was at par, while lower leaf area among all was recorded with cv. BPT 5204 at all seed rates particularly with 25 kg ha^{-1} (606.3). Variety X micronutrient revealed significant variations, in that cv. MTU 1010 with combined application of $FeSO_4 + ZnSO_4$ (V_2M_4)

rerecorded higher LA (831.0) and $V_2 M_{2-3}$ were at par, while lower LA was observed with cv. BPT 5204 in the absence of addition of micronutrients ($V_3 M_1$ - 602.5). Similarly, among seed rates and micronutrients medium seed rate of 30 kg with the application of $FeSO_4 + ZnSO_4$ ($S_2 M_4$) recorded higher LA (766.9), while 25 kg ha^{-1} seed rate without micronutrient ($S_1 M_1$) recorded lower LA (691.0).

In all, the three way interaction revealed significantly higher LA (851.0) with cv. MTU 1010 sown with 30 kg seed rate and applied with $FeSO_4 + ZnSO_4$ ($V_2 S_2 M_4$), while lower LA (588.7) was recorded with BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient ($V_3 S_1 M_1$).

At 90 DAS, again cv. MTU 1010 (V_2) among the varieties recorded significantly higher LA followed by cvs. GGV 0501 and BPT 5204 (1290.8, 1209.7 and 1067.2, respectively); among seed rates higher LA (1224.6) was recorded with the seed rate of 30 kg ha^{-1} and LA decreased with lower and higher seed rate (S_1 and S_3). Use of micronutrients produced significant variations individually and with combined application wherein the latter (M_4 - $FeSO_4 + ZnSO_4$) resulted in higher LA (1223.8), M_3 receiving $ZnSO_4$ was at par, while no application of micronutrient (M_1) recorded significantly lower LA (1156.5).

Among variety and seed rate, cv. MTU 1010 at 30 kg ha^{-1} ($V_2 S_2$) recorded higher LA (1336.4); while lower LA among all was recorded with cv. BPT 5204 at all seed rates particularly at 25 kg ha^{-1} (1054.3). In variety X micronutrient cv. MTU 1010 with combined application of $FeSO_4$ and $ZnSO_4$ ($V_2 M_4$) rerecorded higher LA (1335.9) and $V_2 M_{2-3}$ were at par; LA decreased in the absence of micronutrient application and lower leaf area (1036.0) was observed with cv. BPT 5204 ($V_3 M_1$) though other micronutrient levels in same variety were at par. Similarly, interaction due to seed rates and micronutrients were significant wherein 30 kg seed rate with the application of $FeSO_4 + ZnSO_4$ ($S_2 M_4$) recorded higher LA (1256.0) ; while 25 kg ha^{-1} seed rate with no supplementation of micronutrient ($S_1 M_1$) recorded lower green LA (1129.6).

On the whole, the three way interaction revealed significantly higher LA (1380.2) with cv. MTU 1010 sown using 30 kg seed rate and applied with both $FeSO_4 + ZnSO_4$ ($V_2 S_2 M_4$), while lower LA was recorded with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient ($V_3 S_{1\&3} M_1$) (1004.8 and 1029.0, respectively) among all.

Table 13. Effect of genotypes, seed rates and micronutrients on leaf area (cm² plant⁻¹) at 45 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	474.2 ^{b-h}	493.3 ^{a-h}	435.2 ^h	467.6 ^c	459.3 ^{a-c}	492.0 ^{a-c}	415.2 ^c	455.5 ^b	466.8 ^{b-j}	492.7 ^{a-h}	425.2 ^j	459.0 ^c
	M ₂	504.3 ^{a-g}	505.3 ^{a-g}	452.0 ^{gh}	487.2 ^{b-c}	465.5 ^{a-c}	493.2 ^{a-c}	415.3 ^c	458.0 ^b	484.9 ^{a-h}	499.2 ^{a-f}	433.7 ^{i-j}	472.6 ^{bc}
	M ₃	509.0 ^{a-g}	513.2 ^{a-g}	454.3 ^{f-h}	492.2 ^{a-c}	469.5 ^{a-c}	494.5 ^{a-c}	432.0 ^{b-c}	465.3 ^a	489.3 ^{a-h}	503.8 ^{a-e}	443.2 ^{g-j}	478.8 ^{bc}
	M ₄	512.0 ^{a-g}	528.3 ^{ab}	462.0 ^{d-h}	500.8 ^{a-c}	472.0 ^{a-c}	494.7 ^{a-c}	434.3 ^{b-c}	467.0 ^b	492.0 ^{a-h}	511.5 ^{a-c}	448.2 ^{f-j}	483.9 ^{a-c}
S ₂	M ₁	503.8 ^{a-g}	479.3 ^{b-h}	435.3 ^h	472.8 ^{bc}	484.3 ^{a-c}	505.5 ^{a-b}	447.0 ^{b-c}	478.9 ^b	494.1 ^{a-g}	492.4 ^{a-h}	441.2 ^{h-j}	475.9 ^{b-c}
	M ₂	514.5 ^{a-g}	492.0 ^{a-h}	457.7 ^{e-h}	488.1 ^{bc}	485.3 ^{a-c}	508.3 ^{a-b}	448.0 ^{b-c}	480.5 ^b	499.9 ^{a-f}	500.2 ^{a-f}	452.8 ^{e-j}	484.3 ^{a-c}
	M ₃	517.8 ^{a-e}	504.2 ^{a-g}	468.0 ^{b-h}	496.7 ^{a-c}	488.8 ^{a-c}	508.5 ^{a-b}	454.2 ^{a-c}	483.8 ^b	503.3 ^{a-e}	506.3 ^{a-d}	461.1 ^{c-j}	490.2 ^{ab}
	M ₄	551.8 ^a	514.7 ^{a-g}	501.8 ^{a-g}	522.8 ^a	489.0 ^{a-c}	531.8 ^a	457.2 ^{a-c}	492.7 ^b	520.4 ^a	523.5 ^a	479.5 ^{a-j}	507.8 ^a
S ₃	M ₁	485.5 ^{b-h}	522.2 ^{a-d}	463.0 ^{c-h}	490.2 ^{a-c}	473.3 ^{a-c}	495.5 ^{a-b}	437.7 ^{b-c}	468.8 ^b	479.4 ^{a-i}	508.8 ^{a-c}	450.3 ^{f-j}	479.5 ^{a-c}
	M ₂	489.5 ^{a-h}	522.8 ^{a-d}	466.3 ^{b-h}	492.9 ^{a-c}	481.8 ^{a-c}	497.8 ^{a-b}	442.0 ^{b-c}	473.9 ^b	485.7 ^{a-h}	510.3 ^{a-c}	454.2 ^{d-j}	483.4 ^{a-c}
	M ₃	508.8 ^{a-g}	525.5 ^{a-d}	467.0 ^{b-h}	500.4 ^{a-c}	483.8 ^{a-c}	502.0 ^{a-b}	443.0 ^{b-c}	476.3 ^b	496.3 ^{a-f}	506.3 ^{a-d}	461.1 ^{c-j}	487.9 ^{ab}
	M ₄	515.5 ^{a-f}	528.5 ^{ab}	477.2 ^{b-h}	507.1 ^{ab}	484.2 ^{a-c}	502.8 ^{a-b}	446.3 ^{b-c}	477.8 ^b	499.8 ^{a-f}	515.7 ^{a-b}	461.8 ^{c-j}	492.4 ^{ab}
Variety		507.2 ^a	510.8 ^a	461.7 ^b		478.1 ^a	502.2 ^a	439.4 ^b		495.0 ^a	505.9 ^a	451.0 ^b	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	499.9 ^{a-b}	510.0 ^{a-b}	450.9 ^b	486.9 ^a	466.6 ^{c-e}	493.6 ^{a-c}	424.2 ^f	461.5 ^b	483.2 ^{a-b}	501.8 ^a	437.5 ^c	474.2 ^b
	S ₂	522.0 ^a	497.5 ^{a-b}	465.7 ^{a-b}	495.1 ^a	486.9 ^{a-c}	513.5 ^a	451.6 ^{d-f}	484.0 ^a	504.4 ^{ab}	505.5 ^a	485.6 ^{a-b}	498.5 ^a
	S ₃	499.8 ^{a-b}	524.8 ^a	468.4 ^{a-b}	497.6 ^a	480.8 ^{b-d}	499.6 ^{a-b}	442.3 ^{ef}	474.2 ^{ab}	490.3 ^{ab}	512.2 ^a	455.3 ^{b-c}	485.9 ^{ab}
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M	M ₁	487.8 ^{b-d}	498.3 ^{a-c}	444.5 ^e	476.9 ^c	472.3 ^{a-c}	497.7 ^a	433.3 ^c	467.8 ^a	480.1 ^{b-c}	498.0 ^{a-b}	438.9 ^d	472.3 ^b
	M ₂	502.8 ^{a-c}	506.7 ^{a-c}	458.7 ^{de}	489.4 ^{bc}	477.6 ^{a-b}	499.8 ^a	435.1 ^c	470.8 ^a	490.2 ^{a-b}	503.3 ^{ab}	446.9 ^d	480.1 ^{ab}
	M ₃	511.9 ^{a-c}	514.3 ^{a-b}	463.1 ^{de}	496.4 ^{ab}	480.7 ^{a-b}	501.7 ^a	443.1 ^{b-c}	475.2 ^a	496.3 ^{a-b}	508.0 ^{ab}	453.1 ^d	485.8 ^{ab}
	M ₄	526.4 ^a	523.8 ^a	480.3 ^{c-d}	510.2 ^a	481.7 ^{a-b}	509.8 ^a	445.9 ^{b-c}	479.1 ^a	504.1 ^{a-b}	516.8 ^a	463.1 ^{cd}	494.7 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		7.1				7.7				6.4			
Seed (S)		10.3				5.4				5.9			
Micro (M)		6.0				7.6				5.0			
V x S		17.9				9.4				10.2			
V x M		10.4				13.2				8.7			
S x M		10.4				13.2				8.7			
V x S x M		18.0				22.9				15.1			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 14. Effect of genotypes, seed rates and micronutrients on leaf area (cm² plant⁻¹) at 67 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	734.4 ^{d-f}	758.9 ^{b-e}	608.0 ^g	700.4^d	709.4 ^{c-f}	765.9 ^{a-c}	569.3 ^g	681.5 ^b	721.9^{de}	762.4 ^{b-d}	588.7 ^g	691.0^d
	M ₂	741.6 ^{de}	784.3 ^{a-d}	623.5 ^g	716.5^{b-d}	715.5 ^{b-e}	771.2 ^{a-c}	583.0 ^g	689.9 ^b	728.6^{de}	777.8 ^{a-d}	603.3 ^{fg}	703.2^{cd}
	M ₃	760.2 ^{b-c}	842.7 ^{a-c}	634.5 ^g	745.8^{a-d}	716.6 ^{b-e}	776.0 ^{a-c}	589.8 ^g	694.1 ^{ab}	738.4^{cd}	809.4 ^{a-c}	612.2 ^{fg}	720.0^{b-d}
	M ₄	784.7 ^{a-d}	847.5 ^{a-c}	643.8 ^g	758.7^{a-c}	731.0 ^{a-d}	777.5 ^{a-c}	598.5 ^g	702.3 ^{ab}	757.8^{b-d}	812.5 ^{a-c}	621.2 ^{fg}	730.5^{a-d}
S ₂	M ₁	740.5 ^{de}	796.2 ^{a-d}	614.8 ^g	717.2^{b-d}	751.8 ^{a-d}	817.7 ^{ab}	618.8 ^{e-g}	729.4 ^{ab}	746.2^{cd}	806.9 ^{a-c}	616.8 ^{fg}	723.3^{b-d}
	M ₂	770.0 ^{a-e}	802.7 ^{a-d}	642.3 ^g	738.3^{a-d}	758.9 ^{a-d}	822.5 ^a	624.5 ^{e-g}	735.3 ^{ab}	764.4^{b-d}	812.6 ^{a-c}	633.2 ^{fg}	736.7^{a-c}
	M ₃	790.9 ^{a-d}	829.3 ^{a-d}	651.5 ^{fg}	757.2^{a-c}	759.3 ^{a-d}	829.4 ^a	626.5 ^{e-g}	738.4 ^{ab}	775.1^{a-d}	829.4 ^{ab}	639.0 ^{fg}	747.8^{ab}
	M ₄	805.3 ^{a-d}	863.5 ^a	679.8 ^g	782.9^a	759.7 ^{a-d}	838.5 ^{a-c}	654.8 ^{d-g}	751.0 ^a	782.5^{a-d}	851.0 ^a	667.3 ^{ef}	766.9^a
S ₃	M ₁	756.0 ^{c-e}	783.9 ^{a-d}	594.3 ^g	711.4^{cd}	733.9 ^{a-d}	777.7 ^{a-c}	609.5 ^{fg}	707.0 ^{ab}	744.9^{cd}	780.8 ^{a-d}	601.9 ^{fg}	709.2^{b-d}
	M ₂	770.0 ^{a-e}	802.7 ^{a-d}	642.3 ^g	738.3^{a-d}	735.2 ^{a-d}	777.7 ^{a-c}	609.6 ^{fg}	707.5 ^{ab}	747.8^{cd}	789.3 ^{a-d}	622.0 ^{fg}	719.7^{b-d}
	M ₃	776.8 ^{a-d}	802.7 ^{a-d}	643.7 ^g	741.1^{a-d}	735.3 ^{a-d}	780.3 ^{a-c}	617.3 ^{e-g}	711.0 ^{ab}	756.1^{b-d}	791.5 ^{a-d}	630.5 ^{fg}	726.0^{a-d}
	M ₄	802.5 ^{a-d}	854.4 ^{ab}	649.0 ^{fg}	768.6^{ab}	745.0 ^{a-d}	804.3 ^{a-c}	618.7 ^{e-g}	722.7 ^{ab}	773.7^{b-d}	829.4 ^{ab}	633.8 ^{fg}	745.6^{a-c}
Variety		769.4^b	814.1^a	635.6^c		737.6^b	794.9^a	610.0^c		753.1^b	804.4^a	622.5^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	755.2 ^a	808.4 ^a	627.5 ^b	730.4^a	718.1 ^d	772.6 ^b	585.2 ^f	692.0^c	736.7 ^c	790.5 ^{ab}	606.3 ^d	711.2^b
	S ₂	776.7 ^a	822.9 ^a	647.1 ^b	748.9^a	757.4 ^{bc}	827.0 ^a	631.0 ^e	738.5^a	767.1 ^{bc}	825.0 ^a	639.1 ^d	743.7^a
	S ₃	773.9 ^a	810.5 ^a	630.4 ^b	738.3^a	737.3 ^{cd}	785.0 ^b	613.8 ^{ef}	712.0^b	755.6 ^{bc}	797.7 ^{ab}	622.1 ^d	725.1^{ab}
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	743.6 ^d	779.6 ^{b-d}	605.7 ^f	709.6^c	731.7 ^d	787.1 ^{a-d}	599.2 ^e	706.0^a	737.7 ^e	783.4 ^{b-d}	602.5 ^f	707.9^c
	M ₂	757.3 ^{cd}	796.0 ^{bc}	633.4 ^{ef}	728.9^{bc}	736.5 ^{cd}	790.4 ^{a-c}	605.5 ^e	710.8^a	746.9 ^{de}	793.2 ^{a-c}	619.5 ^f	719.9^{bc}
	M ₃	776.0 ^{b-d}	824.9 ^{ab}	643.3 ^{ef}	748.1^{ab}	737.1 ^{cd}	795.3 ^{ab}	611.2 ^e	714.5^a	756.5 ^{c-e}	810.1 ^{ab}	627.2 ^f	731.3^{ab}
	M ₄	797.5 ^{bc}	855.2 ^a	657.5 ^e	770.1^a	745.2 ^{b-d}	806.8 ^a	624.0 ^e	725.3^a	771.4 ^{b-e}	831.0 ^a	640.8 ^f	747.7^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		4.0				10.7				6.5			
Seed (S)		12.3				5.9				7.4			
Micro (M)		9.3				10.2				7.6			
V x S		21.3				10.2				12.8			
V x M		16.1				18.1				13.1			
S x M		16.1				18.1				13.1			
V x S x M		27.9				31.4				22.7			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 15. Effect of genotypes, seed rates and micronutrients on leaf area (cm² plant⁻¹) at 90 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	1179.7 ^{c-k}	1222.1 ^{a-j}	1018.2 ^k	1140.0^{cd}	1121.2 ^{c-h}	1245.1 ^{a-e}	991.5 ^h	1119.3^c	1150.4 ^{e-i}	1233.6 ^{c-f}	1004.8 ^j	1129.6^c
	M ₂	1204.8 ^{b-j}	1250.8 ^{a-h}	1106.1 ^{f-k}	1187.2^{a-d}	1145.3 ^{b-h}	1248.1 ^{a-d}	1003.2 ^{gh}	1132.2^{bc}	1175.0 ^{d-i}	1249.5 ^{b-e}	1054.6 ^{ij}	1159.7^{cd}
	M ₃	1214.7 ^{a-j}	1270.5 ^{a-g}	1108.0 ^{f-k}	1197.7^{a-d}	1164.7 ^{b-h}	1251.0 ^{a-d}	1041.2 ^{e-h}	1152.3^{a-c}	1189.7 ^{d-h}	1260.8 ^{b-e}	1074.6 ^{b-j}	1175.0^{b-d}
	M ₄	1239.8 ^{a-j}	1312.4 ^{a-d}	1117.7 ^{f-k}	1223.3^{a-d}	1189.8 ^{a-g}	1251.2 ^{a-d}	1048.4 ^{f-h}	1163.1^{a-c}	1214.8 ^{d-g}	1281.8 ^{a-d}	1083.0 ^{b-j}	1193.2^{b-d}
S ₂	M ₁	1218.5 ^{a-j}	1286.3 ^{a-f}	1056.2 ^{jk}	1187.0^{a-d}	1219.9 ^{a-f}	1297.4 ^{a-c}	1091.1 ^{d-h}	1202.8^{a-c}	1219.2 ^{d-f}	1299.0 ^{a-d}	1073.6 ^{b-j}	1194.9^d
	M ₂	1260.1 ^{a-g}	1306.1 ^{a-e}	1067.9 ^{b-k}	1211.4^{a-d}	1224.8 ^{a-f}	1330.8 ^{ab}	1093.0 ^{d-h}	1216.2^{a-c}	1242.5 ^{b-e}	1218.5 ^{a-f}	1080.5 ^{b-j}	1180.5^{b-d}
	M ₃	1266.2 ^{a-g}	1345.8 ^{a-c}	1094.2 ^{g-k}	1235.4^{a-c}	1228.2 ^{a-f}	1364.6 ^a	1102.7 ^{c-h}	1231.8^{ab}	1247.2 ^{b-e}	1355.2 ^{ab}	1098.5 ^{g-j}	1233.6^b
	M ₄	1310.4 ^{a-d}	1379.6 ^{ab}	1122.1 ^{e-k}	1270.7^a	1235.8 ^{a-f}	1380.8 ^a	1107.1 ^{c-h}	1241.2^a	1273.1 ^{a-e}	1380.2 ^a	1114.6 ^{f-j}	1326.7^a
S ₃	M ₁	1136.2 ^{d-k}	1219.5 ^{a-j}	1006.5 ^k	1120.7^d	1199.7 ^{a-f}	1255.5 ^{a-d}	1052.9 ^{e-h}	1169.4^{a-c}	1167.9 ^{d-i}	1237.5 ^{b-e}	1029.7 ^j	1145.0^{cd}
	M ₂	1160.3 ^{c-k}	1243.2 ^{a-i}	1063.4 ^{i-k}	1155.6^{b-d}	1203.5 ^{a-f}	1271.3 ^{a-d}	1075.7 ^{d-h}	1183.5^{a-c}	1181.9 ^{d-h}	1257.3 ^{b-e}	1069.5 ^{b-j}	1169.6^{b-d}
	M ₃	1234.9 ^{a-j}	1266.0 ^{a-g}	1090.7 ^{g-k}	1197.2^{a-d}	1204.5 ^{a-f}	1291.1 ^{a-c}	1077.1 ^{d-h}	1190.9^{a-c}	1219.7 ^{d-f}	1278.6 ^{a-d}	1084.2 ^{b-j}	1194.2^{b-d}
	M ₄	1263.1 ^{a-g}	1395.8 ^a	1092.7 ^{g-k}	1250.5^{ab}	1207.1 ^{a-f}	1295.4 ^{a-c}	1079.2 ^{d-h}	1193.9^{a-c}	1235.1 ^{b-e}	1345.6 ^{a-c}	1086.0 ^{b-j}	1222.2^{b-c}
Variety		1224.1^b	1291.5^a	1078.6^c		1195.4^b	1290.2^a	1063.6^c		1209.7^a	1290.8^a	1067.2^b	
Variety x Seed rate		S				S				S			
S	S ₁	1209.7 ^{ab}	1264.0 ^{ab}	1087.5 ^{cd}	1187.1^a	1155.2 ^{cd}	1248.9 ^b	1021.1 ^e	1141.7^b	1180.5 ^d	1256.4 ^{bc}	1054.3 ^e	1163.7^b
	S ₂	1263.8 ^{ab}	1329.5 ^a	1085.1 ^{cd}	1226.1^a	1227.2 ^{bc}	1343.4 ^a	1098.5 ^{de}	1223.0^a	1245.5 ^{bc}	1336.4 ^a	1091.8 ^e	1224.6^a
	S ₃	1198.6 ^{bc}	1281.1 ^{ab}	1063.3 ^d	1181.0^a	1203.7 ^{bc}	1278.4 ^{ab}	1071.4 ^{de}	1184.5^{ab}	1201.2 ^{cd}	1279.7 ^b	1067.3 ^e	1182.7^b
Variety x Micro		M				M				M			
M	M ₁	1178.1 ^{cd}	1242.6 ^{b-c}	1026.9 ^e	1149.2^b	1180.2 ^b	1266.0 ^{ab}	1045.1 ^c	1163.8^a	1179.2 ^e	1254.3 ^{b-d}	1036.0 ^f	1156.5^c
	M ₂	1208.4 ^{bc}	1266.7 ^{b-c}	1079.1 ^e	1184.7^{bc}	1191.2 ^b	1283.4 ^{ab}	1057.3 ^c	1177.3^a	1199.8 ^{de}	1275.1 ^{a-c}	1068.2 ^f	1181.0^{bc}
	M ₃	1238.6 ^{bc}	1294.1 ^{ab}	1097.6 ^{d-e}	1210.1^{ab}	1199.1 ^b	1302.2 ^a	1073.9 ^c	1191.7^a	1218.9 ^{c-e}	1298.2 ^{ab}	1085.7 ^f	1200.9^{ab}
	M ₄	1271.1 ^{a-c}	1362.6 ^a	1110.8 ^{d-e}	1248.2^a	1210.9 ^{ab}	1309.1 ^a	1078.2 ^c	1199.4^a	1241.0 ^{b-e}	1335.9 ^a	1094.5 ^f	1223.8^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		15.3				21.1				16.7			
Seed (S)		20.9				15.7				10.3			
Micro (M)		17.9				18.7				11.9			
V x S		36.3				27.2				17.9			
V x M		31.0				32.3				20.5			
S x M		31.0				32.3				20.5			
V x S x M		53.7				56.0				35.6			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 16. Effect of genotypes, seed rates and micronutrients on leaf area (cm² plant⁻¹) at harvest under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	710.1 ^a	733.1 ^a	705.6 ^a	716.3^c	729.0 ^a	751.7 ^a	695.6 ^a	725.4^a	719.5 ^c	742.4 ^{a-c}	700.6 ^c	720.8^d
	M ₂	735.9 ^a	753.4 ^a	715.4 ^a	734.9^{a-c}	729.4 ^a	757.3 ^a	699.4 ^a	728.7^a	732.6 ^{bc}	755.4 ^{a-c}	707.0 ^c	731.7^{b-d}
	M ₃	736.7 ^a	758.4 ^a	761.7 ^a	752.3^{a-c}	733.6 ^a	757.9 ^a	699.8 ^a	730.4^a	735.1 ^{a-c}	758.1 ^{a-c}	730.7 ^{b-c}	741.3^{a-d}
	M ₄	758.1 ^a	767.3 ^a	774.9 ^a	766.8^{a-c}	734.6 ^a	764.9 ^a	702.1 ^a	733.9^a	746.4 ^{a-c}	766.1 ^{a-c}	738.5 ^{a-c}	750.3^{a-d}
S ₂	M ₁	748.8 ^a	743.6 ^a	744.6 ^a	745.7^{a-c}	745.5 ^a	781.4 ^a	723.1 ^a	750.0^a	747.1 ^{a-c}	762.5 ^{a-c}	733.9 ^{b-c}	747.8^{a-d}
	M ₂	761.7 ^a	755.5 ^a	750.9 ^a	756.0^{a-c}	748.1 ^a	782.1 ^a	723.2 ^a	751.1^a	754.9 ^{a-c}	768.8 ^{a-c}	737.0 ^{a-c}	753.6^{a-d}
	M ₃	779.0 ^a	792.1 ^a	767.9 ^a	779.7^{a-c}	748.4 ^a	798.6 ^a	725.8 ^a	757.6^a	763.7 ^{a-c}	795.4 ^{ab}	746.8 ^{a-c}	768.6^{a-c}
	M ₄	788.7 ^a	812.0 ^a	791.4 ^a	797.4^a	751.7 ^a	802.0 ^a	726.7 ^a	760.1^a	770.2 ^{a-c}	807.0 ^a	759.0 ^{a-c}	778.7^a
S ₃	M ₁	729.9 ^a	728.1 ^a	709.4 ^a	722.5^{a-c}	735.0 ^a	766.8 ^a	705.4 ^a	735.7^a	732.4 ^{bc}	747.5 ^{a-c}	707.4 ^c	729.1^{cd}
	M ₂	739.4 ^a	732.7 ^a	712.1 ^a	728.1^{bc}	738.8 ^a	769.0 ^a	718.1 ^a	742.0^a	739.1 ^{a-c}	750.9 ^{a-c}	715.1 ^c	735.0^{b-d}
	M ₃	745.0 ^a	739.0 ^a	733.2 ^a	739.1^{a-c}	740.9 ^a	773.9 ^a	719.9 ^a	744.9^a	742.9 ^{a-c}	756.5 ^{a-c}	726.5 ^{bc}	742.0^{a-d}
	M ₄	783.9 ^a	808.6 ^a	776.8 ^a	789.8^{ab}	743.4 ^a	778.7 ^a	722.7 ^a	748.3^a	763.6 ^{a-c}	793.7 ^{ab}	749.8 ^{a-c}	769.0^{ab}
Variety		751.4^a	760.3^a	745.3^a		739.9^b	773.7^a	713.5^b		745.6^b	767.0^a	729.4^b	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	735.2 ^a	753.1 ^a	739.4 ^a	742.6^a	731.7 ^{b-d}	757.9 ^{a-c}	699.2 ^d	729.6^a	733.4 ^b	755.5 ^{ab}	719.3 ^c	736.1^a
	S ₂	769.6 ^a	775.8 ^a	763.7 ^a	769.7^a	748.4 ^{a-d}	791.0 ^a	724.7 ^{b-d}	754.7^a	759.0 ^{ab}	783.4 ^a	744.2 ^{ab}	762.2^a
	S ₃	749.5 ^a	752.1 ^a	732.9 ^a	744.8^a	739.5 ^{b-d}	772.1 ^{ab}	716.5 ^{cd}	742.7^a	744.5 ^{ab}	762.1 ^{ab}	724.7 ^b	743.8^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	729.6 ^b	734.9 ^{ab}	719.9 ^b	728.1^b	736.9 ^{a-c}	766.6 ^{a-c}	708.0 ^c	737.2^a	733.0 ^{b-d}	750.8 ^{b-d}	714.0 ^d	732.6^b
	M ₂	745.7 ^{ab}	747.2 ^{ab}	726.1 ^b	739.7^b	738.8 ^{a-c}	769.5 ^{a-c}	713.6 ^{bc}	740.6^a	742.2 ^{b-d}	758.3 ^{a-c}	719.8 ^{cd}	740.1^b
	M ₃	753.6 ^{ab}	763.2 ^{ab}	754.2 ^{ab}	757.0^{ab}	740.9 ^{a-c}	776.8 ^{a-c}	715.2 ^{bc}	744.3^a	747.3 ^{b-d}	770.0 ^{ab}	734.7 ^{b-d}	750.7^{ab}
	M ₄	776.9 ^{ab}	796.0 ^a	781.0 ^{ab}	784.6^a	743.2 ^{a-c}	781.9 ^a	717.2 ^{a-c}	747.4^a	760.1 ^{ab}	788.9 ^a	749.1 ^{b-d}	766.0^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		7.9				7.0				5.2			
Seed (S)		16.6				8.8				8.3			
Micro (M)		11.0				11.3				6.9			
V x S		28.7				15.2				14.4			
V x M		19.1				19.6				11.9			
S x M		19.1				19.6				11.9			
V x S x M		33.1				33.9				20.6			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

At harvest, cv.MTU 1010 (V_2) recorded significantly higher leaf area among varieties followed by cvs.GGV 0501 and BPT 5204 (767.0, 745.6 and 729.4, respectively), similarly application $\text{FeSO}_4 + \text{ZnSO}_4$ to soil and to the foliage (M_4) resulted in higher LA (766.0); M_3 receiving ZnSO_4 only was at par, while no application of micronutrient (M_1) recorded significantly lower LA (732.6).

Cv. MTU 1010 at 30 seed rate kg ha^{-1} (V_2S_2) recorded higher LA (783.4) among variety and seed rate; others seed rates with the varieties were on par, while lower LA among all was recorded with cv. BPT 5204 at seed rate of 25 kg ha^{-1} (719.3). Variety X micronutrient also revealed significant variations, in that cv. MTU 1010 with combined application of FeSO_4 and ZnSO_4 (V_2M_4) rerecorded higher LA (788.9) and was on par with V_2M_{2-3} and V_1M_4 ; LA decreased in the absence of micronutrient application particularly with cv. BPT 5204 (V_3M_1 - 714.0). Similarly, among seed rates and micronutrients, medium seed rate of 30 kg ha^{-1} with the application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) recorded higher LA (778.8); while 25 kg ha^{-1} seed rate with no micronutrient (S_1M_1) recorded lower LA (720.9).

On the whole, the three way interaction revealed significantly higher LA (807.0) with cv. MTU 1010 sown using 30 kg ha^{-1} seed rate and applied with $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_2S_2M_4$), while lower LA (700.6 and 770.0, respectively) was recorded with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient and FeSO_4 ($V_3S_1M_1$).

4.1.1.1.4 Leaf area index (c.f. Table 17-20)

Leaf area index (LAI) more or less followed trends in leaf area and varied significantly due to cultivars, seed rates (except at 45 DAS harvest) and use of micronutrients (except at harvest) and their interactions at different stages of crop growth during both the years and on pooled basis as well.

Among the varieties at 45 DAS, cv.MTU 1010 (V_2) recorded significantly higher LAI (2.53) followed by cvs.GGV 0501 and BPT 5204 (2.46 and 2.25, respectively), among micronutrients combined application FeSO_4 and ZnSO_4 to soil and to the foliage resulted in higher LAI (2.47), M_3 and M_2 receiving ZnSO_4 and FeSO_4 were at par, while no application of micronutrient (M_1) recorded significantly lower LAI (2.36).

In variety and seed rate, cv. MTU 1010 at all seed rates (V_2S_{1-3}) recorded significantly higher LAI particularly with V_2S_3 (2.56) and V_1S_{1-3} ; while lower LAI among all was recorded with cv. BPT 5204 at seed rate of 25 kg ha^{-1} (2.19). Variety X micronutrient also revealed significant variations; in that cv. MTU 1010 with combined application of FeSO_4 and ZnSO_4 (V_2M_4) rerecorded higher LAI (2.58) and $V_{1-2}M_{2-4}$ were at par. In the absence of micronutrient LAI decreased particularly with cv. BPT 5204 (V_3M_1 - 2.19). Similarly, interaction due to seed rates and micronutrients were significant wherein 30 kg seed rate with the application of $\text{FeSO}_4 + \text{ZnSO}_4$ ($S_2 M_4$) recorded higher LAI (2.54); while 25 kg ha^{-1} seed rate without supplementation of micronutrient (S_1M_1) recorded lower LAI (2.31).

The three way interaction revealed significantly higher LAI (2.62) with cv. MTU 1010 sown using 30 kg seed rate and applied with both $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_2S_2M_4$), closely followed by $V_1S_2M_4$ (2.60) which was on par with it, while the lower LAI (2.13) was recorded with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient ($V_3M_1S_1$) among all and it was on par with $V_3S_{1-3}M_{1-4}$.

At 67 DAS, among the varieties, again cv. MTU 1010 (V_2) recorded significantly higher LAI (4.02) followed by cvs. GGV 0501 and BPT 5204 (3.77 and 3.11, respectively); among seed rates higher LAI (3.72) was recorded with 30 kg ha^{-1} (S_2) and 35 kg ha^{-1} (S_3) was at par ; LAI decreased with lower seed rate (S_1). Similarly, among micronutrients combined application FeSO_4 and ZnSO_4 to soil and to the foliage (M_4) resulted in higher LAI (3.74), M_3 receiving ZnSO_4 only was at par, while no application of micronutrient (M_1) recorded significantly lower LAI (3.54).

Among variety and seed rate, cv. MTU 1010 at 30 kg ha^{-1} seed rate (V_2S_4) recorded higher LAI (4.12); cv. MTU 1010 with other seed rates (V_2S_{1-3}) were at par, while the lower LAI among all was recorded with cv. BPT 5204 at all seed rates particularly with 25 kg ha^{-1} (3.03). Variety X micronutrient also revealed significant variations. Cv. MTU 1010 coupled with combined application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_2M_4) rerecorded higher LAI (4.15) and V_2M_3 was at par. LAI was lower (3.01) with no application of micronutrient across cultivars particularly with cv. BPT 5204 (V_3M_1). Similarly, seed rates and micronutrients revealed higher LAI (3.83) with 30 kg seed rate and application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4); while 25 kg ha^{-1} seed rate with supplementation of micronutrient (S_3M_1) recorded lower LAI (3.45).

Overall, the three way interaction revealed significantly higher LAI (4.26) with cv.MTU 1010 sown with 30 kg seed rate and combined application of micronutrients ($V_2S_2M_4$), while lower LAI (2.94) was recorded with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient ($V_3S_1M_1$) among all and it was on par with $V_3S_{1-3}M_{1-4}$.

At 90 DAS, among the varieties, cv. MTU 1010 (V_2) recorded significantly higher LAI (6.46) followed by cvs.GGV 0501 and BPT 5204(6.05 and 5.36, respectively); among seed rates higher LAI (6.12) was recorded with medium seed rates of 30 kg ha^{-1} (S_2) and; LAI decreased significantly with lower and higher seed rates (S_1 and S_3). Similarly, use of micronutrients produced significant variations individually and with combined application wherein $FeSO_4 + ZnSO_4$ to soil and to the foliage resulted in higher LAI (6.12), M_3 receiving $ZnSO_4$ only was at par, while no micronutrient (M_1) recorded significantly lower LAI (5.78).

Interactions due to variety and seed rate were significant and among all cv. MTU 1010 at 30 seed rate kg ha^{-1} (V_2S_4) recorded higher LAI (6.68) and it was at par with V_2S_{1-3} ; while lower LAI was recorded with cv.BPT 5204 at all seed rates particularly with 25 kg ha^{-1} (5.27). Variety X micronutrient revealed significant variations, in that cv.MTU 1010 with application of $FeSO_4 + ZnSO_4$ (V_2M_4) rerecorded higher LAI (6.68) and V_2M_{2-3} was at par. LAI decreased irrespective micronutrient application with cv. BPT 5204 particularly when micronutrient was not applied (V_3M_1 - 5.14). Similarly, interactions due to seed rates and micronutrients were significant wherein 30 kg seed rate with the application of $FeSO_4 + ZnSO_4$ ($S_2 M_4$) recorded higher LAI (6.28); while 25 kg ha^{-1} seed rate with no supplementation of micronutrient (S_1M_1) recorded lower LAI (6.65).

The three way interaction also revealed significantly higher LAI (6.90) with cv.MTU 1010 sown with 30 kg seed rate and applied with $FeSO_4 + ZnSO_4$ ($V_2S_2M_4$) and was on par with $V_1S_2M_4$ and $V_2S_{2-3}M_{2-4}$, while lower LAI was recorded with BPT 5204 sown using 25 kg ha^{-1} seed and supplied with no micronutrient ($V_3S_{1-3} M_1$) (5.03 and 5.15) and it was on par with $V_3S_{1-3} M_{1-4}$.

At harvest, among the varieties, cv. MTU 1010 (V_2) recorded significantly higher LAI (3.87) followed by cvs.GGV 0501 and BPT 5204(3.70 and 3.57, respectively). Main effects due to other factors were non-significant. Interaction due to variety and seed rate

Table 17. Effect of genotypes, seed rates and micronutrients on leaf area index at 45 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	2.37 ^{b-g}	2.47 ^{a-g}	2.18 ^g	2.34 ^c	2.30 ^{a-c}	2.46 ^{a-c}	2.08 ^c	2.28 ^a	2.33 ^{b-k}	2.46 ^{a-i}	2.13 ^k	2.31 ^c
	M ₂	2.52 ^{a-f}	2.53 ^{a-f}	2.26 ^{fg}	2.44 ^{a-c}	2.33 ^{a-c}	2.47 ^{a-c}	2.08 ^c	2.29 ^a	2.42 ^{a-j}	2.50 ^{a-g}	2.17 ^{jk}	2.36 ^{bc}
	M ₃	2.55 ^{a-f}	2.57 ^{a-f}	2.27 ^{d-g}	2.46 ^{a-c}	2.35 ^{a-c}	2.47 ^{a-c}	2.16 ^{bc}	2.33 ^a	2.45 ^{a-i}	2.52 ^{a-f}	2.22 ^{h-k}	2.40 ^{a-c}
	M ₄	2.56 ^{a-f}	2.64 ^{ab}	2.31 ^g	2.50 ^{a-c}	2.36 ^{a-c}	2.47 ^{a-c}	2.17 ^{bc}	2.33 ^a	2.46 ^{a-i}	2.56 ^{a-c}	2.24 ^{g-k}	2.42 ^{a-c}
S ₂	M ₁	2.52 ^{a-f}	2.40 ^{a-g}	2.18 ^{e-g}	2.37 ^{bc}	2.42 ^{a-c}	2.53 ^{ab}	2.24 ^{bc}	2.40 ^a	2.47 ^{a-i}	2.46 ^{a-i}	2.21 ^{i-k}	2.38 ^{be}
	M ₂	2.57 ^{a-e}	2.46 ^{a-f}	2.29 ^{b-g}	2.44 ^{a-c}	2.43 ^{a-c}	2.49 ^{ab}	2.21 ^{bc}	2.38 ^a	2.50 ^{a-g}	2.50 ^{a-g}	2.26 ^{f-k}	2.42 ^{a-c}
	M ₃	2.59 ^a	2.52 ^{a-f}	2.34 ^{a-f}	2.48 ^{a-c}	2.44 ^{a-c}	2.54 ^{ab}	2.16 ^{bc}	2.38 ^a	2.52 ^{a-f}	2.53 ^{a-e}	2.31 ^{c-k}	2.45 ^{a-c}
	M ₄	2.76 ^{b-g}	2.57 ^{a-d}	2.51 ^{c-g}	2.61 ^a	2.45 ^{a-c}	2.66 ^a	2.29 ^{a-c}	2.47 ^a	2.60 ^a	2.62 ^a	2.40 ^{a-j}	2.54 ^a
S ₃	M ₁	2.43 ^{a-g}	2.61 ^{a-d}	2.32 ^{b-g}	2.45 ^{a-c}	2.37 ^{a-c}	2.48 ^{a-c}	2.19 ^{bc}	2.35 ^a	2.40 ^{a-j}	2.54 ^{a-d}	2.25 ^{g-k}	2.40 ^{a-c}
	M ₂	2.45 ^{a-f}	2.61 ^{a-c}	2.33 ^{b-g}	2.46 ^{a-c}	2.41 ^{a-c}	2.49 ^{ab}	2.16 ^{bc}	2.35 ^a	2.43 ^{a-i}	2.55 ^{a-c}	2.27 ^{e-k}	2.42 ^{a-c}
	M ₃	2.54 ^{a-f}	2.63 ^{ab}	2.34 ^{b-g}	2.50 ^{a-c}	2.42 ^{a-c}	2.51 ^{ab}	2.22 ^{bc}	2.38 ^a	2.48 ^{a-h}	2.57 ^{a-c}	2.28 ^{d-k}	2.44 ^{a-c}
	M ₄	2.58 ^{a-f}	2.64 ^{ab}	2.39 ^{d-g}	2.54 ^{ab}	2.42 ^{a-c}	2.51 ^{ab}	2.23 ^{bc}	2.39 ^a	2.50 ^{a-g}	2.58 ^{ab}	2.31 ^{c-k}	2.46 ^{ab}
Variety		2.54 ^a	2.55 ^a	2.31 ^b		2.39 ^a	2.51 ^a	2.18 ^b		2.46 ^a	2.53 ^a	2.25 ^b	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	2.50 ^{ab}	2.55 ^{ab}	2.25 ^b	2.43 ^a	2.33 ^{c-e}	2.47 ^{a-c}	2.12 ^f	2.31 ^b	2.42 ^{a-c}	2.51 ^a	2.19 ^d	2.37 ^a
	S ₂	2.61 ^a	2.49 ^{ab}	2.33 ^{ab}	2.48 ^a	2.43 ^{a-c}	2.57 ^a	2.26 ^{d-f}	2.42 ^a	2.52 ^a	2.53 ^a	2.29 ^{b-d}	2.45 ^a
	S ₃	2.50 ^{ab}	2.62 ^a	2.34 ^{ab}	2.49 ^a	2.40 ^{b-d}	2.50 ^{ab}	2.21 ^{ef}	2.37 ^{ab}	2.45 ^{ab}	2.56 ^a	2.28 ^{cd}	2.43 ^a
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M	M ₁	2.44 ^{b-d}	2.49 ^{a-c}	2.22 ^e	2.38 ^c	2.36 ^{a-c}	2.49 ^a	2.17 ^c	2.34 ^a	2.40 ^{bc}	2.49 ^{ab}	2.19 ^d	2.36 ^b
	M ₂	2.51 ^{a-c}	2.53 ^{a-c}	2.29 ^{de}	2.44 ^{bc}	2.39 ^{ab}	2.50 ^a	2.18 ^c	2.36 ^a	2.45 ^{ab}	2.52 ^{ab}	2.23 ^d	2.40 ^{ab}
	M ₃	2.56 ^{a-c}	2.57 ^{ab}	2.32 ^{de}	2.48 ^{ab}	2.40 ^{ab}	2.51 ^a	2.22 ^{bc}	2.38 ^a	2.48 ^{ab}	2.54 ^{ab}	2.27 ^d	2.43 ^{ab}
	M ₄	2.63 ^a	2.62 ^a	2.40 ^{cd}	2.55 ^a	2.41 ^{ab}	2.55 ^a	2.23 ^{bc}	2.40 ^a	2.52 ^{ab}	2.58 ^a	2.32 ^{c-d}	2.47 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.04				0.04				0.03			
Seed (S)		0.05				0.03				0.03			
Micro (M)		0.03				0.04				0.03			
V x S		0.09				0.05				0.05			
V x M		0.05				0.07				0.04			
S x M		0.05				0.07				0.04			
V x S x M		0.09				0.11				0.08			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 18. Effect of genotypes, seed rates and micronutrients on leaf area index at 67 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	3.67 ^{d-f}	3.79 ^{b-e}	3.04 ^g	3.50^d	3.55 ^{c-f}	3.83 ^{a-c}	2.85 ^g	3.41^b	3.61 ^{ef}	3.81 ^{b-e}	2.94 ^h	3.45^d
	M ₂	3.71 ^{de}	3.92 ^{a-d}	3.12 ^g	3.58^{bc}	3.58 ^g	3.86 ^{a-c}	2.92 ^g	3.45^{ab}	3.64 ^{d-f}	3.89 ^{a-e}	3.02 ^{gh}	3.52^{cd}
	M ₃	3.80 ^{b-e}	4.21 ^{a-c}	3.17 ^g	3.73^{a-c}	3.58 ^{b-e}	3.88 ^{a-c}	2.95 ^g	3.47^{ab}	3.69 ^{c-e}	4.05 ^{a-c}	3.06 ^{gh}	3.60^{b-d}
	M ₄	3.92 ^{a-d}	4.24 ^{a-c}	3.22 ^g	3.79^{a-c}	3.65 ^{a-d}	3.89 ^{a-c}	2.99 ^g	3.51^{ab}	3.79 ^{b-e}	4.06 ^{a-c}	3.11 ^{gh}	3.65^{a-d}
S ₂	M ₁	3.70 ^{de}	3.98 ^{a-d}	3.07 ^g	3.58^{bc}	3.76 ^{a-d}	4.09 ^{a-c}	3.09 ^{e-g}	3.65^{ab}	3.73 ^{c-e}	4.03 ^{a-d}	3.08 ^{gh}	3.61^{b-d}
	M ₂	3.85 ^{a-e}	4.01 ^{a-d}	3.17 ^g	3.68^{a-c}	3.79 ^{a-d}	4.11 ^{a-b}	3.12 ^{e-g}	3.67^{ab}	3.82 ^{b-e}	4.06 ^{a-c}	3.17 ^{gh}	3.68^{a-c}
	M ₃	3.95 ^{a-d}	4.15 ^{a-d}	3.26 ^{f-g}	3.79^{a-c}	3.80 ^{a-d}	4.15 ^a	3.13 ^{e-g}	3.69^{ab}	3.88 ^{a-e}	4.15 ^{ab}	3.20 ^{gh}	3.74^{ab}
	M ₄	4.03 ^{a-d}	4.32 ^a	3.40 ^{e-g}	3.92^a	3.80 ^{a-d}	4.19 ^a	3.27 ^{d-g}	3.75^a	3.91 ^{a-e}	4.26 ^a	3.34 ^{fg}	3.84^a
S ₃	M ₁	3.78 ^{c-e}	3.92 ^{a-d}	2.97 ^g	3.56^c	3.67 ^{a-d}	3.89 ^{a-c}	3.05 ^{f-g}	3.54^{ab}	3.72 ^{c-e}	3.90 ^{a-e}	3.02 ^{gh}	3.55^{b-d}
	M ₂	3.80 ^{b-e}	4.01 ^{a-d}	3.17 ^g	3.66^{a-c}	3.68 ^{a-d}	3.89 ^{a-c}	3.05 ^{f-g}	3.54^{ab}	3.74 ^{c-e}	3.95 ^{a-e}	3.11 ^{gh}	3.60^{b-d}
	M ₃	3.88 ^{a-d}	4.01 ^{a-d}	3.22 ^g	3.70^{a-c}	3.68 ^{a-d}	3.90 ^{a-c}	3.09 ^{e-g}	3.56^{ab}	3.78 ^{b-e}	3.96 ^{a-e}	3.15 ^{gh}	3.63^{a-d}
	M ₄	4.01 ^{a-d}	4.27 ^{ab}	3.25 ^{f-g}	3.84^{ab}	3.73 ^{a-d}	4.02 ^{a-c}	3.09 ^{e-g}	3.61^{ab}	3.87 ^{b-e}	4.15 ^{ab}	3.17 ^{gh}	3.73^a
Variety		3.84^b	4.07^a	3.17^c		3.69^b	3.98^a	3.05^c		3.77^b	4.02^a	3.11^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	3.78 ^a	4.04 ^a	3.14 ^b	3.65^a	3.59 ^d	3.86 ^b	2.93 ^f	3.46^c	3.68 ^c	3.95 ^{ab}	3.03 ^d	3.55^b
	S ₂	3.88 ^a	4.11 ^a	3.24 ^b	3.74^a	3.79 ^{bc}	4.14 ^a	3.16 ^e	3.70^a	3.84 ^{bc}	4.12 ^a	3.20 ^d	3.72^a
	S ₃	3.87 ^a	4.05 ^a	3.15 ^b	3.69^a	3.69 ^{cd}	3.93 ^b	3.07 ^{ef}	3.56^b	3.78 ^{bc}	3.99 ^{ab}	3.11 ^d	3.63^{ab}
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	3.72 ^d	3.90 ^{b-d}	3.03 ^f	3.55^c	3.66 ^c	3.94 ^{a-c}	3.00 ^d	3.53^a	3.69 ^e	3.92 ^{b-d}	3.01 ^e	3.54^c
	M ₂	3.79 ^{cd}	3.98 ^{bc}	3.17 ^{ef}	3.65^{bc}	3.68 ^c	3.95 ^{a-c}	3.03 ^d	3.55^a	3.73 ^{d-e}	3.97 ^{a-c}	3.10 ^{b-d}	3.60^{bc}
	M ₃	3.88 ^{b-d}	4.12 ^{ab}	3.22 ^{ef}	3.74^{ab}	3.69 ^c	3.98 ^{ab}	3.06 ^d	3.58^a	3.78 ^{c-e}	4.05 ^{cab}	3.14 ^{b-d}	3.66^{ab}
	M ₄	3.99 ^{bc}	4.28 ^a	3.29 ^e	3.85^a	3.73 ^{bc}	4.03 ^a	3.12 ^d	3.63^a	3.86 ^{b-e}	4.15 ^a	3.20 ^{b-e}	3.74^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.02				0.05				0.03			
Seed (S)		0.06				0.03				0.04			
Micro (M)		0.05				0.05				0.04			
V x S		0.11				0.05				0.06			
V x M		0.08				0.09				0.07			
S x M		0.08				0.09				0.07			
V x S x M		0.14				0.16				0.11			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 19. Effect of genotypes, seed rates and micronutrients on leaf area index at 90 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	5.90 ^{c-i}	6.11 ^{a-h}	5.09 ⁱ	5.70^{c-d}	5.61 ^{c-j}	6.23 ^{a-g}	4.96 ^{i-j}	5.60^c	5.75 ^{g-j}	6.17 ^{c-g}	5.02 ^k	5.65^d
	M ₂	6.02 ^{b-h}	6.25 ^{a-g}	5.53 ^{e-i}	5.93^{a-d}	5.73 ^{b-j}	6.24 ^{a-f}	5.02 ^{h-j}	5.66^{b-c}	5.88 ^{e-i}	6.25 ^{b-g}	5.27 ^{j-k}	5.80^{c-d}
	M ₃	6.07 ^{a-h}	6.35 ^{a-f}	5.54 ^{e-i}	5.99^{a-d}	5.82 ^{b-j}	6.26 ^{a-f}	5.21 ^{h-j}	5.76^{a-c}	5.95 ^k	6.30 ^{b-g}	5.37 ^{i-k}	5.87^{b-d}
	M ₄	6.20 ^{a-h}	6.56 ^{a-d}	5.59 ^{e-i}	6.12^{a-c}	5.95 ^{a-i}	6.26 ^{a-c}	5.24 ^{e-j}	5.82^{a-c}	6.07 ^{d-h}	6.41 ^{a-f}	5.42 ^{i-k}	5.97^{a-d}
S ₂	M ₁	6.09 ^{a-h}	6.43 ^{a-e}	5.28 ^{h-i}	5.93^{a-d}	6.10 ^{a-h}	6.49 ^{a-b}	5.46 ^{e-j}	6.02^{a-c}	6.10 ^{d-h}	6.46 ^{a-e}	5.37 ^{i-k}	5.98^{a-d}
	M ₂	5.80 ^{c-i}	6.22 ^{a-g}	5.32 ^{g-i}	5.78^{b-d}	6.12 ^{a-h}	6.65 ^a	5.47 ^{d-j}	6.08^{a-c}	6.21 ^{b-g}	6.59 ^{a-d}	5.40 ^{i-k}	6.07^{a-c}
	M ₃	6.33 ^{a-f}	6.73 ^{a-c}	5.47 ^{f-i}	6.18^{a-c}	6.14 ^{a-h}	6.82 ^a	5.51 ^{c-j}	6.16^{ab}	6.24 ^{b-g}	6.78 ^{ab}	5.49 ^{i-k}	6.17^{ab}
	M ₄	6.55 ^{a-d}	6.90 ^{ab}	5.61 ^{e-i}	6.35^a	6.18 ^{a-h}	6.90 ^{a-f}	5.54 ^{g-j}	6.21^a	6.37 ^{a-f}	6.90 ^a	5.57 ^{h-k}	6.28^a
S ₃	M ₁	5.68 ^{d-i}	6.10 ^{a-h}	5.03 ⁱ	5.60^d	6.00 ^{a-h}	6.28 ^{a-e}	5.26 ^{f-j}	5.85^{a-c}	5.84 ^{f-j}	6.19 ^{b-g}	5.15 ^k	5.73^d
	M ₂	5.80 ^{c-i}	6.22 ^{a-g}	5.32 ^{g-i}	5.78^{b-d}	6.02 ^{a-h}	6.36 ^{a-d}	5.38 ^{e-j}	5.92^{a-c}	5.91 ^{e-i}	6.29 ^{b-g}	5.35 ^{i-k}	5.85^{b-d}
	M ₃	6.17 ^{a-h}	6.33 ^a	5.45 ^{f-i}	5.98^{a-d}	6.02 ^{a-h}	6.46 ^{a-d}	5.39 ^{e-j}	5.96^{a-c}	6.10 ^{d-h}	6.39 ^{a-f}	5.42 ^{i-k}	5.97^{a-d}
	M ₄	6.32 ^{a-f}	6.98 ^{a-f}	5.46 ^{f-i}	6.25^{ab}	6.04 ^{a-h}	6.48 ^{a-d}	5.40 ^{e-j}	5.97^{a-c}	6.18 ^{b-g}	6.73 ^{a-c}	5.43 ^{i-k}	6.11^{a-c}
Variety		6.08^b	6.43^a	5.39 ^c		5.98^b	6.45^a	5.32 ^c		6.05^b	6.46^a	5.36 ^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	6.05 ^{ab}	6.32 ^{ab}	5.44 ^{cd}	5.94^a	5.78 ^{cd}	6.24 ^b	5.11 ^e	5.71^b	5.91 ^c	6.28 ^{ab}	5.27 ^d	5.82^b
	S ₂	6.32 ^{ab}	6.65 ^a	5.43 ^{cd}	6.13^a	6.14 ^{bc}	6.72 ^a	5.49 ^{de}	6.12^a	6.23 ^{bc}	6.68 ^a	5.46 ^d	6.12^a
	S ₃	5.99 ^{bc}	6.41 ^{ab}	5.32 ^d	5.91^a	6.02 ^{bc}	6.39 ^{ab}	5.36 ^{de}	5.92^c	6.01 ^{bc}	6.40 ^{ab}	5.34 ^d	5.92^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	5.89 ^{cd}	6.21 ^{bc}	5.13 ^e	5.74^b	5.90 ^c	6.33 ^{a-c}	5.23 ^d	5.82^{ab}	5.90 ^e	6.27 ^{b-d}	5.18 ^f	5.78^c
	M ₂	6.04 ^{bc}	6.33 ^{bc}	5.40 ^e	5.92^b	5.96 ^c	5.42 ^d	5.29 ^d	5.56^b	6.00 ^{de}	6.38 ^{a-c}	5.34 ^f	5.91^{bc}
	M ₃	6.19 ^{bc}	6.47 ^{ab}	5.49 ^{de}	6.05^{ab}	6.00 ^c	6.51 ^{ab}	5.37 ^d	5.96^a	6.09 ^{c-e}	6.49 ^{ab}	5.43 ^f	6.00^{ab}
	M ₄	6.36 ^{a-c}	6.81 ^a	5.55 ^{de}	6.24^a	6.05 ^{bc}	6.55 ^a	5.39 ^d	6.00^a	6.21 ^{b-e}	6.68 ^a	5.47 ^f	6.12^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.08				0.11				0.08			
Seed (S)		0.10				0.08				0.05			
Micro (M)		0.09				0.09				0.06			
V x S		0.18				0.14				0.09			
V x M		0.15				0.16				0.10			
S x M		0.15				0.16				0.10			
V x S x M		0.27				0.28				0.18			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)
M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 20. Effect of genotypes, seed rates and micronutrients on leaf area index at harvest under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	3.56 ^a	3.70 ^a	4.06 ^a	3.77^a	3.60 ^a	3.71 ^a	3.50 ^a	3.60^a	3.65 ^a	3.76 ^a	3.48 ^a	3.63^a
	M ₂	3.88 ^a	3.65 ^a	3.75 ^a	3.76^a	3.66 ^a	3.78 ^a	3.54 ^a	3.66^a	3.65 ^a	3.79 ^a	3.50 ^a	3.65^a
	M ₃	3.55 ^a	3.92 ^a	3.78 ^a	3.75^a	3.68 ^a	3.79 ^a	3.65 ^a	3.71^a	3.67 ^a	3.79 ^a	3.50 ^a	3.65^a
	M ₄	3.67 ^a	3.73 ^a	3.96 ^a	3.79^b	3.73 ^a	3.83 ^a	3.69 ^a	3.75^a	3.67 ^a	3.82 ^a	3.51 ^a	3.67^a
S ₂	M ₁	3.81 ^a	3.68 ^a	3.70 ^a	3.73^a	3.74 ^a	3.81 ^a	3.67 ^a	3.74^a	3.73 ^a	3.91 ^a	3.62 ^a	3.75^a
	M ₂	3.58 ^a	3.79 ^a	3.66 ^a	3.68^a	3.77 ^a	3.84 ^a	3.69 ^a	3.77^a	3.74 ^a	3.91 ^a	3.62 ^a	3.76^a
	M ₃	3.53 ^a	3.68 ^a	4.04 ^a	3.75^a	3.82 ^a	3.98 ^a	3.73 ^a	3.84^a	3.74 ^a	3.99 ^a	3.63 ^a	3.79^a
	M ₄	3.87 ^a	3.55 ^a	3.64 ^a	3.69^a	3.85 ^a	4.04 ^a	3.80 ^a	3.90^a	3.76 ^a	4.01 ^a	3.63 ^a	3.80^a
S ₃	M ₁	3.75 ^a	3.90 ^a	3.67 ^a	3.77^a	3.66 ^a	3.74 ^a	3.54 ^a	3.65^a	3.68 ^a	3.83 ^a	3.53 ^a	3.68^a
	M ₂	3.72 ^a	3.81 ^a	3.79 ^a	3.77^a	3.70 ^a	3.75 ^a	3.58 ^a	3.68^a	3.69 ^a	3.85 ^a	3.59 ^a	3.71^a
	M ₃	3.84 ^a	3.74 ^a	3.77 ^a	3.78^a	3.71 ^a	3.78 ^a	3.63 ^a	3.71^a	3.70 ^a	3.87 ^a	3.60 ^a	3.72^a
	M ₄	3.96 ^a	3.94 ^a	3.84 ^a	3.91^a	3.82 ^a	3.97 ^a	3.75 ^a	3.85^a	3.72 ^a	3.89 ^a	3.61 ^a	3.74^a
Variety		3.73^c	3.76^b	3.81^a		3.73^{ab}	3.84^a	3.65^b		3.70^b	3.87^a	3.57^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	3.66 ^a	3.75 ^a	3.88 ^a	3.76^a	3.67 ^{ab}	3.78 ^{ab}	3.60 ^b	3.68^a	3.66 ^{b-d}	3.79 ^{a-c}	3.50 ^d	3.65^a
	S ₂	3.70 ^a	3.68 ^a	3.76 ^a	3.71^a	3.79 ^{ab}	3.92 ^a	3.72 ^{ab}	3.81^a	3.74 ^{a-d}	3.96 ^a	3.62 ^{b-d}	3.77^a
	S ₃	3.82 ^a	3.85 ^a	3.77 ^a	3.81^a	3.72 ^{ab}	3.81 ^{ab}	3.62 ^b	3.72^a	3.70 ^{b-d}	3.86 ^{ab}	3.58 ^{cd}	3.71^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	3.71 ^a	3.76 ^a	3.81 ^a	3.76^a	3.67 ^{ab}	3.75 ^{ab}	3.57 ^b	3.66^a	3.68 ^{cd}	3.83 ^{b-d}	3.54 ^d	3.68^a
	M ₂	3.73 ^a	3.75 ^a	3.72 ^a	3.73^a	3.71 ^{ab}	3.79 ^{ab}	3.60 ^b	3.70^a	3.69 ^{b-d}	3.85 ^{a-c}	3.57 ^d	3.70^a
	M ₃	3.64 ^a	3.78 ^a	3.86 ^a	3.76^a	3.74 ^{ab}	3.85 ^{ab}	3.67 ^{ab}	3.75^a	3.70 ^{b-d}	3.88 ^{ab}	3.58 ^d	3.72^a
	M ₄	3.83 ^a	3.74 ^a	3.81 ^a	3.79^a	3.80 ^{ab}	3.94 ^a	3.75 ^{ab}	3.83^a	3.72 ^{b-d}	3.91 ^a	3.59 ^d	3.74^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.01				0.03				0.03			
Seed (S)		0.06				0.04				0.04			
Micro (M)		0.05				0.03				0.06			
V x S		0.11				0.07				0.08			
V x M		0.09				0.06				0.10			
S x M		0.09				0.06				0.10			
V x S x M		0.16				0.10				0.17			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

were significant and among all cv. MTU 1010 at 30 kg ha⁻¹ seed rate (V₂S₂) recorded higher LAI (3.96) and V₁S₂ and V₂S₁₋₃ were on par; while lower LAI was recorded with cv. BPT 5204 at seed rate of 25 kg ha⁻¹ (3.50). In variety X micronutrient cv. MTU 1010 with combined application of FeSO₄ and ZnSO₄ (V₂M₄) rerecorded higher LAI (3.91) and it was on par with V₂M₂₋₃. LAI decreased with cv. BPT 5204 irrespective micronutrient application particularly in the absence of micronutrient (V₃M₁- 3.54).

Interaction due to seed rates and micronutrients and three way interaction due to V x S x M were non-significant.

4.1.1.1.5 Dry matter accumulation in leaves (g plant⁻¹) (c.f. Table 21-24 and Fig.4a)

At different stages of crop growth during both the years and on pooled basis as well dry matter accumulation (DMA) in leaves varied significantly due to cultivars, seed rates (except 90 DAS) and use of micronutrients and their interactions.

At 45 DAS, among the varieties, cv. MTU 1010 (V₂) recorded significantly higher dry matter in leaves (0.15) followed by cvs. GGV 0501 and BPT 5204 (0.14 and 0.12, respectively); among seed rates higher DMA in leaves (0.14) was recorded with the seed rate of 30 (S₂) and 35 kg ha⁻¹ (S₃). Similarly, among micronutrients levels M₄ i.e. application FeSO₄+ZnSO₄ to soil and to the foliage resulted in higher DMA in leaves (0.17), while no application of micronutrient (M₁) recorded significantly lower DMA (0.15).

Interactions due to variety and seed rate were significant and among all cv. MTU 1010 at 30 kg ha⁻¹ (V₂S₂) and 35 kg ha⁻¹ seed rates (V₂S₃) recorded higher DMA in leaves (0.16); and cv. GGV 0510 with 30 kg seed rate (V₁S₂) was at par, while lower DMA in leaves was recorded with cv. BPT 5204 irrespective of seed rates used particularly with lower seed rate of 25 kg ha⁻¹ (V₃S₁- 0.11). Variety X micronutrient also revealed significant variations, in that cv. MTU 1010 with FeSO₄ + ZnSO₄ (V₂M₄) rerecorded higher DMA in leaves (0.21). In the absence of micronutrient lower DMA in leaves occurred with cv. BPT 5204 (V₃M₁) (0.10). Similarly, interactions due to seed rates and micronutrients were significant wherein 30 kg (S₂) and 35 kg (S₃) seed rates with FeSO₄ + ZnSO₄ recorded higher DMA in leaves (0.19 and 0.18, respectively), while 35 kg ha⁻¹ seed rate with no supplementation of micronutrient (S₃M₁) recorded lower DMA in leaves (0.10).

Overall, the three way interaction revealed significantly higher DMA in leaves (0.23) with cv. MTU 1010 sown with 30 kg seed rate and applied with both $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_2S_2M_4$), closely followed by $V_1S_2M_4$ (0.19) which was on par, while lower DMAs in leaves (0.09 each) were recorded with cvs. BPT 5204 ($V_3S_3M_1$) and GGV 0510 ($V_1S_3M_1$) sown using 35 kg ha^{-1} seed rate and supplied with no micronutrient.

At 67 DAS, cv.MTU 1010 (V_2) recorded significantly higher DMA in leaves followed by cvs. GGV 0501 and BPT 5204(0.40, 0.37 and 0.35, respectively); among seed rates higher DMA in leaves (0.39 each) was recorded with the seed rate of 30 (S_2) and 35 kg ha^{-1} (S_3). Similarly, application, $\text{FeSO}_4 + \text{ZnSO}_4$ to soil and to the foliage resulted in higher DMA in leaves (0.43), while no application of micronutrient (M_1) and M_2 receiving only FeSO_4 recorded significantly lower DMA in leaves (0.33 and 0.35, respectively).

Interactions due to variety and seed rate were significant and among all cv. MTU 1010 at 30 kg ha^{-1} (V_2S_3) recorded highest DMA in leaves (0.46); while lower DMA among all was recorded with cv. BPT 5204 at 30 (V_3S_2) and 25 kg ha^{-1} (V_3S_1) seed rates used (0.33 and 0.34, respectively). Cv. MTU 1010 with combined application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_2M_4) rerecorded higher DMA in leaves (0.48) among variety X micronutrient. No micronutrient application resulted in lower DMA particularly with cv. BPT 5204 (V_3M_1) and GGV 0510 (V_1M_1) (0.33 each). Similarly, among seed rate and micronutrients 30 kg seed rate with $\text{FeSO}_4 + \text{ZnSO}_4$ recorded higher DMA in leaves (0.48), S_3M_4 was at par, while 25 kg ha^{-1} seed rate with no micronutrient (S_1M_1) recorded lower DMA in leaves (0.32).

On the whole, the three way interaction revealed significantly higher DMA with cv. MTU 1010 sown with 30 kg seed rate and application of ZnSO_4 ($V_2S_2M_3$) and applied with both $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_2S_2M_4$) and 35 kg ha^{-1} with both $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_2S_3M_4$) (0.53, 0.52 and 0.52, respectively), while lower DMA was recorded with cv. BPT 5204 sown using 30 kg ha^{-1} seed rate and supplied with only FeSO_4 ($V_3S_2M_2$) or no micronutrient ($V_3S_2M_1$) (0.29 and 0.30, respectively).

Among the varieties at 90 DAS, cv. MTU 1010 (V_2) recorded significantly higher DMA in leaves followed by cvs. GGV 0501 and BPT 5204(18.20, 13.10 and 11.80, respectively). Similarly, use of micronutrients produced significant variations individually and with combined application wherein the latter (M_4) i.e. combined

application $\text{FeSO}_4 + \text{ZnSO}_4$ to soil and to the foliage resulted in higher DMA in leaves (17.90), while no application of micronutrient (M_1) recorded significantly lower DMA in leaves (11.50).

Of the two-way interactions, effects due to variety and seed rate were significant and among all cv. MTU 1010 at 35 kg ha^{-1} (V_2S_3) and 25 kg ha^{-1} (V_2S_1) seed rates recorded higher DMA in leaves (19.10), while lower DMA in leaves among all was recorded with cv. BPT 5204 irrespective of seed rates used particularly with lower seed rate of 25 kg ha^{-1} (V_3S_1) (9.40). Variety X micronutrient revealed significant variations, in that cv. MTU 1010 with combined application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_2M_4) and V_2M_3 receiving ZnSO_4 recorded higher DMA in leaves (21.70 and 19.90, respectively). DMA decreased in the absence of micronutrient application more so with cv. BPT 5204 (V_3M_1) (8.60). Similarly, interactions due to seed rates and micronutrients were significant wherein 30 (18.70) and 35 kg (17.10) seed rates with the application of $\text{FeSO}_4 + \text{ZnSO}_4$ recorded higher DMA in leaves, while 25 kg ha^{-1} seed rate with no supplementation of micronutrient (S_1M_1) recorded lower DMA in leaves (11.10).

Overall, among three factor combinations significantly higher (22.40) DMA in leaves occurred with cv. MTU 1010 sown with 25 (S_1) and 30 kg (S_2) seed rate and applied with $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_2S_{1-2}M_4$) and $V_2S_3M_{3\&4}$ were at par, while lower DMA in leaves (6.90) was recorded with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient ($V_3S_1M_1$).

At harvest, among the varieties, cv. MTU 1010 (V_2) recorded significantly higher dry matter in leaves followed by cvs. GGV 0501 and BPT 5204 (20.84, 18.67 and 16.85, respectively); among seed rates higher DMA in leaves was recorded with the seed rate of 30 and 35 kg ha^{-1} (19.30 and 19.10, respectively); Similarly, use of micronutrients produced significant variations individually and with combined application wherein $\text{FeSO}_4 + \text{ZnSO}_4$ application (M_4) resulted in higher DMA in leaves (21.90), while no application of micronutrient (M_1) recorded significantly lower DMA in leaves (15.80).

Interactions due to variety and seed rate were significant and cvs. MTU 1010 and GGV 0510 at 30 kg ha^{-1} (V_1S_{2-3}) and 35 kg ha^{-1} seed rate (V_2S_{1-3}) recorded higher DMA in leaves; while lower DMA in leaves among all was recorded with cv. BPT 5204 irrespective of seed rates used particularly with lower seed rate of 25 kg ha^{-1} (V_3S_1) (16.20). Variety X micronutrient also revealed significant variations, in that cv. MTU

Table 21. Effect of genotypes, seed rates and micronutrients on dry matter accumulation in leaves (g plant⁻¹) at 45 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	0.12 ^{f-h}	0.13 ^{e-h}	0.12 ^{f-h}	0.12^{cd}	0.10 ^{c-e}	0.11 ^{c-e}	0.09 ^{de}	0.10^{cd}	0.11 ^{e-g}	0.12 ^{d-g}	0.11 ^{e-g}	0.11^a
	M ₂	0.14 ^{d-h}	0.17 ^{c-e}	0.12 ^{f-h}	0.14^{bc}	0.11 ^{c-e}	0.15 ^{bc}	0.10 ^{c-e}	0.12^{bc}	0.13 ^{c-g}	0.16 ^{b-d}	0.11 ^{e-g}	0.13^a
	M ₃	0.15 ^{d-g}	0.14 ^{d-h}	0.12 ^{f-h}	0.14^{b-d}	0.12 ^{c-e}	0.12 ^{c-e}	0.09 ^{de}	0.11^{b-d}	0.14 ^{c-f}	0.13 ^{c-g}	0.11 ^{e-g}	0.13^a
	M ₄	0.18 ^{cd}	0.18 ^{cd}	0.13 ^{e-h}	0.16^b	0.15 ^{bc}	0.15 ^{bc}	0.10 ^{c-e}	0.13^b	0.16 ^{b-d}	0.17 ^{bc}	0.12 ^{d-g}	0.15^a
S ₂	M ₁	0.14 ^{d-h}	0.12 ^{f-h}	0.11 ^{gh}	0.12^d	0.11 ^{c-e}	0.10 ^{c-e}	0.08 ^e	0.10^{cd}	0.13 ^{c-g}	0.11 ^{e-g}	0.10 ^{fg}	0.11^a
	M ₂	0.16 ^{c-f}	0.16 ^{c-f}	0.13 ^{e-h}	0.15^{bc}	0.14 ^{b-d}	0.13 ^{c-e}	0.10 ^{c-e}	0.12^{bc}	0.15 ^{b-e}	0.15 ^{b-e}	0.11 ^{e-g}	0.14^a
	M ₃	0.16 ^{c-f}	0.16 ^{c-f}	0.14 ^{d-h}	0.15^{bc}	0.14 ^{b-d}	0.13 ^{c-e}	0.12 ^{c-e}	0.13^b	0.15 ^{b-e}	0.14 ^{c-f}	0.13 ^{c-g}	0.14^a
	M ₄	0.20 ^{bc}	0.25 ^a	0.17 ^{c-e}	0.21^a	0.18 ^{ab}	0.22 ^a	0.14 ^{b-d}	0.18^a	0.19 ^{ab}	0.23 ^a	0.15 ^{b-e}	0.19^a
S ₃	M ₁	0.10 ^h	0.14 ^{d-h}	0.11 ^{gh}	0.12^d	0.08 ^{er}	0.11 ^{c-e}	0.08 ^e	0.09^d	0.09 ^g	0.13 ^{c-g}	0.09 ^g	0.10^a
	M ₂	0.13 ^{e-h}	0.14 ^{d-h}	0.12 ^{f-h}	0.13^{cd}	0.12 ^{c-e}	0.11 ^{c-e}	0.10 ^{c-e}	0.11^{b-d}	0.12 ^{d-g}	0.12 ^{d-g}	0.11 ^{e-g}	0.12^a
	M ₃	0.15 ^{d-g}	0.18 ^{cd}	0.15 ^{d-g}	0.16^b	0.12 ^{c-e}	0.15 ^{bc}	0.10 ^{c-e}	0.12^{bc}	0.13 ^{c-g}	0.16 ^{b-d}	0.14 ^{c-f}	0.14^a
	M ₄	0.18 ^{cd}	0.23 ^{ab}	0.17 ^{c-e}	0.19^a	0.15 ^{bc}	0.20 ^a	0.14 ^{b-d}	0.16^a	0.16 ^{b-d}	0.22 ^a	0.16 ^{b-d}	0.18^a
Variety		0.15 ^a	0.17 ^a	0.13 ^a		0.13 ^a	0.14 ^a	0.10 ^b		0.14 ^a	0.15 ^a	0.12 ^b	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	0.15 ^a	0.16 ^a	0.12 ^a	0.14 ^a	0.12 ^{bc}	0.13 ^{ab}	0.10 ^d	0.12 ^b	0.13 ^{cd}	0.14 ^{bc}	0.11 ^e	0.13 ^b
	S ₂	0.17 ^a	0.17 ^a	0.14 ^a	0.16 ^a	0.14 ^a	0.14 ^a	0.11 ^{cd}	0.13 ^a	0.15 ^{ab}	0.16 ^a	0.12 ^{de}	0.14 ^a
	S ₃	0.14 ^a	0.17 ^a	0.14 ^a	0.15 ^a	0.12 ^{bc}	0.14 ^a	0.11 ^{cd}	0.12 ^b	0.13 ^{cd}	0.16 ^a	0.12 ^{de}	0.14 ^a
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M	M ₁	0.12 ^{de}	0.13 ^{c-e}	0.11 ^e	0.12 ^c	0.10 ^{de}	0.11 ^{cd}	0.08 ^e	0.10 ^c	0.11 ^{ef}	0.12 ^{d-f}	0.10 ^f	0.11 ^c
	M ₂	0.14 ^{b-d}	0.16 ^b	0.12 ^{de}	0.14 ^b	0.12 ^{cd}	0.13 ^c	0.10 ^{de}	0.12 ^b	0.13 ^{c-e}	0.14 ^{cd}	0.11 ^{ef}	0.13 ^b
	M ₃	0.15 ^{bc}	0.16 ^b	0.14 ^{b-d}	0.15 ^b	0.13 ^c	0.13 ^c	0.11 ^{cd}	0.12 ^b	0.14 ^{cd}	0.15 ^c	0.12 ^{d-f}	0.14 ^b
	M ₄	0.19 ^a	0.21 ^a	0.16 ^b	0.19 ^a	0.16 ^b	0.19 ^a	0.13 ^c	0.16 ^a	0.17 ^b	0.21 ^a	0.14 ^{cd}	0.17 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.004				0.004				0.004			
Seed (S)		0.003				0.029				0.002			
Micro (M)		0.004				0.004				0.004			
V x S		0.005				0.005				0.005			
V x M		0.008				0.008				0.008			
S x M		0.008				0.008				0.008			
V x S x M		0.039				0.014				0.014			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 22. Effect of genotypes, seed rates and micronutrients on dry matter accumulation in leaves (g plant⁻¹) at 67 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	0.35 ^{d-f}	0.35 ^{d-f}	0.35 ^{d-f}	0.35^d	0.29 ^{e-f}	0.29 ^{e-g}	0.29 ^{e-g}	0.29^e	0.32 ^{de}	0.32 ^{de}	0.32 ^{de}	0.32^e
	M ₂	0.38 ^{d-f}	0.37 ^{d-f}	0.38 ^{d-f}	0.38^{cd}	0.33 ^{b-g}	0.35 ^{b-e}	0.30 ^{d-g}	0.33^{c-e}	0.36 ^{c-e}	0.36 ^{c-e}	0.34 ^{c-e}	0.35^{c-e}
	M ₃	0.37 ^{d-f}	0.38 ^{d-f}	0.41 ^{c-f}	0.39^{cd}	0.37 ^{b-d}	0.34 ^{b-f}	0.33 ^{b-g}	0.35^c	0.37 ^{c-e}	0.36 ^{c-e}	0.37 ^{c-e}	0.37^{c-e}
	M ₄	0.43 ^{c-e}	0.42 ^{c-f}	0.35 ^{d-f}	0.40^{cd}	0.38 ^{bc}	0.37 ^{b-d}	0.31 ^{c-g}	0.35^c	0.40 ^{cd}	0.40 ^{cd}	0.33 ^{de}	0.38^{cd}
S ₂	M ₁	0.36 ^{d-f}	0.39 ^{c-f}	0.31 ^f	0.35^d	0.30 ^{d-g}	0.33 ^{b-g}	0.27 ^{fg}	0.30^{de}	0.33 ^{de}	0.36 ^{c-e}	0.29 ^e	0.33^{de}
	M ₂	0.36 ^{d-f}	0.44 ^{c-e}	0.33 ^{ef}	0.38^{cd}	0.30 ^{d-g}	0.38 ^{bc}	0.26 ^g	0.32^{c-e}	0.33 ^{de}	0.41 ^{b-d}	0.30 ^e	0.35^{c-e}
	M ₃	0.39 ^{c-f}	0.57 ^a	0.35 ^{d-f}	0.44^{bc}	0.32 ^{c-g}	0.48 ^a	0.29 ^{e-g}	0.36^c	0.35 ^{c-e}	0.53 ^a	0.32 ^{de}	0.40^{bc}
	M ₄	0.50 ^{a-c}	0.55 ^{ab}	0.46 ^{b-d}	0.50^a	0.49 ^a	0.49 ^a	0.40 ^b	0.46^a	0.49 ^{ab}	0.52 ^a	0.43 ^{bc}	0.48^a
S ₃	M ₁	0.39 ^{c-f}	0.36 ^{d-f}	0.42 ^{c-f}	0.39^{cd}	0.31 ^{c-g}	0.30 ^{d-g}	0.34 ^{b-f}	0.32^{c-e}	0.35 ^{c-e}	0.33 ^{de}	0.38 ^{c-e}	0.35^{c-e}
	M ₂	0.39 ^{c-f}	0.36 ^{d-f}	0.41 ^{c-f}	0.39^{cd}	0.33 ^{ab-g}	0.32 ^{c-g}	0.34 ^{b-f}	0.33^{c-e}	0.36 ^{c-e}	0.34 ^{c-e}	0.38 ^{c-e}	0.36^{c-e}
	M ₃	0.42 ^{c-f}	0.40 ^{c-f}	0.39 ^{c-f}	0.40^{cd}	0.35 ^{b-e}	0.34 ^{b-f}	0.34 ^{b-f}	0.34^{cd}	0.38 ^{c-e}	0.37 ^{c-e}	0.37 ^{c-e}	0.37^{c-e}
	M ₄	0.44 ^{c-e}	0.57 ^a	0.42 ^{c-f}	0.48^{ab}	0.36 ^{b-e}	0.47 ^a	0.38 ^{bc}	0.40^b	0.40 ^{cd}	0.52 ^a	0.40 ^{cd}	0.44^{ab}
Variety		0.4^b	0.43^a	0.38^b		0.34^b	0.37^a	0.33^b		0.37^b	0.40^a	0.35^a	
Variety x Seed rate					S	Variety x Seed rate				S	Variety x Seed rate		
S	S ₁	0.38 ^{cd}	0.38 ^{cd}	0.37 ^{cd}	0.38^b	0.34 ^b	0.34 ^b	0.31 ^c	0.33^b	0.36 ^{bc}	0.36 ^{bc}	0.34 ^c	0.35^b
	S ₂	0.40 ^{b-d}	0.49 ^a	0.36 ^d	0.42^a	0.35 ^b	0.42 ^a	0.31 ^c	0.36^a	0.38 ^b	0.46 ^a	0.33 ^c	0.39^a
	S ₃	0.41 ^{bc}	0.43 ^b	0.41 ^{bc}	0.42^a	0.34 ^b	0.36 ^b	0.35 ^b	0.35^a	0.38 ^b	0.39 ^b	0.39 ^b	0.39^a
Variety x Micro					M	Variety x Micro				M	Variety x Micro		
M	M ₁	0.37 ^c	0.37 ^c	0.36 ^c	0.37^c	0.30 ^e	0.31 ^{ef}	0.30 ^f	0.30^c	0.33 ^d	0.34 ^{cd}	0.33 ^d	0.33^c
	M ₂	0.38 ^c	0.39 ^{bc}	0.37 ^c	0.38^{bc}	0.32 ^{d-f}	0.35 ^{de}	0.30 ^f	0.32^c	0.35 ^{cd}	0.37 ^b	0.34 ^{cd}	0.35^c
	M ₃	0.39 ^{bc}	0.45 ^b	0.39 ^{bc}	0.41^b	0.35 ^{a-f}	0.39 ^{bc}	0.32 ^{d-f}	0.35^b	0.37 ^b	0.42 ^b	0.35 ^{bc}	0.38^b
	M ₄	0.45 ^b	0.52 ^a	0.41 ^{bc}	0.46^a	0.41 ^{cd}	0.44 ^a	0.36 ^{cd}	0.40^a	0.43 ^b	0.48 ^a	0.39 ^{bc}	0.43^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.006				0.003				0.005			
Seed (S)		0.008				0.003				0.005			
Micro (M)		0.011				0.007				0.008			
V x S		0.014				0.006				0.009			
V x M		0.019				0.013				0.015			
S x M		0.019				0.013				0.015			
V x S x M		0.033				0.227				0.026			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 23. Effect of genotypes, seed rates and micronutrients on dry matter accumulation in leaves (g plant⁻¹) at 90 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	11.00 ^{i-m}	16.50 ^{d-h}	7.60 ^m	11.70^f	10.30 ^{b-m}	15.10 ^{c-g}	6.20 ^m	10.50^g	10.70 ^{h-m}	15.80 ^{c-g}	6.90 ^m	11.10^g
	M ₂	12.20 ^{h-j}	17.10 ^{c-f}	8.60 ^{lm}	12.60^{ef}	11.20 ^{f-l}	16.30 ^{b-e}	7.90 ^{lm}	11.80^{e-g}	11.70 ^{a-l}	16.70 ^{b-e}	8.20 ^{lm}	12.20^{e-g}
	M ₃	15.50 ^{d-h}	19.50 ^{a-d}	9.50 ^{k-m}	14.80^{c-e}	14.20 ^{d-h}	17.90 ^{a-d}	8.10 ^{k-m}	13.40^{d-f}	14.80 ^{d-h}	18.70 ^{a-d}	8.80 ^{k-m}	14.10^{d-f}
	M ₄	19.20 ^{a-d}	22.60 ^a	14.30 ^{e-j}	18.70^a	17.80 ^{a-d}	21.10 ^a	12.80 ^{e-j}	17.20^{ab}	18.50 ^{a-d}	21.90 ^a	13.50 ^{e-j}	17.90^{ab}
S ₂	M ₁	12.10 ^{h-j}	13.60 ^{e-k}	10.40 ^{i-m}	12.00^f	10.70 ^{g-l}	12.20 ^{e-l}	9.00 ^{j-m}	10.60^g	11.40 ^{g-l}	12.90 ^{e-k}	9.70 ^{i-m}	11.30^g
	M ₂	12.50 ^{g-i}	13.80 ^{e-k}	12.60 ^{g-l}	12.90^{d-f}	11.30 ^{f-l}	13.30 ^{e-i}	11.40 ^{f-l}	12.00^{e-g}	11.90 ^{f-l}	13.60 ^{e-j}	12.00 ^{e-l}	12.50^{e-g}
	M ₃	13.50 ^{e-k}	20.90 ^{a-c}	13.60 ^{e-k}	16.00^{bc}	11.90 ^{e-l}	19.20 ^{a-c}	12.10 ^{e-l}	14.40^{cd}	12.70 ^{e-k}	20.00 ^{a-c}	12.90 ^{e-k}	15.20^{cd}
	M ₄	16.10 ^{d-h}	23.10 ^a	19.10 ^{a-d}	19.40^a	14.70 ^{d-h}	21.60 ^a	17.70 ^{a-d}	18.00^a	15.40 ^{d-g}	22.40 ^a	18.40 ^{a-d}	18.70^a
S ₃	M ₁	10.90 ^{i-m}	16.80 ^{c-g}	9.90 ^{j-m}	12.50^f	9.50 ^{i-m}	15.70 ^{c-f}	8.50 ^{j-m}	11.20^{fg}	10.20 ^{i-m}	16.20 ^{c-f}	9.20 ^{j-m}	11.90^{fg}
	M ₂	13.40 ^{e-k}	18.90 ^{a-d}	13.00 ^{f-k}	15.10^{cd}	12.20 ^{e-l}	17.70 ^{a-d}	11.80 ^{e-l}	13.90^{de}	12.80 ^{e-k}	18.30 ^{a-d}	12.40 ^{c-d}	14.50^{de}
	M ₃	14.20 ^{e-j}	21.40 ^{ab}	13.40 ^{e-k}	16.30^{bc}	12.50 ^{e-k}	20.30 ^{ab}	12.80 ^{e-j}	15.20^{b-d}	13.30 ^{e-j}	20.90 ^{ab}	13.10 ^{e-k}	15.80^{b-d}
	M ₄	14.40 ^{e-i}	21.60 ^{ab}	17.50 ^{e-k}	17.80^{ab}	12.90 ^{e-j}	20.10 ^{ab}	16.10 ^{b-e}	16.40^{a-c}	13.70 ^{e-i}	20.90 ^{ab}	16.80 ^{b-e}	17.10^{a-c}
Variety		13.70^b	18.80^a	12.40^{bc}		12.40^b	17.50^a	11.20^c		13.10^b	18.20^a	11.80^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	14.50 ^c	18.90 ^{ab}	10.00 ^d	14.50^a	13.40 ^b	17.60 ^a	8.80 ^c	13.20^a	13.90 ^c	18.30 ^a	9.40 ^d	13.90^a
	S ₂	13.60 ^c	17.40 ^b	13.90 ^c	14.90^a	12.10 ^b	16.60 ^a	12.60 ^b	13.80^a	12.90 ^c	17.20 ^b	13.20 ^c	14.40^a
	S ₃	13.20 ^c	19.70 ^a	13.40 ^c	15.40^a	11.80 ^b	18.50 ^a	12.30 ^b	14.20^a	12.50 ^c	19.10 ^a	12.90 ^c	14.80^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	11.30 ^{ef}	15.60 ^{bc}	9.30 ^f	12.07^d	10.20 ^f	14.30 ^{bc}	7.90 ^f	10.80^d	10.80 ^e	15.00 ^{bc}	8.60 ^f	11.50^d
	M ₂	12.70 ^{de}	16.60 ^{bc}	11.40 ^{ef}	13.57^c	11.60 ^{de}	15.80 ^b	10.40 ^e	12.60^c	12.10 ^{de}	16.20 ^b	10.90 ^e	13.10^c
	M ₃	14.40 ^{cd}	20.60 ^a	12.20 ^{de}	15.73^b	12.90 ^{cd}	19.10 ^a	11.00 ^{de}	14.30^b	13.60 ^{cd}	19.90 ^a	11.6 ^{de}	15.00^b
	M ₄	16.60 ^{bc}	22.40 ^a	17.00 ^b	18.67^a	15.10 ^a	21.00 ^a	15.50 ^b	17.20^a	15.90 ^b	21.70 ^a	16.20 ^b	17.90^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.25				0.27				0.26			
Seed (S)		0.31				0.34				0.32			
Micro (M)		0.43				0.44				0.43			
V x S		0.55				0.59				0.56			
V x M		0.74				0.76				0.74			
S x M		0.74				0.76				0.74			
V x S x M		1.29				1.32				1.29			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 24. Effect of genotypes, seed rates and micronutrients on dry matter accumulation in leaves (g plant⁻¹) at harvest under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	14.70 ^{i-l}	19.00 ^{c-i}	14.00 ^{j-l}	15.9^f	13.70 ^{l-n}	18.60 ^{d-k}	15.00 ^{g-n}	15.70^{ef}	14.20 ^{m-o}	18.80 ^{c-f}	14.50 ^{l-o}	15.80^f
	M ₂	16.70 ^{e-l}	20.00 ^{a-h}	15.00 ^{h-l}	17.2^{ef}	16.00 ^{h-m}	20.00 ^{a-h}	16.30 ^{g-m}	17.40^{d-f}	16.40 ^{g-m}	20.00 ^{a-j}	15.60 ^{i-o}	17.30^{ef}
	M ₃	17.70 ^{d-k}	22.00 ^{a-d}	15.20 ^{g-i}	18.3^{c-f}	17.00 ^{l-l}	21.60 ^{a-e}	16.80 ^{f-m}	18.50^{cd}	17.30 ^{e-n}	21.80 ^{a-f}	16.00 ^{h-o}	18.40^{c-e}
	M ₄	21.50 ^{a-e}	22.90 ^{a-d}	18.30 ^{c-i}	20.9^{bc}	18.00 ^{e-k}	22.70 ^{a-d}	19.00 ^{c-j}	19.90^{bc}	19.80 ^{b-j}	22.80 ^{a-c}	18.70 ^{c-l}	20.40^{bc}
S ₂	M ₁	15.70 ^{i-l}	19.80 ^{b-i}	13.00 ^{kl}	16.2^f	14.70 ^{a-n}	19.20 ^{b-l}	12.90 ^{mn}	15.60^f	15.20 ^{k-o}	19.50 ^{b-k}	13.00 ^{no}	15.90^f
	M ₂	18.30 ^{c-j}	20.20 ^{a-h}	15.50 ^{f-l}	18.0^{d-f}	18.10 ^{e-k}	19.80 ^{a-h}	15.40 ⁱ⁻ⁿ	17.80^{c-e}	18.20 ^{e-m}	20.00 ^{a-i}	15.50 ^{j-o}	17.90^{d-f}
	M ₃	21.10 ^{a-e}	21.00 ^{a-e}	18.60 ^{c-j}	20.2^{b-d}	20.10 ^{a-h}	20.20 ^{a-g}	18.10 ^{e-k}	19.50^{b-d}	20.60 ^{a-g}	20.60 ^{a-g}	18.30 ^{d-m}	19.80^{b-d}
	M ₄	24.40 ^{ab}	25.00 ^a	23.30 ^{a-c}	24.2^a	23.30 ^{ab}	23.70 ^a	22.00 ^{a-e}	23.00^a	23.80 ^{ab}	24.30 ^a	22.70 ^{a-d}	23.60^a
S ₃	M ₁	19.00 ^{c-j}	16.70 ^{e-l}	12.30 ^l	16.0^f	18.70 ^{d-k}	16.70 ^{l-m}	11.90 ⁿ	15.80^{ef}	18.80 ^{e-l}	16.70 ^{f-n}	12.10 ^o	15.90^f
	M ₂	19.80 ^{a-b}	20.70 ^{a-f}	16.70 ^{e-o}	19.0^{c-e}	19.40 ^{b-i}	19.80 ^{a-h}	16.50 ^{g-m}	18.60^{cd}	19.60 ^{b-j}	20.30 ^{a-h}	16.60 ^{g-n}	18.80^{c-e}
	M ₃	20.10 ^{a-d}	21.90 ^{a-e}	18.20 ^{c-j}	20.0^{b-d}	19.90 ^{a-h}	21.60 ^{a-e}	17.90 ^{e-k}	19.80^{b-d}	20.00 ^{al}	21.70 ^{a-e}	18.00 ^{e-m}	9.90^{b-d}
	M ₄	20.30 ^{a-d}	24.30 ^{ab}	21.90 ^{a-e}	22.1^{ab}	19.80 ^{a-h}	22.90 ^{a-c}	20.80 ^{a-f}	21.20^{ab}	20.10 ^{a-h}	23.60 ^{ab}	21.40 ^{a-e}	21.70^{ab}
Variety		19.10^b	21.10^a	16.80^c		18.20^b	20.60^a	16.90^c		18.67^b	20.84^a	16.85^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	17.60 ^{bc}	21.00 ^a	15.60 ^c	18.00^b	16.20 ^c	20.70 ^a	16.80 ^c	17.90^b	16.90 ^b	20.90 ^a	16.20 ^b	18.00^b
	S ₂	19.90 ^{ab}	21.50 ^a	17.60 ^{bc}	19.70^a	19.00 ^b	20.70 ^a	17.10 ^c	18.90^a	19.40 ^a	21.10 ^a	17.40 ^b	19.30^a
	S ₃	19.80 ^{ab}	20.90 ^a	17.30 ^c	19.30^a	19.50 ^{ab}	20.30 ^{ab}	16.80 ^c	18.80^a	19.60 ^a	20.60 ^a	17.00 ^b	19.10^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	16.40 ^{ef}	18.50 ^{c-e}	13.10 ^g	16.00^c	15.70 ^f	18.20 ^{c-e}	13.30 ^g	15.70^d	16.10 ^{ef}	18.30 ^{c-e}	13.20 ^g	15.80^b
	M ₂	18.30 ^{c-f}	20.30 ^{bc}	15.70 ^f	18.10^b	17.80 ^{c-f}	19.90 ^{bc}	16.10 ^{ef}	17.90^c	18.10 ^{d-f}	20.10 ^{bc}	15.90 ^f	18.00^c
	M ₃	19.60 ^{b-d}	21.60 ^{ab}	17.30 ^{d-f}	19.50^b	19.00 ^{b-d}	21.20 ^b	17.60 ^{d-f}	19.30^b	19.30 ^{b-d}	21.40 ^b	17.50 ^{d-f}	19.40^b
	M ₄	22.00 ^{ab}	24.10 ^a	21.20 ^b	22.40^a	20.40 ^b	23.10 ^a	20.60 ^b	21.40^a	21.20 ^b	23.60 ^a	20.90 ^b	21.90^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.49				0.34				0.36			
Seed (S)		0.41				0.27				0.32			
Micro (M)		0.50				0.40				0.49			
V x S		0.72				0.45				0.56			
V x M		0.86				0.70				0.74			
S x M		0.86				0.70				0.74			
V x S x M		1.50				1.20				1.28			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

1010 with combined application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_2M_4) rerecorded higher DMA in leaves (23.60). In the absence of micronutrient application DMA in leaves decreased irrespective of cultivars used and recorded lower DMA in leaves with cv. BPT 5204 (V_3M_1) (13.20). Similarly, interactions due to seed rates and micronutrients were significant wherein 30 kg seed rate with the application of FeSO_4 and ZnSO_4 (S_2M_4) recorded higher DMA in leaves (23.60) and it was at par with S_3M_4 (21.70), while 25 kg ha^{-1} seed rate with no supply of micronutrient recorded lower DMA in leaves S_1M_1 (18.50).

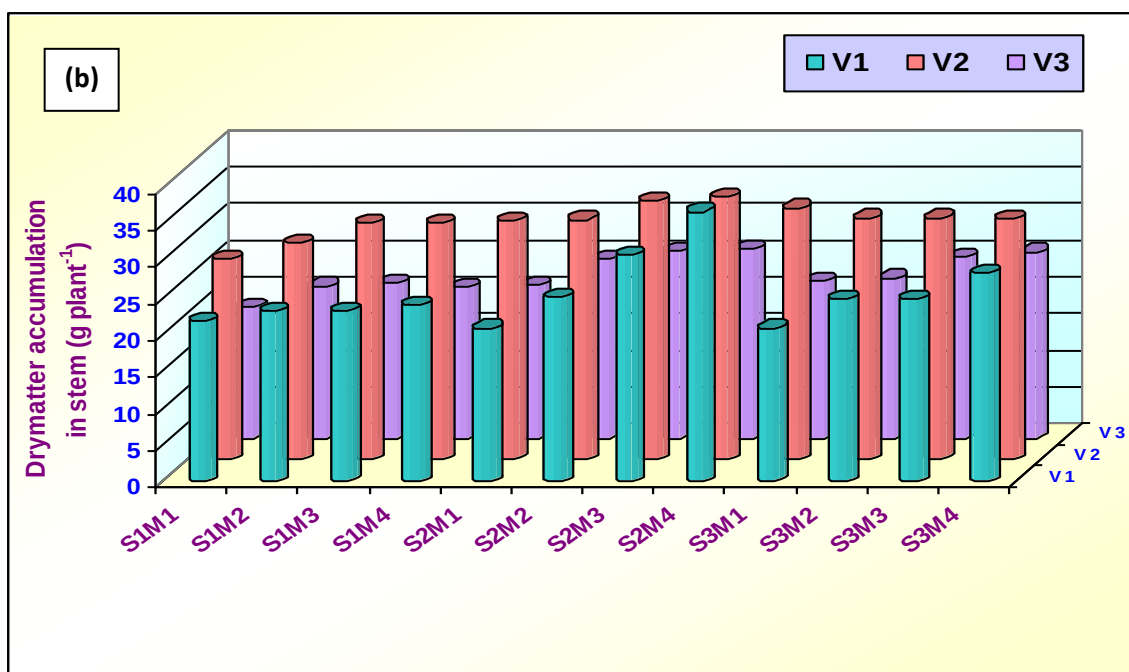
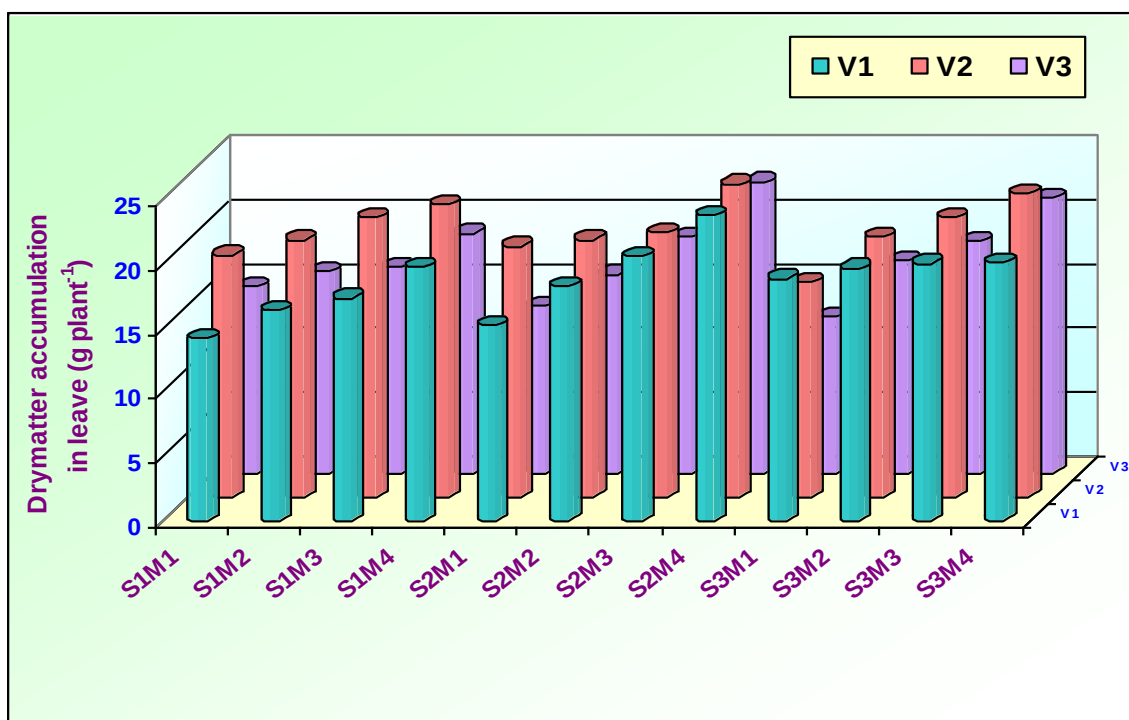
Overall, the three way interaction revealed significantly higher DMA in leaves (24.30) with cv. MTU 1010 sown using 30 kg seed rate and applied with $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_2S_2M_4$), closely followed by $V_1S_2M_4$ (23.80), while lower DMA in leaves (12.10) was recorded with cvs. BPT 5204 sown using 35 kg ha^{-1} seed rate and supplied with no ($V_3S_3M_1$) micronutrient.

4.1.1.1.6 Dry matter accumulation in stem (g plant^{-1}) (c.f. Table 25-28 and Fig. 4b)

Dry matter accumulation in stem varied significantly due to cultivars, seed rates and use of micronutrients and their interactions at different stages of crop growth during both the years and on pooled basis as well.

Cv. MTU 1010 (V_2) at 45 DAS among varieties recorded significantly higher DMA in stem followed by cvs. GGV 0501 and BPT 5204 (1.55, 1.29 and 1.19, respectively); among seed rates higher DMA in stem (1.44) was recorded with 30 kg ha^{-1} (S_2) and S_3 (1.35) was at par; similarly, use of micronutrients produced significant variations individually and with combined application wherein M_4 i.e. $\text{FeSO}_4 + \text{ZnSO}_4$ resulted in higher DMA in stem (1.66), while no application of micronutrient (M_1) recorded significantly lower DMA (1.12).

Among variety and seed rate cv. MTU 1010 at 30 kg ha^{-1} (V_2S_2) (1.76) recorded higher DMA in stem and it was at par with 35 kg ha^{-1} seed rate (V_2S_3) (1.57), while lower DMA in stem among all was recorded with cv. BPT 5204 irrespective of seed rates used particularly with lower seed rate of 25 kg ha^{-1} (V_3S_1 , 1.15). Variety X micronutrient also revealed significant variations, in that cv. MTU 1010 with $\text{FeSO}_4 + \text{ZnSO}_4$ (V_2M_4) rerecorded higher DMA in stem (2.09). In the absence of micronutrient application DMA decreased irrespective of cultivars particularly with cv. BPT 5204 (V_3M_1 , 1.08).



LEGEND

Varieties: V₁- GGV 0501, V₂- MTU 1010, V₃- BPT 5204;
 Seed Rate: S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
 Micronutrient: M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₄- FeSO₄ + ZnSO₄ (Each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

Fig. 4. Effect of genotypes, seed rates and micronutrients on dry matter accumulation in (a) leaves and (b) stem (g plant⁻¹) at harvest under direct seeded condition during rainy season

Similarly, among seed rate and micronutrients, 30 kg seed with the application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) recorded higher DMA in stem (1.90) while 25 kg ha^{-1} seed rate with no supplementation of micronutrient (S_1M_1) recorded lower DMA in stem (1.06).

Overall, the three way interaction revealed significantly higher DMA in stem (2.49) with cv. MTU 1010 sown with 30 kg seed rate and applied with both $\text{FeSO}_4 + \text{ZnSO}_4$ ($\text{V}_2\text{S}_2\text{M}_4$), closely followed by $\text{V}_2\text{S}_3\text{M}_4$ (2.32), while lower DMA in stem (0.97) was recorded with cv. BPT 5204 with 30 kg ha^{-1} seed rate and supplied with FeSO_4 followed by ZnSO_4 separately.

At 67 DAS, among the varieties, cv. MTU 1010 (V_2) recorded significantly higher DMA in stem followed by cvs. GGV 0501 and BPT 5204 (2.18, 1.99 and 1.92, respectively); among seed rates higher DMA in stem was recorded with the seed rate of 30 and 35 kg ha^{-1} (2.10 and 2.07, respectively), similarly, use of micronutrients produced significant variations wherein application $\text{FeSO}_4 + \text{ZnSO}_4$ (M_4) resulted in higher DMA in stem (2.28), while no application of micronutrient (M_1) recorded significantly lower DMA in stem (1.89).

Of the two-way interactions those due to variety and seed rate were significant and among all cv. MTU 1010 at 30 kg ha^{-1} (V_2S_2) recorded higher DMA in stem (2.44), while lower DMA in stem was recorded with cv. BPT 5204 irrespective of seed rates used particularly with seed rate of 30 kg ha^{-1} (V_3S_2) (1.83). Variety X micronutrient were also significant, in that cv. MTU 1010 with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_2M_4) recorded higher DMA in stem (2.56) and V_1M_4 and V_2M_3 were on par. DMA decreased in the absence of micronutrient application irrespective of cultivars used and recorded lower DMA particularly with cvs. GGV 0501 (V_3M_1) (1.80) and BPT 5204 (1.82). Similarly, interactions due to seed rates and micronutrients were significant wherein 30 kg seed rate with the application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) recorded higher DMA in stem (2.47) and it was at par with 35 kg ha^{-1} seed rate with supplementation of micronutrient (S_3M_4), while S_1M_1 recorded lower DMA in stem (1.73).

The three way interaction revealed significantly higher DMA in stem (2.80) with cv. MTU 1010 sown using 30 kg seed rate and applied with ZnSO_4 ($\text{V}_2\text{S}_2\text{M}_3$) and it was at par with by $\text{V}_2\text{S}_{1-2}\text{M}_4$, $\text{V}_1\text{S}_2\text{M}_4$ and $\text{V}_3\text{S}_2\text{M}_4$, while lower DMA in stem (1.61) was recorded with cv. BPT 5204 sown using 30 kg ha^{-1} seed rate and supplied with no micronutrient ($\text{V}_3\text{M}_2\text{M}_1$).

At 90 DAS, among the varieties, cv. MTU 1010 (V_2) recorded significantly higher DM (20.50) in stem followed by cvs. GGV 0501 and BPT 5204 (18.40 and 14.50, respectively); among seed rates higher DMA in stem (19.40) was recorded with the seed rate of 30 kg ha^{-1} (S_2), while lower DMA (16.23) was recorded with 25 kg ha^{-1} (S_1); similarly, among micronutrients, $\text{FeSO}_4 + \text{ZnSO}_4$ to soil and to the foliage (M_4) resulted in higher DMA in stem (22.53) and M_3 was at par, while no application of micronutrient (M_1) recorded significantly lower DMA in stem (14.00).

Cv. MTU 1010 at 30 kg ha^{-1} (V_2S_2) (21.21) among variety and seed rate recorded higher DMA in stem and it was at par with 35 kg ha^{-1} seed rate (V_2S_3 , 21.20), while lower DMA among all was recorded with cv. BPT 5204 particularly with lower seed rate of 25 kg ha^{-1} (V_3S_1) (11.50). Variety X micronutrient revealed that cv. MTU 1010 with the combined application of FeSO_4 and ZnSO_4 (V_2M_4) rerecorded higher DMA in stem (27.81). When micronutrient application was withheld DMA in stem decreased irrespective of cultivars used and recorded lower DMA particularly with cv. BPT 5204 (V_3M_1) (10.94). Similarly, 30 kg seed with the application of $\text{FeSO}_4 + \text{ZnSO}_4$ among seed rate and micronutrient recorded higher DMA in stem (25.49) and it was at par with S_3M_4 , while 25 kg ha^{-1} seed rate with no supplementation of micronutrient (S_1M_1) recorded lower DMA in stem (13.40).

Among the three way interactions significantly higher DMA in stem (31.40) occurred with cv. MTU 1010 sown with 30 kg seed rate and applied with $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_2S_2M_4$), while the lower DMA was recorded with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and without supplementation of micronutrient ($V_3S_1M_1$) (9.00).

At harvest, among the varieties, again cv. MTU 1010 (V_2) recorded significantly higher DMA followed by cvs. GGV 0501 and BPT 5204 (32.60, 25.42 and 22.56, respectively). Among seed rates higher DMA (28.92) was recorded with the seed rate of 30 kg ha^{-1} (S_2), DMA decreased (24.55) with lower seed rate (S_1). Similarly, use of micronutrients produced significant variations individually and with combined application wherein M_4 receiving $\text{FeSO}_4 + \text{ZnSO}_4$ to soil and to the foliage recorded higher DMA (29.14) followed by ZnSO_4 application (M_3) (27.90) which was at par, while no application of micronutrient (M_1) recorded significantly lower DMA in stem (24.24).

Table 25. Effect of genotypes, seed rates and micronutrients on dry matter accumulation in stem (g plant⁻¹) at 45 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	1.17 ^d	1.20 ^d	1.13 ^d	1.17 ^c	0.96 ^e	0.99 ^e	0.92 ^e	0.96 ^d	1.06 ^{de}	1.10 ^{c-e}	1.03 ^{de}	1.06 ^d
	M ₂	1.77 ^{b-d}	1.47 ^{cd}	1.17 ^d	1.47 ^{bc}	1.58 ^{b-d}	1.28 ^{c-e}	0.98 ^e	1.28 ^{b-d}	1.67 ^{b-d}	1.37 ^{c-e}	1.07 ^{c-e}	1.37 ^{b-d}
	M ₃	1.37 ^{cd}	1.40 ^{cd}	1.30 ^{cd}	1.36 ^{bc}	1.22 ^{c-e}	1.22 ^{c-e}	1.12 ^{c-e}	1.19 ^{cd}	1.30 ^{c-e}	1.31 ^{c-e}	1.21 ^{c-e}	1.27 ^{cd}
	M ₄	1.37 ^{cd}	1.50 ^{cd}	1.37 ^{cd}	1.41 ^{bc}	1.20 ^{c-e}	1.34 ^{c-e}	1.20 ^{c-e}	1.25 ^{b-d}	1.29 ^{c-e}	1.42 ^{b-e}	1.29 ^{c-e}	1.33 ^{b-d}
S ₂	M ₁	1.30 ^{cd}	1.37 ^{cd}	1.13 ^d	1.27 ^c	1.09 ^{c-e}	1.16 ^{c-e}	0.92 ^e	1.06 ^{cd}	1.20 ^{c-e}	1.26 ^{c-e}	1.03 ^{de}	1.16 ^{cd}
	M ₂	1.30 ^{cd}	1.43 ^{cd}	1.07 ^d	1.27 ^c	1.11 ^{c-e}	1.21 ^{c-e}	0.88 ^a	1.07 ^{cd}	1.21 ^{c-e}	1.32 ^{c-e}	0.97 ^e	1.17 ^{cd}
	M ₃	1.37 ^{cd}	2.07 ^{a-c}	1.10 ^d	1.51 ^{bc}	1.19 ^{c-e}	1.90 ^{ab}	0.92 ^e	1.34 ^{bc}	1.28 ^{c-e}	1.99 ^{ab}	1.01 ^e	1.43 ^{bc}
	M ₄	2.07 ^{a-c}	2.57 ^a	1.80 ^{b-d}	2.15 ^a	1.60 ^{b-d}	2.40 ^a	1.64 ^{bc}	1.88 ^a	1.48 ^{b-e}	2.49 ^a	1.72 ^{bc}	1.90 ^a
S ₃	M ₁	1.17 ^d	1.23 ^d	1.30 ^{cd}	1.23 ^c	0.96 ^e	1.02 ^{de}	1.09 ^{c-e}	1.02 ^{cd}	1.06 ^{de}	1.13 ^{c-e}	1.20 ^{c-e}	1.13 ^{cd}
	M ₂	1.37 ^{cd}	1.47 ^{cd}	1.37 ^{cd}	1.40 ^{bc}	1.18 ^{c-e}	1.28 ^{c-e}	1.18 ^{c-e}	1.21 ^{cd}	1.27 ^{c-e}	1.37 ^{c-e}	1.27 ^{c-e}	1.30 ^{b-d}
	M ₃	1.33 ^{cd}	1.57 ^{cd}	1.40 ^{cd}	1.43 ^{bc}	1.16 ^{c-e}	1.39 ^{b-e}	1.22 ^{c-e}	1.26 ^{b-d}	1.25 ^{c-e}	1.48 ^{b-e}	1.31 ^{c-e}	1.35 ^{b-d}
	M ₄	1.43 ^{cd}	2.40 ^{ab}	1.30 ^{cd}	1.71 ^b	1.27 ^{c-e}	2.24 ^a	1.14 ^{c-e}	1.55 ^b	1.35 ^{c-e}	2.32 ^a	1.22 ^{c-e}	1.63 ^{ab}
Variety		1.42 ^b	1.64 ^a	1.29 ^b		1.21 ^b	1.45	1.10 ^b		1.29 ^b	1.55 ^a	1.19 ^b	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	1.42 ^{bc}	1.39 ^{bc}	1.24 ^c	1.35 ^a	1.24 ^{bc}	1.21 ^c	1.06 ^c	1.17 ^b	1.33 ^{bc}	1.30 ^{bc}	1.15 ^c	1.26 ^b
	S ₂	1.51 ^{a-c}	1.86 ^a	1.28 ^{bc}	1.55 ^a	1.25 ^{bc}	1.67 ^a	1.48 ^{ab}	1.47 ^a	1.38 ^{bc}	1.76 ^a	1.18 ^c	1.44 ^a
	S ₃	1.33 ^{bc}	1.67 ^{ab}	1.34 ^{bc}	1.45 ^a	1.14 ^c	1.48 ^{ab1}	1.16 ^c	1.26 ^b	1.23 ^c	1.57 ^{ab}	1.25 ^{bc}	1.35 ^{ab}
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M	M ₁	1.21 ^e	1.27 ^{bc}	1.19 ^c	1.22 ^b	1.00 ^d	1.06 ^{cd}	0.98 ^d	1.01 ^c	1.11 ^d	1.16 ^{cd}	1.08 ^d	1.12 ^c
	M ₂	1.48 ^{bc}	1.46 ^{bc}	1.20 ^c	1.38 ^b	1.29 ^{b-d}	1.26 ^{b-d}	1.01 ^d	1.19 ^b	1.38 ^{b-d}	1.36 ^{b-d}	1.11 ^d	1.28 ^{bc}
	M ₃	1.36 ^{bc}	1.68 ^b	1.27 ^{bc}	1.44 ^b	1.19 ^b	1.50 ^b	1.09 ^{cd}	1.26 ^b	1.27 ^{b-d}	1.59 ^b	1.18 ^{cd}	1.35 ^b
	M ₄	1.62 ^{bc}	2.16 ^a	1.49 ^{bc}	1.76 ^a	1.36 ^a	1.99 ^a	1.33 ^{bc}	1.56 ^a	1.49 ^{bc}	2.09 ^a	1.41 ^{b-d}	1.66 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.04				0.03				0.04			
Seed (S)		0.07				0.04				0.05			
Micro (M)		0.07				0.05				0.06			
V x S		0.12				0.08				0.09			
V x M		0.13				0.09				0.10			
S x M		0.13				0.09				0.10			
V x S x M		0.23				0.18				0.18			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 26. Effect of genotypes, seed rates and micronutrients on dry matter accumulation in stem (g plant⁻¹) at 67 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	1.73 ^{cd}	1.93 ^{cd}	1.87 ^{cd}	1.84^c	1.62 ^{d-f}	1.59 ^{d-f}	1.65 ^{d-f}	1.62^e	1.68 ^e	1.76 ^{de}	1.76 ^{de}	1.73^d
	M ₂	2.10 ^{a-c}	2.10 ^{a-c}	1.90 ^{cd}	2.03^{bc}	1.95 ^{c-f}	1.85 ^{c-f}	1.82 ^{c-f}	1.87^{c-e}	2.03 ^{de}	1.98 ^{de}	1.86 ^{de}	2.10^{cd}
	M ₃	2.10 ^{a-c}	2.13 ^{a-c}	2.03 ^{bc}	2.09^{bc}	1.45 ^f	1.85 ^{c-f}	1.99 ^{c-f}	1.76^{de}	1.78 ^{de}	1.98 ^{de}	2.01 ^{de}	2.10^{cd}
	M ₄	2.20 ^{a-c}	2.23 ^{a-c}	2.10 ^{a-c}	2.18^{bc}	1.82 ^{c-f}	2.05 ^{c-f}	1.52 ^{ef}	1.80^{c-e}	2.01 ^{de}	2.14 ^{c-e}	1.81 ^{de}	2.20^{cd}
S ₂	M ₁	2.03 ^{bc}	2.10 ^{a-c}	1.77 ^{cd}	1.97^{bc}	1.59 ^{d-f}	1.85 ^{c-f}	1.45 ^f	1.63^{de}	1.81 ^{de}	1.98 ^{de}	1.61 ^e	2.03^d
	M ₂	2.03 ^{bc}	2.17 ^{a-c}	1.73 ^d	1.98^{bc}	1.59 ^{d-f}	2.29 ^{a-c}	1.55 ^{d-f}	1.81^{c-e}	1.81 ^{de}	2.23 ^{b-e}	1.64 ^e	2.03^{cd}
	M ₃	2.10	2.81 ^{ab}	1.80 ^{cd}	2.24^{a-c}	1.75 ^{c-f}	2.79 ^a	1.72 ^{c-f}	2.09^{bc}	1.93 ^{de}	2.80 ^a	1.76 ^{de}	2.10^{bc}
	M ₄	2.47 ^{a-c}	2.87 ^a	2.53 ^{a-c}	2.62^a	2.65 ^{ab}	2.75 ^a	2.09 ^{b-e}	2.49^a	2.63 ^{a-c}	2.76 ^{ab}	2.31 ^{a-d}	2.47^a
S ₃	M ₁	1.90 ^{cd}	1.97 ^{cd}	2.03 ^{bc}	1.97^{bc}	1.95 ^{c-f}	1.65 ^{d-f}	2.12 ^{b-e}	1.91^{c-e}	1.93 ^{de}	1.81 ^{de}	2.08 ^{c-e}	1.90^{cd}
	M ₂	2.10 ^{a-c}	2.07 ^{a-c}	2.10 ^{a-c}	2.09^{bc}	1.85 ^{c-f}	1.69 ^{c-f}	1.99 ^{c-f}	1.84^{c-e}	1.98 ^{de}	1.88 ^{de}	2.04 ^{de}	2.10^{cd}
	M ₃	2.07 ^{a-c}	2.10 ^{a-c}	2.10 ^{a-c}	2.09^{bc}	2.09 ^{b-e}	1.92 ^{c-f}	1.89 ^{c-f}	1.97^{cd}	2.08 ^{c-e}	2.01 ^{de}	1.99 ^{de}	2.07^{cd}
	M ₄	2.17 ^{a-c}	2.80 ^{ab}	2.17 ^{a-c}	2.38^{ab}	2.15 ^{b-d}	2.75 ^a	2.12 ^{b-e}	2.34^{ab}	2.16 ^{c-e}	2.78 ^{ab}	2.14 ^{c-ec}	2.17^{ab}
Variety		2.08^b	2.27^a	2.01^b		1.88^b	2.08^a	1.83^b		1.99^b	2.18^a	1.92^b	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	2.03 ^{ab}	2.10 ^{ab}	1.98 ^b	2.04^a	1.71 ^d	1.83 ^{b-d}	1.75 ^{cd}	1.76^b	1.87 ^{cd}	1.96 ^{b-d}	1.86 ^{cd}	1.90^b
	S ₂	2.16 ^{ab}	2.49 ^a	1.96 ^b	2.20^a	1.93 ^{bc}	2.40 ^a	1.70 ^d	2.01^a	2.04 ^{b-d}	2.44 ^a	1.83 ^d	2.10^a
	S ₃	2.06 ^{ab}	2.23 ^{ab}	2.10 ^{ab}	2.13^a	2.01 ^b	2.00 ^b	2.03 ^b	2.01^a	2.04 ^{b-d}	2.12 ^b	2.06 ^{bc}	2.07^a
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M	M ₁	1.89 ^c	2.00 ^{bc}	1.89 ^c	1.93^b	1.72 ^d	1.70 ^d	1.74 ^d	1.72^c	1.80 ^c	1.85 ^c	1.82 ^c	1.89^c
	M ₂	2.08 ^{bc}	2.11 ^{bc}	1.91 ^{bc}	2.03^b	1.80 ^d	1.94 ^{cd}	1.79 ^d	1.84^{bc}	1.94 ^c	2.03 ^{bc}	1.85 ^c	2.08^b
	M ₃	2.09 ^{bc}	2.35 ^{ab}	1.98 ^{bc}	2.14^b	1.76 ^d	2.18 ^{bcx}	1.86 ^d	1.93^b	1.93 ^c	2.26 ^{ab}	1.92 ^c	2.09^b
	M ₄	2.28 ^{a-c}	2.63 ^a	2.27 ^{a-c}	2.39^a	2.25 ^{ab}	2.49 ^a	1.91 ^{cd}	2.22^a	2.27 ^{ab}	2.56 ^a	2.09 ^{bc}	2.28^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.03				0.02				0.05			
Seed (S)		0.08				0.04				0.05			
Micro (M)		0.08				0.59				0.06			
V x S		0.14				0.06				0.09			
V x M		0.14				0.10				0.10			
S x M		0.14				0.10				0.10			
V x S x M		0.24				0.18				0.18			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 27. Effect of genotypes, seed rates and micronutrients on dry matter accumulation in stem (g plant⁻¹) at 90 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	15.50 ^{c-i}	16.90 ^{c-h}	9.40 ⁱ	13.91^d	14.20 ^{e-h}	15.80 ^{c-h}	8.60 ⁱ	12.89^d	14.85 ^{g-k}	16.35 ^{c-k}	9.00 ^l	13.40^d
	M ₂	17.40 ^{c-h}	21.70 ^{b-e}	11.90 ^{hi}	16.97^d	16.90 ^{c-g}	20.80 ^{b-d}	11.20 ^{g-i}	16.30^{bc}	17.12 ^{ac-j}	21.23 ^{b-e}	11.55 ^{j-l}	16.63^{be}
	M ₃	18.90 ^{c-g}	17.80 ^{c-h}	12.90 ^{g-i}	16.54^{b-d}	18.50 ^{b-e}	16.80 ^{c-g}	12.40 ^{g-i}	15.88^{b-d}	18.72 ^{c-g}	16.12 ^{c-j}	12.65 ^{h-l}	16.21^{b-d}
	M ₄	22.10 ^{b-d}	22.60 ^{bc}	13.10 ^{g-i}	19.28^b	20.50 ^{b-d}	21.30 ^{bc}	12.50 ^{f-i}	18.09^b	21.36 ^{b-d}	22.98 ^{bc}	12.80 ^{i-l}	18.68^b
S ₂	M ₁	17.50 ^{c-h}	15.50 ^{e-i}	12.90 ^{g-i}	15.33^{cd}	16.90 ^{c-g}	14.30 ^{c-h}	12.30 ^{f-i}	14.50^{cd}	17.22 ^{c-j}	14.93 ^{g-k}	12.60 ^{h-l}	14.92^{cd}
	M ₂	20.30 ^{b-f}	19.90 ^{b-f}	15.10 ^{f-i}	18.42^{bc}	19.50 ^{b-e}	18.60 ^{b-e}	15.70 ^{c-h}	17.94^b	19.90 ^{b-g}	19.24 ^g	15.40 ^{e-h}	18.16^b
	M ₃	20.50 ^{b-f}	19.70 ^{b-f}	17.80 ^{c-h}	19.31^b	19.90 ^{b-e}	18.80 ^{b-e}	17.50 ^{c-f}	18.73^b	20.18 ^{b-g}	19.25 ^{b-g}	17.63 ^{c-i}	19.02^b
	M ₄	25.50 ^b	32.10 ^a	20.80 ^{b-f}	26.12^a	23.80 ^b	30.70 ^a	20.00 ^{b-e}	24.87^a	24.65 ^b	31.40 ^a	20.43 ^{b-g}	25.49^a
S ₃	M ₁	13.10 ^{g-i}	17.68 ^{c-h}	11.70 ^{hi}	14.18^d	12.30 ^{f-i}	16.40 ^{c-h}	10.70 ^{hi}	13.14^d	12.70 ^{h-l}	17.05 ^{c-j}	11.23 ^{kl}	13.66^{cd}
	M ₂	15.90 ^{d-h}	16.87 ^{c-h}	15.40 ^{e-i}	16.07^{b-d}	15.70 ^{c-h}	16.50 ^{c-g}	15.10 ^{b-h}	15.76^{b-d}	15.77 ^{d-k}	16.72 ^{c-k}	15.25 ^{f-k}	15.91^{b-d}
	M ₃	18.10 ^{c-h}	22.00 ^{b-d}	18.70 ^{c-g}	19.61^b	17.00 ^{c-g}	19.90 ^{b-e}	17.7 ^{c-f}	18.18^b	17.52 ^{c-i}	21.97 ^{b-f}	18.20 ^{c-h}	18.89^b
	M ₄	22.10 ^{b-d}	31.09 ^a	19.10 ^{c-g}	24.19^a	20.30 ^{b-d}	29.10 ^a	18.9 ^{b-e}	22.70^a	21.18 ^{b-e}	30.07 ^a	19.03 ^{c-g}	23.40^a
Variety		18.90 ^b	21.10 ^a	14.90 ^c		17.90 ^b	19.90 ^a	14.4 ^c		18.40 ^b	20.50 ^a	14.50 ^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	18.47 ^{ab}	19.73 ^{ab}	11.83 ^c	16.67^b	17.53 ^{bc}	18.68 ^{ab}	11.17 ^d	15.78^c	18.00 ^{cd}	19.20 ^{bc}	11.50 ^f	16.23^c
	S ₂	20.93 ^{ab}	21.78 ^{ab}	16.68 ^{a-c}	19.79^a	20.04 ^a	20.63 ^a	16.36 ^{bc}	19.00^a	20.49 ^{ab}	21.21 ^a	16.52 ^{de}	19.40^a
	S ₃	17.28 ^{ab}	21.93 ^a	16.25 ^{bc}	18.48^{ab}	16.31 ^c	20.47 ^a	15.61 ^c	17.46^b	16.79 ^{de}	21.20 ^a	15.93 ^e	17.97^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	15.87 ^{de}	16.70 ^{c-e}	11.36 ^f	14.47^c	14.48 ^{de}	15.5 ^{c-e}	10.53 ^f	13.51^c	14.92 ^{de}	16.11 ^{c-e}	10.94 ^f	14.00^c
	M ₂	17.83 ^{cd}	19.45 ^c	14.13 ^{ef}	17.13^b	17.56 ^{cd}	18.6 ^c	14.00 ^e	16.66^b	17.59 ^{cd}	19.06 ^c	14.07 ^e	16.90^b
	M ₃	19.16 ^c	19.82 ^c	16.49 ^{c-e}	18.49^{c-e}	18.50 ^c	18.5 ^c	15.83 ^{c-e}	17.59^b	18.81 ^c	19.16 ^c	16.16 ^{c-e}	18.04^b
	M ₄	23.21 ^b	28.58 ^a	17.70 ^{cd}	23.16^a	21.5 ^b	27.03 ^a	17.14 ^{cd}	21.90^a	22.38 ^b	27.81 ^a	17.42 ^{cd}	22.53^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.44				0.329				0.32			
Seed (S)		0.32				0.41				0.32			
Micro (M)		0.62				0.56				0.56			
V x S		0.56				0.71				1.568			
V x M		1.08				0.97				0.97			
S x M		1.08				0.97				0.97			
V x S x M		1.87				1.69				1.68			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 28. Effect of genotypes, seed rates and micronutrients on dry matter accumulation in stem (g plant⁻¹) at harvest under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	23.15 ^{i-k}	29.19 ^{c-j}	18.81 ^k	23.72 ^e	20.64 ^{j-m}	25.60 ^{e-k}	17.01 ^m	21.01 ^e	21.90 ^{g-i}	27.39 ^{d-h}	17.91 ⁱ	22.40 ^e
	M ₂	23.71 ^{i-k}	30.67 ^{b-i}	22.43 ^{jk}	25.60 ^{ade}	22.77 ^{h-m}	28.50 ^{c-i}	19.07 ^{k-m}	23.45 ^{c-e}	23.24 ^{f-i}	29.58 ^{b-f}	20.75 ^{hi}	24.53 ^{de}
	M ₃	24.30 ^{i-k}	32.59 ^{a-g}	22.59 ^{jk}	26.49 ^{de}	22.13 ^{i-m}	31.96 ^{a-e}	19.92 ^{k-m}	24.67 ^{c-e}	23.22 ^{f-i}	32.27 ^{a-d}	21.26 ^{hi}	25.58 ^{c-e}
	M ₄	25.37 ^{g-k}	34.10 ^{d-f}	24.03 ^{h-k}	27.83 ^{c-e}	22.83 ^{ah-m}	30.60 ^{c-f}	17.23 ^m	23.55 ^{c-e}	24.10 ^{f-i}	32.55 ^{a-d}	21.63 ^{hi}	23.69 ^{c-e}
S ₂	M ₁	22.91 ^{ik}	33.74 ^{a-f}	24.01 ^{i-k}	26.89 ^{c-e}	18.77 ^{k-m}	31.38 ^{c-e}	17.84 ^{lm}	22.66 ^{de}	20.84 ^{hi}	32.56 ^{a-d}	20.92 ^{hi}	24.78 ^{de}
	M ₂	28.14 ^{d-ja}	34.41 ^{a-e}	25.57 ^{g-ka}	29.37 ^{b-d}	22.24 ^m	31.06 ^{c-f}	23.40 ^{h-m}	25.47 ^{b-d}	25.19 ^{e-h}	32.74 ^{a-d}	24.48 ^{a-i}	27.47 ^{b-d}
	M ₃	32.67 ^{a-g}	36.00 ^{a-c}	27.71 ^{d-j}	32.13 ^{ab}	29.37 ^{c-h}	34.83 ^{ab}	22.28 ^b	29.09 ^{ab}	30.92 ^{a-e}	35.42 ^{ab}	25.50 ^{e-h}	30.61 ^{ab}
	M ₄	37.67 ^{ab}	38.74 ^a	29.50 ^{c-j}	35.30 ^a	35.83 ^a	32.99 ^{cd}	22.32 ^{h-m}	30.38 ^a	36.74 ^a	35.87 ^a	25.91 ^{e-h}	32.84 ^a
S ₃	M ₁	22.67 ^{jk}	34.52 ^{e-a}	23.19 ^{ai-k}	26.80 ^{c-e}	19.04 ^{k-m}	34.17 ^{ab}	19.69 ^{k-m}	24.30 ^{ac-e}	20.86 ^{hi}	34.36 ^{a-c}	21.44 ^{hi}	25.55 ^{a-e}
	M ₂	26.35 ^{f-k}	34.72 ^{a-e}	23.66 ^{c-k}	28.25 ^{b-d}	23.19 ^{h-m}	31.27 ^{c-e}	19.05 ^m	24.84 ^{c-e}	24.77 ^{e-h}	33.19 ^{a-d}	21.86 ^{g-i}	26.54 ^{cd}
	M ₃	27.01 ^{e-j}	34.72 ^{a-e}	24.91 ^{h-k}	28.88 ^{b-d}	22.84 ^{h-m}	31.22 ^{c-f}	24.41 ^{f-l}	26.16 ^{b-d}	24.92 ^{e-h}	33.97 ^{a-d}	24.66 ^{e-h}	27.52 ^{b-d}
	M ₄	30.01 ^{b-j}	35.39 ^{a-d}	27.37 ^{ae-j}	30.92 ^{bc}	26.84 ^{d-j}	30.22 ^{c-g}	23.49 ^{g-m}	26.85 ^{a-c}	28.42 ^{e-g}	32.81 ^{a-d}	25.43 ^{e-h}	28.89 ^{bc}
Variety		26.99 ^b	34.06 ^a	24.48 ^c		24.88 ^b	31.15 ^a	20.64 ^c		25.42 ^b	32.60 ^a	22.56 ^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	24.13 ^{de}	31.64 ^{bc}	21.97 ^e	25.91 ^b	22.09 ^d	29.16 ^{bc}	18.31 ^e	23.18 ^b	23.18 ^d	30.40 ^{bc}	20.14 ^e	24.55 ^c
	S ₂	30.35 ^c	35.73 ^a	26.70 ^d	30.92 ^a	26.50 ^c	32.57 ^a	21.72 ^d	26.92 ^a	28.43 ^c	34.14 ^a	24.20 ^d	28.92 ^a
	S ₃	26.51 ^d	34.84 ^{ab}	24.78 ^{de}	28.71 ^a	23.18 ^d	31.72 ^{ab}	21.99 ^d	25.53 ^a	24.74 ^d	33.28 ^{ab}	23.25 ^d	27.12 ^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	22.91 ^{ef}	32.49 ^{ab}	22.00 ^f	25.90 ^c	19.48 ^{de}	30.38 ^{ab}	18.18 ^e	22.68 ^b	21.20 ^{de}	31.44 ^{ab}	20.09 ^e	24.24 ^b
	M ₂	26.07 ^{d-f}	33.27 ^{ab}	23.89 ^{d-f}	27.74 ^{bc}	22.74 ^{cd}	30.28 ^{ab}	20.84 ^{de}	24.61 ^b	24.40 ^{cd}	31.77 ^{ab}	22.36 ^{de}	26.17 ^b
	M ₃	27.99 ^{cd}	34.44 ^{ab}	25.09 ^{d-f}	29.16 ^b	24.7 ^c	32.67 ^a	22.54 ^{cd}	26.64 ^a	26.35 ^c	33.55 ^a	23.81 ^{cd}	27.90 ^a
	M ₄	31.01 ^{bc}	36.08 ^a	26.78 ^{de}	31.35 ^a	28.5 ^b	31.27 ^{ab}	21.01 ^{de}	26.92 ^a	29.76 ^b	33.67 ^a	23.99 ^{cd}	29.14 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.63				0.68				0.61			
Seed (S)		0.65				0.55				0.55			
Micro (M)		0.76				0.68				0.66			
V x S		1.13				0.95				0.95			
V x M		1.32				1.19				1.14			
S x M		1.32				1.19				1.14			
V x S x M		2.28				2.06				1.98			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Interactions due to variety and seed rate were significant and cv. MTU 1010 at 30 seed rate kg ha^{-1} (V_2S_2) recorded higher DMA (34.14) and V_2S_3 was on par; while the lower DMA was recorded with cv. BPT 5204 at seed rate of 25 kg ha^{-1} (V_3S_2) (20.14). Variety X micronutrient effects were also significant, in that cv. MTU 1010 with of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_2M_4), and only ZnSO_4 (V_2M_3) recorded higher DMA (33.67 and 33.55, respectively). Overall DMA decreased in the absence of micronutrient application particularly with cv. BPT 5204 (V_3M_1) (20.09). Similarly, 30 kg seed rate with the application of $\text{FeSO}_4 + \text{ZnSO}_4$ ($S_2 M_4$) among seed rate and micronutrient recorded higher DMA (32.84) and it was on par with S_2M_3 ; while 25 kg ha^{-1} seed rate with no micronutrient (S_1M_1) recorded lower DMA (22.40).

Of the three way interactions, significantly higher DMA occurred with cvs. GGV 0501 and MTU 1010 sown with 30 kg seed rate and applied with both $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_{1-2}S_2M_4$) (36.74 and 35.87, respectively), while the lower (17.91) DMA was recorded with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient ($V_3S_1 M_1$) among all.

4.1.1.1.7 Dry matter accumulation in panicle (g plant^{-1}) (c.f. Table 29 and Fig. 5a)

Among the varieties, cv. MTU 1010 (V_2) recorded significantly higher dry matter in panicle followed by cvs. GGV 0501 and BPT 5204 (42.56, 31.51 and 28.52, respectively); among seed rates higher DMA in panicle (37.19) was recorded with the seed rate of 30 kg ha^{-1} (S_2); similarly, use of micronutrients produced significant variations individually and with combined application wherein combined application $\text{FeSO}_4 + \text{ZnSO}_4$ to soil and to the foliage (M_4) resulted in higher DMA in panicle (38.66), while no application of micronutrient (M_1) recorded significantly lower DMA in panicle (30.22).

Interactions due to variety and seed rate were significant and among them cv. MTU 1010 at 30 kg ha^{-1} (V_2S_2) recorded higher DMA in panicle (48.86); while the lower DMA in panicle (25.97) among all was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha^{-1} (V_3S_1). Variety X micronutrient again revealed significant variations, in that cv. MTU 1010 with combined application of FeSO_4 and ZnSO_4 (V_2M_4) rerecorded higher DMA in panicle (47.70). In the absence of micronutrient application DMA in panicle decreased irrespective of cultivars used and recorded lower DMA (26.34) with cv. BPT 5204 (V_3M_1) and V_1S_1 at par. Similarly, interactions due to seed rates and

Table 29. Effect of genotypes, seed rates and micronutrients on dry matter accumulation in panicle (g plant⁻¹) at harvest under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	28.86 ^{g-i}	31.09 ^{c-i}	25.33 ⁱ	28.43^c	27.67 ^{g-j}	29.75 ^{e-i}	24.33 ^j	27.26^f	28.26 ^{i-m}	30.43 ^{g-m}	24.83 ^{h-m}	27.94^e
	M ₂	33.10 ^{d-i}	34.51 ^{d-i}	25.99 ^{hi}	31.20^{bc}	31.65 ^{f-j}	32.93 ^{e-i}	25.02 ^j	29.87^{d-f}	32.38 ^{f-m}	33.72 ^{e-k}	25.51 ^{k-m}	30.53^{de}
	M ₃	33.45 ^{d-i}	39.06 ^{b-f}	26.59 ^{hi}	33.03^{bc}	31.78 ^{f-j}	34.71 ^{d-g}	25.25 ^{ij}	30.61^{d-f}	32.61 ^{f-l}	36.93 ^{e-h}	25.92 ^{j-m}	31.82^{c-e}
	M ₄	34.51 ^{d-i}	41.88 ^{b-d}	27.76 ^{hi}	34.71^b	33.31 ^{e-h}	39.93 ^{c-e}	27.46 ^{g-j}	33.57^{cd}	33.92 ^{e-j}	40.89 ^{c-e}	27.61 ^{i-m}	34.14^{cd}
S ₂	M ₁	24.72 ⁱ	7.24 ^{a-c}	28.27 ^{hi}	33.41^{bc}	23.65 ^k	44.27 ^{a-c}	27.70 ^{g-j}	28.88^{c-e}	24.19 ^m	45.76 ^{a-c}	27.99 ^{i-m}	32.64^{cd}
	M ₂	29.45 ^{f-i}	47.42 ^{ab}	29.02 ^{g-i}	35.30^b	27.49 ^{g-j}	45.48 ^{a-c}	28.27 ^{g-j}	33.75^{c-e}	28.47 ^{i-m}	46.45 ^{a-c}	28.64 ^{h-m}	34.14^{cd}
	M ₃	39.25 ^{b-c}	52.67 ^a	29.30 ^{g-i}	40.41^a	36.65 ^{d-f}	48.37 ^a	28.28 ^{g-j}	37.77^{ab}	38.16 ^{d-g}	50.52 ^{ab}	28.79 ^{h-m}	39.09^{ab}
	M ₄	47.57 ^{ab}	54.01 ^a	30.83 ^{e-i}	44.14^a	41.17 ^{b-d}	51.40 ^a	30.14 ^{f-j}	40.90^a	44.37 ^{b-d}	52.71 ^a	30.48 ^{i-m}	42.52^a
S ₃	M ₁	27.87 ^{hi}	38.13 ^{c-g}	26.86 ^{hi}	30.95^{abc}	26.00 ^{h-j}	36.70 ^{d-f}	25.53 ^{ij}	29.41^{ef}	26.93 ^{i-m}	37.42 ^{d-g}	26.19 ^{j-m}	30.18^{de}
	M ₂	27.37 ^{hi}	40.33 ^{b-e}	31.04 ^{e-i}	32.92^{bc}	26.90 ^{h-j}	39.47 ^{c-e}	29.87 ^{f-j}	32.05^{c-e}	27.14 ^{i-m}	39.90 ^{c-i}	30.41 ^{g-m}	32.48^f
	M ₃	27.72 ^{hi}	47.52 ^{ab}	32.00 ^{e-i}	35.75^b	27.07 ^{e-h}	45.79 ^{a-c}	31.70 ^{f-j}	34.85^{bc}	27.39 ^{i-m}	46.65 ^{a-c}	31.85 ^{f-m}	35.30^{bc}
	M ₄	35.48 ^{d-h}	51.51 ^a	34.92 ^{d-i}	40.68^a	33.61 ^{f-j}	47.33 ^{ab}	33.24 ^{e-h}	38.06^{ab}	34.55 ^{e-i}	49.42 ^{ab}	34.08 ^{e-j}	39.35^{ab}
Variety		32.44^b	43.77^a	28.99^c		30.58^b	41.35^a	28.05^b		31.51^b	42.56^a	28.52^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	32.48 ^{c-e}	36.63 ^e	26.42 ^f	31.84^c	31.10 ^{cd}	34.36 ^c	25.52 ^e	30.32^c	31.79 ^{c-e}	35.49 ^c	25.97 ^f	31.08^c
	S ₂	35.25 ^{cd}	50.34 ^a	29.36 ^{ef}	38.31^a	32.25 ^{cd}	47.38 ^a	28.60 ^{de}	36.07^a	33.75 ^{cd}	48.86 ^a	28.98 ^f	37.19^a
	S ₃	29.61 ^{ef}	44.37 ^b	31.21 ^{d-f}	35.06^b	28.40 ^{de}	42.32 ^e	30.06 ^d	33.59^b	29.00 ^f	43.35 ^b	30.63 ^{de}	34.32^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	27.15 ^d	38.82 ^b	26.82 ^d	30.93^d	25.77 ^c	36.91 ^b	25.85 ^c	29.51^a	26.46 ^d	37.87 ^b	26.34 ^d	30.22^d
	M ₂	29.98 ^{cd}	40.75 ^b	28.68 ^{cd}	33.13^c	28.68 ^{c-e}	39.29 ^b	26.69 ^{de}	31.88^b	29.33 ^{cd}	40.02 ^b	28.19 ^{cd}	32.51^c
	M ₃	33.47 ^c	46.42 ^a	29.30 ^{cd}	36.37^b	31.84 ^c	42.98 ^a	28.41 ^{c-e}	34.41^c	32.66 ^c	47.70 ^a	28.85 ^{cd}	35.40^b
	M ₄	39.19 ^b	49.12 ^a	31.17 ^{cd}	39.82^a	36.03 ^b	46.22 ^a	30.28 ^{cd}	37.51^d	37.61 ^b	47.67 ^a	30.72 ^{cd}	38.66^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.75				0.76				0.72			
Seed (S)		0.91				0.70				0.76			
Micro (M)		0.94				0.74				0.80			
V x S		1.59				1.22				1.31			
V x M		1.64				1.28				1.38			
S x M		1.64				1.28				1.38			
V x S x M		2.84				2.22				2.39			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

micronutrients revealed significantly higher DMA (42.52) with 30 kg seed coupled with application of $\text{FeSO}_4 + \text{ZnSO}_4$ and S_3M_4 and S_2M_3 were at par with it, while 25 kg ha⁻¹ seed rate with no supplementation of micronutrient (S_1M_1) recorded lower DMA in panicle (27.94).

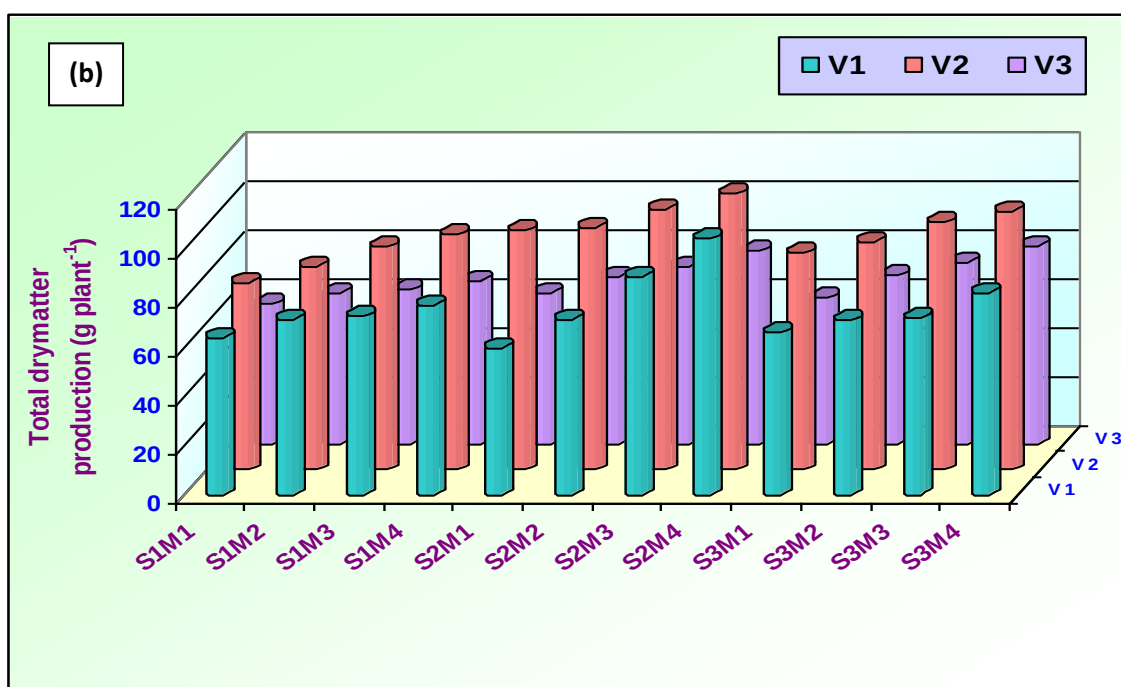
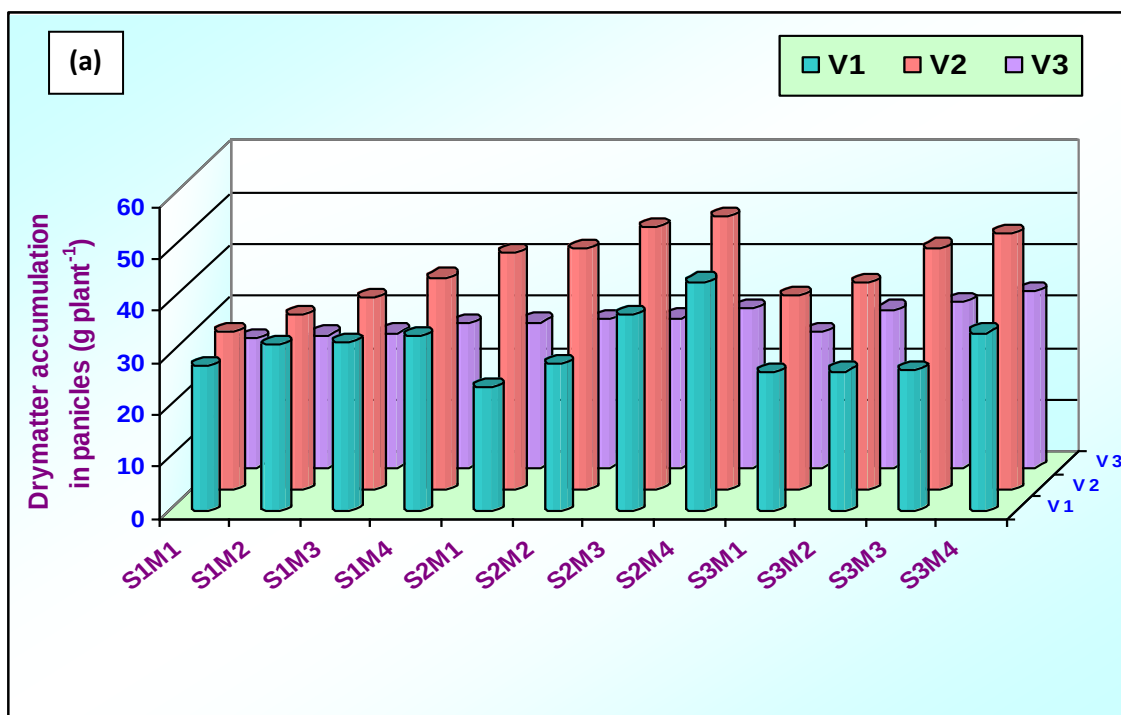
Overall, the three way interaction revealed significantly higher DMA in panicle (52.71) with cv. MTU 1010 sown using 30 kg seed rate and applied with $\text{FeSO}_4 + \text{ZnSO}_4$ ($\text{V}_2\text{S}_2\text{M}_4$) and $\text{V}_2\text{S}_{2-3}\text{M}_{1-4}$ were at par with it, while the lower DMA (24.19) was recorded with cv. GGV 0501 at 30 kg ha⁻¹ seed rate and no application of micronutrient followed by $\text{V}_3\text{S}_1\text{M}_1$ (24.83).

4.1.1.1.8 Total dry matter production (g plant⁻¹) (c.f. Table 30-33 and Fig.5b)

Total dry matter production (TDMP) varied significantly due to cultivars, seed rate and use of micronutrients and their interactions during both the years and on pooled basis as well.

At 45 DAS, among the cultivars, significantly higher TDMP (1.70) was recorded with cv. MTU 1010 (V_2) followed by cvs. GGV 0501 and BPT 5204 (1.46 and 1.31, respectively). Among seed rates, 30 kg ha⁻¹ seed rate (S_2) recorded significantly higher TDMP (1.59) which was on par with 35 kg ha⁻¹ seed rate (S_3), while lower TDMP (1.39) was recorded with 25 kg ha⁻¹ (S_1). Similarly, application of micronutrients produced significant variations individually and with combined application wherein $\text{FeSO}_4 + \text{ZnSO}_4$ to soil and to the foliage (M_4) resulted in higher TDMP (1.83). Significantly lower TDMP (1.23) was recorded in no application of micronutrient (M_1).

Two factor interactions due to variety and seed rate were significant and cv. MTU 1010 at 30 kg ha⁻¹ seed rate (V_2S_2) recorded higher TDMP (1.92) and same cultivar with 30 kg seed rate (V_2S_3) was at par, while the lower TDMP (1.26) was recorded with cv. BPT 5204 irrespective of seed rates used and more so with lower seed rate of 25 kg ha⁻¹ (V_3S_1). Variety X micronutrient had significant variations, in that cv. MTU 1010 with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_2M_4) rerecorded higher TDMP (2.28), while in the absence of micronutrient TDMP decreased irrespective of cultivars used and recorded lower TDMP (1.18) with cv. BPT 5204 (V_3M_1). Similarly, interactions due to seed rates and micronutrients were significant, wherein 30 kg seed rate with application of $\text{FeSO}_4 +$



LEGEND

Varieties: V₁- GGV 0501, V₂- MTU 1010, V₃- BPT 5204;
 Seed Rate: S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
 Micronutrient: M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₄- FeSO₄ + ZnSO₄ (Each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

Fig. 5. Effect of genotypes, seed rates and micronutrients on (a) drymatter accumulation in panicles and (b) total dry matter production (g plant^{-1}) at harvest under direct seeded condition during rainy season

ZnSO₄ (S₂ M₄) recorded higher TDMP (2.20) and S₂M₃ was at par, while 25 kg ha⁻¹ seed rate with no supplementation of micronutrient (S₁M₁) recorded lower TDMP (1.17).

Of the three way interactions, significantly higher TDMP (2.72) was obtained with cv. MTU 1010 sown using 30 kg seed rate and applied with both FeSO₄+ ZnSO₄ (V₂S₂M₄) and it was on par with V₂S₃M₄, while the lower TDMP (1.09 each) was recorded with cv. BPT 5204 with medium seed rate and FeSO₄ application (V₃S₂M₂) followed by and V₃S₂M₃ and V₃S₁M₁ (1.14 each).

At 67 DAS, among the cultivars, significantly higher TDMP was recorded with cv. MTU 1010 (V₂) followed by cvs. GGV 0501 and BPT 5204 (2.58, 2.36 and 2.27 respectively). Among seed rates, 30 kg ha⁻¹ (S₂) recorded significantly higher TDMP (2.50) which was on par with 35 kg ha⁻¹ (S₃) seed rate (2.46), while lower TDMP (2.26) was recorded with seed rate of 25 kg ha⁻¹ (S₁). Application of micronutrients also induced significant variations and application FeSO₄ + ZnSO₄ (M₄) resulted in higher TDMP (2.74), while significantly lower TDMP (2.16) was recorded in no application of micronutrient (M₁).

Interactions due to variety and seed rate were significant and among them cv. MTU 1010 at 30 kg ha⁻¹ seed rate (V₂S₂) recorded higher TDMP (2.90), while lower TDMP (2.20) was recorded with cv. BPT 5204 irrespective of seed rates used particularly with lower seed rate of 25 kg ha⁻¹ (V₃S₂). Variety X micronutrient also had significant variations, in that cv. MTU 1010 coupled with application of FeSO₄ + ZnSO₄ (V₂M₄) rerecorded higher TDMP (3.04), while without application of micronutrient TDMP decreased irrespective of cultivars used and recorded lower TDMP with cvs. GGV 0501 (V₁M₁) (2.14) and BPT 5204 (V₃M₁) (2.15). Similarly, interactions due to seed rate and micronutrients were significant, wherein 30 kg seed rate with application of FeSO₄ + ZnSO₄ (S₂ M₄) recorded higher TDMP (3.05) and S₃M₄ was at par, while 25 kg ha⁻¹ seed rate with no supplementation of micronutrient (S₁M₁) recorded lower TDMP (2.05).

Of the three way interactions, significantly higher TDMP (3.32) with cv. MTU 1010 sown with 30 kg seed rate and applied with ZnSO₄ V₂S₂M₃ – 3.32), FeSO₄ + ZnSO₄ (V₂S₂M₄ – 3.28) and FeSO₄ + ZnSO₄ (V₂S₃M₄ – 3.30), while lower TDMP (2.08 each) was recorded with cv. BPT 5204 with 30 kg seed rate and no micronutrient application (V₃S₂M₁).

At 90 DAS, among the varieties, cv. MTU 1010 (V_2) recorded significantly higher TDMP (38.71) followed by cvs. GGV 0501 and BPT 5204 (31.51 and 26.47, respectively); among seed rates higher TDMP (33.84) was recorded with 30 kg ha⁻¹ (S_2) and it was at par with 35 kg seed rate (S_3), while lower seed rate (S_1) had lower TDMP (30.08). Similarly, among micronutrient levels combined application (M_4) resulted in higher TDMP (40.46), while no application of micronutrient (M_1) recorded significantly lower TDMP (25.42).

Interactions due to variety and seed rate were significant and cv. MTU 1010 at 30 kg ha⁻¹ seed rate (V_2S_3) recorded higher TDMP (40.28) which was on par with V_2S_2 ; while lower TDMP was recorded with cv. BPT 5204 at all seed rates particularly with 25 kg ha⁻¹ (V_3S_1 - 20.88). Variety X micronutrient also revealed significant variations, in that cv. MTU 1010 with $FeSO_4 + ZnSO_4$ (V_2M_4) rerecorded higher TDMP (49.51), while cv. BPT 5204 with no micronutrients supply (V_3M_1) recorded lower TDMP (19.50). Similarly, interaction due to seed rates and micronutrients were significant wherein 30 kg seed rate with the application of $FeSO_4 + ZnSO_4$ ($S_2 M_4$) recorded higher TDMP (44.22), while 25 kg ha⁻¹ seed rate with no supplementation of micronutrient (S_1M_1) recorded lower TDMP (24.51).

Among the three way interactions, significantly higher TDMP (53.77) was occurred with cv. MTU 1010 sown using 30 kg seed rate and supplied with $FeSO_4 + ZnSO_4$ ($V_2S_2M_4$), while lower TDMP (15.90) was recorded with cv. BPT 5204 sown using 25 kg ha⁻¹ seed rate and supplied with no micronutrient ($V_3S_1M_1$).

At harvest, among the varieties, cv. MTU 1010 (V_2) recorded significantly higher TDMP (96.02) followed by cvs. GGV 0501 and BPT 5204 (75.59 and 67.70, respectively); among seed rates higher TDMP (85.42) was recorded with moderate seed rate of 30 kg ha⁻¹ (S_2) while TDMP was lower (73.62) with lower seed rate (S_1); and among micronutrient levels significantly higher TDMP (89.70) was recorded with combined application $FeSO_4$ and $ZnSO_4$ (M_4), while no micronutrient supply (M_1) recorded significantly lower TDMP (70.33).

Interactions due to variety and seed rate were significant. MTU 1010 at 30 kg ha⁻¹ seed rate (V_2S_2) recorded higher TDMP (104.12), while lower TDMP (62.32) was recorded with cv. BPT 5204 at seed rate of 25 kg ha⁻¹ (V_3S_1). Variety X micronutrient revealed significant variations, in that cv. MTU 1010 with application of $FeSO_4 + ZnSO_4$

Table 30. Effect of genotypes, seed rates and micronutrients on total dry matter production (g plant⁻¹) at 45 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	1.29 ^e	1.33 ^c	1.25 ^e	1.29^c	1.05 ^g	1.10 ^{fg}	1.02 ^g	1.06^e	1.17 ^{fg}	1.22 ^{e-g}	1.14 ^g	1.18^d
	M ₂	1.91 ^{b-e}	1.64 ^{c-e}	1.29 ^e	1.61^{bc}	1.69 ^{c-f}	1.43 ^{d-g}	1.08 ^g	1.40^{cd}	1.80 ^{c-f}	1.53 ^{c-g}	1.18 ^{fg}	1.50^{b-d}
	M ₃	1.52 ^{c-e}	1.54 ^{c-e}	1.42 ^e	1.49^{bc}	1.35 ^{d-g}	1.34 ^{d-g}	1.22 ^{d-g}	1.30^{c-e}	1.43 ^{d-g}	1.44 ^{d-g}	1.32 ^{e-g}	1.4^{cd}
	M ₄	1.54 ^{c-e}	1.68 ^{c-e}	1.50 ^{c-e}	1.57^{bc}	1.35 ^{d-g}	1.49 ^{c-g}	1.31 ^{d-g}	1.38^{cd}	1.45 ^{d-g}	1.59 ^{c-g}	1.40 ^{d-g}	1.4b-d^a
S ₂	M ₁	1.44 ^{de}	1.49 ^{c-e}	1.24 ^e	1.39^c	1.20 ^{d-g}	1.25 ^{d-g}	1.01 ^g	1.15^{c-e}	1.36 ^{e-g}	1.37 ^{e-g}	1.12 ^g	1.28^{cd}
	M ₂	1.46 ^{de}	1.59 ^{c-e}	1.19 ^e	1.41^c	1.25 ^{d-g}	1.35 ^{d-g}	0.98 ^g	1.19^{c-e}	1.36 ^{e-g}	1.47 ^{d-g}	1.09 ^g	1.31^{cd}
	M ₃	1.53 ^{c-e}	2.23 ^{a-d}	1.24 ^e	1.67^{bc}	1.33 ^{d-g}	2.03 ^{bc}	1.04 ^g	1.47^{bc}	1.43 ^{d-g}	2.13 ^{bc}	1.14 ^g	1.57^{bc}
	M ₄	2.27 ^{a-c}	2.81 ^a	1.97 ^{b-e}	2.35^a	1.75 ^{c-e}	2.62 ^a	1.78 ^{cd}	2.05^a	2.03 ^{b-d}	2.72 ^a	1.87 ^{c-e}	2.21^a
S ₃	M ₁	1.27 ^e	1.37 ^e	1.41 ^e	1.35^c	1.03 ^g	1.14 ^{fg}	1.17 ^{e-g}	1.11^{de}	1.15 ^{fg}	1.26 ^{e-g}	1.29 ^{e-g}	1.23^{cd}
	M ₂	1.49 ^{c-e}	1.60 ^{c-e}	1.49 ^{c-e}	1.53^{bc}	1.30 ^{d-g}	1.39 ^{d-g}	1.28 ^{d-g}	1.32^{c-e}	1.40 ^{d-g}	1.50 ^{d-g}	1.38 ^{e-g}	1.43^{cd}
	M ₃	1.48 ^{c-e}	1.74 ^{c-e}	1.54 ^{c-e}	1.59^{bc}	1.28 ^{d-g}	1.54 ^{c-g}	1.35 ^{d-g}	1.39^{cd}	1.38 ^{e-g}	1.64 ^{c-g}	1.45 ^{d-g}	1.49^{b-d}
	M ₄	1.61 ^{c-e}	2.63 ^{ab}	1.47 ^{de}	1.90^b	1.42 ^{d-g}	2.44 ^{ab}	1.28 ^{a-g}	1.71^b	1.51 ^{d-g}	2.53 ^{ab}	1.38 ^{e-g}	1.81^b
Variety		1.57 ^b	1.8 ^b	1.42 ^b		1.33 ^b	1.59 ^a	1.21 ^b		1.46 ^b	1.70 ^a	1.31 ^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	1.56 ^{bc}	1.55 ^{bc}	1.36 ^c	1.49^a	1.36 ^c	1.34 ^c	1.15 ^c	1.28^b	1.46 ^{bc}	1.44 ^{bc}	1.26 ^c	1.39^b
	S ₂	1.68 ^{a-c}	2.03 ^a	1.41 ^c	1.71^a	1.39 ^{bc}	1.81 ^a	1.20 ^c	1.47^a	1.53 ^{bc}	1.92 ^a	1.31 ^c	1.59^a
	S ₃	1.46 ^{bc}	1.84 ^{ab}	1.48 ^{bc}	1.59^a	1.26 ^c	1.63 ^{ab}	1.27 ^c	1.39^{ab}	1.36 ^c	1.73 ^{ab}	1.37 ^c	1.49^{ab}
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	1.33 ^d	1.44 ^{b-d}	1.30 ^d	1.36^b	1.10 ^{ef}	1.16 ^{d-f}	1.06 ^f	1.11^c	1.22 ^{cd}	1.28 ^{cd}	1.18 ^d	1.23^c
	M ₂	1.62 ^{b-d}	1.61 ^{b-d}	1.32 ^d	1.52^b	1.41 ^{b-e}	1.39 ^{b-e}	1.11 ^{ef}	1.30^b	1.52 ^{b-d}	1.50 ^{b-d}	1.22 ^{cd}	1.41^b
	M ₃	1.51 ^{b-d}	1.84 ^b	1.40 ^{cd}	1.58^b	1.32 ^{c-f}	1.64 ^b	1.20 ^{d-f}	1.39^b	1.41 ^{b-d}	1.74 ^b	1.30 ^{cd}	1.48^b
	M ₄	1.81 ^{bc}	2.37 ^a	1.64 ^{b-d}	1.94^a	1.52 ^{bc}	2.18 ^a	1.45 ^b	1.72^a	1.66 ^b	2.28 ^a	1.55 ^{bc}	1.83^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.040				0.035				0.366			
Seed (S)		0.071				0.046				0.055			
Micro (M)		0.076				0.056				0.062			
V x S		0.123				0.080				0.096			
V x M		0.132				0.098				0.108			
S x M		0.132				0.098				0.108			
V x S x M		0.230				0.170				0.187			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 31. Effect of genotypes, seed rates and micronutrients on total dry matter production (g plant⁻¹) at 67 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	2.09 ^c	2.28 ^{bc}	2.22 ^{bc}	2.20^d	1.91 ^{e-h}	1.88 ^{f-h}	1.94 ^{d-h}	1.91^e	2.00 ^{e-g}	2.08 ^{d-g}	2.08 ^{d-g}	2.05^e
	M ₂	2.48 ^{bc}	2.47 ^{bc}	2.28 ^{bc}	2.41^{cd}	2.28 ^{c-h}	2.21 ^{c-h}	2.12 ^{c-h}	2.20^{b-e}	2.38 ^{c-g}	2.34 ^{c-g}	2.20 ^{c-g}	2.31^{c-e}
	M ₃	2.47 ^{bc}	2.52 ^{bc}	2.44 ^{bc}	2.48^{b-d}	1.82 ^{gh}	2.16 ^{c-h}	2.32 ^{c-g}	2.10^{c-e}	2.15 ^{d-g}	2.34 ^{c-g}	2.38 ^{c-g}	2.29^{c-e}
	M ₄	2.63 ^{bc}	2.66 ^{bc}	2.45 ^{bc}	2.58^{b-d}	2.20 ^{c-h}	2.42 ^{c-f}	1.83 ^{gh}	2.15^{b-e}	2.41 ^{c-g}	2.54 ^{c-f}	2.14 ^{d-g}	2.36^{c-e}
S ₂	M ₁	2.39 ^{bc}	2.49 ^{bc}	2.08 ^c	2.32^{cd}	1.89 ^{f-h}	2.19 ^{c-h}	1.72 ^h	1.93^{de}	2.14 ^{d-g}	2.34 ^{c-g}	1.90 ^g	2.13^{de}
	M ₂	2.39 ^{bc}	2.61 ^{bc}	2.06 ^c	2.35^{cd}	1.89 ^{f-h}	2.67 ^{bc}	1.82 ^{gh}	2.13^{c-e}	2.14 ^{d-gg}	2.64 ^{b-d}	1.94 ^{fg}	2.24^{de}
	M ₃	2.49 ^{bc}	3.38 ^a	2.15 ^c	2.67^{bc}	2.07 ^{d-h}	3.27 ^a	2.01 ^{d-h}	2.45^b	2.28 ^{c-g}	3.32 ^a	2.08 ^{d-g}	2.56^{bc}
	M ₄	2.96 ^{ab}	3.42 ^a	2.99 ^{ab}	3.12^a	3.28 ^a	3.14 ^{ab}	2.49 ^{c-e}	2.97^a	3.12 ^{ab}	3.28 ^a	2.74 ^{bc}	3.05^a
S ₃	M ₁	2.29 ^{bc}	2.33 ^{bc}	2.46 ^{bc}	2.36^{cd}	2.27 ^{c-h}	1.95 ^{d-h}	2.46 ^{c-f}	2.23^{b-d}	2.28 ^{c-g}	2.14 ^{d-g}	2.46 ^{c-g}	2.29^{c-e}
	M ₂	2.49 ^{bc}	2.43 ^{bc}	2.51 ^a	2.48^{b-d}	2.19 ^{c-h}	2.01 ^{d-h}	2.33 ^{c-g}	2.18^{b-e}	2.34 ^{c-g}	2.22 ^{c-g}	2.42 ^{c-g}	2.33^{c-e}
	M ₃	2.48 ^{bc}	2.50 ^{bc}	2.49 ^{bc}	2.49^{b-d}	2.44 ^{c-f}	2.26 ^{c-h}	2.23 ^{c-h}	2.31^{bc}	2.46 ^{c-g}	2.38 ^{c-g}	2.36 ^{c-g}	2.40^{cd}
	M ₄	2.60 ^{bc}	3.37 ^a	2.58 ^{bc}	2.85^{ab}	2.52 ^{cd}	3.23 ^a	2.50 ^{cd}	2.75^a	2.56 ^{c-e}	3.30 ^a	2.54 ^{c-e}	2.80^{ab}
Variety		2.48	2.71	2.39		2.23^b	2.45^a	2.15^b		2.36^b	2.58^a	2.27^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	2.42 ^b	2.48 ^b	2.35 ^b	2.42^a	2.05 ^c	2.17 ^{bc}	2.05 ^c	2.09^b	2.24 ^{bc}	2.33 ^{bc}	2.20 ^c	2.26^b
	S ₂	2.56 ^b	2.98 ^a	2.32 ^b	2.62^a	2.28 ^b	2.82 ^a	2.01 ^c	2.37^a	2.42 ^{bc}	2.90 ^a	2.17 ^c	2.50^a
	S ₃	2.47 ^b	2.66 ^{ab}	2.51 ^b	2.55^a	2.35 ^b	2.36 ^b	2.38 ^b	2.36^a	2.41 ^{bc}	2.51 ^b	2.45 ^{bc}	2.46^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	2.26 ^d	2.37 ^{cd}	2.25 ^d	2.29^c	2.02 ^d	2.0 ^d	2.04 ^d	2.02^c	2.14 ^e	2.19 ^{de}	2.15 ^e	2.16^c
	M ₂	2.46 ^{b-d}	2.51 ^{b-d}	2.29 ^d	2.42^{bc}	2.12 ^d	2.29 ^{cd}	2.09 ^d	2.17^{bc}	2.29 ^{de}	2.40 ^{c-e}	2.19 ^{de}	2.29^{bc}
	M ₃	2.48 ^{b-d}	2.80 ^{ab}	2.36 ^{cd}	2.55^b	2.11 ^d	2.56 ^{bc}	2.18 ^d	2.28^b	2.30 ^{de}	2.68 ^{bc}	2.27 ^{de}	2.42^b
	M ₄	2.73 ^{a-c}	3.15 ^a	2.67 ^{cd}	2.85^a	2.66 ^{ab}	2.93 ^a	2.27 ^d	2.62^a	2.70 ^b	3.04 ^a	2.47 ^{b-d}	2.74^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.02				0.02				0.02			
Seed (S)		0.07				0.04				0.05			
Micro (M)		0.07				0.06				0.06			
V x S		0.13				0.06				0.09			
V x M		0.13				0.10				0.10			
S x M		0.13				0.10				0.10			
V x S x M		0.22				0.17				0.17			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 32. Effect of genotypes, seed rates and micronutrients on total dry matter production (g plant⁻¹) at 90 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	26.47 ^o	33.33 ^{f-l}	17.00 ^p	25.60^f	24.57 ^{i-o}	30.90 ^{f-l}	14.80 ^q	23.42^g	25.52 ^{l-p}	32.12 ^{g-l}	15.90 ^q	24.51^e
	M ₂	29.57 ^{j-m}	38.73 ^{b-h}	20.43 ^{op}	29.58^{de}	28.07 ^{h-m}	37.13 ^{b-f}	19.13 ^{pq}	28.11^{ef}	28.82 ^{j-m}	37.93 ^{b-g}	19.48 ^{pq}	28.84^{cd}
	M ₃	34.40 ^{e-k}	37.30 ^{c-h}	22.47 ^{m-p}	31.39^d	32.70 ^{d-j}	34.60 ^{c-h}	20.53 ^{o-q}	29.28^e	33.55 ^{d-j}	36.17 ^{c-h}	21.48 ^{n-q}	30.83^c
	M ₄	41.30 ^{b-e}	45.20 ^b	27.40 ^{k-o}	37.97^c	38.30 ^{b-e}	42.43 ^b	25.27 ^{k-p}	35.33^c	39.80 ^{b-e}	43.82 ^b	26.33 ^{k-o}	36.65^b
S ₂	M ₁	29.67 ^{j-m}	29.13 ^{j-m}	23.33 ^{m-p}	27.38^{ef}	27.63 ⁱ⁻ⁿ	26.53 ^{j-o}	21.27 ^{n-p}	25.14^{fg}	28.65 ^{i-m}	27.83 ^{j-n}	22.30 ^{m-p}	26.26^d
	M ₂	32.7 ^{-l}	33.67 ^{fl}	27.38 ^{k-n}	31.39^d	30.83 ^{f-l}	31.94 ^{d-k}	27.07 ^{j-n}	29.95^{de}	31.80 ^{g-l}	32.81 ^{f-h}	27.40 ^{j-n}	30.67^c
	M ₃	34.00 ^{e-k}	40.17 ^{b-f}	31.39 ^{b-l}	35.39^c	31.77 ^{e-k}	38.50 ^{b-e}	29.60 ^{g-l}	33.13^{cd}	32.88 ^{f-k}	39.28 ^{b-f}	30.50 ^{b-l}	34.22^b
	M ₄	41.93 ^{b-d}	55.17 ^a	40.17 ^{b-g}	45.67^a	38.50 ^{b-d}	52.37 ^a	37.70 ^{b-e}	42.86^a	40.05 ^{b-d}	53.77 ^a	38.83 ^{b-f}	44.22^a
S ₃	M ₁	23.97 ^{m-o}	34.50 ^{e-k}	21.60 ^{n-p}	26.69^{ef}	21.77 ^{m-p}	32.07 ^{d-j}	19.20 ^{pq}	24.34^g	22.87 ^{m-p}	33.28 ^j	20.40 ^{o-q}	25.52^d
	M ₂	29.30 ^{j-m}	35.87 ^{d-j}	28.37 ^{k-n}	31.18^d	27.9 ^{i-m}	34.23 ^{c-i}	26.87 ^{j-n}	29.67^e	28.60 ^{i-m}	35.05 ^{d-i}	27.62 ^{j-n}	30.42^c
	M ₃	32.23 ^{h-j}	43.43 ^{bc}	32.13 ^{h-l}	35.93^c	29.47 ^{g-l}	40.23 ^{bc}	30.47 ^{f-l}	33.39^c	30.85 ^{h-l}	41.83 ^{bc}	31.30 ^{g-l}	34.66^b
	M ₄	36.47 ^{c-j}	52.67 ^a	36.67 ^{c-i}	41.93^b	33.23 ^{d-j}	49.20 ^a	35.00 ^{c-g}	39.14^b	34.85 ^{d-i}	50.93 ^a	35.83 ^{c-h}	40.54^b
Variety		32.67^b	39.96^a	27.37^c		30.49^b	37.47^a	25.57^c		31.51^b	38.71^a	26.47^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	32.93 ^c	38.64 ^b	21.83 ^e	31.13^b	30.91 ^{bc}	36.28 ^a	19.93 ^f	29.03^b	31.92 ^c	37.46 ^d	20.88 ^e	30.08^b
	S ₂	34.59 ^c	39.63 ^b	30.61 ^d	34.94^a	32.18 ^b	37.22 ^a	28.91 ^{cd}	32.77^a	33.35 ^c	38.42 ^{ab}	29.76 ^d	33.84^a
	S ₃	30.49 ^d	41.62 ^a	29.69 ^d	33.93^a	28.09 ^c	38.93 ^a	27.88 ^d	31.63^b	29.29 ^d	40.28 ^a	28.79 ^d	32.78^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	26.70 ^f	32.32 ^{c-e}	20.64 ^{gh}	26.55^d	24.66 ^f	29.83 ^{d-f}	18.42 ^h	24.30^d	25.68 ^h	31.74 ^{e-g}	19.50 ⁱ	25.42^d
	M ₂	30.54 ^{de}	36.09 ^c	25.51 ^f	30.71^c	28.93 ^{ef}	34.44 ^{bc}	24.36 ^g	29.24^c	29.74 ^{fg}	35.26 ^{cd}	24.90 ^h	29.97^c
	M ₃	33.54 ^{cd}	40.42 ^b	28.67 ^{ef}	34.21^b	31.31 ^{c-e}	37.68 ^b	26.86 ^{fg}	31.93^b	32.43 ^{d-f}	39.03 ^b	27.80 ^{gh}	33.07^b
	M ₄	39.90 ^b	51.01 ^a	34.68 ^d	41.68^a	36.68 ^b	48.00 ^{a^d}	32.66 ^{cd}	39.11^a	38.23 ^{bc}	49.51 ^a	33.70 ^{de}	40.46^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.54				0.327				0.38			
Seed (S)		0.34				0.501				0.39			
Micro (M)		0.72				0.65				0.65			
V x S		0.60				0.86				0.68			
V x M		1.25				1.12				1.13			
S x M		1.25				1.12				1.13			
V x S x M		2.17				1.95				1.96			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 33. Effect of genotypes, seed rates and micronutrients on total dry matter production (g plant⁻¹) at harvest under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	66.68 ^{n-p}	79.30 ^{h-n}	58.18 ^p	68.07^f	61.97 ^{h-p}	74.07 ^{h-k}	56.35 ^p	64.11^f	64.33 ^{l-p}	76.65 ^{h-k}	57.26 ^p	66.08^f
	M ₂	73.53 ^{i-o}	85.20 ^{f-k}	63.39 ^{op}	74.04^{ef}	70.43 ^{h-m}	81.39 ^{fh}	60.42 ^{m-p}	70.74^e	72.98 ^{h-o}	83.29 ^{e-h}	61.90 ^{m-p}	72.39^e
	M ₃	75.41 ^{i-o}	93.65 ^{c-g}	64.36 ^{op}	77.81^{c-e}	70.89 ^{h-m}	88.36 ^{d-g}	62.01 ^{h-p}	73.75^{dcd}	73.15 ^{h-m}	91.00 ^{c-f}	63.19 ^{j-p}	75.78^{de}
	M ₄	81.39 ^{g-m}	98.86 ^{b-e}	70.13 ^{l-p}	83.48^{cd}	74.13 ^{h-k}	93.24 ^{b-e}	63.39 ^{k-p}	77.02^e	77.76 ^{g-k}	96.05 ^{b-d}	66.91 ^{j-p}	80.24^{cd}
S ₂	M ₁	63.35 ^{op}	100.81 ^{b-d}	65.28 ^{n-p}	76.48^{de}	57.11 ^{op}	94.82 ^{b-e}	58.48 ^{n-p}	70.14^{cd}	60.23 ^{n-p}	97.82 ^{b-d}	61.88 ^{m-p}	73.31^e
	M ₂	75.91 ^{i-o}	102.00 ^{b-d}	70.13 ^{l-p}	82.68^{cd}	67.82 ^{h-o}	96.38 ^{b-e}	67.03 ^{h-p}	77.08^b	71.87 ^{h-o}	99.19 ^{b-d}	68.58 ^{j-p}	79.88^{cd}
	M ₃	93.00 ^{c-h}	109.67 ^{ba}	75.69 ^{ai-o}	92.75^b	85.90 ^{e-g}	103.43 ^{ab}	69.67 ⁱ⁻ⁿ	86.34^a	89.45 ^{d-g}	106.55 ^{ab}	72.63 ^{h-m}	89.54^b
	M ₄	109.60 ^{ab}	117.77 ^a	83.65 ^{f-m}	103.67^a	100.27 ^{a-c}	108.06 ^a	74.45 ^{h-k}	94.26^{ef}	104.93 ^{ab}	112.91 ^a	79.05 ^{g-j}	98.96^a
S ₃	M ₁	69.50 ^{m-p}	89.36 ^{d-i}	62.39 ^{op}	73.75^{ef}	63.72 ^{k-p}	87.61 ^{e-g}	57.14 ^{op}	69.49^{c-e}	66.61 ^{k-p}	88.49 ^{d-g}	59.77 ^{op}	71.62^{e-f}
	M ₂	73.54 ^{i-o}	95.78 ^{c-f}	71.37 ^{k-p}	80.28^{c-e}	69.51 ⁱ⁻ⁿ	90.53 ^{c-f}	66.29 ^p	75.45^{bc}	71.53 ^{h-o}	93.15 ^{c-e}	68.83 ^{i-p}	77.84^{ce}
	M ₃	74.80 ^{i-o}	104.11 ^{bc}	75.11 ^{i-o}	84.75^c	69.81 ⁱ⁻ⁿ	98.64 ^{a-d}	72.98 ^{h-l}	80.81^b	72.31 ^{h-n}	101.37 ^{bc}	74.55 ^{h-i}	82.74^c
	M ₄	85.80 ^{e-g}	111.15 ^{ab}	84.22 ^{f-l}	93.71^b	80.29 ^{f-i}	100.49 ^{a-c}	77.57 ^{g-j}	86.11^a	83.02 ^{e-h}	105.82 ^{ab}	80.89 ^{f-i}	89.91^b
Variety		78.54^c	98.97^a	70.31^b		72.65^b	93.08^a	65.59^c		75.59^b	96.02^a	67.70^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	74.26 ^d	89.25 ^c	64.01 ^e	75.84^c	69.36 ^e	84.25 ^c	60.62 ^f	71.40^c	71.81 ^d	86.75 ^d	62.32 ^e	73.62^c
	S ₂	85.47 ^c	107.56 ^a	73.66 ^d	88.89^a	77.78 ^d	100.67 ^a	67.41 ^e	81.95^a	81.62 ^c	104.12 ^a	70.54 ^d	85.42^a
	S ₃	70.90 ^d	100.10 ^b	73.27 ^d	83.09^b	70.83 ^e	94.32 ^b	68.75 ^e	77.96^b	73.37 ^d	97.21 ^b	71.01 ^d	80.52^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	66.51 ^{fg}	89.82 ^b	62.95 ^g	72.76^d	60.94 ^{fg}	85.48 ^b	57.32 ^g	67.91^d	63.72 ^{fg}	87.65 ^b	59.64 ^g	70.33^d
	M ₂	74.33 ^{de}	94.33 ^b	68.30 ^{e-g}	78.98^c	69.25 ^{de}	89.43 ^b	64.58 ^{ef}	74.42^c	71.79 ^{de}	91.88 ^b	66.44 ^{ef}	76.70^c
	M ₃	81.07 ^c	102.48 ^a	71.69 ^{ef}	85.07^b	75.54 ^c	96.81 ^a	68.56 ^{de}	80.30^b	78.30 ^c	99.64 ^a	70.12 ^{de}	82.68^b
	M ₄	92.25 ^b	109.26 ^a	79.33 ^{cd}	93.61^a	84.90 ^b	100.59 ^a	71.90 ^{cd}	85.79^a	88.57 ^b	104.93 ^a	75.62 ^{cd}	89.70^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		1.21				0.74				0.90			
Seed (S)		1.27				1.18				1.15			
Micro (M)		1.40				1.13				1.20			
V x S		2.20				2.04				1.99			
V x M		2.42				1.95				2.08			
S x M		2.42				1.95				2.08			
V x S x M		4.19				3.38				3.61			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

(V₂M₄) rerecorded higher TDMP (104.93) and V₂M₃ was on par with, while lower TDMP (59.64) occurred with cv. BPT 5204 not supplied with micronutrients (V₃M₁). Similarly, among seed rate X micronutrients 30 kg seed rate with FeSO₄ + ZnSO₄ (S₂M₄) recorded higher TDMP (98.96), while 25 kg ha⁻¹ seed rate with no micronutrients (S₃M₁) recorded lower TDMP (66.08).

Further, three way interactions revealed significantly higher TDMP (112.91) with cv. MTU 1010 sown with 30 kg seed rate and applied with both FeSO₄ + ZnSO₄ (V₂S₂M₄) and it was on par with V₂S₂₋₃M₃₋₄ and V₁S₂M₄, while the lower TDMP (57.26) was recorded with cv. BPT 5204 sown using 25 kg ha⁻¹ seed and supplied with no micronutrient (V₃S₁ M₁).

4.1.1.1.9 Spectral indices

4.1.1.1.9.1 SPAD values (leaf chlorophyll) (c.f. Table 34-36)

Data on SPAD reading varied significantly due to cultivars, seed rates and use of micronutrients and their interactions at all the stages of observations during both the years and on pooled basis as well except at 45 DAS wherein it ranged from 29.5 (V₁S₃M₂) to 33.7 (V₃S₃M₂).

At 67 DAS, among the cultivars significantly higher SPAD value (35.9 each) was recorded with cvs. GGV 0501 (V₁) and BPT 5204 (V₃) compared to cv. MTU 1010 (V₂) (34.5). There occurred no significant differences in levels of seed rates. But, application of micronutrients produced significant variations, wherein ZnSO₄ (M₃) resulted in higher SPAD value (36.1), while significantly lower SPAD value (35.1) was recorded with no application of micronutrient (M₁) and M₂ receiving FeSO₄ was on par.

Interactions due to variety and seed rate were significant. Cv. GGV 0501 at 35 kg ha⁻¹ seed rate (V₁S₃) recorded higher SPAD value (36.6), while lower SPAD value (34.1) was recorded with cv. MTU 1010 with 35kg ha⁻¹ (V₂S₃). There were no significant differences among levels of variety x micronutrient and seed rate x micronutrient combinations.

On the whole, the three way interaction revealed significantly higher SPAD value (37.8) with cv. BPT 5204 sown with 35 kg seed rate and applied with FeSO₄ (V₃S₃M₂), while lower SPAD value (32.5) was recorded with 35 kg seed rate and FeSO₄ application (V₂S₃M₂).

Table 34. Effect of genotypes, seed rates and micronutrients on SPAD value (leaf chlorophyll) at 45 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	30.1 ^{ab}	30.0 ^{ab}	30.2 ^{ab}	30.1^a	31.6 ^{ab}	30.0 ^{ab}	31.8 ^{ab}	31.1^a	30.8 ^a	30.0 ^a	31.0 ^a	30.6^a
	M ₂	30.5 ^{ab}	31.4 ^{ab}	32.3 ^{ab}	31.4^a	33.0 ^{ab}	29.2 ^b	32.4 ^{ab}	31.5^a	31.7 ^a	30.3 ^a	32.3 ^a	31.4^a
	M ₃	31.4 ^{ab}	31.7 ^{ab}	32.5 ^{ab}	31.87^a	33.0 ^{ab}	34.0 ^{ab}	33.0 ^{ab}	33.3^a	32.1 ^a	32.8 ^a	32.7 ^a	32.6^a
	M ₄	32.0 ^{ab}	32.2 ^{ab}	30.9 ^{ab}	31.7^a	32.7 ^b	30.3 ^b	29.9 ^b	30.9^a	32.3 ^a	31.2 ^a	32.3 ^a	31.9^a
S ₂	M ₁	31.9 ^a	31.6 ^{ab}	29.6 ^{ab}	31.0^a	31.9 ^{ab}	31.6 ^{ab}	32.7 ^{ab}	32.0^a	31.8 ^a	30.6 ^a	31.1 ^a	31.2^a
	M ₂	32.0 ^{ab}	30.4 ^{ab}	29.7 ^{ab}	30.7^a	32.9 ^{ab}	34.0 ^{ab}	32.9 ^{ab}	33.2^a	32.4 ^a	30.2 ^a	31.2 ^a	31.3^a
	M ₃	32.2 ^{ab}	32.9 ^{ab}	30.1 ^{ab}	31.73^a	32.9 ^{ab}	33.6 ^{ab}	33.8 ^{ab}	33.4^a	32.5 ^a	33.2 ^a	31.9 ^a	32.5^a
	M ₄	31.0 ^{ab}	33.0 ^{ab}	32.0 ^{ab}	32.0^a	29.0 ^b	29.2 ^b	36.8 ^a	31.6^a	30.0 ^a	31.0 ^a	34.4 ^a	31.8^a
S ₃	M ₁	29.5 ^{ab}	30.8 ^{ab}	31.6 ^{ab}	30.6^a	29.6 ^{ab}	30.0 ^{ab}	30.1 ^{ab}	29.9^a	29.5 ^a	30.4 ^a	30.8 ^a	30.2^a
	M ₂	30.2 ^{ab}	31.9 ^{ab}	32.0 ^{ab}	31.3^a	34.7 ^{ab}	34.9 ^{ab}	35.6 ^{ab}	35.0^a	32.4 ^a	33.3 ^a	33.7 ^a	33.2^a
	M ₃	30.4 ^{ab}	32.1 ^{ab}	33.8 ^a	32.1^a	32.8 ^{ab}	32.7 ^{ab}	33.5 ^{ab}	33.0^a	32.6 ^a	32.3 ^a	33.6 ^a	32.8^a
	M ₄	32.3 ^{ab}	32.9 ^{ab}	31.3 ^{ab}	32.1^a	32.2 ^{ab}	31.4 ^{ab}	33.4 ^{ab}	32.3^a	32.2 ^a	32.1 ^a	32.2 ^a	32.2^a
Variety		31.1^a	31.7^a	31.3^a		32.1^a	31.7^a	32.9^a		31.7^a	31.4^a	32.33^a	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	31.0 ^a	31.3 ^a	31.5 ^a	31.27^a	32.6 ^a	30.0 ^a	31.9 ^a	31.5^a	31.7 ^a	31.1 ^a	31.6 ^a	31.5^a
	S ₂	31.8 ^a	31.9 ^a	30.3 ^a	31.3^a	31.7 ^a	32.1 ^a	34.1 ^a	32.6^a	31.7 ^a	32.0 ^a	32.2 ^a	31.9^a
	S ₃	30.6 ^a	31.9 ^a	32.2 ^a	31.5^a	32.3 ^a	32.3 ^a	33.2 ^a	32.6^a	31.4 ^a	32.0 ^a	32.6 ^a	32.0^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	30.5 ^a	30.8 ^a	30.5 ^a	30.6^b	31.0 ^a	30.6 ^a	31.5 ^a	31.0^b	30.7 ^a	30.6 ^a	31.0 ^a	30.8^a
	M ₂	30.9 ^a	31.2 ^a	31.3 ^a	31.1^{ab}	33.5 ^a	32.7 ^a	33.6 ^a	33.2^a	32.2 ^a	31.9 ^a	32.4 ^a	32.2^b
	M ₃	31.3 ^a	32.2 ^a	32.1 ^a	31.8^a	32.9 ^a	33.4 ^a	33.4 ^a	33.2^a	32.1 ^a	32.8 ^a	32.7 ^a	32.5^b
	M ₄	31.8 ^a	32.7 ^a	31.4 ^a	31.9^a	31.3 ^a	30.3 ^a	33.4 ^a	31.6^{ab}	31.5 ^a	31.4 ^a	32.4 ^a	31.8^b
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.7				0.7				0.7			
Seed (S)		0.4				0.7				0.6			
Micro (M)		0.4				0.6				0.5			
V x S		0.6				1.3				0.9			
V x M		0.7				1.2				0.9			
S x M		0.7				1.2				0.9			
V x S x M		1.2				2.1				1.6			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 35. Effect of genotypes, seed rates and micronutrients on SPAD value (leaf chlorophyll) at 67 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	37.4 ^a	36.8 ^a	38.8 ^a	37.6 ^a	32.4 ^{ab}	34.0 ^{ab}	33.2 ^{ab}	33.2 ^a	34.9 ^{ab}	35.4 ^{ab}	36.0 ^{ab}	35.4 ^a
	M ₂	37.1 ^a	37.2 ^a	36.0 ^a	36.7 ^a	32.7 ^{ab}	34.5 ^{ab}	32.7 ^{ab}	33.3 ^a	34.9 ^{ab}	35.8 ^{ab}	34.4 ^b	35.0 ^a
	M ₃	36.8 ^a	34.9 ^a	37.3 ^a	36.3 ^a	35.0 ^{ab}	34.1 ^{ab}	36.8 ^a	35.3 ^a	35.9 ^{ab}	34.5 ^{ab}	37.0 ^{ab}	35.8 ^a
	M ₄	37.7 ^a	36.5 ^a	38.6 ^a	37.6 ^a	35.1 ^{ab}	32.6 ^{ab}	33.3 ^{ab}	33.6 ^a	36.4 ^{ab}	34.6 ^{ab}	35.9 ^{ba}	35.6 ^a
S ₂	M ₁	37.3 ^a	35.0 ^a	37.4 ^a	36.5 ^a	33.2 ^{ab}	32.9 ^{ab}	33.9 ^{ab}	33.3 ^a	35.4 ^{ab}	33.9 ^{ab}	35.7 ^{ab}	35.0 ^a
	M ₂	36.6 ^a	36.1 ^a	35.7 ^a	36.1 ^a	32.9 ^{ab}	34.3 ^{ab}	35.1 ^{ab}	34.1 ^a	34.8 ^{ab}	35.2 ^{ab}	35.4 ^{ab}	35.1 ^a
	M ₃	37.1 ^a	36.4 ^a	37.4 ^a	36.9 ^a	35.4 ^{ab}	34.2 ^{ab}	35.6 ^{ab}	35.0 ^a	36.3 ^{ab}	35.3 ^{ab}	36.5 ^{ab}	36.0 ^a
	M ₄	37.2 ^a	33.8 ^a	36.6 ^a	35.8 ^a	35.9 ^{ab}	32.7 ^{ab}	36.8 ^a	35.1 ^a	36.6 ^{ab}	33.3 ^{ab}	36.7 ^{ab}	35.5 ^a
S ₃	M ₁	38.7 ^a	33.9 ^a	37.1 ^a	36.5 ^a	36.1 ^a	33.0 ^b	34.2 ^{ab}	34.4 ^a	37.1 ^{ab}	33.5 ^{ab}	35.7 ^{ab}	35.5 ^a
	M ₂	36.2 ^a	33.8 ^a	37.5 ^a	35.8 ^a	35.8 ^{ab}	31.3 ^a	36.9 ^a	34.6 ^a	36.0 ^{ab}	32.5 ^b	37.8 ^a	35.2 ^a
	M ₃	37.7 ^a	37 ^a	37.3 ^a	37.3 ^a	36.2 ^a	36.1 ^{ab}	34.3 ^{ab}	35.5 ^a	36.9 ^{ab}	36.5 ^{ab}	35.8 ^{ab}	36.4 ^a
	M ₄	37.3 ^a	34.9 ^a	38.4 ^a	36.8 ^a	34.4 ^{ab}	32.5 ^{ab}	32.5 ^{ab}	33.1 ^a	35.8 ^{ab}	33.7 ^{ab}	35.5 ^{ab}	35.0 ^a
Variety		37.2 ^a	35.5 ^a	37.3 ^a		34.5	33.5	34.6		35.9 ^a	34.5 ^b	35.9 ^a	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	37.2 ^a	36.3 ^a	37.7 ^a	37.0 ^a	33.8 ^{bc}	33.8 ^{bc}	34.0 ^{a-c}	33.8 ^a	35.5 ^{a-c}	35.1 ^{a-c}	35.8 ^{ab}	35.4 ^a
	S ₂	37.1 ^a	35.3 ^a	36.8 ^a	36.4	34.4 ^{a-c}	33.5 ^c	35.4 ^{ab}	34.4 ^a	35.7 ^{a-c}	34.4 ^{bc}	36.1 ^a	35.4 ^a
	S ₃	37.5 ^a	34.9 ^a	37.6 ^a	36.6 ^a	35.6 ^a	33.2 ^c	34.5 ^{a-c}	34.4 ^a	36.6 ^a	34.1 ^c	36.0 ^{ab}	35.5 ^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	37.8 ^a	36.6 ^a	37.8 ^a	37.4 ^a	33.9 ^a	33.3 ^{ab}	33.8 ^{ab}	33.6 ^b	35.9 ^a	34.3 ^a	35.8 ^a	35.3 ^a
	M ₂	36.6 ^a	35.7 ^a	36.4 ^a	36.2 ^a	33.8 ^a	33.3 ^{ab}	34.9 ^{ab}	34.0 ^b	35.2 ^a	34.5 ^a	35.7 ^a	35.1 ^a
	M ₃	37.2 ^a	36.1 ^a	37.3 ^a	36.8 ^a	35.5 ^a	34.8 ^{ab}	35.6 ^a	35.3 ^a	36.4 ^a	35.4 ^a	36.5 ^a	36.1 ^a
	M ₄	37.4 ^a	35.1 ^a	37.2 ^a	36.5 ^a	35.1 ^a	32.6 ^b	34.2 ^{ab}	33.9 ^b	36.3 ^a	33.9 ^a	36.0 ^a	35.4 ^b
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.6				0.8				0.3			
Seed (S)		0.6				0.3				0.3			
Micro (M)		0.8				0.4				0.4			
V x S		1.1				0.5				0.5			
V x M		1.3				0.8				0.8			
S x M		1.3				0.8				0.8			
V x S x M		2.3				1.3				1.3			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 36. Effect of genotypes, seed rates and micronutrients on SPAD value (leaf chlorophyll) at 90 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	30.7 ^{a-f}	33.9 ^{a-e}	33.4 ^{a-f}	32.7 ^{bc}	31.1 ^{a-d}	32.8 ^{a-d}	32.2 ^{a-d}	32.3 ^a	30.9 ^{c-f}	33.3 ^{a-e}	32.8 ^{a-f}	32.3 ^a
	M ₂	31.2 ^{a-f}	35.3 ^{a-d}	33.2 ^{a-f}	33.2 ^{ab}	31.8 ^{a-d}	36.3 ^a	33.2 ^{a-d}	33.8 ^a	31.5 ^{a-f}	35.8 ^{a-c}	29.9 ^{d-f}	32.4 ^a
	M ₃	29.7 ^{d-f}	30.3 ^{b-f}	32.4 ^{a-f}	30.8 ^c	31.4 ^{a-d}	28.2 ^b	33.9 ^{a-d}	31.1 ^a	30.6 ^{d-f}	29.2 ^{ef}	33.1 ^{a-f}	30.9 ^a
	M ₄	32.6 ^{a-f}	34.6 ^{a-d}	32.9 ^{a-f}	33.4 ^a	33.6 ^{a-d}	34.7 ^{a-c}	32.8 ^{a-d}	33.7 ^a	33.1 ^{a-f}	34.6 ^{a-d}	32.9 ^{a-f}	33.5 ^a
S ₂	M ₁	32.0 ^{a-f}	34.5 ^{a-e}	27.4 ^f	31.3 ^{bc}	31.5 ^{a-d}	33.5 ^{a-d}	28.8 ^{cd}	31.2 ^a	31.7 ^{a-f}	34.0 ^{a-e}	28.1 ^f	31.2 ^a
	M ₂	31.4 ^{a-f}	36.3 ^{ab}	31.3 ^{a-f}	33.0 ^a	31.5 ^{ad}	36.2 ^{ab}	32.1 ^{a-d}	33.2 ^a	31.4 ^{a-f}	36.2 ^a	31.7 ^{a-f}	33.1 ^a
	M ₃	31.2 ^{a-f}	32.2 ^{a-f}	34.7 ^{a-d}	32.7 ^{a-c}	32.0 ^{a-d}	33.4 ^{a-d}	34.1 ^{a-d}	33.1 ^a	31.6 ^{a-f}	32.8 ^{a-f}	34.4 ^{a-d}	32.9 ^a
	M ₄	31.2 ^{a-f}	32.6 ^{a-f}	33.6 ^{a-e}	32.5 ^a	31.3 ^{a-d}	33.9 ^{a-d}	34.6 ^{a-c}	33.2 ^a	31.3 ^{a-f}	33.3 ^{a-e}	34.1 ^{a-e}	32.9 ^a
S ₃	M ₁	31.9 ^{a-f}	35.8 ^{a-c}	31.7 ^{a-f}	33.1 ^{a-c}	31.8 ^{a-d}	31.2 ^{a-d}	32.3 ^{a-d}	31.7 ^a	31.9 ^{a-f}	33.5 ^{a-e}	32.0 ^{a-f}	32.4 ^a
	M ₂	33.2 ^{a-f}	34.0 ^{a-e}	33.4 ^{a-f}	33.5 ^{a-c}	31.0 ^{a-d}	31.9 ^{a-d}	34.1 ^{a-d}	32.3 ^a	32.1 ^{a-f}	33.0 ^{a-f}	33.7 ^{a-e}	32.9 ^a
	M ₃	31.8 ^{a-f}	36.5 ^a	30.0 ^{c-f}	32.7 ^{a-c}	31.2 ^{a-d}	35.4 ^{ab}	32.1 ^{a-d}	32.9 ^a	31.5 ^{a-f}	36.0 ^{ab}	31.1 ^{b-f}	32.8 ^a
	M ₄	28.5 ^{ef}	32.9 ^{a-f}	31.4 ^{a-f}	30.9 ^a	30.3 ^{a-d}	33.4 ^{a-d}	32.2 ^{a-d}	31.9 ^a	21.4 ^g	33.2 ^{a-e}	31.8 ^{a-f}	28.8 ^a
Variety		31.2 ^a	34.0 ^a	32.1 ^a		31.5 ^a	33.4 ^a	32.7 ^a		30.75 ^b	33.74 ^a	32.13 ^{ab}	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	31.1 ^d	33.5 ^{a-c}	30.0 ^e	22.5 ^b	32.0 ^b	33.0 ^b	33.0 ^a	32.7 ^a	31.5 ^a	33.2 ^a	32.2 ^a	32.3 ^a
	S ₂	31.4 ^{cd}	33.9 ^{ab}	31.b-d ^a	32.4 ^a	31.6 ^b	34.3 ^a	32.4 ^a	32.7 ^a	31.5 ^a	34.1 ^a	32.1 ^a	32.5 ^a
	S ₃	31.4 ^{cd}	34.8 ^a	31.6 ^{cd}	32.6 ^a	31.1 ^b	33.0 ^{ab}	32.7 ^a	32.2 ^a	31.2 ^a	33.9 ^a	32.2 ^a	32.4 ^a
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M	M ₁	31.5 ^{bc}	34.7 ^{ab}	30.8 ^c	32.3 ^a	31.5 ^b	32.5 ^b	31.1 ^b	31.7 ^a	31.5 ^b	33.6 ^{ab}	31.0 ^b	32.0 ^a
	M ₂	31.9 ^{bc}	35.2 ^a	32.7 ^{a-c}	33.3 ^a	31.4 ^b	34.8 ^a	33.1 ^{ab}	33.1 ^a	31.7 ^b	35.0 ^a	31.8 ^b	32.8 ^a
	M ₃	30.9 ^c	33.0 ^{a-c}	32.4 ^{a-c}	32.1 ^a	31.5 ^b	32.3 ^{ab}	33.4 ^{ab}	32.4 ^a	31.2 ^b	32.7 ^{ab}	32.9 ^{ab}	32.2 ^a
	M ₄	30.8 ^c	33.4 ^{a-c}	32.7 ^{a-c}	32.3 ^a	31.6 ^{ab}	34.0 ^{ab}	33.2 ^{ab}	32.9 ^a	31.2 ^b	33.7 ^{ab}	32.9 ^{ab}	32.6 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.8				0.6				0.6			
Seed (S)		0.4				0.4				0.5			
Micro (M)		0.4				0.6				0.5			
V x S		0.6				0.6				0.9			
V x M		1.0				1.0				0.8			
S x M		1.0				1.0				0.8			
V x S x M		1.7				1.7				1.4			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

At 90 DAS, among the varieties, cv. MTU 1010 (V_2) recorded significantly higher SPAD value (33.7) followed by cvs. BPT 5204 (V_3) and GGV 0501 (V_1) (32.1 and 30.7, respectively). Main effects due to seed rate and micronutrient did not vary significantly.

Interactions due to variety and seed rate and seed rate x micronutrient were non-significant, while variety X micronutrient revealed significant variations wherein cv. MTU 1010 with application of FeSO_4 (V_2M_2) rerecorded higher SPAD value (35.0), while cv. BPT 5204 without micronutrient supply (V_3M_1) recorded lower SPAD readings (31.0).

Of the three way interactions, significantly higher SPAD value (36.2) was recorded with cv. MTU 1010 sown with 30 kg seed rate and applied with FeSO_4 ($V_2S_2M_3$), while lower SPAD value (28.1) was recorded with cv. BPT 5204 sown using 30 kg ha^{-1} seed rate and supplied with no micronutrient ($V_3S_2M_1$).

4.1.1.1.9.2 NDVI (Green seeker readings) (c.f. Table 37-39)

Green seeker reading varied significantly due to cultivars, seed rates and use of micronutrients and their interactions except at 90 DAS of crop growth during both the years and on pooled basis.

At 45 DAS, Green seeker reading was not significant due to cultivars, seed rate and interaction of variety x seed rate. Among the levels of micronutrients, supply of either FeSO_4 and Zn SO_4 or both (M_{2-4}) fared superior to no supply (M_1 - 0.32).

Effects due to $V \times S$ did not vary significantly. Variety X micronutrient revealed significant variations, in that cv. BPT 5204 with application of FeSO_4 (V_3M_2) recorded higher green seeker reading (0.36), while all other treatment combinations were at par and were next in the order. Similarly, interaction due to seed rates and micronutrients were significant wherein 35 kg seed rate with $\text{FeSO}_4 + \text{ZnSO}_4$ ($S_3 M_4$) recorded higher Green seeker reading (0.35) and was superior to 30 kg seed rate with no supply of micronutrient (S_2M_1 - 0.31). Among $V \times S \times M$ combinations, cv. BPT 5204 sown using 25 kg seed rate and supplied with FeSO_4 ($V_3S_1M_2$) recorded higher SPAD reading (0.37), while cv. GGV 0501 with 25 kg seed rate and no supply of micronutrient ($V_1S_1M_1$) recorded lower reading (0.29).

Table 37. Effect of genotypes, seed rates and micronutrients on NDVI (green seeker) reading at 45 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	0.27 ^b	0.32 ^{ab}	0.33 ^{ab}	0.31^b	0.31 ^{ab}	0.34 ^{ab}	0.34 ^{ab}	0.33^a	0.29 ^c	0.35 ^{a-c}	0.36 ^{a-c}	0.33^{ab}
	M ₂	0.34 ^{ab}	0.33 ^{ab}	0.38 ^a	0.35^{ab}	0.30 ^{ab}	0.35 ^{ab}	0.36 ^{ab}	0.34^a	0.32 ^{a-c}	0.34 ^{a-c}	0.37 ^a	0.34^{ab}
	M ₃	0.34 ^{ab}	0.35 ^{ab}	0.32 ^{ab}	0.34^{ab}	0.36 ^{ab}	0.32 ^{ab}	0.36 ^{ab}	0.35^a	0.35 ^{a-c}	0.33 ^{a-c}	0.34 ^{a-c}	0.34^{ab}
	M ₄	0.34 ^{ab}	0.34 ^{ab}	0.33 ^{ab}	0.34^{ab}	0.36 ^{ab}	0.37 ^{ab}	0.32 ^{ab}	0.35^a	0.35 ^{a-c}	0.35 ^{a-c}	0.32 ^{a-c}	0.34^{ab}
S ₂	M ₁	0.32 ^{ab}	0.31 ^{ab}	0.29 ^{ab}	0.31^b	0.35 ^{ab}	0.30 ^{ab}	0.31 ^{ab}	0.32^a	0.33 ^{a-c}	0.30 ^{bc}	0.30 ^{bc}	0.31^b
	M ₂	0.32 ^{ab}	0.31 ^{ab}	0.34 ^{ab}	0.32^{ab}	0.32 ^{ab}	0.33 ^{ab}	0.38 ^a	0.34^a	0.32 ^{a-c}	0.32 ^{a-c}	0.36 ^{ab}	0.33^{ab}
	M ₃	0.32 ^{ab}	0.36 ^{ab}	0.31 ^{ab}	0.33^{ab}	0.30 ^{ab}	0.36 ^{ab}	0.32 ^{ab}	0.33^a	0.31 ^{a-c}	0.36 ^{ab}	0.31 ^{a-c}	0.33^{ab}
	M ₄	0.33 ^{ab}	0.33 ^{ab}	0.33 ^{ab}	0.33^{ab}	0.30 ^{ab}	0.37 ^{ab}	0.33 ^{ab}	0.33^a	0.32 ^{a-c}	0.35 ^{a-c}	0.33 ^{a-c}	0.33^{ab}
S ₃	M ₁	0.30 ^{ab}	0.31 ^{ab}	0.34 ^{ab}	0.32^{ab}	0.36 ^{ab}	0.28 ^b	0.31 ^{ab}	0.32^a	0.33 ^{bc}	0.30 ^{a-c}	0.33 ^{a-c}	0.32^{ab}
	M ₂	0.29 ^{ab}	0.30 ^{ab}	0.36 ^{ab}	0.32^{ab}	0.33 ^{ab}	0.33 ^{ab}	0.35 ^{ab}	0.34^a	0.31 ^{a-c}	0.32 ^{a-c}	0.36 ^{a-c}	0.33^{ab}
	M ₃	0.31 ^{ab}	0.31 ^{ab}	0.32 ^{ab}	0.31^b	0.32 ^{ab}	0.32 ^{ab}	0.31 ^{ab}	0.32^a	0.32 ^{a-c}	0.31 ^{a-c}	0.32 ^{a-c}	0.32^{ab}
	M ₄	0.35 ^{ab}	0.34 ^{ab}	0.32 ^{ab}	0.34^a	0.35 ^{ab}	0.36 ^{ab}	0.36 ^{ab}	0.36^a	0.35 ^{a-c}	0.35 ^{a-c}	0.34 ^{a-c}	0.35^a
Variety		0.32^a	0.33^a	0.33		0.33^a	0.34^a	0.34^{ab}		0.33^a	0.33^a	0.34^a	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	0.32 ^a	0.33 ^a	0.34 ^a	0.33^a	0.33 ^a	0.35 ^a	0.35 ^a	0.34^a	0.33 ^a	0.34 ^a	0.35 ^a	0.34^a
	S ₂	0.32 ^a	0.33 ^a	0.32 ^a	0.32^a	0.32 ^a	0.34 ^a	0.33 ^a	0.33^a	0.32 ^a	0.33 ^a	0.33 ^a	0.33^a
	S ₃	0.31 ^a	0.31 ^a	0.34 ^a	0.32^a	0.34 ^a	0.32 ^a	0.33 ^a	0.33^a	0.33 ^a	0.32 ^a	0.34 ^a	0.33^a
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M	M ₁	0.30 ^b	0.31 ^{ab}	0.32 ^{ab}	0.31^b	0.34 ^a	0.32 ^a	0.33 ^a	0.33^a	0.32 ^b	0.32 ^b	0.33 ^{ab}	0.32^b
	M ₂	0.32 ^{ab}	0.32 ^{ab}	0.36 ^a	0.33^{ab}	0.32 ^a	0.34 ^a	0.36 ^a	0.34^a	0.32 ^b	0.33 ^{ab}	0.36 ^a	0.34^a
	M ₃	0.32 ^{ab}	0.34 ^{ab}	0.32 ^{ab}	0.33^{ab}	0.33 ^a	0.33 ^a	0.33 ^a	0.33^a	0.32 ^b	0.34 ^{ab}	0.32 ^b	0.33^{ab}
	M ₄	0.34 ^{ab}	0.34 ^{ab}	0.33 ^{ab}	0.34^a	0.34 ^a	0.36 ^a	0.34 ^a	0.35^a	0.34 ^{ab}	0.35 ^{ab}	0.33 ^{ab}	0.34^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.008				0.008				0.007			
Seed (S)		0.007				0.010				0.008			
Micro (M)		0.008				0.008				0.006			
V x S		0.013				0.018				0.015			
V x M		0.015				0.015				0.010			
S x M		0.015				0.015				0.010			
V x S x M		0.026				0.026				0.018			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 38. Effect of genotypes, seed rates and micronutrients on NDVI (green seeker) reading at 67 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	0.67 ^{a-d}	0.72 ^{ab}	0.69 ^{a-c}	0.69^{ab}	0.61 ^{a-e}	0.64 ^{a-d}	0.55 ^{de}	0.60^a	0.64 ^a	0.68 ^a	0.62 ^a	0.65^a
	M ₂	0.67 ^{a-d}	0.69 ^{a-c}	0.71 ^{a-c}	0.69^{ab}	0.63 ^{a-d}	0.63 ^{a-d}	0.63 ^{a-d}	0.63^a	0.65 ^a	0.66 ^a	0.67 ^a	0.66^a
	M ₃	0.70 ^{a-c}	0.74 ^a	0.67 ^{a-d}	0.70^{ab}	0.61 ^{a-e}	0.65 ^{a-d}	0.56 ^{c-e}	0.61^a	0.66 ^a	0.69 ^a	0.62 ^a	0.66^a
	M ₄	0.69 ^{a-c}	0.74 ^a	0.71 ^{a-c}	0.71^a	0.61 ^{a-e}	0.65 ^{a-d}	0.57 ^{b-e}	0.61^a	0.65 ^a	0.70 ^a	0.64 ^a	0.66^a
S ₂	M ₁	0.66 ^{b-d}	0.74 ^a	0.69 ^{a-c}	0.70^{ab}	0.59 ^{a-e}	0.66 ^{a-d}	0.59 ^{a-e}	0.61^a	0.63 ^a	0.70 ^a	0.64 ^a	0.66^a
	M ₂	0.67 ^{a-d}	0.74 ^a	0.68 ^{a-d}	0.70^{ab}	0.62 ^{a-e}	0.66 ^{a-d}	0.50 ^e	0.59^a	0.65 ^a	0.70 ^a	0.62 ^a	0.66^a
	M ₃	0.69 ^d	0.74 ^a	0.70 ^{a-c}	0.71^a	0.60 ^{a-e}	0.70 ^a	0.57 ^{b-e}	0.62^a	0.65 ^a	0.72 ^a	0.64 ^a	0.67^a
	M ₄	0.67 ^{a-c}	0.72 ^{ab}	0.71 ^{a-c}	0.70^{ab}	0.61 ^{a-e}	0.69 ^{ab}	0.65 ^{a-d}	0.65^a	0.64 ^a	0.70 ^a	0.68 ^a	0.67^a
S ₃	M ₁	0.61 ^{d-e}	0.72 ^{ab}	0.64 ^{a-d}	0.66^b	0.55 ^{de}	0.68 ^{a-e}	0.55 ^{de}	0.59^a	0.58 ^a	0.70 ^a	0.59 ^a	0.62^a
	M ₂	0.69 ^{a-c}	0.72 ^a	0.66 ^{a-d}	0.69^{ab}	0.62 ^{a-e}	0.62 ^{a-e}	0.56 ^{c-e}	0.60^a	0.65 ^a	0.67 ^a	0.62 ^a	0.65^a
	M ₃	0.70 ^{a-c}	0.71 ^{a-c}	0.68 ^{a-d}	0.70^{ab}	0.65 ^{a-d}	0.62 ^{a-e}	0.60 ^{a-e}	0.62^a	0.68 ^a	0.67 ^a	0.64 ^a	0.66^a
	M ₄	0.73 ^b	0.70 ^{a-c}	0.69 ^{a-d}	0.71^a	0.70 ^a	0.64 ^{a-d}	0.61 ^{a-e}	0.65^a	0.71 ^a	0.67 ^a	0.65 ^a	0.68^a
Variety		0.68^c	0.72^a	0.69^b		0.62^{ab}	0.65^a	0.58^b		0.65^a	0.69^a	0.64^a	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	0.68 ^{bc}	0.72 ^{ab}	0.70 ^{a-c}	0.70^a	0.62 ^{bc}	0.64 ^{ab}	0.58 ^c	0.61^a	0.65 ^a	0.68 ^a	0.64 ^a	0.66^a
	S ₂	0.67 ^c	0.73 ^a	0.70 ^{a-c}	0.70^a	0.60 ^{bc}	0.68 ^a	0.59 ^{bc}	0.62^a	0.64 ^a	0.70 ^a	0.64 ^a	0.66^a
	S ₃	0.68 ^{bc}	0.71 ^{a-c}	0.67 ^c	0.69^a	0.63 ^{a-c}	0.64 ^{ab}	0.58 ^c	0.62^a	0.65 ^a	0.68 ^a	0.63 ^a	0.65^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	0.65 ^d	0.73 ^a	0.67 ^{cd}	0.68^b	0.58 ^{b-d}	0.66 ^a	0.56 ^{cd}	0.60^b	0.62 ^a	0.69 ^a	0.62 ^a	0.64^a
	M ₂	0.68 ^{b-d}	0.71 ^{a-c}	0.69 ^{b-d}	0.69^{ab}	0.62 ^{a-c}	0.64 ^{ab}	0.58 ^{bd}	0.61^{ab}	0.65 ^a	0.67 ^a	0.64 ^a	0.65^a
	M ₃	0.70 ^{a-c}	0.73 ^a	0.68 ^{b-d}	0.70^{ab}	0.62 ^{a-c}	0.66 ^a	0.58 ^d	0.62^{ab}	0.66 ^a	0.69 ^a	0.63 ^a	0.66^a
	M ₄	0.70 ^{a-e}	0.72 ^{ab}	0.71 ^{a-c}	0.71^a	0.64 ^{ab}	0.66 ^a	0.61 ^{a-c}	0.64^a	0.67 ^a	0.69 ^a	0.66 ^a	0.67^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.01				0.02				0.01			
Seed (S)		0.01				0.01				0.01			
Micro (M)		0.01				0.01				0.01			
V x S		0.01				0.02				0.02			
V x M		0.01				0.02				0.03			
S x M		0.01				0.02				0.02			
V x S x M		0.02				0.04				0.04			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 39. Effect of genotypes, seed rates and micronutrients on NDVI (green seeker) reading at 90 DAS under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled					
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M		
S ₁	M ₁	0.61 ^{a-h}	0.66 ^{a-c}	0.54 ^{gh}	0.60^{bc}	0.57 ^{ab}	0.61 ^{ab}	0.51 ^{ab}	0.56^{ab}	0.59 ^{a-e}	0.63 ^{a-d}	0.53 ^{de}	0.58^{ab}		
	M ₂	0.64 ^{a-e}	0.66 ^{a-c}	0.57 ^{f-h}	0.62^{a-c}	0.58 ^{ab}	0.62 ^{ab}	0.58 ^{ab}	0.59^{ab}	0.61 ^{a-e}	0.64 ^{a-c}	0.57 ^{a-e}	0.61^{ab}		
	M ₃	0.63 ^{a-f}	0.60 ^{b-h}	0.54 ^{gh}	0.59^c	0.64 ^a	0.62 ^{ab}	0.52 ^{ab}	0.59^{ab}	0.63 ^{a-d}	0.61 ^{a-e}	0.53 ^{de}	0.59^{ab}		
	M ₄	0.64 ^{a-e}	0.64 ^{a-e}	0.54 ^{gh}	0.61^{a-c}	0.62 ^{ab}	0.60 ^{ab}	0.57 ^{ab}	0.60^{ab}	0.63 ^{a-d}	0.62 ^{a-d}	0.56 ^{b-e}	0.60^{ab}		
S ₂	M ₁	0.64 ^{a-e}	0.63 ^{a-f}	0.55 ^{af-h}	0.61^{a-c}	0.58 ^{ab}	0.59 ^{ab}	0.57 ^{ab}	0.58^{ab}	0.61 ^{a-e}	0.61 ^{a-e}	0.56 ^{b-e}	0.59^{ab}		
	M ₂	0.64 ^{a-e}	0.63 ^{a-f}	0.57 ^{d-h}	0.61^{a-c}	0.58 ^{ab}	0.63 ^{ab}	0.60 ^{ab}	0.60^{ab}	0.61 ^{a-e}	0.63 ^{a-d}	0.59 ^{a-e}	0.61^{ab}		
	M ₃	0.65 ^{a-d}	0.69 ^a	0.56 ^{e-h}	0.61^{ab}	0.60 ^{ab}	0.60 ^{ab}	0.59 ^{ab}	0.60^{ab}	0.63 ^{a-d}	0.65 ^{a-c}	0.57 ^{a-e}	0.62^{ab}		
	M ₄	0.67 ^{ab}	0.63 ^{a-f}	0.58 ^{c-h}	0.63^{a-c}	0.63 ^{ab}	0.56 ^{ab}	0.53 ^{ab}	0.57^{ab}	0.65 ^{a-c}	0.59 ^{a-e}	0.55 ^{c-e}	0.60^{ab}		
ab S ₃	M ₁	0.62 ^{a-g}	0.62 ^{a-g}	0.55 ^{f-h}	0.63^{b-c}	0.52 ^{ab}	0.56 ^{ab}	0.48 ^b	0.52^b	0.57 ^{a-e}	0.59 ^{a-e}	0.51 ^e	0.56^b		
	M ₂	0.64 ^{a-e}	0.67 ^{ab}	0.53 ^h	0.60^{a-c}	0.58 ^{ab}	0.63 ^{ab}	0.60 ^{ab}	0.62^a	0.62 ^{a-d}	0.66 ^{ab}	0.51 ^e	0.60^{ab}		
	M ₃	0.69 ^a	0.68 ^{ab}	0.57 ^{d-h}	0.61^a	0.60 ^{ab}	0.60 ^{ab}	0.59 ^{ab}	0.62^a	0.67 ^a	0.66 ^{ab}	0.56 ^{b-e}	0.63^a		
	M ₄	0.65 ^{a-d}	0.63 ^{a-f}	0.58 ^{c-h}	0.65^{a-c}	0.63 ^{ab}	0.56 ^{ab}	0.53 ^{ab}	0.57^{ab}	0.64 ^{ab}	0.59 ^{a-d}	0.55 ^{b-e}	0.59^{ab}		
Variety		0.64^a	0.65^a	0.56^b		0.59^{ab}	0.60^a	0.56^b		0.62^a	0.63^a	0.55^b			
	Variety x Seed rate				S	Variety x Seed rate				S	Variety x Seed rate				S
S	S ₁	0.63 ^a	0.64 ^a	0.55 ^b	0.61^a	0.60 ^b	0.61 ^{ab}	0.55 ^{ab}	0.59^a	0.62 ^a	0.62 ^a	0.55 ^b	0.60^a		
	S ₂	0.65 ^a	0.64 ^a	0.57 ^b	0.62^a	0.60 ^b	0.60 ^{ab}	0.57 ^{ab}	0.39^a	0.62 ^a	0.62 ^a	0.57 ^b	0.60^a		
	S ₃	0.65 ^a	0.65 ^a	0.56 ^b	0.62^a	0.61 ^b	0.63 ^a	0.52 ^c	0.59^a	0.63 ^a	0.64 ^a	0.54 ^b	0.60^a		
	Variety x Micro				M	Variety x Micro				M	Variety x Micro				M
M	M ₁	0.62 ^a	0.64 ^a	0.55 ^b	0.60^b	0.56 ^{a-c}	0.59 ^{a-c}	0.52 ^c	0.56^a	0.59 ^{bc}	0.61 ^{a-c}	0.53 ^d	0.58^b		
	M ₂	0.64 ^a	0.65 ^a	0.56 ^b	0.62^{ab}	0.59 ^{a-c}	0.63 ^{ab}	0.56 ^{a-c}	0.59^a	0.61 ^{a-c}	0.64 ^{ab}	0.56 ^{cd}	0.60^{ab}		
	M ₃	0.66 ^a	0.66 ^a	0.56 ^b	0.63^{ab}	0.63 ^{ab}	0.62 ^{ab}	0.55 ^{bc}	0.60^a	0.65 ^a	0.64 ^{ab}	0.56 ^{cd}	0.62^a		
	M ₄	0.65 ^a	0.63 ^a	0.57 ^b	0.62^a	0.64 ^a	0.60 ^{a-c}	0.55 ^{abc}	0.60^a	0.64 ^{ab}	0.61 ^{a-c}	0.56 ^{cd}	0.60^{ab}		
Comparison		S.Em±				S.Em±				S.Em±					
Variety (V)		0.02				0.02				0.02					
Seed (S)		0.01				0.01				0.01					
Micro (M)		0.01				0.01				0.01					
V x S		0.01				0.02				0.01					
V x M		0.01				0.02				0.02					
S x M		0.01				0.02				0.02					
V x S x M		0.02				0.04				0.03					

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

At 67 DAS, Green seeker readings varied between 0.58 to 0.70 due to different combinations of factors (V, S and M) but neither the main effects nor the interactions revealed significant differences.

While, at 90 DAS except main effects due to seed rates all other main and interaction effects varied significantly. Among the varieties, cv. MTU 1010 (V_2) recorded significantly higher Green seeker reading (0.63) followed by cv. GGV 0501 which was on par while cv. BPT 5204 had lower readings (0.55). Levels of micronutrients produced significant variations wherein application $ZnSO_4$ resulted in higher Green seeker reading (0.62) and was significantly superior to no application of micronutrient (M_1 – 0.58).

Interactions due to variety and seed rate were significant and among the combinations irrespective of seed rates cvs. MTU 1010 and GV 0501 (0.62-0.64) fared better than cv. BPT 5204 (0.54 – 0.57). Variety X micronutrient also revealed significant variations, in that cv. GGV 0501 with application of $ZnSO_4$ (V_1M_3) rerecorded higher Green seeker reading (0.65) and all GGV 0501 and MTU 1010 combinations were at par and superior to cv. BPT 5204 particularly with no micronutrient supplementation (V_3M_1 – 0.53). Similarly, interactions due to seed rates and micronutrients were significant wherein 35 kg seed rate with the application of $ZnSO_4$ (S_3M_3) recorded higher Green seeker reading (0.63) followed by S_3M_4 which were superior to similar seed rate but without micronutrient supply (S_3M_1 - 0.56).

Among the V x S x M, significantly higher Green seeker reading (0.67) occurred with cv. GGV 0501 sown using 35 kg seed rate and applied with $ZnSO_4$ ($V_1S_3M_3$); all GGV 0501 and MTU 1010 combinations were at par, while lower Green seeker reading was recorded with cv. BPT 5204 sown using 35kg ha⁻¹ seed rate and supplied with $FeSO_4$, or no micronutrient ($V_3S_3 M_{1-2}$) (0.51 each).

4.1.1.1.10 Days to 50 percent flowering (days) (c.f. Table 40)

Days to fifty percent flowering varied significantly due to cultivars, and use of micronutrients and their interactions except seed rates during both the years and on pooled basis as well.

Among cultivars, cv. BPT 5204 (V_3) recorded significantly more days to fifty per cent flowering (114.8) while less days to fifty percent flowering (87.4) were recorded

Table 40. Effect of genotypes, seed rates and micronutrients on 50% flowering (days) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	96.0 ^{d-g}	89.0 ^{efg}	111.3 ^{abc}	98.8^{ab}	93.8 ^{d-g}	86.3 ^{d-h}	109.7 ^{ab}	82.3^{ab}	94.9 ^{c-f}	87.6 ^{efg}	110.5 ^{ab}	97.7^{ab}
	M ₂	96.7 ^{d-g}	92.0 ^{efg}	113.7 ^{ab}	100.8^{ab}	94.4 ^{def}	88.9 ^{d-h}	112.0 ^a	85.7^{ab}	95.5 ^{c-f}	90.5 ^{d-g}	112.9 ^a	99.6^{ab}
	M ₃	99.3 ^{b-e}	92.3 ^{efg}	119.0 ^a	103.5^{ab}	96.9 ^{cde}	89.3 ^{d-h}	117.3 ^a	84.7^{ab}	98.1 ^{cde}	90.8 ^{d-g}	118.2 ^a	102.4^{ab}
	M ₄	102.0 ^{d-g}	94.3 ^{efg}	119.3 ^a	96.8^a	99.6 ^{bcd}	91.2 ^{d-h}	107.6 ^{abc}	99.5^a	100.8 ^{bcd}	92.8 ^{d-g}	118.5 ^a	104.0^a
S ₂	M ₁	95.7 ^{d-g}	86.7 ^{fg}	108.0 ^{abcd}	98.4^b	93.4 ^{d-g}	83.8 ^{gh}	110.4 ^{ab}	95.9^b	94.6 ^{c-f}	85.2 ^{efg}	107.2 ^{abc}	95.7^b
	M ₂	96.3 ^{d-g}	87.0 ^{fg}	112.0 ^{abc}	101.6^{ab}	94.1 ^{def}	84.1 ^{e-h}	110.5 ^{a b}	96.2^{ab}	95.2 ^{c-f}	85.6 ^{efg}	111.2 ^{ab}	97.3^{ab}
	M ₃	96.7 ^{d-g}	91.3 ^{efg}	116.7 ^a	103.7^{ab}	94.4 ^{def}	88.3 ^{d-h}	115.3 ^a	99.3^{ab}	95.5 ^{c-f}	89.8 ^{d-g}	115.8 ^a	100.4^{ab}
	M ₄	97.3 ^{d-g}	96.7 ^{d-g}	117.0 ^a	102.1^{ab}	95.1 ^{def}	93.4 ^{d-g}	115.3 ^a	101.3^{ab}	96.2 ^{cde}	95.1 ^{ef}	116.2 ^a	102.5^{ab}
S ₃	M ₁	98.5 ^{d-e-f}	91.9 ^{efg}	115.8 ^a	100.1^{ab}	92.5 ^{d-g}	79.3 ^h	114.3 ^a	95.4^b	93.6 ^{def}	80.6 ^g	115.2 ^a	96.5^b
	M ₂	96.5 ^{d-g}	90.4 ^{efg}	113.4 ^{ab}	99.6^{ab}	94.1 ^{def}	89.2 ^{d-h}	115.3 ^a	99.5^{ab}	95.2 ^{c-f}	82.6 ^{fg}	116.2 ^a	98.0^{ab}
	M ₃	96.8 ^{d-g}	84.3 ^g	117.6 ^a	97.7^{ab}	95.7 ^{c-f}	81.2 ^{gh}	116.0 ^a	97.6^{ab}	96.9 ^{cde}	82.6 ^{fg}	116.8 ^a	98.8^{ab}
	M ₄	95.4 ^{d-g}	85.9 ^g	111.8 ^{abc}	100.7^{ab}	96.0 ^{c-f}	84.4 ^{e-h}	118.0 ^a	99.5^{ab}	97.2 ^{cde}	85.9 ^{efg}	118.8 ^a	100.6^{ab}
Variety		97.6^b	90.4^b	114.6^a		95.0^b	86.6^b	113.5^a		96.2^b	87.4^b	114.8^a	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	94.4 ^b	87.7 ^{bc}	111.2 ^a	102.6^a	96.2 ^b	88.9 ^{cd}	114.2 ^a	99.8^a	97.3 ^b	90.4 ^c	115.0 ^a	100.9^a
	S ₂	98.0 ^{bc}	89.2 ^{cd}	117.8 ^a	100.1^a	94.3 ^{bc}	87.4 ^{de}	111.8 ^a	97.8^a	95.4 ^{bc}	88.9 ^{cd}	112.6 ^a	99.0^a
	S ₃	99.2 ^{bc}	92.8 ^d	118.7 ^a	99.6^a	94.6 ^{bc}	81.5 ^e	115.9 ^a	97.3^a	95.7 ^{bc}	82.9 ^d	116.7 ^a	98.4^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	95.4 ^{bc}	85.9 ^d	111.8 ^a	97.7^c	93.2 ^{cd}	83.1 ^e	110.2 ^b	95.5^c	94.3 ^c	84.5 ^d	111.0 ^b	96.6^c
	M ₂	96.4 ^b	87.7 ^d	114.2 ^a	99.4^{bc}	94.2 ^{cd}	84.7 ^e	112.6 ^{ab}	97.2^{bc}	95.3 ^c	86.2 ^d	113.4 ^{ab}	98.3^{bc}
	M ₃	98.0 ^b	89.2 ^{cd}	117.8 ^a	101.7^{ab}	95.7 ^{cd}	86.2 ^e	116.1 ^{ab}	99.3^{ab}	96.8 ^c	87.7 ^d	116.9 ^{ab}	100.5^{ab}
	M ₄	99.2 ^b	92.8 ^{bcd}	118.7 ^a	103.6^a	96.9 ^c	89.7 ^{de}	117.0 ^a	101.2^a	98.1 ^c	91.2 ^{cd}	117.8 ^a	102.4^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		2.8				2.5				2.6			
Seed (S)		1.2				1.1				1.2			
Micro (M)		1.3				1.2				1.3			
V x S		2.2				2.0				2.0			
V x M		2.3				2.2				2.2			
S x M		2.3				2.2				2.2			
V x S x M		4.0				3.8				3.8			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

with cv. MTU 1010 (V_2). Among micronutrient levels, significantly more days to fifty per cent flowering (102.4) were taken by combined application of $FeSO_4$ and $ZnSO_4$ (M_4) and lesser days (96.6) was recorded with no supplementation of micronutrient (M_1).

Interactions due to variety and seed rates were significant wherein cv. BPT 5204 irrespective of the seed rates used (V_3S_{1-3}) took more days to fifty percent flowering (111.6 – 116.7), while cv. MTU 1010 with lower seed rate (V_2S_1) took fewer days to fifty per cent flowering (90.4). In variety x micronutrients combinations cv. BPT 5204 with application of $FeSO_4 + ZnSO_4$ micronutrients (V_3M_4) recorded significantly higher days to fifty per cent flowering (117.8), while cv. MTU 1010 without micronutrients (V_2M_1), and with $FeSO_4$ (V_2M_2) and $ZnSO_4$ (V_2M_3) recorded lesser days (84.5, 86.2 and 87.7, respectively). Similarly, seed rate x micronutrient application revealed significant differences, among them lower seed rate and $FeSO_4 + ZnSO_4$ (S_1M_4) recorded significantly more days to 50 per cent flowering (104.0), while significantly lesser days for peak flowering occurred with no application of micronutrient with a seed rate of 30 (S_2M_1) and 35 kg ha⁻¹ (S_3M_1).

Overall, V x S x M interaction revealed significantly more days to fifty per cent flowering with cv. BPT 5204 irrespective of seed rate and micronutrient application (110.5 – 118.8), while lesser days (80.6) were taken by cv. MTU 1010 sown using higher seed rate and without the supply of micronutrients ($V_2S_3M_1$).

4.1.1.1.12 Heat use efficiency (g GDD⁻¹) (c.f. Table 41 and Fig. 6a)

Heat use efficiency (HUE) revealed differences due to cultivars, seed rates and use of micronutrients and their interactions during both the years and on pooled basis as well.

Among the varieties, cv. MTU 1010 (V_2) recorded significantly higher HUE (1.90) followed by cvs. GGV 0501 (V_1) and BPT 5204 (V_3) (1.62 and 1.38 respectively); among seed rates higher HUE (1.77) was recorded with medium seed rate of 30 kg ha⁻¹ (S_2); HUE decreased both with lower or higher seed rate (S_1 and S_3) and both were at par, and among micronutrients levels application $FeSO_4 + ZnSO_4$ (M_4) resulted in higher HUE (1.80) while no application of micronutrient (M_1) recorded significantly lower HUE (1.46).

Table 41. Effect of genotypes, seed rates and micronutrients on heat use efficiency (g GDD⁻¹) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	1.46 ⁱ⁻ⁿ	1.71 ^{d-h}	1.18 ^{op}	1.45^{f-h}	1.41 ^j	1.61 ^g	1.15 ^{hi}	1.39^f	1.44 ^{j-n}	1.66 ^{f-i}	1.16 ^{op}	1.42^f
	M ₂	1.56 ^{g-m}	1.74 ^{c-g}	1.26 ^{n-p}	1.52^{e-g}	1.43 ^{e-i}	1.72 ^{c-f}	1.24 ^{g-i}	1.46^{ef}	1.50 ^{i-m}	1.73 ^{d-i}	1.25 ^{n-p}	1.49^{ef}
	M ₃	1.63 ^{f-j}	1.88 ^{a-e}	1.32 ^{m-p}	1.61^{c-e}	1.54 ^{d-h}	1.72 ^{c-f}	1.40 ^{j-i}	1.55^{d-f}	1.59 ^{g-l}	1.80 ^{d-g}	1.36 ^{l-o}	1.58^{de}
	M ₄	1.71 ^{d-g}	1.90 ^{a-e}	1.36 ^{o-p}	1.66^{b-d}	1.75 ^{e-f}	1.86 ^{cd}	1.53 ^{d-h}	1.71^{cd}	1.73 ^{d-i}	1.88 ^{c-f}	1.44 ^{j-n}	1.68^{cd}
S ₂	M ₁	1.28 ^{n-p}	1.79 ^{b-g}	1.13 ^p	1.40^{gh}	1.59 ^{d-g}	2.12 ^{a-c}	1.70 ^{d-f}	1.80^{bc}	1.42 ^{k-n}	1.95 ^{b-d}	1.39 ^{k-n}	1.59^{de}
	M ₂	1.62 ^{f-j}	1.95 ^{a-d}	1.42 ^{l-o}	1.66^{b-d}	1.62 ^{d-g}	2.25 ^{ab}	1.68 ^{d-f}	1.85^{bc}	1.62 ^{g-k}	2.09 ^{a-c}	1.54 ^{h-m}	1.75^{bc}
	M ₃	1.67 ^{e-l}	1.97 ^{a-c}	1.48 ^{h-n}	1.71^{a-c}	1.79 ^{c-f}	2.26 ^{ab}	1.79 ^{e-f}	1.95^{ab}	1.72 ^{d-i}	2.11 ^{ab}	1.62 ^{g-h}	1.82^b
	M ₄	1.82 ^{b-f}	2.07 ^a	1.61 ^{f-k}	1.83^a	2.11 ^{a-c}	2.31 ^a	1.79 ^{c-f}	2.07^a	1.95 ^{b-d}	2.18 ^a	1.69 ^{f-i}	1.94^a
S ₃	M ₁	1.37 ^{k-p}	1.59 ^{f-l}	1.16 ^p	1.37^b	1.52 ^{d-h}	1.55 ^{d-h}	1.10 ^d	1.39^f	1.44 ^{j-n}	1.57 ^{g-l}	1.13 ^p	1.38^f
	M ₂	1.47 ^{h-n}	1.83 ^{a-f}	1.34 ^{m-p}	1.55^{d-f}	1.59 ^{d-g}	1.72 ^{e-f}	1.40 ^{f-i}	1.57^f	1.53 ^{h-m}	1.70 ^{e-i}	1.24 ^{n-p}	1.49^{ef}
	M ₃	1.69 ^{e-i}	1.99 ^{ab}	1.36 ^{l-p}	1.68^{bc}	1.84 ^{c-e}	1.87 ^{cd}	1.23 ^{g-i}	1.65^{c-e}	1.76 ^{d-h}	1.93 ^{b-e}	1.31 ^{m-p}	1.67^{cd}
	M ₄	1.71 ^{d-h}	2.03 ^{ab}	1.42 ^{j-o}	1.72^{ab}	1.90 ^{b-d}	2.26 ^{ab}	1.41 ^{f-i}	1.86^{bc}	1.73 ^{d-i}	2.14 ^{ab}	1.42 ^{k-o}	1.76^{bc}
Variety		1.58^a	1.87^a	1.34^a		1.67^b	1.94^a	1.45^c		1.62^b	1.90^a	1.38^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	1.59 ^c	1.81 ^b	1.28 ^e	1.56^b	1.53 ^{bc}	1.73 ^b	1.33 ^{cd}	1.53^b	1.56 ^d	1.77 ^{bc}	1.30 ^e	1.54^b
	S ₂	1.60 ^c	1.94 ^a	1.41 ^d	1.65^a	1.78 ^b	2.24 ^a	1.74 ^b	1.92^a	1.68 ^{cd}	2.08 ^a	1.56 ^d	1.77^a
	S ₃	1.58 ^c	1.86 ^{ab}	1.33 ^{de}	1.59^{ab}	1.71 ^b	1.81 ^b	1.21 ^d	1.58^b	1.61 ^d	1.84 ^b	1.27 ^e	1.57^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	1.37 ^g	1.70 ^d	1.16 ^h	1.41^d	1.51 ^{e-h}	1.76 ^{b-d}	1.32 ^h	1.53^c	1.43 ^{ef}	1.73 ^{cd}	1.23 ^g	1.46^d
	M ₂	1.55 ^{ef}	1.84 ^{bc}	1.34 ^g	1.58^c	1.55 ^{d-g}	1.84 ^{bc}	1.35 ^{gh}	1.58^c	1.55 ^e	1.84 ^{bc}	1.34 ^{ef}	1.58^c
	M ₃	1.66 ^{de}	1.94 ^{ab}	1.39 ^g	1.66^b	1.72 ^{c-e}	1.95 ^{ab}	1.4	1.71^b	1.69 ^d	1.95 ^b	1.43 ^{ef}	1.69^b
	M ₄	1.77 ^{cd}	2.00 ^a	1.46 ^{gh}	1.74^a	1.92 ^{bc}	2.14 ^a	1.58 ^{d-f}	1.88^a	1.80 ^{cd}	2.07 ^a	1.52 ^e	1.80^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.02				0.03				0.02			
Seed (S)		0.02				0.05				0.02			
Micro (M)		0.02				0.04				0.02			
V x S		0.02				0.09				0.04			
V x M		0.04				0.07				0.04			
S x M		0.04				0.07				0.04			
V x S x M		0.07				0.12				0.07			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Two-way interactions were significant. Among variety and seed rate cv. MTU 1010 at 30 kg ha⁻¹ seed rate (V₂S₂) recorded higher HUE (2.08) while lower HUE was recorded with cv. BPT 5204 irrespective of seed rates used particularly with higher seed rate of 35 kg ha⁻¹ (V₃S₃) (1.27); among variety X micronutrient cv. MTU 1010 with combined application of FeSO₄ + ZnSO₄ (V₂M₄) recorded higher HUE (2.07) and in the absence of micronutrient application HUE decreased irrespective of cultivars used and recorded lower HUE with cv. BPT 5204 (V₃M₁) (1.23), and among seed rate X micronutrients medium seed rate of 30 kg with application of FeSO₄ + ZnSO₄ (S₂M₄) recorded higher HUE (1.94) while 35 kg ha⁻¹ seed rate without supplementation of micronutrient (S₃M₁) recorded lower HUE (1.38).

On the whole, of the three way interactions significantly higher HUE (2.18) was recorded with cv. MTU 1010 sown with 30 kg seed rate and applied with both FeSO₄ + ZnSO₄ (V₂S₂M₄), while lower HUE (1.13) was recorded with cv. BPT 5204 sown using 25 kg ha⁻¹ seed rate and supplied with no micro nutrient (V₃S₁M₁).

4.1.1.2. Yield components and yield

The data on yield components of rice viz., number of tillers m⁻², productive tillers or panicles m⁻², unproductive tillers m⁻², panicle length (cm), filled grains per panicle, unfilled grains per panicle, total grains per panicle, sterility percentage, thousand grain weight, grain yield per hill and per ha, straw yield and harvest index as influenced by different treatments are presented here.

4.1.1.2.1 Unproductive tillers at harvest (no.m⁻²) (c.f. Table 42)

Unproductive tillers count varied significantly due to cultivars, seed rates and use of micronutrients and their interactions during both the years and on pooled basis as well.

Among the cultivars, significantly higher unproductive tillers (117.6) occurred with cv. BPT 5204 (V₃), while significantly lower unproductive tillers (74.2) were recorded with cv. GGV 0501 (V₁); among seed rates higher unproductive tillers were recorded with the seed rate of 30 (S₂) and 35 kg ha⁻¹ (S₃) (103.8 and 97.9, respectively), while lower count (87.9) was recorded with lower seed rate (S₁). Similarly, application of micronutrients produced significant variations and application FeSO₄+ZnSO₄ (M₄) resulted in higher unproductive tiller count (110.8), while significantly lower unproductive tillers count (85.7) was recorded with no application of micronutrient (M₁).

Table 42. Effect of genotypes, seed rates and micronutrients on unproductive tillers (m⁻²) at harvest under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	82.3 ^b	82.3 ^b	82.3 ^b	84.4^d	67.8 ^{gh}	61.8 ^{hi}	102.8 ^{a-e}	77.5^c	63.7 ^{kl}	83.6 ^{f-l}	95.7 ^{d-k}	81.0^c
	M ₂	85.7 ^b	85.7 ^b	85.7 ^b	77.8^d	59.3 ^{hi}	82.7 ^{e-h}	111.3 ^{b-f}	84.4^{bc}	58.7 ^l	80.7 ^{f-l}	104.0 ^{c-i}	81.1^c
	M ₃	84.7 ^b	84.7 ^b	84.7 ^b	86.0^d	78.3 ^{e-h}	86.3 ^{e-h}	119.8 ^{b-f}	94.8^{a-c}	77.3 ^{g-l}	88.3 ^{e-l}	105.8 ^{b-h}	90.5^{bc}
	M ₄	98.1 ^b	98.1 ^b	98.1 ^b	98.1^{cd}	55.3 ^{hi}	129.0 ^{a-d}	119.0 ^{b-f}	101.1^{ab}	66.3 ^{j-l}	122.7 ^{a-d}	109.9 ^{b-j}	99.6^{ab}
S ₂	M ₁	94.7 ^b	94.7 ^b	94.7 ^b	94.7^d	55.7 ^{hi}	103.3 ^{c-g}	153.0 ^a	104.0^{ab}	74.9 ^{h-l}	86.2 ^{f-l}	137.1 ^{ab}	99.4^{ab}
	M ₂	91.1 ^b	91.1 ^b	91.1 ^{ab}	91.1^d	58.3 ^{hi}	75.7 ^{f-h}	143.0 ^{a-c}	92.3^{a-c}	70.1 ^{j-l}	69.4 ^{j-l}	135.4 ^{a-c}	91.6^{bc}
	M ₃	118.7 ^{ab}	118.7 ^{ab}	118.7 ^{ab}	118.7^b	56.3 ^{hi}	89.7 ^{d-h}	120.5 ^{f-h}	88.8^{a-c}	71.5 ^{i-l}	120.5 ^{a-d}	119.3 ^{a-e}	103.8^{ab}
	M ₄	142.0 ^a	142.0 ^a	142.0 ^a	142.0^a	27.8 ^{ai}	91.7 ^{d-h}	150.0 ^{ab}	89.8^{a-c}	74.5 ^{h-l}	126.4 ^{a-d}	149.7 ^a	116.9^a
S ₃	M ₁	80.5 ^b	80.5 ^b	80.5 ^b	80.5^d	69.3 ^{jh}	76.0 ^{f-h}	75.3 ^{f-h}	73.5^c	75.5 ^{h-l}	78.9 ^{f-l}	75.3 ^{h-l}	76.6^c
	M ₂	83.3 ^b	83.3 ^b	83.3 ^b	83.3^d	74.3 ^{f-h}	79.0 ^{f-h}	134.0 ^{a-c}	95.8^{a-c}	86.2 ^{f-l}	76.4 ^{h-l}	111.1 ^{b-f}	91.2^{bc}
	M ₃	111.5 ^{ab}	111.5 ^{ab}	111.5 ^{ab}	111.5^b	56.7 ^{hi}	127.3 ^{a-d}	145.0 ^{ab}	109.7^a	75.1 ^{h-l}	122.4 ^{a-d}	134.5 ^{a-c}	110.7^a
	M ₄	119.9 ^{ab}	119.9 ^{ab}	119.9 ^{ab}	119.9^{bc}	72.0 ^{f-h}	111.5 ^{b-f}	146.2 ^{ab}	109.9^a	97.2 ^{d-j}	107.1 ^{a-h}	135.5 ^{a-c}	113.3^a
Variety		86.8^b	101.7^a	108.6^a		60.9^c	92.8^b	126.7^a		74.2^c	97.3^b	117.6^a	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	67.8 ^c	97.6 ^b	94.4 ^b	86.6^c	65.2 ^e	90.0 ^d	113.3 ^{bc}	87.8^b	66.5 ^f	93.8 ^{cd}	103.8 ^{bc}	87.9^b
	S ₂	96.0 ^b	111.1 ^b	127.7 ^a	111.6^a	49.5 ^f	90.1 ^d	143.1 ^a	94.2^{ab}	72.8 ^{ef}	100.6 ^{bc}	135.4 ^a	103.8^a
	S ₃	98.9 ^b	93.9 ^b	102.9 ^b	98.6^b	68.1 ^e	98.5 ^{cd}	125.2 ^b	98.0^a	83.5 ^{de}	96.2 ^{cd}	114.0 ^b	97.9^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	78.4 ^{ef}	85.4 ^{d-f}	94.9 ^{c-e}	86.2^c	64.3 ^{de}	80.4 ^d	110.4 ^{bc}	85.72^c	71.4 ^c	82.9 ^c	102.7 ^b	85.7^b
	M ₂	79.4 ^{fe}	71.8 ^f	104.4 ^{b-d}	85.2^c	64.0 ^{de}	79.1 ^d	129.4 ^{ab}	87.61^{bc}	71.7 ^c	75.5 ^c	116.9 ^{ab}	87.7^b
	M ₃	85.5 ^{d-f}	119.8 ^{ab}	111.1 ^{a-c}	105.6^b	63.8 ^{de}	101.1 ^c	128.4 ^{ab}	97.7^{ab}	74.6 ^c	110.4 ^b	119.8 ^{ab}	102.2^a
	M ₄	107.0 ^{a-c}	126.6 ^a	123.0 ^{ab}	118.9^a	51.7 ^e	110.7 ^{bc}	140.4 ^a	100.9^a	79.3 ^c	118.7 ^{ab}	131.7 ^a	110.8^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		2.6				2.9				2.9			
Seed (S)		2.9				2.8				2.5			
Micro (M)		3.8				3.9				3.2			
V x S		5.1				4.9				4.3			
V x M		6.6				6.8				5.5			
S x M		6.6				6.8				5.5			
V x S x M		11.5				11.9				9.6			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Among variety X seed rate, significantly more unproductive tillers (135.4) occurred with cv. BPT 5204 at 30 kg ha⁻¹ (V₃S₂), while the lower count was recorded with cv. GGV 0501 irrespective of seed rates used particularly with lower seed rate of 25 kg ha⁻¹ (V₁S₁- 66.5). Variety X micronutrient varied significantly wherein cv. BPT 5204 (V₃S₄) coupled with FeSO₄ + ZnSO₄ (V₂M₄) rerecorded higher unproductive tillers (131.7) which was on par with V₃M₂₋₃ and V₂M₄, while in the absence of micronutrient the count decreased and recorded lower value with combinations involving cvs. GGV 0501 and MTU 1010 (V₃M₁₋₄ and V₂M₁₋₂). Similarly, among seed rate X micronutrients 30 kg seed rate with application of FeSO₄ + ZnSO₄ (S₂M₄) recorded higher unproductive tillers (360.6), while 25 kg ha⁻¹ seed rate with supplementation of both micronutrient (S₁M₄) recorded lower unproductive tillers m⁻² (76.6).

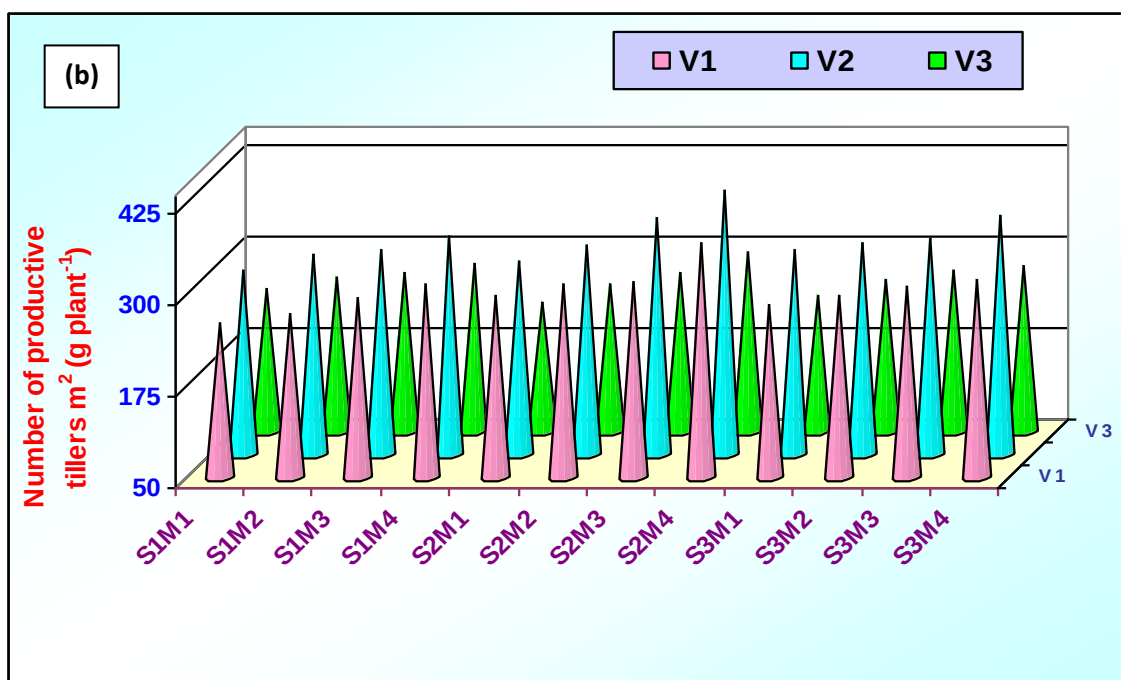
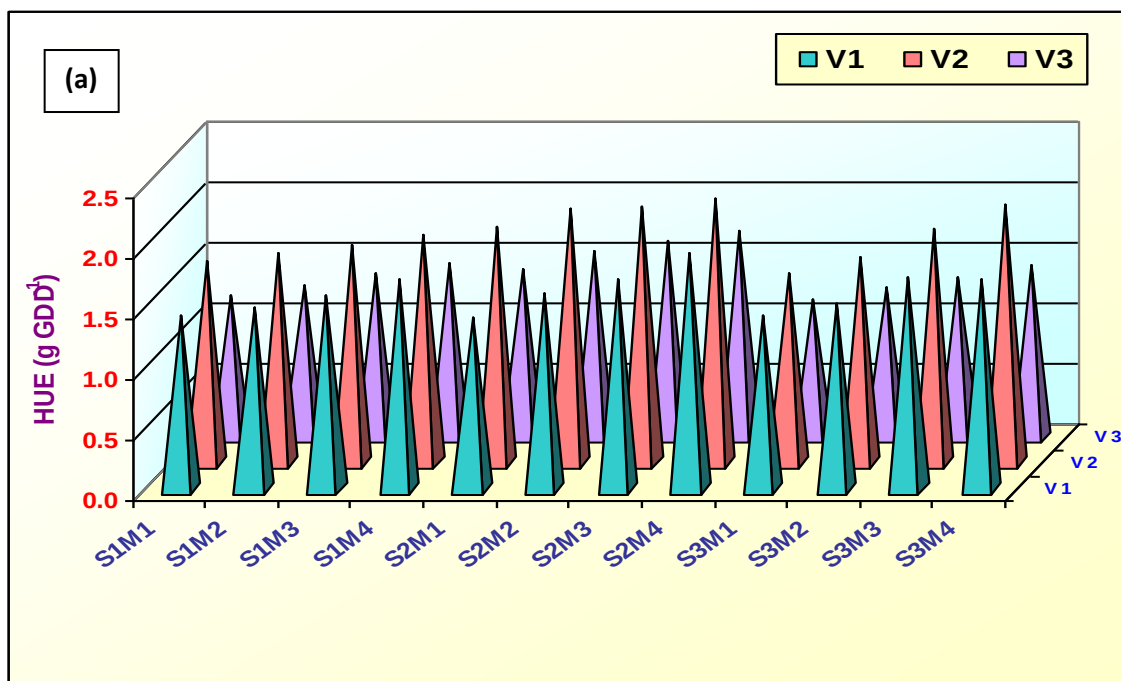
Overall, the three way interaction revealed significantly higher unproductive tiller count (149.7) with cv. BPT 5204 sown with 30 kg seed rate and applied with both FeSO₄ + ZnSO₄ (V₂S₂M₄), while the lower unproductive tiller count occurred with cv. GGV 0501 irrespective of seed rate and micronutrient application particularly with V₁S₁M₂ (58.7).

4.1.1.2.2 Productive tillers or panicles at harvest (no.m⁻²) (c.f. Table 43 and Fig. 6b)

Count of productive tillers with panicles varied significantly due to cultivars, seed rates and use of micronutrients and their interactions during both the years and on pooled basis as well.

Among the cultivars, significantly more panicles were recorded with cv. MTU 1010 (V₂) followed by cvs. GGV 0501 (345.7 and 306.6, respectively) while significantly lower panicles (262.5) were recorded with cv. BPT 5204 (V₃); among seed rates higher number of panicles (316.1) was recorded with the seed rate of 30 kg ha⁻¹ (S₂); productive tiller count decreased both with lower or higher seed rate (S₁ and S₃). Similarly, levels of micronutrients produced significant variations wherein combined application FeSO₄ + ZnSO₄ to soil and to the foliage (M₄) resulted in more panicles (334.1), while significantly lower number of panicles (279.6) was recorded with no application of micronutrient (M₁).

In the two- way interactions, variety X seed rate were significant and cv. MTU 1010 at 30 (V₂S₂) and 35 kg ha⁻¹ seed rates (V₂S₃) recorded more panicles (359.7 and



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Varieties: V₁- GGV 0501, V₂- MTU 1010, V₃- BPT 5204;

Seed Rate: S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient: M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),

M₄- FeSO₄ + ZnSO₄ (Each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

Fig. 6. Effect of genotypes, seed rates and micronutrients on (a) heat use efficiency (g GDD⁻¹) and (b) productive tillers or panicles m⁻² at harvest under direct seeded condition during rainy season

Table 43. Effect of genotypes, seed rates and micronutrients productive tillers or panicles (m^{-2}) at harvest under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	271.8 ^{n-p}	305.4 ^{i-m}	269.4 ^{n-p}	282.2^{ef}	256.7 ^{d-j}	303.2 ^{b-h}	225.2 ^{ij}	261.7^c	264.2 ^{l-p}	304.3 ^{fi}	247.3 ^{n-p}	271.9^e
	M ₂	277.8 ^{m-p}	330.6 ^{e-j}	275.4 ^{n-p}	294.6^{de}	270.0 ^{c-j}	319.0 ^{b-f}	250.0 ^{fi}	279.7^{bc}	273.9 ^{j-o}	324.8 ^{fi-h}	262.7 ^{l-p}	287.1^{de}
	M ₃	313.8 ^{g-l}	337.8 ^{d-h}	285.6 ^{l-p}	312.4^{bc}	278.3 ^{c-i}	326.5 ^{b-e}	251.7 ^{e-j}	285.6^{bc}	296.1 ^{g-m}	332.2 ^{fi}	268.6 ^{l-p}	299.0^{cd}
	M ₄	318.0 ^{f-k}	363.0 ^{b-d}	288.6 ^{k-o}	323.2^{ab}	313.3 ^{b-g}	338.5 ^{a-c}	271.2 ^{c-j}	307.7^b	315.7 ^{e-j}	350.8 ^{b-e}	279.9 ⁱ⁻ⁿ	315.5^{bc}
S ₂	M ₁	307.8 ^{h-l}	333.6 ^{d-i}	256.2 ^p	299.2^{cd}	295.2 ^{b-i}	295.8 ^{b-i}	202.7 ^j	264.6^c	301.5 ^{e-l}	314.7 ^{e-j}	229.4 ^p	281.9^{de}
	M ₂	323.4 ^{e-j}	345.6 ^{d-f}	266.4 ^{op}	311.8^{bc}	306.7 ^{b-h}	327.7 ^{b-d}	242.0 ^{g-j}	292.1^{bc}	315.0 ^{e-j}	336.6 ^{c-g}	254.2 ^{n-p}	301.9^{cd}
	M ₃	324.6 ^{e-j}	385.2 ^b	270.6 ^{n-p}	326.8^{ab}	313.3 ^{b-g}	362.5 ^{ab}	264.5 ^{c-j}	313.4^b	319.0 ^{e-i}	373.9 ^{bc}	267.6 ^{l-p}	320.2^{bc}
	M ₄	375.6 ^{bc}	424.2 ^a	307.2 ^{h-m}	369.0^f	367.5 ^{ab}	403.3 ^a	285.8 ^{c-i}	352.2^a	371.6 ^{bcd}	413.8 ^a	296.5 ^{g-m}	360.6^a
S ₃	M ₁	309.0 ^{g-l}	333.6 ^{d-i}	239.4 ^{d-g}	294.0^{de}	267.5 ^{c-j}	327.7 ^{b-d}	233.3 ^{h-j}	276.2^{bc}	288.3 ^{h-n}	330.6 ^{e-g}	236.4 ^{op}	285.1^{de}
	M ₂	312.0 ^{g-l}	351.6 ^{c-e}	283.8 ^b	315.8^b	286.7 ^{c-i}	329.3 ^{b-d}	233.5 ^{h-j}	283.2^{bc}	299.3 ^{f-m}	340.5 ^{b-f}	258.7 ^{m-p}	299.5^{cd}
	M ₃	319.2 ^{f-k}	361.8 ^{b-d}	289.8 ^b	323.6^{ab}	305.7 ^{d-h}	334.3 ^{a-c}	251.7 ^{e-j}	297.2^{bc}	312.2 ^{e-k}	348.1 ^{b-e}	270.7 ^{k-p}	310.3^{bc}
	M ₄	321.6 ^{e-j}	389.4 ^b	299.4 ⁱ⁻ⁿ	336.6^a	323.2 ^{ab}	366.8 ^{ab}	257.7 ^{d-j}	315.9^b	322.4 ^{e-h}	378.1 ^b	278.5 ⁱ⁻ⁿ	326.3^b
Variety		314.6^b	355.6^a	277.7^c		298.7^b	336.2^a	247.4^c		306.6^b	345.7^a	262.5^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	295.4 ^c	334.2 ^b	279.8 ^c	303.1^b	279.6 ^c	321.8 ^{ab}	249.5 ^d	283.6^b	287.5 ^d	328.0 ^b	264.6 ^e	293.5^c
	S ₂	332.9 ^b	372.2 ^a	275.1 ^c	326.7^a	320.7 ^{ab}	347.3 ^a	248.8 ^d	305.6^a	326.8 ^b	359.7 ^a	261.9 ^e	316.1^a
	S ₃	315.5 ^b	359.1 ^a	278.1 ^c	317.6^a	295.8 ^{bc}	339.5 ^a	244.0 ^d	293.1^c	305.6 ^c	349.3 ^a	261.1 ^e	305.3^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	296.2 ^{gh}	324.2 ^{de}	255.0 ^j	291.8^d	273.1 ^{d-f}	308.9 ^{b-d}	220.4 ^{gh}	267.5^c	284.7 ^{ef}	316.5 ^{cd}	237.7 ^h	279.6^c
	M ₂	304.4 ^{fg}	342.6 ^c	275.2 ⁱ	307.4^c	287.8 ^{c-e}	325.3 ^{bc}	241.8 ^{fg}	285.0^{bc}	296.1 ^{de}	334.0 ^{bc}	258.5 ^g	296.2^{bc}
	M ₃	319.2 ^{ef}	361.6 ^b	282.0 ^{hi}	320.9^b	299.1 ^h	341.1 ^{ab}	255.9 ^{e-g}	298.7^b	309.2 ^d	351.4 ^b	269.0 ^{fg}	309.9^b
	M ₄	338.4 ^{cd}	392.2 ^a	298.4 ^g	343.0^a	334.7 ^{ab}	369.6 ^a	271.6 ^{d-f}	325.3^a	336.5 ^{bc}	380.9 ^a	285.0 ^{ef}	334.1^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		6.1				10.1				4.1			
Seed (S)		3.6				5.4				2.4			
Micro (M)		3.1				7.3				4.1			
V x S		6.3				9.4				4.2			
V x M		5.3				12.6				7.1			
S x M		5.3				12.6				7.1			
V x S x M		9.2				21.8				12.4			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

349.3, respectively), while lower panicles were recorded with cv. BPT 5204 irrespective of seed rates used particularly with higher seed rate of 35 kg ha⁻¹(V₃S₃) (261.1). Variety X micronutrient again revealed significant variations, in that cv. MTU 1010 coupled with application of FeSO₄ + ZnSO₄ (V₂M₄) rerecorded higher panicles (380.9), while in the absence of micronutrient panicles count decreased and recorded lower number with cv. BPT 5204 (V₃M₁) (237.7). Similarly, interactions due to seed rates and micronutrients were significant wherein 30 kg seed rate with application of FeSO₄ + ZnSO₄ (S₂M₄) recorded higher panicles count (360.6), while 25 kg ha⁻¹seed rate without supplementation of micronutrient (S₁M₁) recorded lower panicles count (271.9).

Of the three way interaction, significantly higher panicles count (413.8) was observed with cv. MTU 1010 sown with 30 kg seed rate and applied with both FeSO₄ + ZnSO₄ (V₂S₂M₄), while the lower count was recorded with cv. BPT 5204 irrespective of seed rate and micronutrient application particularly with V₃S₂M₁ (229.4).

4.1.1.2.3 Total tiller count at harvest (no.m⁻²) (c.f. Table 44)

Number of tillers m⁻² at harvest varied significantly due to cultivars, and seed rates and use of micronutrients and their interactions were not significant during both the years and on pooled basis as well. Among the cultivars, significantly more number of tillers m⁻² (442.5) was recorded with cv.MTU 1010 (V₂), while significantly lower panicles m⁻² were observed with cvs. BPT 5204and GGV 0501 (380.2 and 280.7, respectively).

4.1.1.2.4 Panicle length (cm) (c.f. Table 45)

Data on panicle length revealed significant differences due to cultivars and use of micronutrients and their interactions, however seed rate did not vary significantly during both the years and on pooled basis as well.

Among the cultivars, significantly higher panicle length (25.09) was recorded with cv. MTU 1010 (V₂) followed by cvs.GGV 0501 and BPT 5204(24.13 and 18.93, respectively); Levels of micronutrients produced significant variations and FeSO₄ + ZnSO₄ application recorded higher panicle length (23.4) (M₄); M₃ receiving only ZnSO₄ was at par, while significantly lower panicle length (21.8) was recorded with no micronutrient supply (M₁).

Table 44. Effect of genotypes, seed rates and micronutrients on total number of tillers (m⁻²) at harvest under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	331.3 ^{hi}	410.7 ^{e-g}	358.0	366.7 ^e	324.5 ^{gh}	365 ^{c-h}	328.0	339.1 ^a	327.9 ^a	387.8 ^a	343.0 ^a	352.9 ^a
	M ₂	336.0 ^{hi}	409.3 ^{e-g}	372.0 ^a	372.4 ^e	329.2 ^{gh}	401.b-h ^a	361.2 ^a	364.0 ^a	332.6 ^a	405.5 ^a	366.6 ^a	368.3 ^a
	M ₃	390.0 ^{e-h}	428.0 ^{df}	377.3 ^a	398.4 ^{de}	353.2 ^{e-g}	412.5 ^{a-g}	371.2 ^a	378.9 ^a	371.6 ^a	420.3 ^a	374.3 ^a	388.7 ^a
	M ₄	395.3 ^{e-h}	479.3 ^{b-d}	389.3 ^a	421.3 ^{b-d}	368.3 ^{d-h}	467.5 ^{a-c}	390.0 ^a	408.6 ^a	381.8 ^a	473.4 ^a	389.7 ^a	415.0 ^a
S ₂	M ₁	402.0 ^{e-g}	402.7 ^{e-g}	377.3 ^a	394.0 ^{de}	350.8 ^{f-h}	399.2 ^{b-h}	355.7 ^a	368.5 ^a	376.4 ^a	400.9 ^a	366.5 ^a	381.3 ^a
	M ₂	405.3 ^{e-g}	408.7 ^{e-g}	390.7 ^a	401.6 ^{c-e}	361.7 ^{e-b}	401.7 ^{b-h}	381.7 ^a	381.7 ^a	383.5 ^a	405.2 ^a	386.2 ^a	391.6 ^a
	M ₃	411.3 ^{e-g}	536.7 ^{ab}	395.3 ^a	447.7 ^b	369.7 ^{d-h}	451.7 ^{a-e}	385.0 ^a	402.1 ^a	390.5 ^a	494.2 ^a	390.2 ^a	424.9 ^a
	M ₄	496.7 ^{c-h}	585.3 ^a	450.7 ^a	510.9 ^a	395.8 ^{b-h}	495.0 ^a	441.7 ^a	444.1 ^a	446.3 ^a	540.2 ^a	446.2 ^a	477.6 ^a
S ₃	M ₁	390.7 ^{e-g}	415.3 ^{e-g}	314.7 ^a	373.6 ^e	336.7 ^{gh}	403.7 ^{a-h}	308.3 ^a	349.5 ^a	363.7 ^a	409.5 ^a	311.5 ^a	361.6 ^a
	M ₂	410.0 ^{e-g}	425.3 ^{b-d}	372.0 ^a	402.4 ^{c-e}	360.8 ^{e-h}	409.8 ^a	367.3 ^a	379.3 ^a	385.4 ^a	417.6 ^a	369.7 ^a	390.9 ^a
	M ₃	412.7 ^{e-e}	479.3 ^{bc}	413.3 ^a	435.1 ^{bc}	365.7 ^{d-h}	461.7 ^{a-d}	396.7 ^a	408.0 ^a	389.2 ^a	470.5 ^a	405.0 ^a	421.6 ^a
	M ₄	444.0 ^b	492.0 ^a	424.0 ^a	453.3 ^b	394.8 ^a	478.3 ^a	404.0 ^a	425.7 ^a	419.4 ^a	485.2 ^a	414.0 ^a	439.5 ^a
Variety		402.1	456.1	386.2		359.3 ^c	430.0 ^a	374.2 ^b		380.7 ^b	442.5 ^a	380.2 ^b	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	363.2 ^a	431.8 ^a	374.2 ^a	389.7 ^a	343.8 ^a	411.7 ^a	362.6 ^a	372.7 ^a	353.5 ^a	421.8 ^a	368.4 ^a	381.2 ^a
	S ₂	428.8 ^a	483.3 ^a	403.5 ^a	438.5 ^a	369.5 ^a	436.9 ^a	391.0 ^a	399.1 ^a	399.2 ^a	460.1 ^a	397.3 ^a	418.9 ^a
	S ₃	414.3 ^a	453.0 ^a	381.0 ^a	325.1 ^a	364.5 ^a	438.4 ^a	369.1 ^a	390.7 ^a	389.4 ^a	445.7 ^a	375.0 ^a	403.4 ^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	374.7 ^a	409.6 ^a	350.0 ^a	378.1 ^a	337.3 ^a	389.3 ^a	330.7 ^a	352.4 ^a	356.0 ^a	399.4 ^a	340.3 ^a	365.2 ^a
	M ₂	383.8 ^a	414.4 ^a	378.2 ^a	392.1 ^a	350.6 ^a	404.4 ^a	370.1 ^a	375.0 ^a	367.2 ^a	409.4 ^a	374.1 ^a	383.6 ^a
	M ₃	404.7 ^a	481.3 ^a	395.3 ^a	427.1 ^a	362.8 ^a	441.9 ^a	384.3 ^a	396.3 ^a	383.8 ^a	461.4 ^a	389.8 ^a	411.6 ^a
	M ₄	445.3 ^a	518.9 ^a	421.3 ^a	461.8 ^a	386.3 ^a	480.3 ^a	411.9 ^a	426.2 ^a	415.8 ^a	449.6 ^a	416.6 ^a	427.3 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		11.2				1.8				5.8			
Seed (S)		7.2				8.2				5.9			
Micro (M)		6.4				9.2				5.7			
V x S		12.5				14.2				10.3			
V x M		11.0				15.9				10.0			
S x M		11.0				15.9				10.0			
V x S x M		19.1				27.7				17.3			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 45. Effect of genotypes, seed rates and micronutrients on panicle length (cm) at harvest under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	23.6 ^a	23.7 ^a	15.5 ^c	21.6 ^b	22.3 ^{d-g}	23.8 ^{a-e}	17.7 ⁱ	21.5 ^c	23.0 ^d	23.8 ^{b-d}	17.6 ^e	21.5 ^e
	M ₂	24.4 ^a	24.9 ^a	18.2 ^b	22.5 ^{ab}	23.7 ^{a-e}	24.5 ^{a-e}	17.8 ⁱ	22.0 ^{bc}	24.0 ^{b-d}	24.7 ^{a-d}	18.0 ^e	22.2 ^{b-e}
	M ₃	24.3 ^a	25.1 ^a	19.3 ^b	22.9 ^{ab}	24.0 ^{a-e}	24.9 ^{a-e}	18.5 ^{hi}	22.5 ^{a-c}	24.2 ^{a-d}	25.0 ^{a-d}	18.9 ^e	22.7 ^{a-e}
	M ₄	24.0 ^a	25.4 ^a	19.5 ^b	22.9 ^{ab}	24.2 ^{a-e}	25.1 ^{a-e}	20.0 ^{f-i}	23.1 ^{a-c}	24.1 ^{a-d}	25.2 ^{a-d}	19.8 ^e	23.0 ^{a-d}
S ₂	M ₁	24.3 ^a	24.7 ^a	18.5 ^b	22.5 ^{ab}	22.3 ^{d-g}	23.6 ^{a-e}	18.0 ⁱ	21.3 ^c	23.3 ^{cd}	24.1 ^{a-c}	18.2 ^e	21.8 ^{de}
	M ₂	24.5 ^a	24.9 ^a	19.3 ^b	22.9 ^{ab}	22.5 ^{c-g}	26.0 ^{a-c}	19.3 ^{g-i}	22.6 ^{a-c}	23.5 ^{b-d}	25.4 ^{ab}	19.3 ^e	22.7 ^{a-e}
	M ₃	25.1 ^a	25.3 ^a	19.7 ^b	23.4 ^a	25.8 ^{a-d}	26.1 ^{a-c}	19.8 ^{f-i}	23.9 ^{ab}	25.5 ^{a-c}	25.7 ^a	19.8 ^e	23.6 ^{ab}
	M ₄	25.6 ^a	25.9 ^a	19.9 ^b	23.8 ^a	25.8 ^{a-d}	26.8 ^a	19.7 ^{f-i}	24.1 ^a	25.7 ^{ab}	26.4 ^{a-d}	19.8 ^e	23.9 ^a
S ₃	M ₁	24.2 ^a	24.7 ^a	18.8 ^b	22.6 ^{ab}	21.7 ^{e-h}	24.7 ^{a-e}	17.8 ⁱ	21.4 ^c	22.9 ^d	24.7 ^{a-d}	18.3 ^e	21.9 ^{c-e}
	M ₂	25.1 ^a	24.9 ^a	19.5 ^b	23.1 ^{ab}	24.2 ^{a-e}	24.8 ^{a-e}	18.5 ^{hi}	22.5 ^{a-c}	24.6 ^{a-d}	24.8 ^{ab}	19.0 ^e	22.8 ^{a-e}
	M ₃	24.2 ^a	25.0 ^a	19.7 ^b	22.9 ^{ab}	23.0 ^{b-f}	26.6 ^{ab}	18.5 ^{hi}	22.7 ^{a-c}	23.6 ^{b-d}	25.8 ^{ab}	19.1 ^e	22.8 ^{a-e}
	M ₄	24.6 ^a	24.4 ^a	19.9 ^b	22.9 ^{ab}	25.5 ^{a-d}	26.7 ^a	18.7 ^{hi}	23.6 ^{ab}	25.1 ^{a-d}	25.5 ^{ab}	19.3 ^e	23.3 ^{abc}
Variety		24.5 ^a	25.0 ^a	19.0 ^b		23.8 ^b	25.3 ^a	18.7 ^a		24.1 ^a	25.1 ^b	19.0 ^c	
Variety x Seed rate					S	Variety x Seed rate				S	Variety x Seed rate		
S	S ₁	24.1 ^a	24.8 ^a	18.7 ^b	22.5 ^a	23.5 ^a	24.6 ^a	18.5 ^b	22.2 ^a	23.8 ^c	24.7 ^{a-c}	18.6 ^d	22.4 ^a
	S ₂	24.9 ^a	25.2 ^a	19.4 ^b	23.2 ^a	24.1 ^a	25.6 ^a	19.2 ^b	22.9 ^a	24.5 ^{a-c}	25.4 ^a	19.3 ^d	23.1 ^a
	S ₃	24.5 ^a	24.8 ^a	19.5 ^b	22.9 ^a	23.6 ^a	25.7 ^a	18.4 ^b	22.6 ^a	24.0 ^{bc}	25.2 ^{ab}	18.9 ^d	22.7 ^a
Variety x Micro					M	Variety x Micro				M	Variety x Micro		
M	M ₁	24.0 ^a	24.4 ^a	18.3 ^c	22.2 ^b	22.1 ^d	24.0 ^{bc}	17.8 ^e	21.3 ^c	23.1 ^d	24.2 ^{cd}	18.1 ^f	21.8 ^c
	M ₂	24.7 ^a	24.9 ^a	19.0 ^{bc}	22.9 ^{ab}	23.4 ^{cd}	25.1 ^{a-c}	18.6 ^e	22.4 ^b	24.1 ^{cd}	25.0 ^{a-c}	18.8 ^{ef}	22.6 ^b
	M ₃	24.5 ^a	25.2 ^a	19.6 ^{bc}	23.1 ^a	24.3 ^{a-c}	25.9 ^{ab}	18.9 ^e	23.0 ^{ab}	24.4 ^{bc}	25.5 ^{ab}	19.3 ^e	23.1 ^{ab}
	M ₄	24.7 ^a	25.2 ^a	19.8 ^b	23.2 ^a	25.2 ^{a-c}	26.2 ^a	19.4 ^e	23.6 ^a	25.0 ^{a-c}	25.7 ^a	19.6 ^e	23.4 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.5				0.5				0.4			
Seed (S)		0.2				0.4				0.2			
Micro (M)		0.3				0.3				0.2			
V x S		0.4				0.7				0.4			
V x M		0.5				0.6				0.4			
S x M		0.5				0.6				0.4			
V x S x M		0.8				1.1				0.7			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Interactions due to variety and seed rate were significant and cv. MTU 1010 at 30 kg ha⁻¹ seed rate (V₂S₂) recorded longer panicle (25.4); MTU 1010 with other seed rates (V₁S₁₋₃) were at par, while shorter panicle length among all was recorded with cv. BPT 5204 irrespective of seed rates used particularly with lower seed rate of 25 kg ha⁻¹ (V₃S₁) (18.6). Variety X micronutrient again had shown significant variations, in that cv. MTU 1010 coupled with FeSO₄ + ZnSO₄ (V₂M₄) rerecorded longer panicle (25.7); without application of micronutrient panicle length decreased more so with cv. BPT 5204 (V₃M₁) (18.1). Similarly, interactions due to seed rates and micronutrients were significant wherein 30 kg seed rate and application of FeSO₄ + ZnSO₄ (S₂M₄) recorded longer panicle (24.0) while 25 kg ha⁻¹ seed rate with no supplementation of micronutrient (S₁M₁) recorded shorter panicle (21.5).

Among the three factor combinations, significantly longer panicle (25.7) occurred with cv. MTU 1010 sown using 30 kg seed rate and supplied with both FeSO₄ + ZnSO₄ (V₂S₂M₄), while the shorter panicle was recorded with cv. BPT 5204 irrespective of seed rate and micronutrient application (V₃S₁₋₃ M₁₋₄ – 17.6 to 19.8).

4.1.1.2.5 Unfilled grains per panicle (no.) (c.f. Table 46)

Again significant variations occurred in unfilled grains due to main effects of factors and their interactions except main effects due to seed rates during both the years and on pooled basis as well.

Of the three cultivars used, cv. BPT 5204 (V₃) recorded significantly higher unfilled grains per panicle (21.3) while lower unfilled grains (7.6) were recorded with cv. MTU 1010 (V₂). Among micronutrient application, significantly higher unfilled grains (15.5) were recorded with no supplementation of micronutrient (M₁) whereas lower count (12.4) was recorded with combined application (FeSO₄ + ZnSO₄) (M₄).

Among two-way interactions, effects due to variety and seed rates were significant wherein cv. BPT 5204 at seed sown with 30 kg ha⁻¹ (V₃S₂) recorded significantly higher unfilled grains (22.0), V₁S₃ was at par, while cv. MTU 1010 with lower seed rate (V₂S₁) recorded significantly lower unfilled grains (6.7). Variety x micronutrient interaction revealed significantly higher unfilled grains (23.3) with cv. BPT 5204 with no application of micronutrient (V₃M₁), while cv. MTU 1010 with combined application (FeSO₄ + ZnSO₄) (V₂M₄) recorded lower unfilled grains (6.0).

Table 46. Effect of genotypes, seed rates and micronutrients unfilled grains panicle⁻¹ at harvest under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	17.3 ^c	7.8 ^{h-j}	30.5 ^a	18.5 ^a	12.3 ^{ef}	10.0 ^{fg}	16.4 ^{a-c}	12.9 ^{ab}	14.8 ^g	8.9 ^{l-n}	23.5 ^{ab}	15.7 ^a
	M ₂	17.1 ^c	5.3 ^{jk}	27.3 ^b	16.6 ^{bc}	12.0 ^{ef}	8.5 ^g	12.5 ^{-f}	11.0 ^{c-e}	14.6 ^{gh}	6.9 ^{no}	19.9 ^{d-f}	13.8 ^{c-e}
	M ₃	13.7 ^{de}	3.6 ^k	25.7 ^b	14.3 ^{de}	11.8 ^{ef}	7.3 ^g	13.5 ^{c-e}	10.9 ^{de}	12.7 ^{g-i}	5.4 ^o	19.6 ^{ef}	12.6 ^{ef}
	M ₄	13.8 ^d	3.1 ^k	25.0 ^b	14.0 ^e	11.5 ^{ef}	7.9 ^g	11.8 ^{ef}	10.4 ^e	12.7 ^{g-i}	5.5 ^o	18.4 ^f	12.2 ^f
S ₂	M ₁	10.7 ^{e-h}	10.2 ⁻ⁱ	30.1 ^a	17.0 ^{a-c}	14.4 ^{b-e}	9.7 ^{fg}	17.3 ^{ab}	13.8 ^a	12.5 ^{ah-j}	9.9 ^{k-m}	23.7 ^a	15.4 ^{ab}
	M ₂	9.2 ^{hi}	9.5 ^{g-i}	27.1 ^b	15.3 ^{c-e}	13.7 ^{c-e}	8.4 ^g	16.9 ^{ab}	13.0 ^{ab}	11.5 ^{-i-k}	9.0 ^{l-m}	22.0 ^{a-d}	14.2 ^{cd}
	M ₃	9.1 ^{hi}	5.7 ^{jk}	26.1 ^b	13.6 ^e	12.2 ^{e-f}	8.3 ^g	16.9 ^{ab}	12.5 ^{a-d}	10.7 ^{kj}	7.0 ^{no}	21.5 ^{b-e}	13.1 ^{d-f}
	M ₄	7.5 ^{ij}	3.5 ^k	25.0 ^b	12.0 ^f	13.1 ^{de}	7.6 ^g	16.7 ^{ab}	12.5 ^{a-d}	10.3 ^{kj}	5.5 ^o	20.9 ^{c-e}	12.2 ^f
S ₃	M ₁	13.4 ^{d-f}	12.3 ^{d-g}	27.1 ^b	17.5 ^{ab}	13.2 ^{de}	8.3 ^g	18.2 ^a	13.2 ^{ab}	13.2 ^{g-i}	10.0 ^{kl}	22.7 ^{a-c}	15.4 ^{ab}
	M ₂	12.7 ^{d-f}	8.9 ^{hi}	27.1 ^b	16.2 ^{bc}	13.3 ^{de}	7.1 ^g	17.3 ^{ab}	12.6 ^{a-c}	13.0 ^{g-i}	8.0 ^{mn}	22.2 ^{a-c}	14.4 ^{bc}
	M ₃	12.6 ^{d-f}	7.7 ^{hi}	27.0 ^b	15.8 ^{b-d}	12.6 ^{d-f}	7.3 ^g	15.4 ^{a-d}	11.8 ^{b-e}	12.6 ^{h-j}	7.5 ^{no}	21.5 ^{b-e}	13.9 ^{c-e}
	M ₄	7.5 ^{ij}	3.5 ^k	25.0 ^b	12.0 ^{de}	11.4 ^{ef}	7.3 ^g	14.3 ^{b-e}	11.0 ^{c-e}	11.3 ^{i-k}	7.0 ^{no}	19.9 ^{d-f}	12.7 ^{ef}
Variety		12.0 ^b	6.8 ^c	26.9 ^a		12.6 ^b	8.1 ^c	15.6 ^a		12.5 ^b	7.6 ^c	21.3 ^a	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	15.5 ^b	4.9 ^f	27.1 ^a	15.8 ^a	11.9 ^b	8.4 ^c	13.5 ^b	11.3 ^a	13.7 ^c	6.7 ^f	20.3 ^b	13.6 ^a
	S ₂	9.1 ^d	7.2 ^e	27.1 ^a	14.5 ^b	13.4 ^b	8.5 ^c	16.9 ^a	12.9 ^a	11.2 ^d	7.9 ^{ef}	22.0 ^a	13.7 ^a
	S ₃	12.4 ^c	8.9 ^d	26.7 ^a	16.0 ^a	12.6 ^b	7.5 ^c	16.3 ^a	12.1 ^a	12.5 ^c	8.2 ^e	21.5 ^{ab}	14.1 ^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	13.7 ^d	10.1 ^g	29.2 ^a	17.7 ^a	13.3 ^{cd}	9.3 ^e	17.3 ^a	13.3 ^a	13.5 ^d	9.7 ^g	23.3 ^a	15.5 ^a
	M ₂	13.0 ^{de}	7.9 ^h	7.2 ^b	16.0 ^b	13.0 ^{cd}	8.0 ^{ef}	15.6 ^b	12.2 ^b	13.0 ^{dee}	8.0 ^h	21.4 ^b	14.1 ^b
	M ₃	11.8 ^{ef}	5.7 ⁱ	26.2 ^{bc}	14.6 ^c	12.2 ^{de}	7.6 ^f	15.3 ^b	11.7 ^b	12.0 ^{ef}	6.6 ^{hi}	20.8 ^{bc}	13.1 ^c
	M ₄	10.9 ^{fg}	4.1 ^a	25.2 ^c	13.5 ^d	12.0 ^d	7.6 ^f	14.3 ^{bc}	11.3 ^b	11.4 ^f	6.0 ⁱ	19.7 ^c	12.4 ^d
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.3				0.2				0.1			
Seed (S)		0.3				0.5				0.2			
Micro (M)		0.3				0.3				0.4			
V x S		0.5				0.9				0.2			
V x M		0.6				0.5				0.4			
S x M		0.6				0.5				0.4			
V x S x M		1.0				0.9				0.7			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Similarly, in seed rate x micronutrient combinations, lower seed rate and no micronutrient (S_1M_1) recorded significantly higher unfilled grains (15.7) and it was on par with M_1S_{2-3} , while significantly lower values (12.2 each) were obtained with medium and higher seed rates and combined application of micronutrient (S_2M_4 and S_3M_4).

V x S x M revealed significantly higher unfilled grains (23.7) with cv. BPT 5204 sown using 30 kg seed rate and provided with no micronutrients ($V_3S_2M_1$), while the lower unfilled grains (5.5) occurred with cv. MTU 1010 sown using 30 kg ha⁻¹ seed rate and supplied both the micronutrient micro nutrient ($V_2S_2M_4$) among all.

4.1.1.2.6 Filled grains per panicle (no.) (c.f. Table 47 and Fig. 7a)

Significant differences were noticed in filled grains data due to cultivars, seed rates and use of micronutrients and their interactions during both the years and on pooled basis as well.

Among the varieties, cv. MTU 1010 (V_2) recorded significantly higher filled grains (93.2) followed by cvs. GGV 0501 (V_1) and BPT 5204(V_3) (89.4 and 79.8, respectively) and among seed rates higher filled grains (89.9) were recorded with of 30 kg ha⁻¹ seed rate (S_2); filled grains decreased both with lower or higher seed rate (S_1 and S_3) and both were at par. Similarly, use of micronutrients produced significant variations and combined application ($FeSO_4 + ZnSO_4$) to soil and to the foliage (M_4) resulted in higher filled grains (102.8), while no application of micronutrient (M_1) recorded significantly lesser filled grains (71.5).

All the two-way interactions were significant, and among variety X seed rate higher filled grains (98.8) were recorded with cv. MTU 1010 at 30 kg ha⁻¹ seed rate (V_2S_2); while the lower number of filled grains was recorded with cv. BPT 5204 particularly with higher seed rate of 35kg ha⁻¹(V_3S_3) (78.3). In variety X micronutrient, cv. MTU 1010 with combined application of $FeSO_4 + ZnSO_4$ (V_2M_4) rerecorded higher filled grains (108.6) while cv. BPT 5204 (V_3M_1) had lower count of filled grains (62.4). Similarly, in micronutrients X seed rates 30 kg seed rate with the application of $FeSO_4 + ZnSO_4$ (S_2M_4) recorded higher filled grains (109.2) while no supply of micronutrient with 25 kg seed rate (S_1M_1) recorded lower filled grains (69.1).

The three way interaction also revealed significant variations. Higher filled grains (115.8) were observed with cv. MTU 1010 sown using 30 kg seed rate and applied with

Table 47. Effect of genotypes, seed rates and micronutrients on filled grains panicle⁻¹ at harvest under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	78.6 ^{l-o}	73.3 ^{op}	74.5 ^{no}	75.5 ^h	65.3 ^{j-m}	71.1 ^{h-l}	51.8 ^m	62.7 ^e	72.0 ^{n-p}	72.2 ^{n-p}	63.2 ^{qr}	69.1 ^f
	M ₂	90.5 ^{i-j}	87.5 ^{j-m}	85.2 ^{k-n}	87.7 ^{fg}	75.0 ^{g-l}	81.0 ^{f-i}	77.0 ^{g-l}	77.7 ^d	82.7 ^{i-m}	84.3 ^{h-m}	81.1 ^{j-m}	82.7 ^e
	M ₃	93.5 ^{h-k}	117.6 ^{cd}	92.1 ^{i-k}	101.cd ^a	77.4 ^{g-k}	6.5 ^{a-e}	79.8 ^{f-j}	84.6 ^{b-d}	85.5 ^{h-m}	107.1 ^{bc}	85.9 ^{h-m}	92.8 ^{cd}
	M ₄	97.5 ^{g-j}	118.5 ^{b-d}	86.4 ^{j-m}	100.8 ^c	86.9 ^{b-g}	98.0 ^{a-c}	82.8 ^{d-h}	89.2 ^{a-c}	92.2 ^{f-h}	108.3 ^{a-c}	90.9 ^{f-l}	97.1 ^c
S ₂	M ₁	77.1 ^{m-o}	89.1 ^{i-l}	63.8 ^{pq}	76.7 ^h	65.2 ^{j-m}	80.8 ^{f-i}	63.8 ^{k-m}	69.9 ^e	71.2 ^{a-g}	84.9 ^{h-m}	63.8 ^{q-r}	73.3 ^f
	M ₂	83.9 ^{k-o}	93.4 ^{b-k}	78.4 ^{l-o}	85.2 ^g	73.7 ^{ag-l}	84.9 ^{b-h}	76.4 ^{g-l}	78.3 ^d	78.8 ^{l-o}	89.2 ^{f-k}	77.4 ^{m-o}	81.8 ^e
	M ₃	111.8 ^{de}	110.7 ^{d-e}	88.1 ^{i-m}	103.c ^a	80.2 ^{f-i}	99.4 ^{ab}	81.9 ^{e-i}	87.2 ^{bc}	96.0 ^{e-g}	105.1 ^{cd}	85.0 ^{h-m}	95.4 ^c
	M ₄	132.1 ^a	128.8 ^{ab}	107.1 ^{d-g}	122.7 ^a	97.3 ^{a-d}	102.9 ^a	87.0 ^{b-g}	95.7 ^a	114.7 ^{ab}	115.8 ^a	97.1 ^{d-f}	109.2 ^a
S ₃	M ₁	93.9 ^{ah-k}	76.3 ^{m-o}	58.3 ^q	76.2 ^h	73.9 ^{g-l}	67.1 ^{i-l}	62.0 ^{j-m}	67.7 ^e	83.9 ^{h-m}	71.7 ^{o-q}	60.1 ^r	71.9 ^f
	M ₂	99.5 ^{f-i}	91.7 ^{j-k}	83.2 ^{k-o}	91.5 ^{ef}	80.9 ^{f-i}	82.7 ^{d-h}	70.3 ^{h-l}	78.0 ^d	90.2 ^{f-i}	87.2 ^{g-l}	76.7 ^{m-o}	84.7 ^e
	M ₃	108.d-g ^a	93.7 ^{b-k}	86.4 ^{j-m}	96.1 ^{de}	83.3 ^{c-h}	89.1 ^{-g^a}	75.3 ^{g-l}	82.6 ^{cd}	95.8 ^{e-g}	91.4 ^{f-i}	80.8 ^{k-n}	89.3 ^d
	M ₄	123.8 ^{a-c}	110.0 ^{d-e}	103.9 ^{e-h}	112.6 ^b	94.7 ^{a-f}	93.2 ^{a-f}	86.7 ^{b-g}	91.5 ^{ab}	109.2 ^{a-c}	101.6 ^{c-e}	95.3 ^{e-g}	102.0 ^b
Variety		99.2 ^a	99.2 ^a	84.0 ^b		79.5 ^{ab}	87.2 ^a	74.6 ^b		89.4 ^b	93.2 ^a	79.8 ^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	90.0 ^{de}	99.2 ^{bc}	87.7 ^{d-f}	92.3 ^b	76.1 ^{de}	86.7 ^b	72.8 ^e	78.5 ^b	83.1 ^e	92.9 ^{bc}	80.3 ^{ef}	85.4 ^b
	S ₂	101.2 ^{ab}	105.5 ^{ab}	84.4 ^{ef}	97.0 ^a	79.1 ^{cd}	92.0 ^a	77.3 ^{de}	82.8 ^a	90.2 ^{cd}	98.8 ^a	80.8 ^{ef}	89.9 ^a
	S ₃	106.3 ^a	92.9 ^{cd}	82.9 ^f	94.0 ^{ab}	83.2 ^{bc}	83.0 ^{bc}	73.6 ^e	79.9 ^b	94.9 ^{ab}	88.0 ^d	78.3 ^f	87.1 ^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	83.2 ^{de}	79.6 ^e	65.5 ^f	76.1 ^d	68.0 ^e	73.0 ^{de}	59.2 ^f	66.7 ^d	75.7 ^e	76.3 ^e	62.4 ^e	71.5 ^d
	M ₂	91.3 ^c	90.9 ^d	82.3 ^e	88.2 ^c	76.5 ^{cd}	82.9 ^{c-e}	74.6 ^{de}	78.0 ^c	83.9 ^d	86.9 ^d	78.4 ^f	83.1 ^c
	M ₃	104.5 ^b	107.3 ^b	88.8 ^{cd}	100.2 ^b	80.3 ^{b-d}	95.0 ^a	79.0 ^{b-d}	84.8 ^b	92.4 ^c	101.2 ^b	83.9 ^d	92.5 ^b
	M ₄	117.8 ^a	119.1 ^a	103.3 ^b	113.4 ^a	93.0 ^a	98.0 ^a	85.5 ^d	92.2 ^a	105.4 ^{ab}	108.6 ^a	94.4 ^c	102.8 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		2.2				2.1				0.7			
Seed (S)		1.2				0.9				0.8			
Micro (M)		2.1				1.5				0.9			
V x S		1.2				1.6				1.4			
V x M		2.0				2.6				1.6			
S x M		2.0				2.6				1.6			
V x S x M		3.5				4.5				2.8			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

FeSO₄ + ZnSO₄ (V₂S₂M₄) followed by cv. GGV 0501 with similar combination (V₁S₂M₄ - 114.7), while lower filled grains (60.1) occurred with cv. BPT 5204 sown using 35kg ha⁻¹ seed rate and supplied with no micronutrient (V₃S₃ M₁) among all.

4.1.1.2.7 Total grains per panicle (no.) (c.f. Table 48)

Total grains per panicle varied significantly due to cultivars, seed rates and use of micronutrients and their interactions during both the years and on pooled basis as well.

Among all cultivars, cv. GGV 0501 recorded significantly higher grains per panicle (101.8), while lower number of grains (100 and 101.1, respectively) was recorded with cvs. MTU 1010 and BPT 5204; among seed rates higher grains count (103.6) were recorded with medium seed rate of 30 kg ha⁻¹ and it was at par with higher seed rate (S₃), grains per panicle decreased with lower seed rate (S₁) and among micronutrient application, significantly higher grains (115.2) were recorded with combined supplementation of micronutrient (M₄) while lower count (86.9) was recorded with no application of micronutrient (M₁).

Interactions due to variety and seed rates were significant wherein cvs. GGV 0501(V₁) and MTU 1010 (V₂) sown with 30 kg ha⁻¹ recorded significantly higher total grains (107.3 and 106.6, respectively), V₁S₂ was at par, while cv. GGV 0501 (V₁) with lower seed rate (S₁) recorded significantly lower grains (96.8). Variety x micronutrient combinations revealed significantly higher grains (116.8) with cv. GGV 0501 supplied with both the micronutrients (V₁M₄), while no micronutrient recorded lower grains in all cultivars (V₁₋₃M₁). Similarly, seed rate x micronutrient revealed significant differences wherein medium seed rate with combined supplementation of micronutrient (S₂M₄) recorded significantly higher total grain count (121.4) while significantly lower count was recorded with no application of micronutrients irrespective of seed rates used (S₁₋₃M₁).

The three way interaction revealed significantly higher grains with cvs. GGV 0510 and MTU 1010 sown with 30 kg seed rate and applied with FeSO₄ + ZnSO₄ (V₁₋₂S₂M₄) (125.0 and 121.4, respectively), while the lower total grain count (81.1) was recorded with cv. MTU 1010 sown using 25 kg ha⁻¹ seed rate and supplied with no micronutrient (V₂S₁M₁).

Table 48. Effect of genotypes, seed rates and micronutrients total grains panicle⁻¹ at harvest under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	95.9 ^{k-o}	81.1 ^p	105.0 ^{b-m}	94.0^f	77.5 ^{b-j}	81.1 ^{f-j}	68.2 ^j	75.6^f	86.7 ^{p-s}	81.1 ^s	86.6 ^{p-s}	84.8^g
	M ₂	107.6 ^{f-k}	92.8 ^{m-p}	112.4 ^{e-j}	104.e^a	87.0 ^{e-i}	89.5 ^{d-i}	89.4 ^{d-i}	88.6^{cd}	97.3 ^{k-o}	91.1 ^{n-q}	100.9 ⁱ⁻ⁿ	96.4^f
	M ₃	107.2 ^{g-l}	121.2 ^{c-g}	117.7 ^{d-h}	115.c^a	89.2 ^{d-i}	103.8 ^{a-d}	93.2 ^{b-g}	95.4^{bc}	98.2 ^{j-o}	112.5 ^{c-f}	106.5 ^{pq}	105.7^{cd}
	M ₄	111.4 ^{e-j}	121.6 ^{b-f}	124.0 ^{b-e}	119.c^a	98.3 ^{a-e}	105.9 ^{a-c}	103.7 ^{a-d}	102.6^b	104.9 ^{f-j}	113.8 ^{b-f}	109.3 ^{d-h}	109.3^c
S ₂	M ₁	87.8 ^{n-p}	99.3 ^{j-n}	93.9 ^{k-p}	93.7^f	79.6 ^{j-i}	90.5 ^{d-c}	81.1 ^{f-j}	83.7^{de}	83.7 ^{q-s}	94.9 ^{m-p}	87.5 ^{p-s}	88.7^g
	M ₂	93.1 ^{l-p}	103.0 ^{t-m}	105.6 ^{b-g}	100.ef^a	87.4 ^{e-i}	93.3 ^{a-g}	93.3 ^{b-j}	91.3^{cd}	90.3 ^g	98.2 ^{j-o}	99.0 ^{j-o}	95.8^f
	M ₃	120.9 ^{c-g}	101.5 ^{j-n}	113.4 ^{c-j}	111.9^c	92.4 ^{b-h}	107.7 ^{ab}	98.7 ^{a-c}	99.6^b	106.7 ^{e-j}	112.0 ^{c-g}	106.5 ^{e-k}	108.4^c
	M ₄	139.5 ^a	132.3 ^{a-c}	132.1 ^{a-c}	134.6^a	110.5 ^a	110.5 ^a	103.7 ^{a-d}	108.2^a	125.0 ^a	121.4 ^{ab}	117.9 ^{a-d}	121.4^a
S ₃	M ₁	107.0 ^{g-l}	88.6 ^{em-p}	85.4 ^{op}	93.7^f	87.1 ^{e-i}	75.3 ^{ij}	80.2 ^{g-i}	80.9^{ef}	97.1 ^{l-o}	82.0 ^{rs}	82.8 ^{q-s}	87.3^a
	M ₂	112.2 ^{e-j}	100.j-n	110.3 ^{e-j}	107.dc^a	94.2 ^{b-g}	89.9 ^{d-i}	87.6 ^{e-i}	90.6^{cd}	103.2 ^{g-m}	95.5 ^{m-p}	99.0 ^{j-o}	99.2^{c-f}
	M ₃	120.8 ^{c-g}	101.5 ^{j-n}	113.4 ^{c-j}	111.9^{cd}	95.9 ^{a-f}	96.5 ^{a-f}	90.8 ^{c-h}	94.4^{bc}	108.3 ^{e-i}	99.0 ^{j-c}	102.1 ^{s-m}	103.1^{de}
	M ₄	135.0 ^b	116.8 ^{d-i}	129.4 ^{a-d}	127.1^b	106.1 ^{a-c}	100.5 ^{a-e}	101.0 ^{a-e}	102.5^{ab}	120.5 ^{a-c}	108.6 ^{e-i}	115.2 ^{b-e}	114.8^b
Variety		111.5^a	105.0^b	111.9^a		92.1^a	95.4^a	90.9^a		101.8^a	100.8^b	101.1^b	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	105.5 ^{c-e}	104.2 ^{de}	114.8 ^{ab}	108.2^a	88.0 ^{cd}	95.1 ^{ab}	86.4 ^d	89.8^b	96.8 ^c	99.6 ^{bc}	100.6 ^{bc}	99.0^b
	S ₂	110.3 ^{b-d}	112.7 ^{a-c}	111.4 ^{b-d}	111.5^a	92.5 ^{bc}	100.5 ^{bc}	94.2 ^d	95.7^a	101.4 ^{bc}	106.6 ^a	102.8 ^{ab}	103.6^a
	S ₃	118.8 ^a	101.9 ^e	109.6 ^{b-d}	110.1^a	95.9 ^{ab}	90.5 ^{b-d}	89.9 ^{b-d}	92.1^b	107.3 ^a	96.2 ^c	99.7 ^{bc}	101.1^{ab}
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	96.9 ^{ef}	89.7 ^f	94.8 ^{ef}	93.8^d	81.4 ^e	82.3 ^{de}	76.5 ^e	80.1^d	89.2 ^e	86.0 ^e	85.6 ^e	86.9^d
	M ₂	104.cd ^a	98.8 ^{de}	109.4 ^{bc}	104.2^c	89.5 ^{cd}	90.9 ^c	90.1 ^c	90.2^c	96.9 ^{cd}	94.8 ^d	99.8 ^c	97.2^a
	M ₃	116.3 ^b	113.0 ^b	115.1 ^b	114.8^b	92.5 ^{bc}	102.7 ^a	94.2 ^{bc}	96.5^b	104.4 ^b	107.8 ^b	104.7 ^b	105.6^b
	M ₄	128.6 ^a	123.6 ^a	128.5 ^a	126.9^a	105.0 ^a	105.6 ^a	99.8 ^{ab}	103.5^a	116.8 ^a	114.6 ^a	114.1 ^a	115.2^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		2.2				2.1				0.8			
Seed (S)		1.2				1.0				0.9			
Micro (M)		1.2				1.5				0.9			
V x S		2.1				1.8				1.6			
V x M		2.0				2.6				1.6			
S x M		2.0				2.6				1.6			
V x S x M		3.5				4.5				2.8			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

4.1.1.2.8 Sterility percentage (%) (c.f. Table 49 and Fig. 7b)

Data on sterility percentage revealed significant variations due to cultivars, and use of micronutrients and their interactions except seed rates during both the years and on pooled basis as well.

Of the three cultivars, cv. BPT 5204 recorded significantly higher sterility percentage (19.7) while lower sterility percentage (8.9) was recorded with cv. MTU 1010. Among micronutrient levels, significantly higher sterility percentage (17.3) was recorded when micronutrients were not applied (M_1) while lower (11.2) spikelet sterility was recorded with combined application of $FeSO_4 + ZnSO_4$ (M_4).

Cv. BPT 5204 at 30 and 35 kg ha⁻¹ among variety and seed rates recorded significantly higher spikelet sterility percentage (20.3 and 20.2, respectively) while lower sterility percentages were recorded with cv. MTU 1010 irrespective of seed rates (V_2S_{1-3}). In variety x micronutrient, cv. BPT 5204 with no application of micronutrient (V_3M_1) recorded significantly higher sterility percentage (24.6), while cv. MTU 1010 with combined application of $FeSO_4$ and $ZnSO_4$ (V_2M_4) recorded lower sterility percentage (6.6). Similarly, seed rate x micronutrient application revealed significant differences wherein all the seed rates with no supplementation of micronutrient ($S_{1-3}M_1$) recorded significantly higher sterility percentage (16.8 to 17.9), while lower grain sterility (10.8) occurred with lower seed rate and combined application of micronutrients (S_1M_4).

Among V x S x M combinations, significantly higher sterility percentage was recorded with cv. BPT 5204 sown using 25 and 30 kg seed rates and not supplied with micronutrients ($V_3S_1M_1$ and $V_3S_2M_1$, 25.6 and 24.2, respectively), while lower sterility percentage (5.9) was recorded with cv. MTU 1010 sown using 30 kg ha⁻¹ seed rate and supplied with both the micronutrients ($V_2S_2M_4$).

4.1.1.2.9 Test weight or 1000 grain weight (g) (c.f. Table 50)

Among the varieties, cv. MTU 1010 (V_2) recorded significantly higher test weight (24.9) followed by cvs. GGV 0501 and BPT 5204 (23.9 and 19.6, respectively); among seed rates higher test weight (23.3 and 23.0, respectively) was recorded with the seed rates of 30 (S_2) and 35 kg ha⁻¹ (S_3), and of the micronutrient levels combined application $FeSO_4 + ZnSO_4$ to soil and to the foliage (M_4) resulted in higher test weight

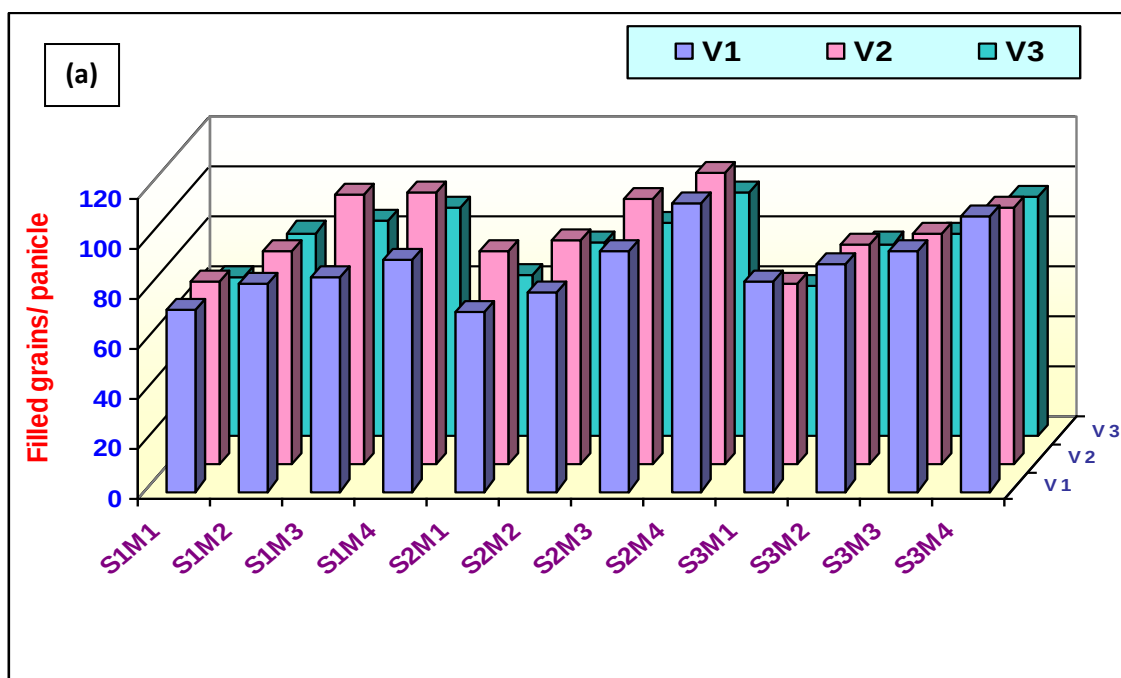
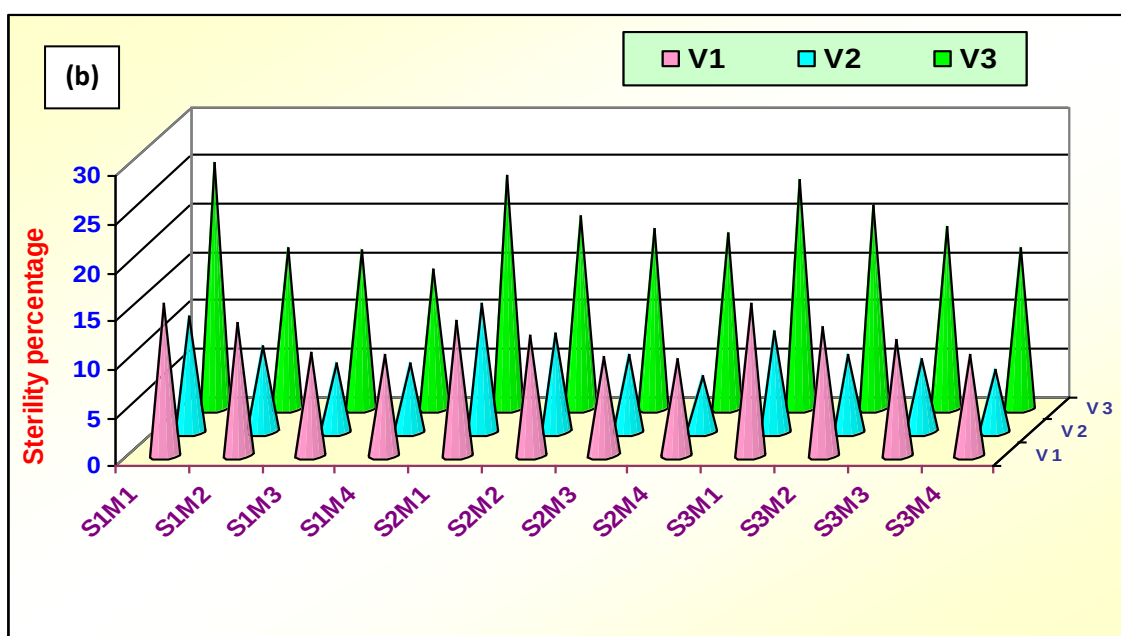


Fig. 10. Effect of genotypes, seed rates and micronutrients on filled grains panicle⁻¹ at harvest under direct seeded condition during rainy



LEGEND

Varieties: V₁- GGV 0501, V₂- MTU 1010, V₃- BPT 5204;
 Seed Rate: S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
 Micronutrient: M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₄- FeSO₄ + ZnSO₄ (Each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

Fig. 7. Effect of genotypes, seed rates and micronutrients on (a) filled grains per panicle and (b) sterility percentage at arvest under direct seeded condition during rainy season

Table 49. Effect of genotypes, seed rates and micronutrients sterility percentage at harvest under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	18.0 ^{gh}	10.1 ^{j-m}	29.4 ^{ab}	19.2 ^a	15.8 ^{d-h}	12.4 ^{g-k}	24.1 ^a	17.4 ^a	15.9 ^{d-f}	12.2 ^{g-k}	25.6 ^a	17.9 ^a
	M ₂	16.1 ^{hi}	5.8 ^{n-p}	24.4 ^{cb}	15.4 ^b	13.8 ^{f-j}	9.5 ^{j-n}	14.0 ^{e-i}	12.4 ^{b-d}	13.8 ^{e-h}	9.1 ^{k-o}	16.9 ^{de}	13.3 ^{bc}
	M ₃	12.8 ^{i-k}	2.9 ^p	21.9 ^{d-g}	12.5 ^{cd}	13.3 ^{f-k}	7.0 ⁿ	14.4 ^{e-i}	11.6 ^{cd}	10.8 ^{h-l}	7.3 ^{m-p}	16.5 ^{d-f}	1.5 ^{c-e}
	M ₄	12.5 ^{i-l}	2.6 ^p	20.2 ^{e-g}	11.8 ^d	11.7 ^{h-m}	7.5 ^{mn}	12.5 ^{g-k}	10.6 ^d	10.5 ^{i-m}	7.2 ^{n-p}	14.7 ^{e-g}	10.8 ^e
S ₂	M ₁	12.3 ^{i-l}	10.6 ^{j-m}	32.2 ^a	18.4 ^a	18.2 ^{c-e}	10.7 ⁱ⁻ⁿ	21.3 ^{a-c}	16.7 ^a	14.0 ^{e-g}	13.4 ^{f-i}	24.2 ^a	17.2 ^a
	M ₂	10.1 ^{j-m}	9.4 ^{k-n}	26.0 ^{bc}	15.2 ^b	15.7 ^{d-h}	9.0 ^{k-n}	18.2 ^{c-e}	14.3 ^b	12.6 ^{g-i}	10.3 ⁱ⁻ⁿ	20.2 ^c	14.4 ^b
	M ₃	7.6 ^o	4.9 ^{op}	22.9 ^{c-f}	11.8 ^d	13.2 ^{f-k}	7.7 ⁱ⁻ⁿ	17.1 ^{d-f}	12.7 ^{b-d}	10.3 ⁱ⁻ⁿ	8.0 ^p	18.7 ^{cd}	12.3 ^{c-e}
	M ₄	5.5 ^{o-p}	2.6 ^p	19.1 ^{f-h}	9.1 ^e	11.8 ^{h-l}	6.9 ⁿ	16.3 ^{d-g}	11.7 ^{cd}	10.0 ⁱ⁻ⁿ	5.9 ^p	18.3 ^{cd}	11.4 ^{de}
S ₃	M ₁	12.3 ^{i-j}	14.1 ^{i-j}	32.1 ^a	19.5 ^a	15.5 ^{e-b}	11.0 ⁱ⁻ⁿ	23.0 ^{ab}	16.5 ^a	15.9 ^{d-f}	10.1 ^{i-l}	23.9 ^{ab}	6.8 ^a
	M ₂	11.4 ^{i-m}	9.1 ^{k-n}	25.0 ^{cda}	15.6 ^a	14.1 ^{e-i}	7.9 ⁱ⁻ⁿ	19.8 ^{b-d}	13.9 ^{bc}	13.4 ^{f-i}	8.2 ^{i-p}	21.2 ^{bc}	14.3 ^b
	M ₃	10.4 ^{i-m}	8.0 ^{n-o}	24.1 ^{c-e}	14.6 ^a	13.1 ^{f-k}	7.6 ⁱ⁻ⁿ	17.0 ^{d-f}	12.6 ^{b-d}	12.2 ^{g-k}	7.8 ^{i-p}	18.9 ^{cd}	13.0 ^{b-d}
	M ₄	8.4 ^{l-o}	5.9 ^{n-p}	19.8 ^{f-h}	11.4 ^d	10.7 ⁱ⁻ⁿ	7.3 ⁿ	14.2 ^{e-i}	10.7 ^d	10.5 ^{i-m}	6.6 ^{op}	16.8 ^{de}	11.3 ^{de}
Variety		11.5 ^b	7.2 ^c	24.8 ^a		13.9 ^b	8.7 ^c	17.7 ^a		12.5 ^b	8.9 ^c	19.7 ^a	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	14.9 ^b	5.3 ^d	23.9 ^a	14.7 ^a	13.6 ^b	9.1 ^c	16.3 ^{ab}	13.0 ^a	12.8 ^c	9.0 ^d	18.4 ^b	13.4 ^a
	S ₂	8.9 ^c	6.9 ^d	25.0 ^a	13.6 ^b	14.7 ^b	8.6 ^c	18.3 ^a	13.9 ^a	11.8 ^c	9.4 ^d	20.3 ^a	13.8 ^a
	S ₃	10.6 ^c	9.3 ^c	25.3 ^a	15.1 ^a	1.4 ^a	8.5 ^a	18.5 ^a	9.5 ^b	13.0 ^c	8.3 ^d	20.2 ^a	13.8 ^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	14.2 ^e	11.6 ^{fg}	31.2 ^a	19.0 ^a	16.5 ^{bc}	11.4 ^e	22.8 ^a	16.9 ^a	15.3 ^d	12.1 ^{ef}	24.6 ^a	17.3 ^a
	M ₂	12.5 ^{ef}	8.1 ⁱ	25.1 ^b	15.2 ^b	14.5 ^{cd}	8.8 ^f	17.3 ^b	13.5 ^b	13.3 ^e	9.2 ^{hi}	19.4 ^b	14.0 ^b
	M ₃	10.3 ^{gh}	5.3 ^j	23.0 ^c	12.9 ^c	13.2 ^{de}	7.5 ^f	16.2 ^{bc}	12.3 ^b	11.1 ^{fg}	7.7 ^{ij}	18.0 ^{bc}	12.3 ^c
	M ₄	8.8 ^{hi}	3.7 ^j	19.7 ^d	10.7 ^d	11.4 ^e	7.2 ^f	14.3 ^{cd}	11.0 ^c	10.4 ^{gh}	6.6 ^j	16.6 ^{cd}	11.2 ^d
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.3				0.3				0.3			
Seed (S)		0.3				0.5				0.3			
Micro (M)		0.4				0.4				0.3			
V x S		0.6				0.8				0.6			
V x M		0.7				0.7				0.6			
S x M		0.7				0.7				0.6			
V x S x M		1.3				1.3				1.0			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 50. Effect of genotypes, seed rates and micronutrients 1000- grain weight (Test weight) (g) at harvest under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	19.9 ^{g-i}	22.2 ^{b-h}	20.3 ^{f-i}	20.8^d	20.9 ^{b-g}	24.8 ^a	16.8 ^h	20.8^b	20.4 ^{f-j}	23.1 ^{b-e}	18.6 ^{jk}	20.7^d
	M ₂	22.7 ^{a-h}	22.3 ^{a-h}	20.5 ^{e-i}	21.8^{cd}	22.3 ^{a-f}	23.1 ^{a-d}	18.5 ^{gh}	21.3^{ab}	22.5 ^{c-h}	22.7 ^{c-g}	19.5 ^{i-k}	21.6^{cd}
	M ₃	22.8 ^{a-h}	24.7 ^{a-c}	20.6 ^{e-i}	22.7^{a-d}	23.0 ^{a-d}	23.4 ^{a-c}	19.7 ^{d-h}	22.0^{ab}	22.9 ^{b-f}	24.0 ^{a-c}	20.2 ^{g-k}	22.4^{bc}
	M ₄	24.8 ^{a-e}	25.8 ^{ab}	20.7 ^{d-i}	23.8^{a-c}	24.7 ^{ab}	24.4 ^{ab}	19.2 ^{e-h}	22.8^{ab}	24.7 ^{a-c}	25.1 ^{a-c}	20.0 ^{h-k}	23.3^{ab}
S ₂	M ₁	24.5 ^{a-c}	24.6 ^{a-f}	19.6 ^{hi}	22.9^{a-d}	22.8 ^{a-c}	25.2 ^a	17.9 ^{gh}	22.0^{ab}	23.6 ^{a-d}	24.9 ^{a-c}	18.8 ^{jk}	22.4^{bc}
	M ₂	25.0 ^{a-d}	25.1 ^{a-c}	21.3 ^{c-i}	23.8^{a-c}	23.9 ^{a-c}	24.4 ^{ab}	18.7 ^{f-h}	22.3^{ab}	24.5 ^{a-c}	24.8 ^{a-c}	20.0 ^{h-k}	23.1^{ab}
	M ₃	25.3 ^{a-c}	25.4 ^{a-c}	21.6 ^{c-i}	24.1^{a-c}	24.1 ^{a-c}	24.6 ^{ab}	19.3 ^{e-h}	22.7^{ab}	24.7 ^{a-c}	25.0 ^{a-c}	20.5 ^{af-i}	23.4^b
	M ₄	25.8 ^{ab}	26.6 ^a	22.1 ^{b-i}	24.8^a	25.2 ^a	25.5 ^a	19.6 ^{dh}	23.4^{ab}	25.5 ^{ab}	26.0 ^a	20.8 ^{e-j}	24.1^a
S ₃	M ₁	24.3 ^{a-f}	24.0 ^{a-g}	17.9 ⁱ	22.1^{c-d}	23.8 ^{a-c}	24.4 ^{ab}	17.4 ^{gh}	21.8^{ab}	24.1 ^{a-c}	24.2 ^{a-c}	17.7 ^k	22.6^{ab}
	M ₂	24.2 ^{a-g}	24.4 ^{a-f}	18.9 ^{hi}	22.5^{b-d}	24.3 ^{a-c}	25.0 ^a	17.7 ^{gh}	22.3^{ab}	24.3 ^{a-c}	24.7 ^{a-c}	18.3 ^{jk}	22.4^{b-d}
	M ₃	25.1 ^{a-c}	25.4 ^{a-c}	21.6 ^{b-i}	24.0^{a-c}	24.2 ^{a-c}	25.3 ^a	18.8 ^{f-h}	22.8^{ab}	24.6 ^{a-c}	25.2 ^{a-c}	19.2 ^{i-k}	23.0^{a-c}
	M ₄	25.5 ^{a-c}	25.4 ^{a-c}	22.2 ^{b-h}	24.4^{ab}	24.6 ^{ab}	25.6 ^a	20.5 ^{c-h}	22.8^{ab}	25.1 ^{a-c}	25.5 ^{ab}	21.4 ^{c-i}	24.0^a
Variety		24.2^a	24.7^a	20.6^b		23.7^a	24.6^a	18.7^b		23.9^a	24.9^a	19.6^b	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	22.6 ^{bc}	23.8 ^{ab}	20.6 ^{cd}	22.3^b	22.7 ^c	23.7 ^{bc}	18.5 ^d	21.6^b	22.6 ^c	23.7 ^{bc}	19.5 ^d	21.9^b
	S ₂	25.2 ^a	25.4 ^a	21.2 ^{cd}	23.9^a	24.0 ^{bc}	24.9 ^{ab}	18.9 ^d	22.6^a	24.6 ^{ab}	25.2 ^a	20.0 ^d	23.3^a
	S ₃	24.8 ^{ab}	24.7 ^{ab}	19.6 ^d	23.0^{ab}	24.2 ^{a-c}	25.9 ^a	18.6 ^d	22.9^a	24.5 ^{ab}	25.3 ^a	19.1 ^d	23.0^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	22.9 ^{cd}	23.6 ^{b-d}	19.3 ^f	21.9^c	22.5 ^b	24.5 ^{ab}	17.4 ^d	21.4^b	22.7 ^c	24.1 ^{bc}	18.3 ^f	21.7^c
	M ₂	24.0 ^{a-c}	23.9 ^{bc}	20.3 ^{ef}	22.7^{bc}	23.5 ^{ab}	24.2 ^{ab}	18.3 ^{cd}	22.0^d	23.7 ^{bc}	24.0 ^{bc}	19.3 ^{ef}	22.3^{bc}
	M ₃	24.4 ^{a-c}	25.1 ^{ab}	20.6 ^{ef}	23.4^{ab}	23.8 ^{ab}	24.4 ^{ab}	19.3 ^{cd}	22.5^{ab}	24.1 ^{bc}	24.7 ^{ab}	19.9 ^{de}	22.9^b
	M ₄	25.4 ^{ab}	25.9 ^a	21.7 ^{de}	24.3^a	24.8 ^a	25.2 ^a	19.8 ^c	23.3^a	25.1 ^{ab}	25.5 ^a	20.7 ^d	23.8^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.4				0.7				0.5			
Seed (S)		0.4				0.4				0.3			
Micro (M)		0.4				0.1				0.3			
V x S		0.7				0.6				0.4			
V x M		0.7				0.7				0.5			
S x M		0.7				0.7				0.5			
V x S x M		1.2				1.2				0.8			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

(23.8), while no application of micronutrient (M_1) recorded significantly lower test weight (21.7).

Interaction effects due to variety and seed rate were significant wherein cv. MTU 1010 at 35 and 30 kg ha⁻¹ seed rates (V_2S_3 and V_2S_2) recorded higher test weight (25.3 and 25.2, respectively); MTU 1010 and GGV 0510 were at par at 35 and 30 kg ha⁻¹ seed rates ($V_{1-2}S_{2-3}$), while lower test weight among all was recorded with cv. BPT 5204 irrespective of seed rates used particularly with higher seed rate of 35 kg ha⁻¹ (V_3S_3 -19.1). Cv. MTU 1010 with combined application of $FeSO_4 + ZnSO_4$ (V_2M_4) among variety X micronutrient rerecorded higher test weight (25.5) and it was at par with V_2M_3 and V_1M_4 . In the absence of micronutrient application test weight decreased irrespective of cultivars used and recorded lower test weight particularly with cv. BPT 5204 (V_3M_1) (21.7). Similarly, interaction due to seed rate and micronutrients were significant wherein 30 (S_2) and 35 kg ha⁻¹ (S_3) with the application of $FeSO_4 + ZnSO_4$ ($S_{2-3} M_4$) recorded higher test weight (24.1 and 21.0, respectively), while 25 kg ha⁻¹ seed rate with no supplementation of micronutrient (S_1M_1) recorded lower test weight (20.7).

Overall, the three way interactions revealed significantly higher test weight (26.0) with cv. MTU 1010 sown with 30 kg seed rate and applied with both $FeSO_4 + ZnSO_4$ ($V_2S_2M_4$), while lower test weight (17.7) was recorded with cv. BPT 5204 sown using 35 kg ha⁻¹ seed rate and supplied with no micronutrient ($V_3S_3 M_1$) among all.

4.1.1.2.10 Grain weight (g plant⁻¹) (c.f. Table 51)

Variations in grain weight revealed significant differences due to cultivars, seed rates and use of micronutrients and their interactions during both the years and on pooled basis as well.

Among the varieties, cv. MTU 1010 (V_2) recorded significantly higher grain weight (34.8) followed by cvs. GGV 0501 and BPT 5204 (32.2 and 31.9, respectively), among seed rates higher grain weight (35.4) was recorded with the seed rate of 30 kg ha⁻¹; yield decreased and recorded lower weight with lower seed rate of 25 kg ha⁻¹ (S_1 -29.7), and similarly use of micronutrients revealed higher grain weight (37.8) with combined application $FeSO_4$ and $ZnSO_4$, while no application of micronutrient (M_1) recorded significantly lower grain weight (27.2).

Table 51. Effect of genotypes, seed rates and micronutrients on grain weight plant⁻¹ under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	19.1 ⁱ	27.8 ^{f-i}	23.3 ^{hi}	23.4^f	24.3 ^k	22.9 ^k	23.9 ^k	23.7^f	21.7 ^l	25.3 ^{j-l}	23.6 ^{kl}	23.6^f
	M ₂	31.1 ^{e-h}	34.0 ^{d-g}	27.4 ^{g-i}	30.8^{de}	28.1 ^{e-k}	27.7 ^{f-k}	24.8 ^{jk}	26.9^{ef}	29.6 ^{e-k}	30.9 ^{e-k}	33.9 ^{b-i}	28.9^e
	M ₃	31.7 ^{d-h}	34.4 ^{d-g}	30.5 ^{e-h}	32.2^{de}	33.3 ^{b-i}	34.6 ^{a-g}	29.3 ^{d-k}	32.4^{bc}	32.5 ^{d-j}	34.5 ^{bh}	29.9 ^{e-k}	32.3^{c-e}
	M ₄	36.0 ^{b-g}	32.4 ^{d-h}	35.0 ^{c-g}	34.5^{c-e}	36.9 ^{a-d}	33.9 ^{b-h}	30.0 ^{c-k}	33.6^{bc}	36.5 ^{b-g}	33.2 ^{c-i}	32.5 ^{d-j}	34.1^{bc}
S ₂	M ₁	28.9 ^{e-h}	30.9 ^{e-h}	32.4 ^{d-h}	30.7^{de}	27.9 ^{e-k}	30.5 ^{c-k}	26.4 ^{h-k}	28.3^{de}	28.4 ^{b-l}	30.7 ^{e-k}	29.4 ^{f-k}	29.5^{de}
	M ₂	35.5 ^{b-g}	36.9 ^{b-g}	35.5 ^{b-g}	36.0^{b-d}	30.0 ^{ck}	34.4 ^{a-g}	32.3 ^{b-j}	32.3^{bc}	32.8 ^{d-j}	35.6 ^{b-h}	33.9 ^{b-i}	34.1^{bc}
	M ₃	37.9 ^{b-e}	44.1 ^a	35.9 ^{b-g}	39.3^{a-c}	35.5 ^{a-e}	37.7 ^{a-c}	35.0 ^{a-f}	36.1^{ab}	36.7 ^{b-f}	40.9 ^{a-c}	35.5 ^{b-h}	37.7^b
	M ₄	41.5 ^{a-d}	49.9 ^{e-h}	36.7 ^{b-g}	42.7^a	38.4 ^{ab}	41.9 ^a	32.7 ^{b-i}	37.7^a	39.9 ^{a-d}	45.9 ^a	34.7 ^{b-i}	40.2^a
S ₃	M ₁	28.9 ^{e-h}	30.2 ^{e-h}	32.0 ^{d-h}	30.4^e	25.7 ^{i-k}	27.2 ^{g-k}	26.1 ^{i-k}	26.3^{ef}	27.3 ^{i-l}	28.7 ^{kl}	29.0 ^{f-l}	28.3^e
	M ₂	31.0 ^{e-h}	32.3 ^{d-h}	32.1 ^{d-h}	31.8^{de}	29.4 ^{d-k}	34.2 ^{b-g}	29.0 ^{e-k}	30.9^{cd}	30.2 ^{e-k}	33.3 ^{c-i}	30.5 ^{e-k}	31.3^{c-e}
	M ₃	32.0 ^{d-h}	38.4 ^{be}	32.8 ^{d-h}	34.4^{c-e}	33.4 ^{b-i}	35.4 ^{a-f}	27.9 ^{e-k}	32.2^{bc}	36.7 ^{b-f}	36.9 ^{b-f}	30.3 ^{e-k}	33.3^{cd}
	M ₄	37.7 ^{b-f}	45.0 ^{ab}	36.4 ^{b-g}	39.7^{ab}	37.3 ^{a-c}	37.3 ^{a-c}	29.1 ^{e-k}	34.6^{a-c}	37.5 ^{b-e}	41.2 ^{ab}	39.0 ^{a-d}	39.2^a
Variety		32.6^b	36.4^a	32.5^b		31.7^b	33.1^a	28.9^c		32.2^b	34.8^a	31.9^b	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	29.5 ^f	32.1 ^e	29.1 ^f	30.2^c	30.6 ^{b-d}	29.8 ^{c-e}	27.0 ^e	29.1^a	30.1 ^{ef}	31.0 ^{de}	28.0 ^f	29.7^c
	S ₂	35.9 ^{bc}	40.4 ^a	35.1 ^{b-d}	37.1^b	33.0 ^b	36.1 ^a	31.6 ^{bc}	33.6^a	34.5 ^{bc}	38.3 ^a	33.4 ^{b-d}	35.4^a
	S ₃	32.4 ^{de}	36.5 ^b	33.3 ^{c-e}	34.1^a	31.4 ^{bc}	33.5 ^{ab}	28.0 ^{de}	31.0^b	31.9 ^{c-e}	35.0 ^b	32.2 ^{b-e}	33.0^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	25.7 ^e	29.6 ^{de}	29.2 ^{de}	29.2^c	25.9 ^f	26.9 ^{ef}	25.5 ^f	26.1^c	25.8 ^h	28.3 ^{f-h}	27.4 ^{gh}	27.2^d
	M ₂	32.5 ^{cd}	34.4 ^{b-d}	31.7 ^{cd}	32.9^b	29.2 ^{d-f}	32.1 ^{b-d}	28.7 ^{d-f}	30.0^b	30.9 ^{e-g}	33.2 ^{de}	30.2 ^{e-g}	31.4^c
	M ₃	33.9 ^{b-d}	38.9 ^{ab}	33.1 ^{cd}	35.3^b	34.0 ^{a-c}	35.9 ^{ab}	30.8 ^{c-e}	33.6^a	33.9 ^{c-e}	37.4 ^{a-c}	31.9 ^{d-f}	34.4^b
	M ₄	38.4 ^{ab}	42.4 ^a	36.0 ^{bc}	38.9^a	37.5 ^a	37.7 ^a	30.6 ^{c-e}	35.3^a	38.0 ^{ab}	40.1 ^a	35.4 ^{b-d}	37.8^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.5				0.7				0.2			
Seed (S)		0.5				0.5				0.5			
Micro (M)		0.9				0.9				0.8			
V x S		0.8				0.7				0.9			
V x M		1.6				1.3				1.3			
S x M		1.6				1.3				1.3			
V x S x M		2.8				2.2				2.3			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Interactions due to variety and seed rate were significant wherein cv. MTU 1010 with 30 kg ha⁻¹ seed rate (V₂S₂) recorded higher grain weight (38.3); while lower seed was recorded with cv. BPT 5204 irrespective of seed rates used particularly with lower seed rate of 25 kg ha⁻¹ (V₃S₁) (28.0), variety X micronutrient also revealed significant variations, in that cv. MTU 1010 with combined application of FeSO₄ and ZnSO₄ (V₂M₄) rerecorded higher grain weight (40.1); V₁M₄ was on par with it while lower yield was obtained with cv. GGV 0501 (V₁M₁) (25.8), and among seed rates and levels of micronutrients 30 kg seed rate with the application of FeSO₄ + ZnSO₄ (S₂ M₄) recorded higher grain weight (40.2) and S₃M₄ was on par with it, while 25 kg ha⁻¹ seed rate with no supplementation of micronutrient (S₁M₁) recorded lower grain weight (23.6).

V x S x M revealed significantly higher yield (45.9) with cv. MTU 1010 sown with 30 kg seed rate and applied with both FeSO₄+ ZnSO₄(V₂S₂M₄), closely followed by V₂S₂₋₃M₃₋₄, V₃S₃M₄ and V₁S₂M₄, while lower grain weight (21.1) was recorded with cv. GGV 0501 sown using 25 kg ha⁻¹ seed rate and supplied with no micronutrient (V₁S₁ M₁) among all.

4.1.1.2.11 Grain yield (kg ha⁻¹) (c.f. Table 52 and Fig. 8a)

Significant variations were observed in grain yield due to cultivars, seed rates and use of micronutrients and their interactions during both the years and on pooled basis as well.

Among the varieties, cv. MTU 1010 (V₂) recorded significantly higher grain yield (5917) followed by cvs. GGV 0501 (V₁) and BPT 5204 (V₃) (5115 and 4663, respectively); among seed rates higher grain yield (5684) was recorded with medium seed rate of 30 kg ha⁻¹; yield decreased both with lower or higher seed rates (S₁ and S₃) and both were at par. Similarly, use of micronutrients produced significant variations individually and with combined application wherein the latter (M₄) i.e. combined application FeSO₄ + ZnSO₄ to soil and to the foliage resulted in higher yield (5614), M₃ receiving ZnSO₄ only was at par, while no application of micronutrient (M₁) recorded significantly lower yield (4685).

Interactions due to variety and seed rate were significant and among the combinations, cv. MTU 1010 sown using 30 kg ha⁻¹ seed rate (V₂S₂) recorded higher yield (6499); cv. MTU 1010 at all the seed rate (V₁S₁₋₃) and all the varieties with 30 kg

Table 52. Effect of genotypes, seed rates and micronutrients grain yield (kg ha⁻¹) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	5014 ^{k-s}	5664 ^{d-n}	4305 ^{r-t}	4994 ^{e-g}	4016 ⁱ⁻ⁿ	4734 ^{e-l}	3567 ^{l-n}	4106 ^f	4515 ^{m-p}	5199 ^{f-m}	3136 ^q	4283 ^f
	M ₂	5349 ^{g-p}	5762 ^{c-l}	4603 ^{p-t}	5238 ^{d-f}	4083 ^{h-n}	5049 ^{c-j}	3854 ^{j-n}	4329 ^{ef}	4716 ^{i-o}	5406 ^{d-k}	4228 ^{op}	4783 ^{ef}
	M ₃	5602 ^{e-n}	6211 ^{a-g}	4801 ^{n-t}	5538 ^{b-d}	4403 ^{e-n}	5054 ^{c-i}	4361 ^{f-n}	4606 ^{def}	5003 ^{g-m}	5633 ^{d-h}	4581 ^{k-o}	5072 ^{de}
	M ₄	5876 ^{b-k}	6282 ^{a-f}	4969 ^{l-s}	5709 ^{bc}	4987 ^{d-k}	5459 ^{c-g}	4776 ^{e-k}	5074 ^{cd}	5432 ^{d-k}	5870 ^{c-f}	4872 ^{i-o}	5391 ^{cd}
S ₂	M ₁	4400 ^{q-t}	5933 ^{b-j}	4107 ^t	4813 ^{fg}	4536 ^{e-n}	6221 ^{a-c}	5298 ^{c-g}	5352 ^{bc}	4468 ^{m-p}	6077 ^{b-d}	4703 ^{k-o}	5083 ^{de}
	M ₂	5563 ^{f-o}	6450 ^{a-e}	5172 ^{i-r}	5728 ^{bc}	4630 ^{e-n}	6616 ^{ab}	5235 ^{c-h}	5494 ^{bc}	5097 ^{g-n}	6533 ^{abc}	5204 ^{f-m}	5611 ^{bc}
	M ₃	5739 ^{c-m}	6519 ^{a-d}	5387 ^{g-i}	5882 ^{ab}	5099 ^{c-i}	6647 ^{ab}	5562 ^{b-f}	5769 ^{ab}	5419 ^{d-k}	6583 ^{ab}	5474 ^{d-j}	5825 ^{ab}
	M ₄	6230 ^{a-g}	6838 ^a	5864 ^{b-t}	6311 ^a	6015 ^{a-d}	6770 ^a	5589 ^{b-e}	6125 ^a	6123 ^{a-d}	6804 ^a	5727 ^{d-g}	6218 ^a
S ₃	M ₁	4696 ^{o-t}	5264 ^{i-q}	4244 st	4735 ^g	4339 ^{g-n}	4558 ^{e-n}	3425 ⁿ	4107 ^f	4517 ^{m-p}	4911 ^{h-o}	3834 ^p	4421 ^f
	M ₂	5056 ^{j-s}	6058 ^{a-i}	4873 ^{m-t}	5329 ^{c-e}	4536 ^{e-n}	4558 ^{e-n}	3484 ^{mn}	4193 ^f	4796 ^{i-o}	5308 ^{e-l}	4178 ^{op}	4761 ^{ef}
	M ₃	5783 ^{c-l}	6584 ^{abc}	5047 ^{k-s}	5805 ^b	5261 ^{c-h}	5414 ^{c-g}	3819 ^{k-n}	4831 ^{cde}	5522 ^{d-i}	6039 ^{b-e}	4433 ^{n-p}	5331 ^{cd}
	M ₄	6119 ^{a-h}	6725 ^{ab}	5185 ^{i-q}	6010 ^{ab}	5418 ^{c-g}	6639 ^{ab}	4386 ^{e-n}	5481 ^{bc}	5769 ^{dk}	6682 ^{ab}	4786 ^{i-o}	5738 ^{bc}
Variety		5452 ^b	6191 ^a	4880 ^c		4777 ^b	5643 ^a	4446 ^c		5115 ^b	5917 ^a	4663 ^c	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	5460 ^c	5980 ^b	4670 ^e	5370 ^b	4372 ^{cde}	5074 ^{bc}	4139 ^{de}	4528 ^b	4916 ^d	5527 ^{bc}	4405 ^e	4949 ^b
	S ₂	5483 ^c	6435 ^a	5133 ^{cd}	5684 ^a	5070 ^{bc}	6564 ^a	5421 ^b	5685 ^a	5277 ^{cd}	6499 ^a	5277 ^{cd}	5684 ^a
	S ₃	5414 ^c	6158 ^{ab}	4837 ^{de}	5470 ^{ab}	4889 ^{bcd}	5312 ^b	3778 ^e	4660 ^b	5068 ^d	5735 ^b	4308 ^e	5037 ^b
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M	M ₁	4703 ^f	5620 ^d	4218 ^g	4847 ^d	4297 ^{ef}	5171 ^{bcd}	4097 ^f	4522 ^c	4500 ^{fg}	5396 ^{b-d}	4158 ^g	4685 ^c
	M ₂	5323 ^{de}	6090 ^{bc}	4882 ^{ef}	5432 ^c	4417 ^{ef}	5408 ^{bc}	4191 ^f	4672 ^c	4870 ^{ef}	5749 ^{ab}	4537 ^{fg}	5052 ^b
	M ₃	5708 ^{cd}	6438 ^{ab}	5078 ^{ef}	5741 ^b	4921 ^{cde}	5732 ^{ab}	4581 ^{def}	5078 ^b	5315 ^{cd}	6085 ^a	4830 ^{ef}	5410 ^a
	M ₄	6075 ^{bc}	6615 ^a	5339 ^{de}	6010 ^a	5474 ^{bc}	6289 ^a	4917 ^{cde}	5560 ^a	5663 ^{a-c}	6052 ^a	5128 ^{de}	5614 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		57.6				75.2				55.7			
Seed (S)		69.6				157.8				68.8			
Micro (M)		89.9				116.1				74.2			
V x S		120.6				273.3				119.2			
V x M		148.9				201.2				128.5			
S x M		148.9				201.2				128.5			
V x S x M		257.9				348.4				228.5			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

seed rate ($V_{1-3}S_2$) were at par, while the lower seed yield was recorded with cv. BPT 5204 irrespective of seed rates used particularly with higher seed rate of 35 kg ha^{-1} (V_3S_3) (4308). Variety X micronutrient revealed higher grain yield (6083 and 6052, respectively) with cv. MTU 1010 with ZnSO_4 (V_2M_3) and combined application of FeSO_4 and ZnSO_4 (V_2M_4). When no micronutrient was applied yield decreased irrespective of cultivars used and recorded lower yield with cv. BPT 5204 (V_3M_1) (4158). Similarly, interaction due to seed rates and micronutrients were significant wherein 30 kg seed rate with the application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) recorded higher grain yield (6218) while 35 kg ha^{-1} seed rate with no supplementation of micronutrient (S_3M_1) recorded lower grain yield (4221).

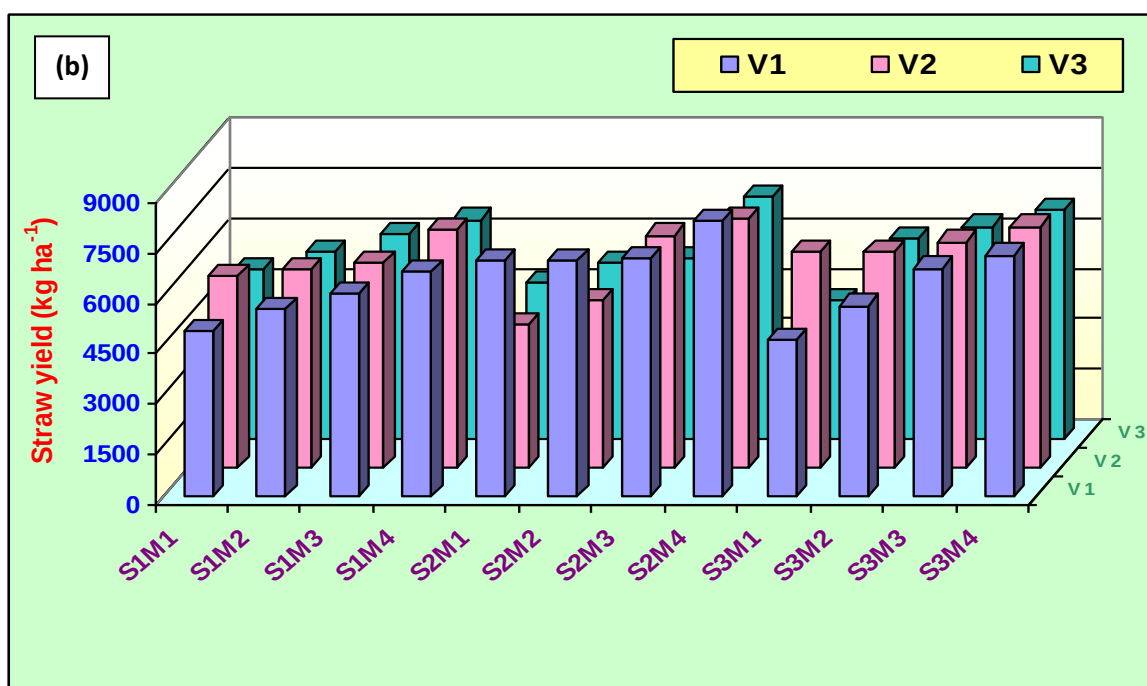
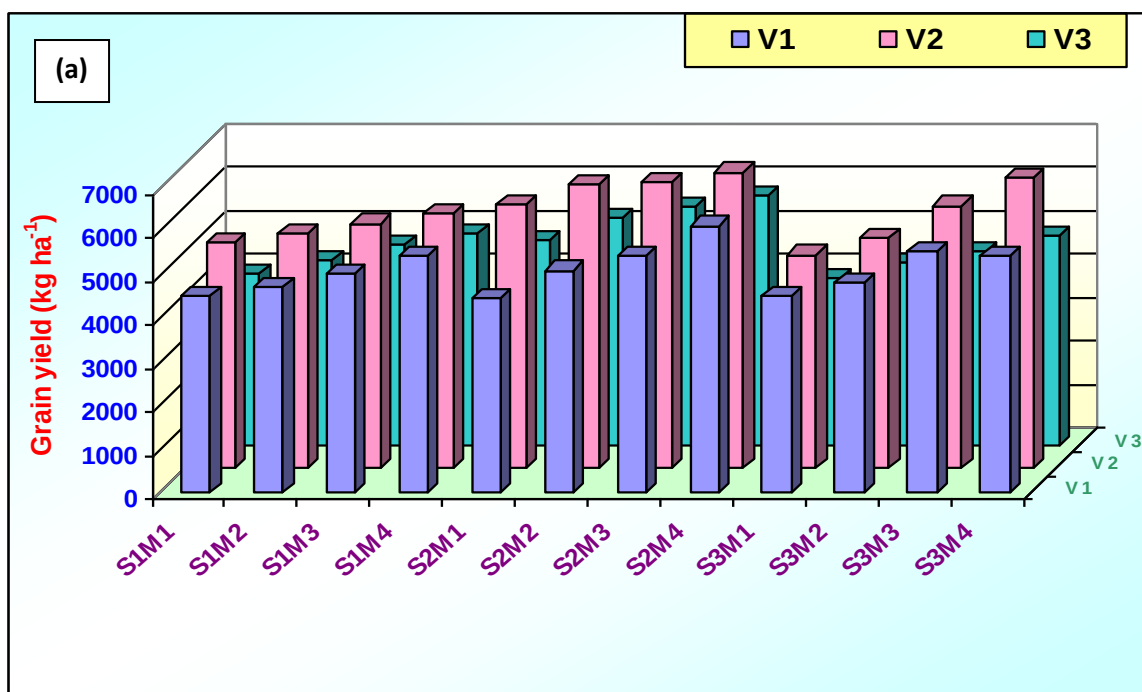
Overall, the three way interactions revealed significantly higher yield (6804) with cv. MTU 1010 sown with 30 kg seed rate and applied with both $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_2S_2M_4$), closely followed by $V_2S_3M_4$ (6682), while the lower grain yield (3136) was recorded with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient ($V_3S_1M_1$) among all.

4.1.1.2.12 Straw yield (kg ha^{-1}) (c.f. Table 53 and Fig. 8b)

Straw yield differed significantly due to cultivars, seed rates and use of micronutrients and their interactions during both the years and on pooled basis as well.

Significantly higher straw yield (6641) among the varieties occurred with cv. MTU 1010 (V_2) followed by cvs. GGV 0501 (V_1) and BPT 5204 (V_3) (6380 and 5974, respectively); among seed rates higher straw yield (6903) was recorded with medium seed rate of 30 kg ha^{-1} (S_2) while significantly lower straw yield (5870) was observed with lower seed rate of 25 kg ha^{-1} (S_1). Similarly, use of micronutrients produced significant variations wherein combined application $\text{FeSO}_4 + \text{ZnSO}_4$ to soil and to the foliage (M_4) resulted in higher straw yield (6949), while no application of micronutrient (M_1) recorded significantly lower yield (5776).

Interactions due to variety and seed rate were significant wherein cv. MTU 1010 at 30 kg ha^{-1} seed rate (V_2S_2) recorded higher yield (7526); MTU 1010 at all the seed rates (V_1S_{1-3}) and GGV 0501 with 30 kg seed rate (V_1S_2) were at par, while lower seed yield among all was recorded with cv. BPT 5204 with higher seed rate of 35 kg ha^{-1} (V_3S_3); while cvs. GGV 0501 (V_1S_1) and BPT 5204 at 25 kg ha^{-1} (V_3S_1) were at par



LEGEND

Varieties: V₁- GGV 0501, V₂- MTU 1010, V₃- BPT 5204;
 Seed Rate: S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
 Micronutrient: M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₄- FeSO₄ + ZnSO₄ (Each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

Fig. 8. Effect of genotypes, seed rates and micronutrients on (a) grain yield (kg ha⁻¹) and (b) straw yield (kg ha⁻¹) under direct seeded condition during rainy season

Table 53. Effect of genotypes, seed rates and micronutrients on straw yield (kg ha⁻¹) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	5914 ^{i-o}	5269 ^o	5670 ^{m-o}	5618^e	5353 ^{ijkl}	5310 ^{ijkl}	5166 ^{kl}	5276^f	5634 ⁱ⁻ⁿ	5289 ^{mn}	5418 ^{k-n}	5447^{ai}
	M ₂	6024 ^{h-o}	5449 ^{no}	5832 ^{k-o}	5768^{de}	5462 ^{i-l}	5787 ^{g-l}	5686 ^{h-l}	5645^{ef}	5743 ^{h-n}	5618 ⁱ⁻ⁿ	5759 ^{h-n}	5707^{gh}
	M ₃	6265 ^{d-n}	6885 ^{b-h}	6109 ^{f-o}	6420^c	5351 ^{ijkl}	5852 ^{g-k}	5728 ^{h-l}	5644^{ef}	5805 ^{h-n}	6368 ^{e-h}	5919 ^{h-m}	6032^{fg}
	M ₄	6778 ^{c-j}	7010 ^{b-g}	6258 ^{d-n}	6682^{bc}	5901 ^{f-k}	6441 ^{c-h}	5950 ^{e-k}	6097^{de}	6340 ^{e-h}	6725 ^{c-f}	6105 ^{f-j}	6390^{de}
S ₂	M ₁	6313 ^{c-n}	6892 ^{b-h}	5402 ^{no}	6202^{cd}	6252 ^{d-j}	6816 ^{b-f}	6099 ^{d-k}	6389^{cd}	6282 ^{e-i}	6854 ^{cde}	5751 ^{h-n}	6296^{ef}
	M ₂	6522 ^{c-m}	7052 ^{b-f}	5851 ^{l-o}	6475^c	6315 ^{d-i}	7494 ^b	6726 ^{b-g}	6845^{bc}	6419 ^{d-h}	7273 ^{bc}	6289 ^{e-i}	6660^{cd}
	M ₃	6922 ^{b-h}	7778 ^b	6748 ^{c-k}	7149^b	6738 ^{b-g}	7606 ^a	6901 ^{b-e}	7082^{ab}	6830 ^{cde}	7692 ^b	6825 ^{cde}	7116^b
	M ₄	7202 ^{bcd}	8739 ^a	6904 ^{b-h}	7615^a	7286 ^{bc}	7831 ^a	7279 ^{bc}	7465^a	7244 ^{bc}	8285 ^a	7091 ^{bcd}	7540^a
S ₃	M ₁	5652 ^{mno}	6092 ^{g-o}	5402 ^{no}	5715^e	6315 ^{d-i}	5181 ^{kl}	4874 ^l	5457^f	5984 ^{h-l}	5637 ⁱ⁻ⁿ	5138 ⁿ	5586^{hi}
	M ₂	6230 ^{e-n}	6811 ^{c-i}	5718 ^{l-o}	6253^c	6501 ^{c-h}	5252 ^{kl}	4896 ^l	5550^f	6366 ^{e-h}	6031 ^{g-k}	5307 ^{lmn}	5901^{gh}
	M ₃	6826 ^{c-i}	7221 ^{bc}	5931 ^{i-o}	6659^{bc}	6849 ^{b-f}	6105 ^{dk}	5818 ^{g-l}	6257^{de}	6838 ^{cde}	6663 ^{c-g}	5575 ^{j-n}	6359^{def}
	M ₄	7094 ^{b-e}	7227 ^{bc}	6641 ^{c-l}	6987^b	7049 ^{bcd}	7291 ^{bc}	6209 ^{d-j}	6850^{bc}	7071 ^{bcd}	7259 ^{bc}	6425 ^{d-h}	6918^{bc}
Variety		6478^a	6869^a	6039^b		6281^b	6414^a	5944^c		6380^b	6641^a	5992^c	
Variety x Seed rate					S	Variety x Seed rate				S	Variety x Seed rate		
S	S ₁	6245 ^{cd}	6153 ^{cd}	5968 ^d	6122^c	5517 ^{cd}	5848 ^c	5633 ^{cd}	5666^c	5881 ^c	6000 ^c	5800 ^c	5870^c
	S ₂	6740 ^b	7615 ^a	6226 ^{cd}	6194^a	6648 ^b	7437 ^a	6751 ^b	6945^c	6694 ^b	7526 ^a	6489 ^b	6903^a
	S ₃	6451 ^{bc}	6838 ^b	5923 ^d	6404^b	6679 ^b	5957 ^c	5299 ^d	5978^b	6565 ^b	6398 ^b	5611 ^c	6191^b
Variety x Micro					M	Variety x Micro				M	Variety x Micro		
M	M ₁	5959 ^{efg}	6085 ^{ef}	5491 ^g	5845^d	5973 ^{def}	5769 ^{fg}	5708 ^g	5541^c	5966 ^{efg}	5927 ^{fg}	5436 ^h	5776^d
	M ₂	6259 ^{def}	6437 ^{de}	5800 ^{fg}	6860^c	6093 ^{c-f}	6178 ^{c-f}	5769 ^{fg}	6013^b	6176 ^{def}	6308 ^{cde}	5785 ^g	6090^c
	M ₃	6671 ^{cd}	7294 ^{ab}	6263 ^{def}	6743^b	6313 ^{b-e}	6521 ^{bc}	5949 ^{ef}	6261^b	6492 ^{cd}	6908 ^b	6106 ^{efg}	6502^b
	M ₄	7025 ^{bc}	7658 ^a	6601 ^{cd}	7095^a	6745 ^{ab}	7188 ^a	6479 ^{bcd}	6804^a	6885 ^b	7423 ^a	6540 ^c	6949^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		106.2				73.8				56.0			
Seed (S)		72.8				86.3				71.9			
Micro (M)		91.8				93.1				67.1			
V x S		136.5				149.5				124.5			
V x M		159.0				161.3				116.2			
S x M		159.0				161.3				116.2			
V x S x M		275.4				279.4				201.2			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Variety X micronutrient revealed significant variations, in that cv. MTU 1010 with combined application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_2M_4) rerecorded higher straw yield (7423). With no micronutrient application yield was decreased irrespective of cultivars used and recorded lower yield with cv. BPT 5204 (V_3M_1) (5436). Similarly, interactions due to seed rates and micronutrients were significant wherein 30 kg ha⁻¹ seed rate with combined application $\text{FeSO}_4 + \text{ZnSO}_4$ to soil and to the foliage resulted in higher straw yield (6918) while 25 kg ha⁻¹ seed rate with supplementation of micronutrient (S_1M_1) recorded lower straw yield (5447).

On the whole, the three way interaction revealed significantly higher yield (8285) with cv. MTU 1010 sown using 30 kg seed rate and applied with both $\text{FeSO}_4 + \text{ZnSO}_4(4)$, closely followed by $V_2S_3M_4$ (6682), while lower straw yield (5138) was recorded with BPT 5204 sown using 35 kg ha⁻¹ seed rate and supplied with no micronutrient ($V_3S_3M_1$) among all.

4.1.1.2.13 Harvest index (c.f. Table 54)

Data on harvest index varied from 0.42 to 0.47 but did not reveal significant variations due to cultivars, seed rates and use of micronutrients and variety x seed rate, seed rate x micronutrient and three way interactions during both the years and on pooled basis as well. However, interaction due to variety and micronutrient varied significantly. Among all, significantly higher harvest indices were recorded with cv. MTU 1010 with application of FeSO_4 (V_2S_{1-2}) (0.48); while significantly lower harvest index was recorded in cv. GGV 0501 irrespective of micronutrient levels particularly with no application of micronutrients (V_1S_1) (0.43).

4.1.1.3 Grain composition

4.1.1.3.1 Grain nitrogen (%) (c.f. Table 55)

N content in grain revealed significant variations due to cultivars, seed rates and use of micronutrients and their interactions during both the years and on pooled basis as well.

Among the varieties, cv. MTU 1010 (V_2) recorded significantly higher N content (1.26) in grain followed by cvs. GGV 0501 and BPT-5204, (1.16 and 1.16 respectively) and both were at par; among seed rates higher N content in grain (1.21) was recorded with the seed rates of 30 and 35 kg ha⁻¹ and both were at par; N content in grain (1.16)

Table 54. Effect of genotypes, seed rates and micronutrients harvest index under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	0.46 ^{abc}	0.52 ^a	0.43 ^c	0.47^a	0.43 ^a	0.47 ^a	0.41 ^a	0.44^a	0.45 ^a	0.50 ^a	0.42 ^a	0.46^a
	M ₂	0.47 ^{abc}	0.51 ^{ab}	0.44 ^{bc}	0.47^a	0.42 ^a	0.47 ^a	0.40 ^a	0.43^a	0.45 ^a	0.49 ^a	0.42 ^a	0.45^a
	M ₃	0.47 ^{abc}	0.42 ^c	0.41 ^c	0.43^{ab}	0.45 ^a	0.46 ^a	0.43 ^a	0.45^a	0.46 ^a	0.47 ^a	0.44 ^a	0.46^a
	M ₄	0.46 ^{abc}	0.47 ^{abc}	0.44 ^{bc}	0.46^{ab}	0.46 ^a	0.46 ^a	0.44 ^a	0.45^a	0.46 ^a	0.47 ^a	0.44 ^a	0.46^a
S ₂	M ₁	0.41 ^c	0.46 ^{abc}	0.43 ^c	0.43^b	0.47 ^a	0.48 ^a	0.47 ^a	0.47^a	0.42 ^a	0.47 ^a	0.45 ^a	0.45^a
	M ₂	0.46 ^{abc}	0.48 ^{abc}	0.47 ^{abc}	0.47^a	0.42 ^a	0.47 ^a	0.44 ^a	0.44^a	0.44 ^a	0.47 ^a	0.45 ^a	0.45^a
	M ₃	0.45 ^{abc}	0.46 ^{abc}	0.44 ^{bc}	0.45^{ab}	0.43 ^a	0.47 ^a	0.45 ^a	0.45^a	0.44 ^a	0.46 ^a	0.45 ^a	0.45^a
	M ₄	0.46 ^{abc}	0.44 ^{bc}	0.47 ^{abc}	0.46^{ab}	0.45 ^a	0.46 ^a	0.43 ^a	0.45^a	0.46 ^a	0.45 ^a	0.45 ^a	0.45^a
S ₃	M ₁	0.45 ^{abc}	0.46 ^{abc}	0.43 ^c	0.45^{ab}	0.41 ^a	0.45 ^a	0.41 ^a	0.42^a	0.43 ^a	0.46 ^a	0.43 ^a	0.44^a
	M ₂	0.45 ^{abc}	0.47 ^{abc}	0.46 ^{abc}	0.46^{ab}	0.41 ^a	0.45 ^a	0.42 ^a	0.43^a	0.43 ^a	0.47 ^a	0.44 ^a	0.45^a
	M ₃	0.46 ^{abc}	0.48 ^{abc}	0.46 ^{abc}	0.47^{ab}	0.43 ^a	0.47 ^a	0.42 ^a	0.44^a	0.45 ^a	0.48 ^a	0.44 ^a	0.46^a
	M ₄	0.46 ^{abc}	0.48 ^{abc}	0.44 ^{ab}	0.46^{ab}	0.43 ^a	0.48 ^a	0.41 ^a	0.44^a	0.43 ^a	0.48 ^a	0.43 ^a	0.45^a
Variety		0.46^{ab}	0.47^a	0.44^b		0.43^b	0.47^a	0.43^b		0.44^a	0.47^a	0.44^a	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	0.47 ^b	0.50 ^a	0.44 ^c	0.47^a	0.44 ^a	0.46 ^a	0.42 ^a	0.44^a	0.46 ^a	0.48 ^a	0.43 ^a	0.46^a
	S ₂	0.45 ^{bc}	0.46 ^{bc}	0.45 ^{bc}	0.45^b	0.43 ^a	0.47 ^a	0.45 ^a	0.45^a	0.44 ^a	0.46 ^a	0.45 ^a	0.45^a
	S ₃	0.46 ^{bc}	0.47 ^b	0.45 ^{bc}	0.46^{ab}	0.42 ^a	0.46 ^a	0.42 ^a	0.43^a	0.43 ^a	0.47 ^a	0.43 ^a	0.44^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	0.44 ^{cd}	0.48 ^{ab}	0.43 ^d	0.45^a	0.42 ^a	0.47 ^a	0.43 ^a	0.44^a	0.43 ^b	0.48 ^a	0.44 ^{ab}	0.45^a
	M ₂	0.46 ^{a-d}	0.49 ^a	0.46 ^{a-d}	0.47^a	0.42 ^a	0.46 ^a	0.42 ^a	0.43^a	0.44 ^{ab}	0.48 ^a	0.44 ^{ab}	0.45^a
	M ₃	0.46 ^{a-d}	0.47 ^{abc}	0.45 ^{bcd}	0.46^a	0.44 ^a	0.47 ^a	0.43 ^a	0.45^a	0.45 ^{ab}	0.47 ^{ab}	0.44 ^{ab}	0.45^a
	M ₄	0.46 ^{a-d}	0.46 ^{a-d}	0.45 ^{bcd}	0.46^a	0.45 ^a	0.47 ^a	0.43 ^a	0.45^a	0.45 ^{ab}	0.47 ^{ab}	0.44 ^{ab}	0.45^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.005				0.009				0.008			
Seed (S)		0.003				0.013				0.007			
Micro (M)		0.006				0.009				0.008			
V x S		0.006				0.023				0.012			
V x M		0.010				0.016				0.014			
S x M		0.010				0.016				0.014			
V x S x M		0.018				0.027				0.025			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 55. Effect of genotypes, seed rates and micronutrients on grain nitrogen content (%) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	1.12 ^{f-l}	1.19 ^{c-i}	1.03 ^l	1.11^c	0.99 ^m	1.18 ^{h-l}	1.17 ^{h-l}	1.18^d	1.06 ^l	1.19 ^{d-k}	1.10 ^{kj}	1.12^e
	M ₂	1.13 ^{f-l}	1.19 ^{c-i}	1.03 ^l	1.12^{bc}	0.99 ^m	1.26 ^{d-j}	1.33 ^{a-g}	1.19^c	1.06 ^l	1.22 ^{b-h}	1.18 ^{e-k}	1.15^{de}
	M ₃	1.13 ^{f-l}	1.20 ^{c-h}	1.04 ^{kl}	1.12^{bc}	1.07 ^{lm}	1.41 ^{ab}	1.20 ^{g-l}	1.23^{bc}	1.10 ^{kl}	1.30 ^{a-c}	1.12 ^{i-l}	1.17^{cd}
	M ₄	1.13 ^{f-l}	1.20 ^{c-h}	1.04 ^{kl}	1.12^{bc}	1.12 ^{j-l}	1.42 ^a	1.18 ^{h-l}	1.24^{bc}	1.13 ^{h-l}	1.31 ^{ab}	1.11 ^{j-l}	1.18^{cd}
S ₂	M ₁	1.14 ^{e-l}	1.25 ^{a-e}	1.07 ^{j-l}	1.15^{bc}	1.22 ^{e-k}	1.23 ^{d-j}	1.20 ^{g-l}	1.22^{bc}	1.18 ^{e-k}	1.24 ^{b-f}	1.14 ^{g-l}	1.19^{cd}
	M ₂	1.15 ^{d-k}	1.28 ^{a-c}	1.07 ^{j-l}	1.17^{bc}	1.15 ^{i-l}	1.22 ^{e-k}	1.36 ^{a-d}	1.24^{bc}	1.15 ^{f-l}	1.25 ^{b-e}	1.21 ^{c-i}	1.20^{cd}
	M ₃	1.15 ^{d-k}	1.31 ^{ab}	1.08 ^{i-l}	1.18^{ab}	1.09 ^{k-m}	1.25 ^{d-j}	1.20 ^{g-l}	1.18^{cd}	1.12 ^{i-l}	1.28 ^{a-d}	1.14 ^{g-l}	1.18^{cd}
	M ₄	1.26 ^{a-d}	1.32 ^a	1.09 ^{h-l}	1.22^a	1.24 ^{a-f}	1.35 ^{a-e}	1.40 ^{a-c}	1.33^a	1.25 ^{b-e}	1.34 ^a	1.25 ^{b-e}	1.28^a
S ₃	M ₁	1.17 ^{c-j}	1.20 ^{c-h}	1.10 ^{g-l}	1.16^{bc}	1.24 ^{d-j}	1.20 ^{g-l}	1.14 ^{i-l}	1.19^{bc}	1.20 ^{d-j}	1.20 ^{d-j}	1.12 ^{i-l}	1.17^{cd}
	M ₂	1.18 ^{c-j}	1.21 ^{b-g}	1.10 ^{g-l}	1.16^{bc}	1.24 ^{d-j}	1.21 ^{f-k}	1.27 ^{c-i}	1.24^{bc}	1.21 ^{c-i}	1.21 ^{c-i}	1.18 ^{e-k}	1.20^{cd}
	M ₃	1.18 ^{c-j}	1.23 ^{a-f}	1.12 ^{f-l}	1.18^{ab}	1.28 ^{b-i}	1.27 ^{c-i}	1.40 ^{a-c}	1.32^a	1.23 ^{b-g}	1.25 ^{b-e}	1.26 ^{a-e}	1.25^{ab}
	M ₄	1.19 ^{c-i}	1.23 ^{a-f}	1.12 ^{f-l}	1.18^{ab}	1.24 ^{d-j}	1.30 ^{a-h}	1.26 ^{d-j}	1.27^{ab}	1.21 ^{c-i}	1.27 ^{a-e}	1.19 ^{d-k}	1.22^{bc}
Variety		1.16^{ab}	1.23^a	1.07^b		1.17^b	1.28^a	1.26^a		1.16^b	1.26^a	1.16^b	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	1.13 ^{cd}	1.20 ^b	1.03 ^e	1.12^b	1.04 ^a	1.32 ^a	1.22 ^a	1.19^a	1.08 ^f	1.26 ^{ab}	1.13 ^{ef}	1.16^b
	S ₂	1.17 ^{bc}	1.29 ^a	1.08 ^d	1.18^a	1.17 ^a	1.26 ^a	1.29 ^a	1.24^a	1.17 ^{de}	1.28 ^a	1.18 ^{c-e}	1.21^a
	S ₃	1.18 ^{bc}	1.22 ^b	1.11 ^d	1.17^a	1.25 ^a	1.25 ^a	1.27 ^a	1.26^a	1.22 ^{b-d}	1.23 ^{a-c}	1.19 ^{cd}	1.21^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	1.14 ^{cd}	1.21 ^{ab}	1.07 ^e	1.14^b	1.15 ^e	1.20 ^{de}	1.17 ^{de}	1.17^c	1.15 ^{de}	1.21 ^{bc}	1.12 ^e	1.16^c
	M ₂	1.15 ^c	1.23 ^{ab}	1.07 ^e	1.15^{ab}	1.13 ^e	1.23 ^{cd}	1.32 ^{ab}	1.23^b	1.14 ^{de}	1.23 ^b	1.19 ^{b-d}	1.19^b
	M ₃	1.15 ^c	1.25 ^a	1.08 ^e	1.16^{ab}	1.14 ^e	1.31 ^{ab}	1.27 ^{bc}	1.24^b	1.15 ^{de}	1.28 ^a	1.17 ^{cd}	1.20^b
	M ₄	1.19 ^{bc}	1.25 ^a	1.09 ^{de}	1.18^a	1.20 ^{de}	1.36 ^a	1.28 ^{bc}	1.28^a	1.20 ^{bc}	1.30 ^a	1.18 ^{cd}	1.23^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.03				0.01				0.01			
Seed (S)		0.01				0.01				0.01			
Micro (M)		0.01				0.03				0.01			
V x S		0.01				0.02				0.02			
V x M		0.02				0.02				0.02			
S x M		0.02				0.04				0.02			
V x S x M		0.03				0.03				0.03			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

was lower with lower seed rate (S_1), and among levels of micronutrients combined application $\text{FeSO}_4 + \text{ZnSO}_4$ to soil and to the foliage (M_4) resulted in higher N content in grain (1.23), while no application of micronutrient (M_1) recorded significantly lower N content in grain (1.16).

Of the two-way interactions, variations due to variety X seed rate were significant and cv. MTU 1010 at 30 kg ha⁻¹ seed rate (V_2S_2) recorded higher N content in grain (1.28); $V_2S_{1\&3}$ at par, while lower seed N content in grain was recorded with cv. GGV 0501 with lower seed rate of 25 kg ha⁻¹ (V_1S_1) (1.08). Variety X micronutrient again revealed higher grain N (1.30) with cv. MTU 1010 receiving combined application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_2M_4) and it was on par with V_2M_3 , while cv. BPT 5204 when not supplied with any micronutrient (V_3M_1) recorded lower grain N (1.12). Similarly, interaction due to seed rates and micronutrients were significant, wherein 30 kg seed rate with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) recorded higher N content in grain (1.28), while 25 kg ha⁻¹ seed rate without supplementation of micronutrient (S_1M_1) recorded lower N content in grain (1.11).

Overall, the three way interaction revealed significantly higher grain N (1.34) with cv. MTU 1010 sown with 30 kg seed rate and applied with both $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_2S_2M_4$), while the lower N content in grain (1.06 each) was recorded with cv. GGV 0501 sown using 25 kg ha⁻¹ seed rate and supplied with no micro nutrient or supplied with only FeSO_4 ($V_1S_1 M_{1-2}$) among all.

4.1.1.3.2. Grain phosphorus (%) (c.f. Table 56)

Grain P content varied significantly due to cultivars, seed rates and use of micronutrients and their interactions during both the years and on pooled basis as well.

Cv.MTU 1010 (V_2) among the cultivars recorded significantly higher (0.28) P content in grain followed by cvs. GGV 0501 and BPT-5204, both were at par (0.23 and 0.24, respectively); among seed rates higher P content in grain (0.26 each) was recorded with the seed rate of 30 and 35 kg ha⁻¹ and both were at par; P content in grain (0.24) decreased with lower seed rate (S_1). Similarly, use of micronutrients revealed significant variations individually and with combined application wherein the latter (M_4) i.e. combined application $\text{FeSO}_4 + \text{ZnSO}_4$ to soil and to the foliage resulted in higher

Table 56. Effect of genotypes, seed rates and micronutrients on grain phosphorus content (%) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	0.20 ^{b-e}	0.24 ^{ab}	0.17 ^e	0.20^b	0.23 ^g	0.28 ^{d-g}	0.25 ^{fg}	0.25^d	0.21 ^g	0.26 ^{b-f}	0.21 ^g	0.23^d
	M ₂	0.20 ^{b-e}	0.24 ^{ab}	0.17 ^e	0.20^b	0.23 ^g	0.31 ^{b-f}	0.27 ^{d-g}	0.27^{cd}	0.21 ^g	0.27 ^{b-e}	0.22 ^{fg}	0.23^{cd}
	M ₃	0.21 ^{a-e}	0.24 ^{ab}	0.18 ^{de}	0.21^{ab}	0.26 ^{e-g}	0.31 ^{b-f}	0.29 ^{d-g}	0.29^{b-d}	0.23 ^{e-g}	0.27 ^{b-e}	0.23 ^{e-g}	0.24^{b-d}
	M ₄	0.21 ^{a-e}	0.24 ^{ab}	0.18 ^{de}	0.21^{ab}	0.32 ^{b-f}	0.37 ^{a-c}	0.28 ^{d-g}	0.32^{ab}	0.26 ^{b-f}	0.30 ^{ab}	0.23 ^{e-g}	0.26^{ab}
S ₂	M ₁	0.22 ^{a-d}	0.25 ^a	0.19 ^{c-e}	0.22^{ab}	0.23 ^g	0.27 ^{d-g}	0.30 ^{c-g}	0.27^{cd}	0.23 ^{e-g}	0.26 ^{b-f}	0.24 ^{d-g}	0.24^{cd}
	M ₂	0.22 ^{a-d}	0.25 ^a	0.19 ^{c-e}	0.22^{ab}	0.25 ^{fg}	0.29 ^{d-g}	0.30 ^{c-g}	0.28^{b-d}	0.23 ^{e-g}	0.27 ^{b-e}	0.25 ^{c-g}	0.25^{b-d}
	M ₃	0.23 ^{a-c}	0.25 ^a	0.19 ^{c-e}	0.22^{ab}	0.25 ^{fg}	0.33 ^{a-c}	0.30 ^{c-g}	0.29^{b-d}	0.24 ^{d-g}	0.29 ^{a-c}	0.25 ^{c-g}	0.26^{a-c}
	M ₄	0.21 ^{a-e}	0.24 ^{ab}	0.18 ^{de}	0.21^a	0.27 ^{d-g}	0.38 ^{ab}	0.31 ^{e-f}	0.32^{ab}	0.25 ^{c-g}	0.32 ^a	0.26 ^{b-f}	0.28^{ab}
S ₃	M ₁	0.21 ^{a-e}	0.24 ^{ab}	0.18 ^{de}	0.21^{ab}	0.23 ^g	0.31 ^{b-f}	0.29 ^{d-g}	0.28^{b-d}	0.22 ^{fg}	0.28 ^{a-d}	0.24 ^{d-g}	0.25^{cd}
	M ₂	0.22 ^{a-d}	0.25 ^a	0.19 ^{c-e}	0.22^{ab}	0.25 ^{fg}	0.31 ^{b-f}	0.32 ^{b-f}	0.29^{b-d}	0.23 ^{e-g}	0.28 ^{a-d}	0.25 ^{c-g}	0.25^{b-d}
	M ₃	0.21 ^{a-c}	0.25 ^a	0.19 ^{c-e}	0.22^{ab}	0.26 ^{e-g}	0.34 ^{a-d}	0.33 ^{a-e}	0.31^{a-c}	0.24 ^{d-g}	0.29 ^{a-c}	0.26 ^{b-f}	0.26^{a-c}
	M ₄	0.22 ^{a-d}	0.25 ^a	0.19 ^{c-e}	0.22^{ab}	0.30 ^{c-g}	0.34 ^{a-d}	0.40 ^a	0.35^a	0.25 ^{c-g}	0.32 ^a	0.26 ^{b-f}	0.28^a
Variety		0.21^b	0.25^a	0.18^c		0.26^b	0.32^a	0.30^a		0.23^b	0.28^a	0.24^b	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	0.20 ^d	0.24 ^{ab}	0.17 ^f	0.20^b	0.26 ^c	0.32 ^{ab}	0.27 ^c	0.28^b	0.23 ^{de}	0.28 ^a	0.22 ^e	0.24^b
	S ₂	0.23 ^{bc}	0.25 ^a	0.19 ^{de}	0.22^a	0.25 ^c	0.32 ^{ab}	0.30 ^b	0.29^b	0.24 ^{cd}	0.29 ^a	0.25 ^{bc}	0.26^a
	S ₃	0.22 ^c	0.25 ^a	0.18 ^{ef}	0.22^a	0.26 ^c	0.33 ^a	0.34 ^a	0.31^a	0.24 ^{cd}	0.29 ^a	0.26 ^b	0.26^a
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M	M ₁	0.21 ^{cd}	0.24 ^{ab}	0.18 ^e	0.21^a	0.23 ^e	0.29 ^{bc}	0.28 ^{cd}	0.27^b	0.22 ^f	0.22 ^f	0.22 ^f	0.22^c
	M ₂	0.21 ^{cd}	0.24 ^{ab}	0.18 ^e	0.21^a	0.24 ^e	0.31 ^{bc}	0.30 ^{bc}	0.28^b	0.23 ^{ef}	0.27 ^{bc}	0.24 ^{d-f}	0.25^b
	M ₃	0.22 ^{bc}	0.25 ^a	0.18 ^e	0.22^a	0.25 ^{de}	0.33 ^{ab}	0.31 ^{bc}	0.30^{ab}	0.24 ^{d-f}	0.29 ^{ab}	0.25 ^{c-e}	0.26^{ab}
	M ₄	0.22 ^{bc}	0.25 ^a	0.19 ^{de}	0.22^a	0.30 ^{bc}	0.36 ^a	0.33 ^{ab}	0.33^a	0.26 ^{cd}	0.30 ^a	0.26 ^{cd}	0.27^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.006				0.008				0.004			
Seed (S)		0.003				0.005				0.003			
Micro (M)		0.005				0.008				0.005			
V x S		0.005				0.008				0.005			
V x M		0.008				0.013				0.008			
S x M		0.008				0.013				0.008			
V x S x M		0.014				0.023				0.014			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

P content in grain (0.27), while no application of micronutrient (M_1) recorded significantly lower P content in grain (0.22).

Interactions due to combination of variety and seed rate were significant wherein cv. MTU 1010 at 30 and 35 kg ha⁻¹ seed rates (V_2S_{2-3}) recorded the highest P content in grain (0.29 each) and both were at par with V_2S_1 (0.28) while the lower seed P (0.22) occurred with cv. BPT 5204 with lower seed rate of 25 kg ha⁻¹ (V_3S_1). Variety X micronutrient combination revealed significant variations, in that cv. MTU 1010 with combined application of $FeSO_4 + ZnSO_4$ (V_2M_4) recorded higher P content in grain (0.30) and it was on par with V_2M_3 . In the absence of micronutrient application P content in grain decreased and lower grain P occurred with cv. BPT 5204 (V_1M_1) (0.22). Similarly, interactions due to seed rates and micronutrients were significant, wherein 35 kg seed rate coupled with application of $FeSO_4 + ZnSO_4$ (S_2M_4) recorded higher P content in grain (0.28), while 25 kg ha⁻¹ seed rate without supplementation of micronutrient (S_1M_1) recorded lower P content in grain (0.23).

Of the three way interaction, significantly higher P content in grain (0.32) was recorded with cv. MTU 1010 sown using 30 to 35 kg seed rate and applied with both $FeSO_4 + ZnSO_4$ ($V_2S_{2-3}M_4$) and it was at par with $V_2S_3M_4$, while lower P content in grain (0.21) was recorded with cvs. GGV 0501 and BPT 5204 sown using 25 kg ha⁻¹ seed rate and not supplied with micro nutrient ($V_{1\&3}S_1M_1$) among all.

4.1.1.3.3 Grain potassium (%) (c.f. Table 57)

Similar to N and P, K contents in grain revealed significant variations due to micronutrients and their interactions except main effects due to cultivars and seed rates during both the years and on pooled basis as well.

Micronutrients application revealed significant variations individually and with combined application wherein the latter (M_4) i.e. combined application $FeSO_4 + ZnSO_4$ to soil and to the foliage resulted in higher grain K content in grain (0.40) and was at par with M_3 , while no application of micronutrient (M_1) recorded significantly lower K content in grain (0.38).

Interactions due to variety and seed rate were significant and cvs. MTU 1010 and BPT 5204 each with 30 kg ha⁻¹ seed rate ($V_{2-3}S_2$) recorded higher K content in grain (0.41 and 0.40, respectively) while lower grain K was recorded with cvs. BPT 5204 and GGV

Table 57. Effect of genotypes, seed rates and micronutrients on grain potassium content (%) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	0.41 ^a	0.44 ^a	0.39 ^a	0.41	0.34 ^{b-e}	0.35 ^{a-e}	0.34 ^{b-e}	0.34^{de}	0.38 ^{ab}	0.39 ^{ab}	0.37 ^{ab}	0.38^{de}
	M ₂	0.41 ^a	0.46 ^a	0.45 ^a	0.44	0.35 ^{a-e}	0.35 ^{a-e}	0.36 ^{a-e}	0.35^{c-e}	0.38 ^{ab}	0.41 ^{ab}	0.40 ^{ab}	0.40^{bc}
	M ₃	0.41 ^a	0.45 ^a	0.43 ^a	0.43	0.35 ^{a-e}	0.39 ^{a-d}	0.36 ^{a-e}	0.37^{a-d}	0.38 ^{ab}	0.42 ^{ab}	0.40 ^{ab}	0.40^{bc}
	M ₄	0.42 ^a	0.44 ^a	0.44 ^a	0.43	0.41 ^{ab}	0.42 ^a	0.37 ^{a-e}	0.40^a	0.41 ^{ab}	0.43 ^{ab}	0.41 ^{ab}	0.42^a
S ₂	M ₁	0.43 ^a	0.46 ^a	0.43 ^a	0.44	0.34 ^{b-e}	0.35 ^{a-e}	0.34 ^{b-e}	0.34^{de}	0.39 ^{ab}	0.40 ^{ab}	0.39 ^{ab}	0.39^{cd}
	M ₂	0.38 ^a	0.46 ^a	0.46 ^a	0.43	0.35 ^{a-e}	0.35 ^{a-e}	0.36 ^{a-e}	0.35^{c-e}	0.37 ^{ab}	0.41 ^{ab}	0.41 ^{ab}	0.40^{cd}
	M ₃	0.38 ^a	0.43 ^a	0.44 ^a	0.42	0.36 ^{a-e}	0.36 ^{a-e}	0.39 ^{a-d}	0.37^{a-d}	0.37 ^{ab}	0.40 ^{ab}	0.41 ^{ab}	0.39^{cd}
	M ₄	0.39 ^a	0.45 ^a	0.48 ^a	0.44	0.36 ^{a-e}	0.39 ^{a-d}	0.40 ^{a-c}	0.38^{a-c}	0.38 ^{ab}	0.42 ^{ab}	0.44 ^a	0.41^{ab}
S ₃	M ₁	0.41 ^a	0.40 ^a	0.49 ^a	0.43	0.32 ^{de}	0.30 ^e	0.33 ^{c-e}	0.32^e	0.36 ^{a-c}	0.35 ^{bc}	0.41 ^{ab}	0.37^{de}
	M ₂	0.41 ^a	0.43 ^a	0.45 ^a	0.43	0.33 ^{c-e}	0.34 ^{b-e}	0.34 ^{b-e}	0.34^{de}	0.37 ^{ab}	0.38 ^{ab}	0.39 ^{ab}	0.38^{de}
	M ₃	0.46 ^a	0.47 ^a	0.44 ^a	0.46	0.36 ^{a-e}	0.35 ^{a-e}	0.37 ^{a-e}	0.36^{b-d}	0.41 ^{ab}	0.41 ^{ab}	0.40 ^{ab}	0.41^{ab}
	M ₄	0.37 ^a	0.46 ^a	0.19 ^b	0.34	0.40 ^{a-c}	0.38 ^{a-d}	0.40 ^{a-c}	0.39^{ab}	0.39 ^{ab}	0.42 ^{ab}	0.29 ^c	0.37^e
Variety		0.41^a	0.45^a	0.42^a		0.36^a	0.36^a	0.36^a		0.38^a	0.40^a	0.39^a	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	0.41 ^{ab}	0.45 ^a	0.43 ^{ab}	0.43^a	0.36 ^{a-c}	0.38 ^a	0.36 ^{a-c}	0.37^a	0.39 ^{ab}	0.41 ^a	0.39 ^{ab}	0.40^a
	S ₂	0.40 ^{ab}	0.45 ^a	0.45 ^a	0.43^a	0.35 ^{bc}	0.36 ^{a-c}	0.37 ^{ab}	0.36^{ab}	0.38 ^b	0.41 ^a	0.41 ^a	0.40^a
	S ₃	0.41 ^{ab}	0.44 ^{ab}	0.39 ^b	0.41^a	0.35 ^{bc}	0.34 ^c	0.36 ^{a-c}	0.35^b	0.38 ^b	0.39 ^{ab}	0.38 ^b	0.38^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	0.42 ^{ab}	0.43 ^{ab}	0.44 ^{ab}	0.43^a	0.33 ^d	0.33 ^d	0.34 ^{cd}	0.33^d	0.38 ^{de}	0.38 ^{de}	0.39 ^{cd}	0.38^c
	M ₂	0.40 ^{ab}	0.45 ^a	0.45 ^a	0.43^a	0.34 ^{cd}	0.35 ^{cd}	0.35 ^{cd}	0.35^c	0.37 ^e	0.40 ^{bc}	0.40 ^{bc}	0.39^b
	M ₃	0.42 ^{ab}	0.45 ^a	0.43 ^{ab}	0.43^a	0.36 ^{b-d}	0.37 ^{a-c}	0.37 ^{a-c}	0.37^b	0.39 ^{cd}	0.41 ^{ab}	0.40 ^{bc}	0.40^a
	M ₄	0.39 ^{ab}	0.45 ^a	0.37 ^b	0.40^a	0.39 ^{ab}	0.40 ^a	0.39 ^{ab}	0.39^a	0.39 ^{cd}	0.42 ^a	0.38 ^{de}	0.40^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.02				0.01				0.01			
Seed (S)		0.01				0.01				0.01			
Micro (M)		0.01				0.01				0.01			
V x S		0.02				0.01				0.01			
V x M		0.02				0.01				0.01			
S x M		0.02				0.01				0.01			
V x S x M		0.01				0.02				0.02			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

0501 with lower seed rate of 25 kg ha⁻¹ (0.38 each). Variety X micronutrient also varied significantly wherein cv. MTU 1010 receiving FeSO₄ + ZnSO₄ (V₂M₄) recorded higher grain K (0.42) and was on par with V₂M₃, while in the absence of micronutrient application K content in grain decreased and so was cv. GGV 0501 with FeSO₄ (V₁M₂) (0.37). Similarly, interactions due to seed rates and micronutrients were significant, wherein 25 kg seed rate with application of FeSO₄ + ZnSO₄ (S₁ M₄) recorded higher K content in grain (0.42) and it was at par with S₂M₄, while 35 kg ha⁻¹ seed rate with both FeSO₄ + ZnSO₄ (S₃M₄) recorded lower K content in grain (0.37).

Among V x S x M, significantly higher K content in grain (0.44) was observed with cv. BPT 5204 sown with 30 kg seed rate and applied with both FeSO₄ + ZnSO₄ (V₂S₂M₄), while the lowest K content in grain (0.29) was recorded with cv. BPT 5204 sown using 35 kg ha⁻¹ seed rate and supplied with both micronutrients (V₁S₃M₄) among all.

4.1.1.3.4 Grain iron (mg kg⁻¹) (c.f. Table 58)

Significant variations in grain iron (Fe) contents were revealed due to cultivars, seed rates and use of micronutrients and their interactions during both the years and on pooled basis as well.

Of the three cultivars, MTU 1010 (V₂) recorded significantly higher Fe (50.82) content in grain followed by cvs. GGV 0501 and BPT-5204, (33.00 and 27.17, respectively); among seed rates higher Fe content in grain was recorded with 35 kg ha⁻¹ seed rate followed by 30 kg ha⁻¹ which was on par while lower Fe occurred with 25 kg ha⁻¹ seed rate, and among the micronutrients levels combined application FeSO₄ + ZnSO₄ to soil and to the foliage resulted in higher Fe content in grain (41.54) while no application of micronutrient (M₁) recorded significantly lower Fe content in grain (31.69).

Interactions due two factor combinations were significant wherein among V x S cv. MTU 1010 at 30 and 25 kg ha⁻¹ seed rate (V₂S_{1&2}) recorded higher Fe content in grain (53.06 and 51.99, respectively) which were at par, while the lower content was recorded with cv. BPT 5204 with lower seed rate of 25kg ha⁻¹ (V₃S₁) (21.64). Effects due to variety X micronutrient were significant, in that cv. MTU 1010 with combined application of FeSO₄ + ZnSO₄ (V₂M₄) recorded higher Fe content (60.13). In the absence

Table 58. Effect of genotypes, seed rates and micronutrients on grain iron content (mg kg⁻¹) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	32.19 ^{e-j}	54.72 ^c	25.0 ^{ij}	37.30^d	14.78 ^{g-i}	26.44 ^{c-g}	13.63 ^{hi}	18.28^e	23.49 ^{k-n}	40.58 ^{c-e}	19.31 ⁿ	27.79
	M ₂	32.53 ^{e-j}	56.46 ^{bc}	25.00 ^{ij}	38.00^{cd}	31.96 ^{c-f}	33.53 ^{c-f}	14.40 ^{g-i}	26.63^d	32.25 ^{e-j}	45.00 ^{b-d}	19.70 ^{mn}	32.32
	M ₃	32.65 ^{e-j}	65.72 ^{ab}	24.00 ^j	40.79^{b-d}	36.20 ^{b-d}	45.52 ^b	29.40 ^{c-f}	37.04^{a-c}	34.43 ^{e-i}	60.62 ^{ab}	19.97 ^{mn}	38.34
	M ₄	33.22 ^{e-j}	66.00 ^{ab}	23.58 ^j	40.93^{b-d}	32.10 ^{c-f}	57.56 ^a	31.55 ^{c-f}	40.40^a	32.66 ^{e-j}	61.78 ^{ab}	27.57 ^{h-m}	40.67
S ₂	M ₁	35.05 ^{e-j}	72.29 ^a	24.98 ^{ij}	44.11^{a-c}	7.6 ⁱ	21.86 ^{f-h}	26.33 ^{c-g}	18.60^e	21.36 ^{l-n}	47.08 ^{bc}	25.66 ^{j-n}	31.37
	M ₂	35.41 ^{e-j}	74.80 ^a	26.53 ^{hij}	45.58^{ab}	26.26 ^{c-g}	22.45 ^{e-h}	31.99 ^{c-f}	26.90^d	30.83 ^{f-k}	48.63 ^b	29.26 ^{f-l}	36.24
	M ₃	36.64 ^{e-i}	75.00 ^a	27.87 ^{g-j}	46.50^{ab}	37.55 ^{bc}	24.85 ^{c-h}	37.01 ^{bc}	33.14^{b-d}	37.09 ^{e-g}	49.93 ^b	32.44 ^{e-j}	39.82
	M ₄	37.21 ^{e-h}	75.00 ^a	29.60 ^{f-j}	47.27^{ab}	31.73 ^{c-f}	58.21 ^a	28.01 ^{c-f}	39.32^{ab}	34.47 ^{e-i}	66.00 ^a	28.80 ^{g-l}	43.09
S ₃	M ₁	38.44 ^{d-g}	67.75 ^a	29.60 ^{f-j}	45.26^{ab}	32.33 ^{c-f}	23.97 ^{d-h}	23.38 ^{e-h}	26.56^d	35.39 ^{e-h}	45.86 ^{bc}	26.49 ⁱ⁻ⁿ	35.91
	M ₂	42.16 ^{de}	67.76 ^a	30.04 ^{f-j}	46.65^{ab}	33.02 ^{c-f}	25.21 ^{c-h}	29.40 ^{c-f}	29.21^d	37.59 ^{d-f}	46.49 ^{bc}	29.72 ^{f-k}	37.93
	M ₃	40.40 ^{d-f}	68.41 ^a	31.00 ^{e-j}	46.60^{ab}	32.40 ^{c-f}	32.14 ^{c-f}	29.84 ^{c-f}	31.46^{cd}	36.40 ^{e-g}	50.27 ^b	30.42 ^{f-k}	39.03
	M ₄	48.11 ^{cd}	68.91 ^a	30.00 ^{f-j}	49.01^a	32.00 ^{c-f}	35.10 ^{b-e}	29.86 ^{c-f}	32.32^{cd}	40.05 ^{c-e}	52.00 ^b	29.93 ^{f-k}	40.66
Variety		37.00^b	67.74^a	27.27^b		28.99^b	33.90^a	27.07^c		33.00^b	51.19^a	26.61^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	32.65 ^g	60.72 ^d	24.39 ^b	39.25^b	28.76 ^d	43.26 ^a	18.88 ^f	30.30^a	30.71 ^d	51.99 ^a	21.64 ^e	34.78^b
	S ₂	36.08 ^f	74.27 ^c	27.25 ^h	45.87^a	25.80 ^e	31.85 ^{bc}	30.84 ^c	29.50^a	30.94 ^d	53.06 ^a	29.04 ^d	37.68^a
	S ₃	42.28 ^e	68.21 ^a	30.16 ^{gh}	46.88^a	32.44 ^b	29.10 ^d	28.12 ^d	29.89^a	37.36 ^c	48.66 ^b	29.14 ^d	38.39^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	35.23 ^b	64.92 ^a	26.653 ^c	42.27^a	18.26 ^g	24.09 ^{e-g}	21.11 ^{fg}	21.15^d	26.75 ^{ef}	44.50 ^c	23.82 ^f	31.69^d
	M ₂	36.70 ^b	66.34 ^a	27.19 ^c	43.41^a	30.41 ^{c-e}	27.06 ^{d-f}	25.26 ^{d-f}	27.58^c	33.56 ^d	46.70 ^c	26.23 ^{ef}	35.50^c
	M ₃	36.56 ^b	69.71 ^a	27.62 ^c	44.63^a	35.38 ^{bc}	37.50 ^b	27.59 ^{d-f}	33.49^b	35.97 ^d	53.61 ^b	27.61 ^{ef}	39.06^b
	M ₄	39.52 ^b	69.97 ^a	27.73 ^c	45.74^a	31.94 ^{b-d}	50.29 ^a	29.81 ^{c-e}	37.35^a	35.73 ^d	60.13 ^a	28.77 ^e	41.54^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		2.81				0.27				1.54			
Seed (S)		0.64				0.27				0.34			
Micro (M)		0.15				1.21				0.83			
V x S		1.11				0.48				0.58			
V x M		1.99				2.11				1.44			
S x M		1.99				2.11				1.44			
V x S x M		3.45				365				2.50			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

of micronutrient application iron content in grain decreased and recorded lower Fe content in grain with cv. BPT 5204 (V_3M_1) (23.82). Similarly, interactions due to seed rates and micronutrients were significant, wherein 35 kg seed rate with application of $FeSO_4 + ZnSO_4$ (S_3M_4) recorded higher Fe content in grain (43.29), while 25 kg ha⁻¹ seed rate without supplementation of micronutrient (S_1M_1) recorded lower iron content in grain (27.79).

Overall in the three way interactions, significantly higher Fe content in grain (66.00) occurred with cv. MTU 1010 sown using 30 kg seed rate and supplied with both $FeSO_4 + ZnSO_4$ ($V_2S_2M_4$) and it was at par with $V_2S_1M_{3-4}$, while the lowest Fe content in grain (19.31) was recorded with cvs. BPT 5204 sown using 25 kg ha⁻¹ seed rate and supplied with no micronutrient ($V_3S_1M_1$) among all.

4.1.1.3.5 Grain zinc (mg kg⁻¹) (c.f. Table 59)

Zinc (Zn) content in grain varied significantly due to cultivars, and use of micronutrients and their interactions except main effects due to seed rates during both the years and on pooled basis as well.

MTU 1010 (V_2) among cultivars recorded significantly higher (16.03) Zn content in grain followed by cvs. GGV 0501 and BPT 5204 (15.02 and 13.27, respectively); similarly, among micronutrients combined application $FeSO_4 + ZnSO_4$ to soil and to the foliage (M_4) resulted in higher Zn content (15.81) which was on par with M_3 , while no application of micronutrient (M_1) recorded significantly lower Zn content in grain (13.78).

Interactions between variety and seed rate were significant, cv. MTU 1010 at 30 kg ha⁻¹ seed rate (V_2S_2) recorded higher Zn content (17.78) while lower Zn content in grain was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha⁻¹ (V_3S_1) (12.91). Variety X micronutrient revealed significant variations, in that cv. MTU 1010 with combined application of $FeSO_4 + ZnSO_4$ (V_2M_4) recorded higher Zn in grain (17.51). In the absence of micronutrient application Zn content in grain decreased and recorded lower Zn content in grain with cv. BPT 5204 (V_3M_1) (12.45). Similarly, interactions due to seed rates and micronutrients were significant, wherein 30 kg seed rate with application of $FeSO_4 + ZnSO_4$ (S_2M_4) recorded higher Zn content in grain (17.32) and it was at par with S_2M_3 , while 25 kg ha⁻¹ seed rate without supplementation of micronutrient (S_1M_1) recorded lower Zn content in grain (13.31).

Table 59. Effect of genotypes, seed rates and micronutrients on grain zinc content (mg kg⁻¹) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	15.33 ^b	16.46 ^b	12.92 ^b	14.90^d	13.70 ^a	11.24 ^{bc}	10.23 ^c	11.72^{ab}	14.51 ^{b-d}	13.85 ^{b-d}	11.57 ^d	13.31^c
	M ₂	15.33 ^b	16.46 ^b	13.52 ^b	15.10^d	14.16 ^{bc}	12.33 ^{bc}	10.38 ^{bc}	12.29^{ab}	14.75 ^{b-d}	14.39 ^{b-d}	11.95 ^{cd}	13.70^c
	M ₃	15.65 ^b	16.80 ^b	13.79 ^b	15.41^d	14.37 ^{bc}	12.59 ^{bc}	14.02 ^{bc}	13.66^{ab}	15.01 ^{b-d}	14.69 ^{b-d}	13.91 ^{b-d}	14.54^{bc}
	M ₄	15.84 ^b	17.25 ^b	13.52 ^b	15.54^d	14.93 ^{bc}	13.46 ^{bc}	14.90 ^{bc}	14.43^a	15.39 ^{b-d}	15.35 ^{b-d}	14.21 ^{b-d}	14.98^{bc}
S ₂	M ₁	16.39 ^b	18.00 ^b	14.97 ^b	16.45^d	14.07 ^{bc}	10.32 ^c	10.08 ^c	11.49^b	15.23 ^{b-d}	14.16 ^{b-d}	12.53 ^{b-d}	13.97^c
	M ₂	17.30 ^b	19.35 ^b	14.97 ^b	17.21^{cd}	14.24 ^{bc}	10.39 ^{bc}	11.72 ^{bc}	12.12^{ab}	15.77 ^{b-d}	14.87 ^{b-d}	13.35 ^{b-d}	14.66^{bc}
	M ₃	17.30 ^b	28.81 ^a	14.97 ^b	20.36^{bc}	14.46 ^{bc}	11.31 ^{bc}	11.79 ^{bc}	12.52^{ab}	15.88 ^{bc}	20.06 ^{ab}	13.38 ^{b-d}	16.44^{ab}
	M ₄	17.37 ^b	30.00 ^a	15.00 ^b	20.79^b	15.58 ^b	14.03 ^{bc}	11.92 ^{bc}	13.84^{ab}	16.47 ^b	22.02 ^a	13.46 ^{b-d}	17.32^a
S ₃	M ₁	15.84 ^b	17.25 ^b	14.04 ^b	15.71^d	10.62 ^{bc}	14.21 ^{bc}	12.45 ^{bc}	12.43^{ab}	13.23 ^{b-d}	15.73 ^{b-d}	13.25 ^{b-d}	14.07^c
	M ₂	16.00 ^b	17.36 ^b	14.00 ^b	15.79^d	11.94 ^{bc}	14.44 ^{bc}	12.48 ^{bc}	12.95^{ab}	13.97 ^{b-d}	15.90 ^{bc}	13.24 ^{b-d}	14.37^{bc}
	M ₃	16.30 ^b	17.36 ^b	14.47 ^b	16.04^d	12.83 ^{bc}	14.93 ^{bc}	12.74 ^{bc}	13.50^{ab}	14.57 ^{b-d}	16.14 ^{bc}	13.61 ^{b-d}	14.77^{bc}
	M ₄	16.30 ^b	16.75 ^b	14.59 ^b	15.88^d	14.67 ^{bc}	13.54 ^{bc}	14.86 ^{bc}	14.36^{ab}	15.48 ^{b-d}	15.15 ^{b-d}	14.72 ^{b-d}	15.12^{bc}
Variety		16.25^b	19.32^a	14.23^c		13.80^a	12.73^{ab}	12.30^b		15.02^b	16.03^a	13.27^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	15.54 ^b	16.74 ^b	13.44 ^b	15.24^b	14.29 ^a	12.40 ^a	12.38 ^a	13.02^a	14.91 ^{ab}	14.57 ^{ab}	12.91 ^b	14.13^a
	S ₂	17.09 ^b	24.04 ^a	14.98 ^b	18.70^a	14.59 ^a	11.51 ^a	11.38 ^a	12.49^a	15.84 ^{ab}	17.78 ^a	13.18 ^b	15.60^a
	S ₃	16.11 ^b	17.18 ^b	14.27 ^b	15.85^b	12.51 ^a	14.28 ^a	13.13 ^a	13.31^a	14.31 ^{ab}	15.73 ^{ab}	13.70 ^{ab}	14.58^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	15.85 ^{bc}	17.23 ^{bc}	13.98 ^c	15.69^a	12.80 ^{a-c}	11.92 ^{bc}	10.92 ^c	11.88^b	14.32 ^{c-e}	14.58 ^{c-e}	12.45 ^e	13.78^c
	M ₂	16.21 ^{bc}	17.72 ^b	14.17 ^{bc}	16.03^a	13.45 ^{a-c}	12.39 ^{a-c}	11.53 ^{bc}	12.46^b	14.83 ^{b-d}	15.05 ^{b-d}	12.85 ^{de}	14.24^{bc}
	M ₃	16.42 ^{bc}	20.99 ^a	14.41 ^{bc}	17.27^a	13.89 ^{ab}	12.94 ^{a-c}	12.85 ^{a-c}	13.23^{ab}	15.15 ^{bc}	16.96 ^{ab}	13.63 ^{c-e}	15.25^{ab}
	M ₄	16.50 ^{bc}	21.23 ^a	14.37 ^{bc}	17.37^a	15.06 ^a	13.68 ^{a-c}	13.89 ^{ab}	14.21^a	15.78 ^{a-c}	17.51 ^a	14.13 ^{c-e}	15.81^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.37				0.28				0.12			
Seed (S)		0.77				0.73				0.74			
Micro (M)		0.64				0.49				0.40			
V x S		1.34				1.27				1.28			
V x M		1.11				0.86				0.69			
S x M		1.11				0.86				0.69			
V x S x M		1.93				1.48				1.20			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Of the three way interactions, significantly higher Zn content in grain (22.02) was observed with cv.MTU 1010 sown with 30 kg seed rate and applied with both $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_2S_2M_4$) and it was at par with $V_2S_2M_3$, while the lower Zn content in grain (11.57) was recorded with cvs. BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micro nutrient ($V_1S_1M_1$) among all.

4.1.1.3.6 Grain copper (mg kg^{-1}) (c.f. Table 60)

Copper (Cu) content in grain varied significantly due to cultivars, seed rates and use of micronutrients and their interactions; during both the years and on pooled basis as well.

Among the varieties, cv.MTU 1010 (V_2) recorded significantly higher Cu (2.56) followed by cvs. GGV 0501 and BPT 5204 (1.71 and 1.21); among seed rates, significantly higher copper (Cu) was recorded with 35 kg of seed rate (S_3 - 2.12) and lower Cu was recorded with seed rate of 25 kg (S_1 - 1.57) and among levels of micronutrients combined application $\text{FeSO}_4 + \text{ZnSO}_4$ to soil and to the foliage (M_4) resulted in higher content in grain (1.98), while no application of micronutrient (M_1) recorded significantly lower Cu in grain (1.65).

Interactions between variety and seed rate were significant; among these cv. MTU 1010 at 30 kg ha^{-1} seed rate (V_2S_2) recorded higher Cu content in grain (2.70); while the lower Cu (0.88) content in grain was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha^{-1} (V_3S_1). Variety X micronutrient also revealed significant variations, in that cv.MTU 1010 with combined application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_2M_4) recorded higher Cu content in grain (2.72) and it was on par with V_2M_3 . In the absence of micronutrient application, Cu content in grain decreased and recorded lower Cu content in grain with cv. BPT 5204 (V_3M_1) (1.04). Similarly, interactions due to seed rates and micronutrients were significant, wherein 35 kg seed rate with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_3M_4) recorded higher Cu content in grain (2.25) and it was at par with S_2M_{2-3} , while 25 kg ha^{-1} seed rates without supplementation of micronutrient irrespective of seed rates (S_1M_1) recorded lower Cu content in grain, particularly with lower seed rate (1.35).

Overall, the three way interaction revealed significantly higher Cu content in grain (2.1) with cv. MTU 1010 sown with 35 kg seed rate and applied with FeSO_4

Table 60. Effect of genotypes, seed rates and micronutrients on grain copper content (mg kg⁻¹) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	1.30 ^{g-i}	3.22 ^{cd}	0.16 ^m	1.56^h	1.44 ^{g-j}	1.15 ^{k-n}	0.83 ^o	1.14^f	1.37 ^{i-k}	2.19 ^{fg}	0.49 ^m	1.35^f
	M ₂	1.41 ^{gh}	3.22 ^{cd}	0.25 ^m	1.63^{gh}	1.21 ^{j-n}	1.55 ^{d-h}	1.74 ^{cd}	1.50^{cd}	1.31 ^{jk}	2.39 ^{ef}	1.00 ^l	1.57^e
	M ₃	1.61 ^{fg}	3.22 ^{cd}	0.25 ^m	1.69^{gh}	1.10 ^{l-n}	1.74 ^{cd}	1.76 ^{a-d}	1.53^{cd}	1.35 ^{i-k}	2.48 ^{b-e}	1.01 ^l	1.61^e
	M ₄	1.61 ^{fg}	3.55 ^{bc}	0.32 ^{lm}	1.83^{fg}	1.48 ^{e-i}	1.83 ^{a-c}	1.73 ^{cd}	1.68^{ab}	1.54 ^{h-j}	2.69 ^{ab}	1.02 ^l	1.75^{cd}
S ₂	M ₁	2.03 ^{ef}	3.62 ^{bc}	0.44 ^{lm}	2.03^{ef}	1.31 ^{i-l}	1.10 ^{l-n}	1.65 ^{c-g}	1.35^e	1.67 ^h	2.36 ^{ef}	1.04 ^l	1.69^{de}
	M ₂	2.03 ^{ef}	3.64 ^{bc}	0.59 ^{k-m}	2.09^e	1.01 ^{no}	1.19 ^{k-n}	1.69 ^{c-f}	1.30^e	1.52 ^{h-j}	2.42 ^{d-f}	1.14 ^{kl}	1.69^{de}
	M ₃	2.10 ^e	3.65 ^{bc}	0.73 ^{j-l}	2.16^{de}	1.28 ^{i-m}	1.69 ^{c-f}	1.72 ^{cd}	1.56^{bc}	1.69 ^h	2.67 ^{a-c}	1.23 ^{kl}	1.86^{bc}
	M ₄	2.10 ^e	3.65 ^{bc}	0.91 ^{i-k}	2.22^{de}	1.34 ^{h-k}	1.72 ^{cd}	1.82 ^{a-c}	1.63^{a-c}	1.72 ^h	2.69 ^{ab}	1.37 ^{i-k}	1.93^b
S ₃	M ₁	2.10 ^e	3.85 ^{ab}	1.14 ^{h-j}	2.36^{cd}	1.05 ^{mn}	1.21 ^{j-n}	1.35 ^{h-k}	1.42^{de}	1.58 ^{hi}	2.53 ^{b-e}	1.57 ^{hi}	1.89^b
	M ₂	2.40 ^e	4.19 ^a	1.14 ^{h-j}	2.58^{bc}	1.67 ^{c-g}	1.44 ^{g-j}	1.99 ^a	1.70^a	2.04 ^g	2.81 ^a	1.57 ^{hi}	2.14^a
	M ₃	2.93 ^d	4.19 ^a	1.14 ^{h-j}	2.75^{ab}	1.75 ^{b-d}	1.14 ^{k-n}	1.98 ^{ab}	1.62^{a-c}	2.34 ^{ef}	2.66 ^{a-d}	1.56 ^{h-j}	2.19^a
	M ₄	3.17 ^{cd}	4.10 ^a	1.24 ^{g-i}	2.84^a	1.70 ^{c-e}	1.46 ^{f-i}	1.86 ^{a-c}	1.67^{ab}	2.43 ^{c-f}	2.78 ^a	1.55 ^{h-j}	2.25^a
Variety		2.07^b	3.68^a	0.69^c		1.36^b	1.44^b	1.68^a		1.71^b	2.56^a	1.21^c	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	1.48 ^f	3.30 ^c	0.25 ⁱ	1.68^c	1.31 ^e	1.57 ^c	1.52 ^c	1.47^b	1.39 ^g	2.44 ^c	0.88 ⁱ	1.57^c
	S ₂	2.07 ^e	3.64 ^b	0.67 ^h	2.13^b	1.23 ^e	1.42 ^d	1.72 ^b	1.46^b	1.65 ^e	2.53 ^b	1.19 ^h	1.79^b
	S ₃	2.65 ^d	4.08 ^a	1.17 ^g	2.63^a	1.54 ^c	1.31 ^e	1.96 ^a	1.60^a	2.10 ^d	2.70 ^a	1.56 ^f	2.12^a
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M	M ₁	1.81 ^c	3.56 ^a	0.58 ^d	1.98^c	1.26 ^{fg}	1.15 ^g	1.49 ^{cd}	1.30^d	1.54 ^e	2.36 ^c	1.04 ^g	1.65^d
	M ₂	1.95 ^c	3.68 ^a	0.66 ^d	2.10^{bc}	1.30 ^{ef}	1.39 ^{de}	1.81 ^a	1.50^c	1.62 ^e	2.54 ^b	1.23 ^f	1.80^c
	M ₃	2.21 ^b	3.69 ^a	0.71 ^d	2.20^{ab}	1.38 ^{d-f}	1.52 ^c	1.82 ^a	1.57^b	1.79 ^d	2.61 ^{ab}	1.27 ^f	1.89^b
	M ₄	2.29 ^b	3.77 ^a	0.82 ^d	2.29^a	1.50 ^{cd}	1.67 ^b	1.80 ^a	1.66^a	1.90 ^d	2.72 ^a	1.31 ^f	1.98^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.04				0.03				0.03			
Seed (S)		0.04				0.01				0.02			
Micro (M)		0.05				0.02				0.03			
V x S		0.07				0.03				0.03			
V x M		0.08				0.04				0.04			
S x M		0.08				0.04				0.04			
V x S x M		0.14				0.07				0.08			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

(V₂S₃M₂) followed by V₂S₃M₄ and was at par with V₂S₁₋₂M₃₋₄, while lower Cu content in grain (0.49) was recorded with cv. BPT 5204 sown using 25 kg ha⁻¹ seed rate and supplied with no micro nutrient (V₃S₁M₁) among all.

4.1.1.3.7 Grain manganese (mg kg⁻¹) (c.f. Table 61)

Variation in manganese (Mn) content in grain due to cultivars, seed rates and use of micronutrients and their interactions were significant during both the years and on pooled basis as well.

MTU 1010 (V₂) recorded significantly higher (38.92) Mn content in grain followed by cvs.GGV 0501 (V₁) and BPT 5204(V₃) (32.02 and 23.13, respectively) among cultivars; significantly higher (33.26) Mn content was recorded with 30 kg ha⁻¹ of seed rate (S₂) and lower content (28.53) was recorded with 25 kg ha⁻¹ (S₁) among seed rates, and combined application FeSO₄+ZnSO₄ to soil and to the foliage (M₄) resulted in higher Mn content in grain (31.99), while no application of micronutrient (M₁) recorded significantly lower Mn content in grain (30.01) among micronutrient levels.

Interactions between variety and seed rate were significant, cv. MTU 1010 at 30 kg ha⁻¹ seed rate (V₂S₂) recorded higher Mn content in grain (40.85); while the lower Mn content was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha⁻¹ (V₃S₁) (19.91). Variety X micronutrient, FeSO₄ + ZnSO₄ (V₂M₄) recorded higher Mn content (39.56) and it was on par with V₂M₃, while lower Mn content was observed with cv. BPT 5204 (V₃M₁) (21.79). Similarly, interactions due to seed rates and micronutrients were significant, wherein 30 kg seed rate with application of FeSO₄ + ZnSO₄ (S₂M₄) recorded higher Mn content in grain (34.17) and it was at par with S₂M₃, while 25 kg ha⁻¹ seed rate without supplementation of micronutrient (S₁M₁) recorded lower Mn content in grain (27.18).

Overall, the three way interaction revealed significantly higher Mn content (41.31) with cv. MTU 1010 sown using 30 kg seed rate and applied with both FeSO₄ + ZnSO₄ (V₂S₂M₄) which was at par with V₂S₁₋₃M₃₋₄, while lower Mn content (19.32) was recorded with cv. BPT 5204 sown using 25 kg ha⁻¹ seed rate but with no micro nutrient (V₁S₁ M₁).

(mg kg⁻¹) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	28.62 ^{i-m}	34.99 ^{d-g}	20.01 ^p	27.87^g	27.24 ^{jk}	33.61 ^{e-g}	18.63 ^p	26.49^h	27.93 ^{gh}	34.30 ^{ef}	19.32 ^o	27.18ⁱ
	M ₂	29.91 ^{h-l}	36.76 ^{c-g}	20.39 ^p	29.02^{fg}	28.53 ^{ij}	35.38 ^{d-f}	19.01 ^p	27.64^{gh}	29.22 ^g	36.07 ^{de}	19.70 ^{no}	28.33^{hi}
	M ₃	30.34 ^{h-k}	37.09 ^{b-f}	20.56 ^p	29.33^{fg}	28.96 ^{h-j}	35.51 ^{c-e}	21.04 ^{n-p}	28.50^{gh}	33.10 ^f	41.10 ^{ab}	26.13 ^{h-j}	33.44^{gh}
	M ₄	32.43 ^{g-j}	38.10 ^{a-e}	21.42 ^{op}	30.65^{ef}	31.05 ^{g-i}	36.72 ^{b-d}	20.04 ^{op}	29.27^{fg}	31.74 ^f	37.41 ^{cd}	20.73 ^{m-o}	29.96^{fg}
S ₂	M ₁	33.49 ^{f-h}	40.80 ^{a-c}	25.28 ^{m-o}	33.19^{a-d}	32.11 ^{gh}	39.42 ^{ab}	23.90 ^{l-n}	31.81^{a-d}	32.80 ^f	40.11 ^{ab}	24.59 ^{j-l}	32.50^{b-d}
	M ₂	33.60 ^{f-h}	41.55 ^{ab}	25.68 ^{l-o}	33.61^{a-c}	32.22 ^g	40.17 ^a	24.30 ^{k-m}	32.23^{a-c}	32.91 ^f	40.86 ^{ab}	24.99 ^{i-k}	32.92^{a-c}
	M ₃	33.79 ^{e-h}	41.79 ^a	26.82 ^{k-n}	34.13^{ab}	32.41 ^{fg}	40.41 ^a	25.44 ^{kl}	32.75^{ab}	33.10 ^f	41.10 ^{ab}	26.13 ^{h-j}	33.44^{ab}
	M ₄	34.32 ^{e-h}	42.00 ^a	28.25 ^{j-m}	34.86^a	32.94 ^{e-g}	40.62 ^a	26.87 ^{j-l}	33.48^a	33.63 ^{ef}	41.31 ^a	27.56 ^{g-i}	34.17^a
S ₃	M ₁	32.86 ^{f-i}	38.10 ^{a-e}	22.17 ^{op}	31.04^{d-f}	31.48 ^{g-i}	36.72 ^{b-d}	20.79 ^{op}	29.66^{ef}	32.17 ^f	37.41 ^{cd}	21.48 ^{m-o}	30.35^f
	M ₂	33.15 ^{f-h}	38.89 ^{a-d}	22.42 ^{op}	31.49^{c-f}	31.77 ^{gh}	37.51 ^{a-d}	21.04 ^{n-p}	30.11^{d-f}	32.46 ^f	38.20 ^{b-d}	21.73 ^{m-o}	30.80^{ef}
	M ₃	33.29 ^{f-h}	39.89 ^{a-c}	22.94 ^{n-p}	32.04^{b-e}	31.91 ^{gh}	38.51 ^{a-c}	21.56 ^{m-p}	30.66^{c-f}	32.60 ^f	39.20 ^{a-c}	22.25 ^{l-n}	31.35^{d-f}
	M ₄	33.32 ^{f-h}	40.63 ^{a-c}	23.66 ^{n-p}	32.54^{a-e}	31.94 ^{gh}	39.25 ^{ab}	22.28 ^{m-o}	31.16^{b-e}	32.63 ^f	39.94 ^{a-c}	22.97 ^{k-m}	31.85^{c-e}
Variety		32.43^b	39.22^a	23.30^c		31.05^b	37.82^a	22.08^c		32.02^b	38.92^a	23.13^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	30.33 ^e	36.73 ^c	20.60 ^h	29.22^c	28.95 ^e	35.35 ^c	19.22 ^g	27.84^c	29.64 ^d	36.04 ^h	19.91 ^g	28.53^c
	S ₂	33.80 ^d	41.54 ^a	26.51 ^f	33.95^a	32.42 ^d	40.16 ^a	25.13 ^f	32.57^a	33.11 ^c	40.85 ^a	25.82 ^e	33.26^a
	S ₃	33.16 ^d	39.38 ^b	22.80 ^g	31.78^b	31.78 ^d	38.00 ^b	21.42 ^d	30.40^b	32.47 ^c	38.69 ^b	22.11 ^f	31.09^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	31.66 ^b	37.97 ^a	22.48 ^c	30.70^b	30.28 ^c	36.59 ^b	21.10 ^e	29.32^c	30.97 ^d	37.28 ^b	21.79 ^f	30.01^c
	M ₂	32.22 ^b	39.07 ^a	22.83 ^c	31.37^{ab}	30.84 ^c	37.69 ^{ab}	21.45 ^{de}	29.99^{bc}	31.53 ^{cd}	38.28 ^{ab}	22.14 ^{ef}	30.65^{bc}
	M ₃	32.47 ^b	39.59 ^a	23.44 ^c	31.83^{ab}	31.09 ^c	38.21 ^{ab}	22.06 ^{de}	30.45^{ab}	31.78 ^{cd}	38.90 ^a	22.75 ^{ef}	31.14^b
	M ₄	33.36 ^b	40.25 ^a	24.44 ^c	32.68^a	31.98 ^c	38.87 ^a	23.06 ^d	31.30^a	32.67 ^c	39.56 ^a	23.75 ^e	31.99^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.48				0.28				0.28			
Seed (S)		0.39				0.28				0.24			
Micro (M)		0.46				0.32				0.28			
V x S		0.68				0.48				0.42			
V x M		0.79				0.56				0.49			
S x M		0.79				0.56				0.49			
V x S x M		1.37				0.97				0.84			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

4.1.1.3.8 Grain protein (%)(c.f. Table 62 and Fig. 9a)

Crude protein content in grain varied significantly due to cultivars, seed rates and use of micronutrients and their interactions during both the years and on pooled basis as well.

Among the varieties, cv. MTU 1010 (V_2) recorded significantly higher (7.47) protein content followed by cvs. BPT 5204(V_3) and GGV 0501 (V_1) both were at par (6.94 and 6.89,respectively); among seed rates higher protein content in grain (7.21 each) was recorded with medium and high seed rates of 30 and 35 kg ha⁻¹and both were at par; protein content in grain (6.88) decreased with lower seed rate (S_1), and among levels of micronutrients combined application FeSO₄ + ZnSO₄ to soil and to the foliage (M_4) resulted in higher protein content in grain (7.31) while no application of micronutrient (M_1) recorded significantly lower protein content in grain (6.89).

Interactions between variety and seed rate were significant wherein cv. MTU 1010 at 30 kg ha⁻¹seed rate (V_2S_2) recorded higher grain protein (7.60) and it at par with V_2S_3 ; while lower seed protein content (6.46) was recorded with cv. GGV 0501 with lower seed rate of 25 kg ha⁻¹ (V_1S_1), among variety X micronutrient cv. MTU 1010 with combined application of FeSO₄ + ZnSO₄ (V_2M_4) recorded higher protein content (7.76) and was on par with V_2M_3 , in the absence of micronutrient application protein content decreased irrespective of cultivars used and recorded lower protein content in grain with cv. BPT 5204 (V_3M_1) (6.66), and among seed rates and micronutrients medium seed rate of 30 kg ha⁻¹ with application of FeSO₄ + ZnSO₄ (S_2M_4) recorded higher protein content in grain (7.61) while 25 kg ha⁻¹seed rate without supplementation of micronutrient (S_1M_1) recorded lower grain protein (6.63).

The three way interaction also revealed significant variations wherein higher protein content (7.96) was observed with cv. MTU 1010 sown using 30 kg seed rate and supplied with both FeSO₄ + ZnSO₄ ($V_2S_2M_4$) and which was on par with $V_2S_1M_{3-4}$, $V_2S_2M_{2-3}$ and V_2SM_4 while lower protein content in grain (6.29) was recorded with cv. GGV 0501 sown using 25 kg ha⁻¹ seed rate but not supplied with micronutrient ($V_1S_1M_1$) among all.

(mg kg⁻¹) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	28.62 ^{i-m}	34.99 ^{d-g}	20.01 ^p	27.87^g	27.24 ^{jk}	33.61 ^{e-g}	18.63 ^p	26.49^h	27.93 ^{gh}	34.30 ^{ef}	19.32 ^o	27.18ⁱ
	M ₂	29.91 ^{h-l}	36.76 ^{c-g}	20.39 ^p	29.02^{fg}	28.53 ^{ij}	35.38 ^{d-f}	19.01 ^p	27.64^{gh}	29.22 ^g	36.07 ^{de}	19.70 ^{no}	28.33^{hi}
	M ₃	30.34 ^{h-k}	37.09 ^{b-f}	20.56 ^p	29.33^{fg}	28.96 ^{h-j}	35.51 ^{c-e}	21.04 ^{n-p}	28.50^{gh}	33.10 ^f	41.10 ^{ab}	26.13 ^{h-j}	33.44^{gh}
	M ₄	32.43 ^{g-j}	38.10 ^{a-e}	21.42 ^{op}	30.65^{ef}	31.05 ^{g-i}	36.72 ^{b-d}	20.04 ^{op}	29.27^{fg}	31.74 ^f	37.41 ^{cd}	20.73 ^{m-o}	29.96^{fg}
S ₂	M ₁	33.49 ^{f-h}	40.80 ^{a-c}	25.28 ^{m-o}	33.19^{a-d}	32.11 ^{gh}	39.42 ^{ab}	23.90 ^{l-n}	31.81^{a-d}	32.80 ^f	40.11 ^{ab}	24.59 ^{j-l}	32.50^{b-d}
	M ₂	33.60 ^{f-h}	41.55 ^{ab}	25.68 ^{l-o}	33.61^{a-c}	32.22 ^g	40.17 ^a	24.30 ^{k-m}	32.23^{a-c}	32.91 ^f	40.86 ^{ab}	24.99 ^{i-k}	32.92^{a-c}
	M ₃	33.79 ^{e-h}	41.79 ^a	26.82 ^{k-n}	34.13^{ab}	32.41 ^{fg}	40.41 ^a	25.44 ^{kl}	32.75^{ab}	33.10 ^f	41.10 ^{ab}	26.13 ^{h-j}	33.44^{ab}
	M ₄	34.32 ^{e-h}	42.00 ^a	28.25 ^{j-m}	34.86^a	32.94 ^{e-g}	40.62 ^a	26.87 ^{j-l}	33.48^a	33.63 ^{ef}	41.31 ^a	27.56 ^{g-i}	34.17^a
S ₃	M ₁	32.86 ^{f-i}	38.10 ^{a-e}	22.17 ^{op}	31.04^{d-f}	31.48 ^{g-i}	36.72 ^{b-d}	20.79 ^{op}	29.66^{ef}	32.17 ^f	37.41 ^{cd}	21.48 ^{m-o}	30.35^f
	M ₂	33.15 ^{f-h}	38.89 ^{a-d}	22.42 ^{op}	31.49^{e-f}	31.77 ^{gh}	37.51 ^{a-d}	21.04 ^{n-p}	30.11^{d-f}	32.46 ^f	38.20 ^{b-d}	21.73 ^{m-o}	30.80^{ef}
	M ₃	33.29 ^{f-h}	39.89 ^{a-c}	22.94 ^{n-p}	32.04^{b-e}	31.91 ^{gh}	38.51 ^{a-c}	21.56 ^{m-p}	30.66^{c-f}	32.60 ^f	39.20 ^{a-c}	22.25 ^{l-n}	31.35^{d-f}
	M ₄	33.32 ^{f-h}	40.63 ^{a-c}	23.66 ^{n-p}	32.54^{a-e}	31.94 ^{gh}	39.25 ^{ab}	22.28 ^{m-o}	31.16^{b-e}	32.63 ^f	39.94 ^{a-c}	22.97 ^{k-m}	31.85^{c-e}
Variety		32.43^b	39.22^a	23.30^c		31.05^b	37.82^a	22.08^c		32.02^b	38.92^a	23.13^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	30.33 ^e	36.73 ^c	20.60 ^h	29.22^c	28.95 ^e	35.35 ^c	19.22 ^g	27.84^c	29.64 ^d	36.04 ^h	19.91 ^g	28.53^c
	S ₂	33.80 ^d	41.54 ^a	26.51 ^f	33.95^a	32.42 ^d	40.16 ^a	25.13 ^f	32.57^a	33.11 ^c	40.85 ^a	25.82 ^e	33.26^a
	S ₃	33.16 ^d	39.38 ^b	22.80 ^g	31.78^b	31.78 ^d	38.00 ^b	21.42 ^d	30.40^b	32.47 ^c	38.69 ^b	22.11 ^f	31.09^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	31.66 ^b	37.97 ^a	22.48 ^c	30.70^b	30.28 ^c	36.59 ^b	21.10 ^e	29.32^c	30.97 ^d	37.28 ^b	21.79 ^f	30.01^c
	M ₂	32.22 ^b	39.07 ^a	22.83 ^c	31.37^{ab}	30.84 ^c	37.69 ^{ab}	21.45 ^{de}	29.99^{bc}	31.53 ^{cd}	38.28 ^{ab}	22.14 ^{ef}	30.65^{bc}
	M ₃	32.47 ^b	39.59 ^a	23.44 ^c	31.83^{ab}	31.09 ^c	38.21 ^{ab}	22.06 ^{de}	30.45^{ab}	31.78 ^{cd}	38.90 ^a	22.75 ^{ef}	31.14^b
	M ₄	33.36 ^b	40.25 ^a	24.44 ^c	32.68^a	31.98 ^c	38.87 ^a	23.06 ^d	31.30^a	32.67 ^c	39.56 ^a	23.75 ^e	31.99^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.48				0.28				0.28			
Seed (S)		0.39				0.28				0.24			
Micro (M)		0.46				0.32				0.28			
V x S		0.68				0.48				0.42			
V x M		0.79				0.56				0.49			
S x M		0.79				0.56				0.49			
V x S x M		1.37				0.97				0.84			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

4.1.1.4 Total nutrient uptake

4.1.1.4.1 Nitrogen uptake (kg ha^{-1}) (c.f. Table 63 and Fig. 9b)

Total N uptake by crop as influenced by cultivars, seed rates and use of micronutrients and their interactions varied significantly during both the years and on pooled basis as well.

Among the varieties, cv. MTU 1010 (V_2) recorded significantly higher N uptake (117.9) followed by cvs. GGV 0501 and BPT 5204 (92.0 and 86.0 respectively); among seed rates higher total N uptake (107.7) was recorded with 30 kg ha^{-1} seed rate while it was lower (88.0) with lower seed rate (S_1), and among levels of micronutrients N uptake was higher (115.0) with combined application $\text{FeSO}_4 + \text{ZnSO}_4$ while no application of micronutrient (M_1) recorded significantly lower N uptake (82.9).

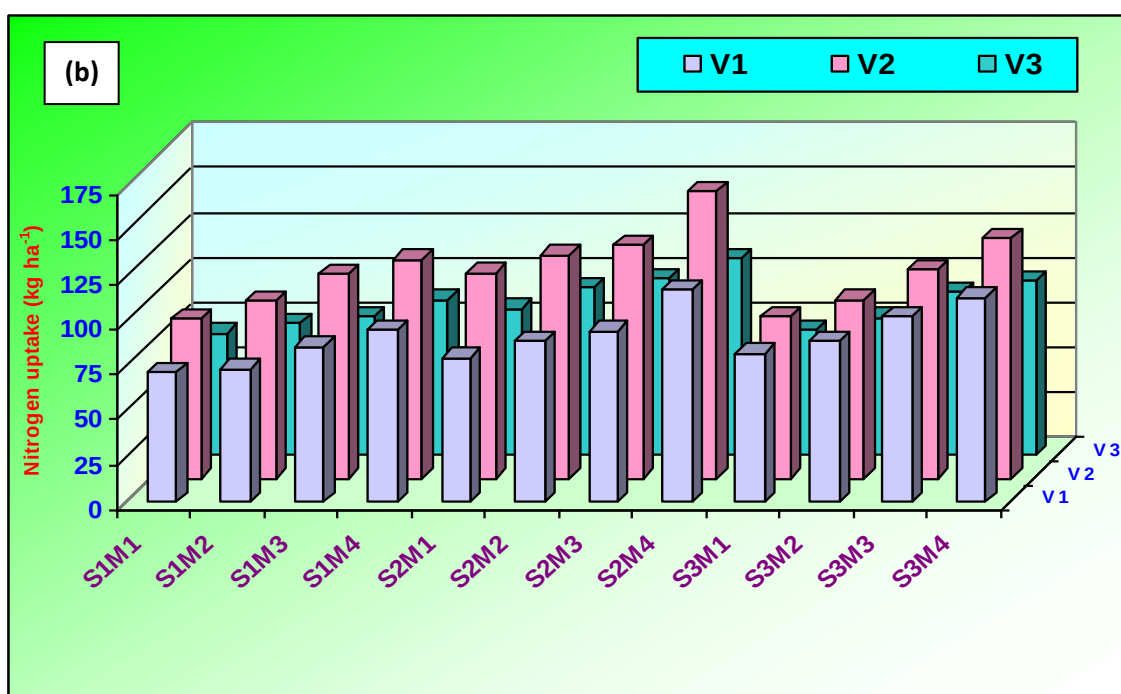
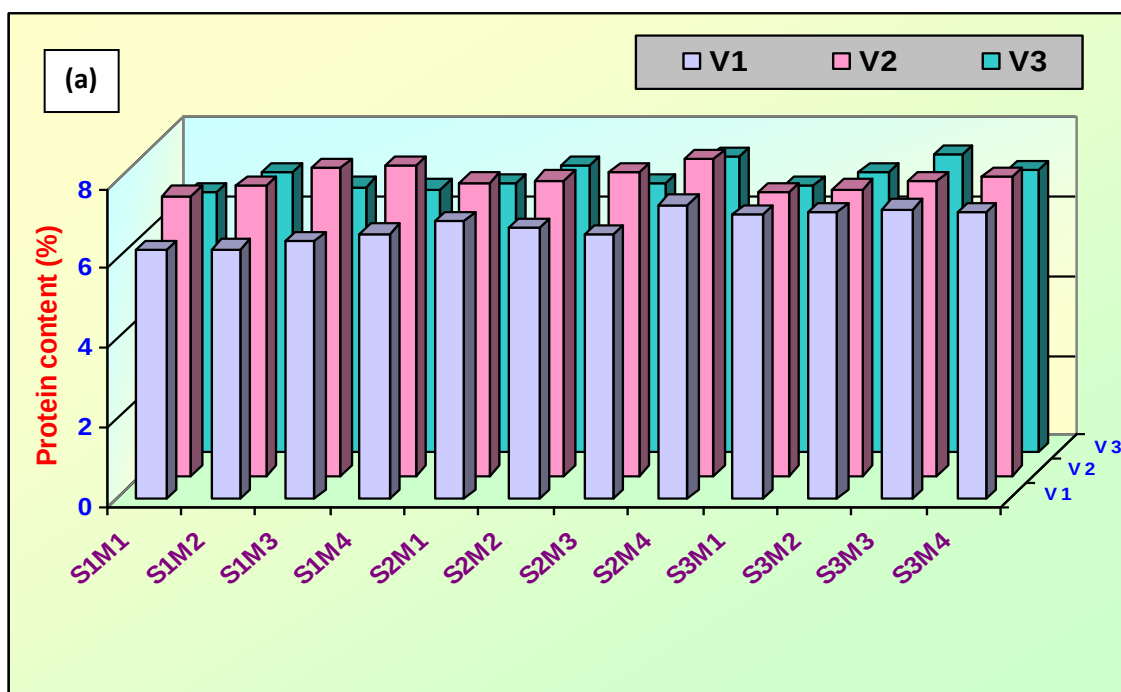
Interactions between variety and seed rate were significant, among all cv. MTU 1010 at 30 kg ha^{-1} seed rate (V_2S_2) recorded higher N uptake (132.0); while the lower uptake (75.7) occurred with cv. BPT 5204 with lower seed rate of 25 kg ha^{-1} (V_3S_1), in variety X micronutrient cv. MTU 1010 with combined application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_2M_4) recorded higher total nitrogen uptake (109.6) and was on par with V_1M_4 and V_2M_{2-3} , while lower N uptake (72.6) was observed with cv. BPT 5204 with no micronutrient supply (V_3M_1), and among seed rates X micronutrients 30 kg seed rate with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) recorded higher N uptake (129.0), while 25 kg ha^{-1} seed rate without supplementation of micronutrient (S_1M_1) recorded lower N uptake (76.3).

Among the three way interactions, significantly higher N uptake (159.5) was with cv. MTU 1010 sown with 30 kg seed rate and applied with both $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_2S_2M_4$), while the lower N uptake (67.5) was recorded with BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micro nutrient ($V_3S_1M_1$).

4.1.1.4.2 Phosphorus uptake (kg ha^{-1}) (c.f. Table 64 and Fig. 10a)

Total phosphorus uptake varied significantly due to cultivars, seed rates and use of micronutrients and their interactions during both the years and on pooled basis as well.

MTU 1010 (V_2) recorded significantly higher P uptake (24.5) followed by cvs. GGV 0501 (V_1) and BPT 5204 (V_3) (16.8 and 15.4, respectively); among seed rates



LEGEND	
Varieties:	V ₁ - GGV 0501, V ₂ - MTU 1010, V ₃ - BPT 5204;
Seed Rate:	S ₁ - 25 kg ha ⁻¹ , S ₂ - 30 kg ha ⁻¹ , S ₃ - 35 kg ha ⁻¹
Micronutrient:	M ₁ - Control, M ₂ - FeSO ₄ (Soil @ 25 kg ha ⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
	M ₃ - ZnSO ₄ (Soil @ 25 kg ha ⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
	M ₄ - FeSO ₄ + ZnSO ₄ (Each to soil @ 25 kg ha ⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

Fig. 9. Effect of genotypes, seed rates and micronutrients on (a) grain protein content (%) and nitrogen uptake (kg ha⁻¹) under direct seeded condition during rainy season

Table 63. Effect of genotypes, seed rates and micronutrients on nitrogen uptake (kg ha⁻¹) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	95.7 ^{k-n}	102.7 ^{i-m}	86.8 ^{n-p}	95.1^e	48.9 ^m	75.5 ^{h-l}	48.2 ^m	57.5^f	72.3 ^{pq}	89.1 ^{i-m}	67.5 ^q	76.3^q
	M ₂	100.7 ^{j-m}	105.4 ^{i-l}	82.6 ^{op}	96.2^e	47.9 ^m	91.5 ^{e-h}	62.5 ^{k-m}	67.3^{ef}	74.3 ^{o-q}	98.5 ^{hi}	72.5 ^{hi}	81.8^{pq}
	M ₃	106.3 ^{ai-l}	121.9 ^{d-g}	87.7 ^{n-p}	105.d^a	66.9 ^{j-l}	105.5 ^{c-e}	66.0 ^{j-l}	79.5^d	86.6 ^{j-m}	113.7 ^{ef}	76.8 ^{ef}	92.4^{n-q}
	M ₄	113.4 ^{i-l}	123.8 ^{c-f}	91.0 ^{m-p}	109.d^a	79.2 ^{h-k}	119.9 ^{bc}	80.7 ^{g-j}	93.3^c	96.3 ^{h-j}	121.8 ^{c-f}	85.8 ^{c-e}	101.3^{k-n}
S ₂	M ₁	93.7 ^{k-o}	121.9 ^{d-g}	79.5 ^p	98.4^e	66.7 ^{j-l}	106.2 ^{c-e}	82.6 ^{g-j}	85.2^d	80.2 ^{m-p}	114.1 ^{ef}	81.0 ^{ef}	91.8^{m-p}
	M ₂	108.9 ^{h-j}	131.4 ^{b-e}	93.9 ^{i-o}	111.cd^a	71.2 ^{j-l}	117.1 ^{b-d}	91.3 ^{e-h}	93.2^c	90.0 ^{i-m}	124.2 ^{cd}	92.6 ^{cd}	102.3^{i-l}
	M ₃	113.7 ^{f-i}	139.1 ^b	102.9 ^{i-m}	118.6^b	76.9 ^{h-k}	120.9 ^{c-f}	92.5 ^{e-h}	96.8^{bc}	95.3 ^{h-k}	130.1 ^{bc}	97.7 ^{bc}	107.7^{hi}
	M ₄	135.4 ^{bc}	159.5 ^a	110.2 ^{g-i}	135.0^a	101.9 ^{d-f}	159.4 ^a	107.7 ^{c-e}	123.0^a	118.7 ^{d-f}	159.5 ^a	109.0 ^{gh}	129.1^{fg}
S ₃	M ₁	96.4 ^{j-n}	108.1 ^{h-k}	80.9 ^p	95.1^e	69.4 ^{i-l}	71.3 ^{i-l}	57.5 ^{lm}	66.1^{ef}	82.9 ^{i-o}	89.7 ^{i-m}	69.2 ^{i-m}	80.6^q
	M ₂	105.8 ^{i-l}	124.0 ^{ac-f}	90.3 ^{m-p}	106.d^a	74.4 ^{h-l}	74.5 ^{h-l}	61.6 ^{k-m}	70.2^{de}	90.1 ^{i-m}	124.2 ^{cd}	92.6 ^{cd}	102.0^{i-l}
	M ₃	119.7 ^{e-n}	134.9 ^{b-d}	95.0 ^{i-o}	116.bc^a	86.4 ^{f-i}	97.2 ^{e-g}	85.1 ^{f-i}	89.6^c	103.1 ^{gh}	116.0 ^{d-f}	90.0 ^{d-f}	103.0^{i-m}
	M ₄	127.4 ^{b-e}	138.4 ^b	101.5 ^{i-m}	122.4^b	100.4 ^{d-f}	128.5 ^b	91.8 ^{e-h}	106.9^b	113.9 ^{ef}	133.5 ^b	96.7 ^b	114.7^{h-j}
Variety		109.8^b	125.9^a	91.9^c		74.2^b	105.6^a	77.3^b		92.0^b	117.9^a	86.0^a	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	104.0 ^{cd}	113.5 ^c	87.0 ^e	101.5^b	60.7 ^f	98.1 ^b	64.3 ^{ef}	74.4^c	82.4 ^d	105.8 ^b	75.7 ^e	88.0^c
	S ₂	112.9 ^c	138.0 ^a	96.6 ^{de}	115.8^a	79.2 ^d	125.9 ^a	93.5 ^b	99.5^a	96.0 ^c	132.0 ^a	95.1 ^c	107.7^a
	S ₃	112.3 ^c	126.3 ^b	91.9 ^e	110.2^a	82.7 ^{cd}	92.9 ^{bc}	74.0 ^{de}	83.2^b	97.5 ^c	109.6 ^b	83.0 ^d	96.7^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	95.3 ^{gh}	110.9 ^{de}	82.4 ⁱ	96.2^d	61.7 ^g	84.4 ^d	62.8 ^{gf}	69.6^d	78.g	97.6 ^d	72.6 ^h	82.9^d
	M ₂	105.1 ^{ef}	120.3 ^c	88.9 ^h	104.c^a	64.5 ^{fg}	94.3 ^c	71.8 ^{ef}	76.9^c	84.8 ^{ef}	107.0 ^{a-c}	80.3 ^{fg}	90.8^c
	M ₃	113.2 ^d	132.0 ^b	95.2 ^{gh}	113.b^a	76.7 ^{de}	107.b ^a	81.2 ^d	88.6^b	95.0 ^d	119.b ^{ab}	88.2 ^e	101.0^b
	M ₄	125.4 ^c	140.6 ^a	100.9 ^{fg}	122.3^a	93.9 ^c	135.9 ^a	93.4 ^c	107.7^a	109.0 ^{a-c}	138.2 ^a	97.1 ^d	115.0^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.8				0.9				0.5			
Seed (S)		1.2				1.9				0.8			
Micro (M)		1.3				1.8				1.0			
V x S		2.1				3.3				1.4			
V x M		2.2				3.1				1.7			
S x M		2.2				3.1				1.7			
V x S x M		3.8				5.3				3.0			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 64. Effect of genotypes, seed rates and micronutrients on phosphorus uptake (kg ha⁻¹) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	14.3 ^{k-n}	18.6 ^h	9.5 ^q	14.1^h	11.6 ⁿ	18.9 ^{g-j}	12.7 ^{m-n}	14.4^h	12.9 ^{op}	18.7 ^{i-k}	11.1 ^p	14.2^h
	M ₂	15.6 ^{jn}	19.2 ^h	11.0 ^{pq}	15.3^g	11.9 ^h	23.6 ^{d-f}	15.0 ⁱ⁻ⁿ	16.8^{f-h}	13.8 ^{no}	21.4 ^{fg}	13.0 ^{op}	55.1^{fg}
	M ₃	16.5 ^{ij}	21.9 ^f	11.8 ^{op}	16.7^f	14.9 ^{j-n}	19.9 ^{f-i}	15.4 ^{j-n}	16.7^{e-g}	15.7 ^{l-n}	23.1 ^{d-f}	14.6 ^{m-o}	17.8^e
	M ₄	17.9 ^{hi}	22.5 ^{ef}	12.5 ^{n-p}	17.6^{ef}	20.0 ^{f-i}	29.9 ^{bc}	18.7 ^{h-j}	22.9^{c-f}	18.9 ^{h-j}	26.2 ^c	15.6 ^{l-n}	20.2^d
S ₂	M ₁	15.5 ^{jk}	23.4 ^{d-f}	11.6 ^{op}	16.8^f	13.7 ^{k-n}	23.8 ^{d-f}	19.8 ^{f-i}	19.1^{e-g}	14.6 ^{m-o}	23.6 ^{de}	15.7 ⁿ	18.0^e
	M ₂	18.4 ^h	25.2 ^{b-d}	13.9 ^{k-n}	19.2^{cd}	14.7 ^{j-n}	27.4 ^{cd}	20.3 ^{f-i}	20.8^{b-d}	16.6 ^{k-m}	26.3 ^c	17.1 ^l	20.0^d
	M ₃	19.6 ^h	26.4 ^b	15.0 ^{j-l}	20.3^b	16.3 ^{i-m}	30.6 ^{bc}	23.1 ^{e-g}	23.3^{ab}	17.9 ^{jk}	28.5 ^b	19.0 ^{h-j}	21.8^c
	M ₄	21.5 ^{fg}	29.0 ^a	16.4 ^{ij}	22.3^a	20.5 ^{f-i}	34.7 ^a	25.1 ^{de}	26.8^a	21.0 ^{gh}	31.8 ^a	20.8 ^{g-i}	24.5^a
S ₃	M ₁	14.6 ^{j-m}	19.5 ^h	11.0 ^{pq}	15.0^{gh}	13.2 ^{l-n}	18.3 ^{ij}	13.8 ^{k-n}	15.1^{gh}	13.9 ^{no}	18.9 ^{h-j}	12.4 ^{op}	15.1^{gh}
	M ₂	16.4 ^{ij}	22.2 ^{ef}	12.7 ^{m-p}	17.1^f	14.6 ^{j-n}	19.9 ^{f-i}	15.4 ^{j-n}	16.6^{d-g}	15.5 ^{l-n}	21.0 ^{gh}	14.0 ^{no}	16.8^{ef}
	M ₃	18.6 ^h	24.1 ^{c-e}	13.2 ^{l-o}	18.6^{de}	17.2 ^{il}	25.5 ^{de}	18.0 ⁱ⁻ⁿ	20.2^{b-e}	17.9 ^{j-k}	24.8 ^{cd}	15.6 ⁱ⁻ⁿ	19.4^d
	M ₄	19.8 ^{gh}	25.4 ^{bc}	14.1 ^{k-n}	19.8^{bc}	25.0 ^{de}	32.9 ^{ab}	22.6 ^{e-h}	26.8^{bc}	22.4 ^{e-g}	29.1 ^b	18.4 ^{j-k}	23.3^b
Variety		17.4^b	23.1^a	12.7^c		16.1^c	25.5^a	18.3^b		16.8^b	24.5^a	15.4^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	16.1 ^e	20.5 ^c	11.2 ^j	15.9^c	14.6 ^{de}	24.2 ^{bc}	16.0^g	18.3^c	15.3 ^d	22.4 ^b	13.6 ^e	17.1^c
	S ₂	18.8 ^d	26.0 ^a	14.2 ^g	19.7^a	16.3 ^{cd}	29.1 ^a	22.1 ^{ef}	22.5^a	17.5 ^c	27.5 ^a	18.1 ^c	21.0^a
	S ₃	17.3 ^e	22.8 ^b	12.7 ^h	17.6^b	17.5 ^d	24.1 ^b	17.4 ^{fg}	19.7^b	17.4 ^c	23.5 ^b	15.1 ^b	18.7^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	14.8 ^g	20.5 ^d	10.7 ^j	15.3^d	12.8 ^{gh}	20.3 ^{cd}	15.4 ^j	16.2^d	13.8 ^{hi}	20.4 ^c	13.1 ⁱ	15.8^d
	M ₂	16.8 ^f	22.2 ^c	12.5 ⁱ	17.2^c	13.8 ^{fg}	23.7 ^{bc}	16.9 ^{aij}	18.1^c	15.3 ^g	22.9 ^b	14.7 ^{gh}	17.6^c
	M ₃	18.2 ^e	24.1 ^b	13.3 ^{hi}	18.5^b	16.1 ^{ef}	26.8 ^{ab}	19.5 ^{hi}	20.8^b	17.2 ^{ef}	25.5 ^{ab}	16.4 ^f	19.7^b
	M ₄	19.7 ^d	25.6 ^a	14.3 ^{gh}	19.9^a	21.9 ^{de}	32.5 ^a	22.1 ^{hi}	25.5^a	20.8 ^c	29.0 ^a	18.2 ^{de}	22.7^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.1				0.2				0.1			
Seed (S)		0.2				0.5				0.2			
Micro (M)		0.2				0.4				0.2			
V x S		0.4				0.8				0.4			
V x M		0.4				0.7				0.4			
S x M		0.4				0.7				0.4			
V x S x M		0.6				1.3				0.7			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

higher P uptake (21.0) was recorded with 30 kg ha⁻¹ seed rate (S₃) while lower uptake (17.1) occurred with lower seed rate (S₁), and among micronutrients combined application FeSO₄ + ZnSO₄ to soil and to the foliage resulted in higher P uptake (22.7) while no application of micronutrient (M₁) recorded significantly lower P uptake (15.8).

Of the two way interactions, among V x M cv. MTU 1010 at 30 kg ha⁻¹ seed rate (V₂S₂) recorded higher P uptake (27.5) while the lower P uptake (13.6) was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha⁻¹ (V₃S₁), in V x M cv. MTU 1010 with combined application of FeSO₄ + ZnSO₄ (V₂M₄) recorded higher P uptake (29.0) and was on par with V₂M₃ while cv. BPT 5204 with no micronutrient supply (V₃M₁) recorded lower P uptake (13.1), and in S x M 30 kg seed rate with application of FeSO₄ + ZnSO₄ (S₂M₄) recorded higher P uptake (24.5) while 25 kg ha⁻¹ seed rate without supplementation of micronutrient (S₁M₁) recorded lower P uptake (14.2).

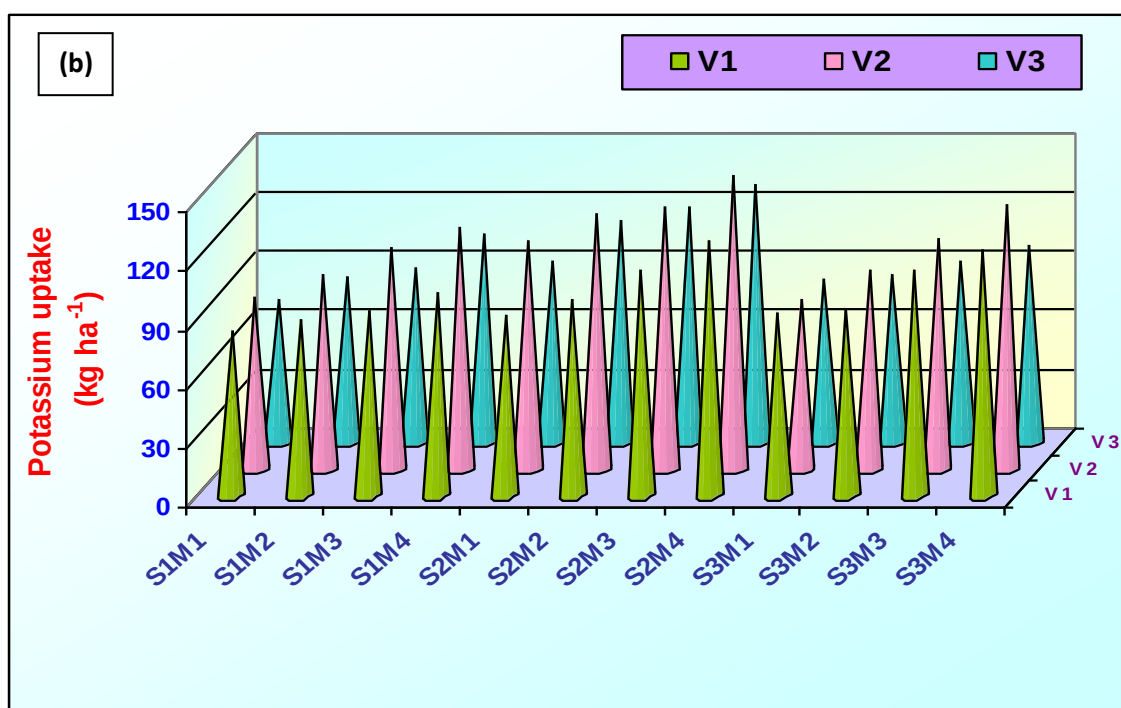
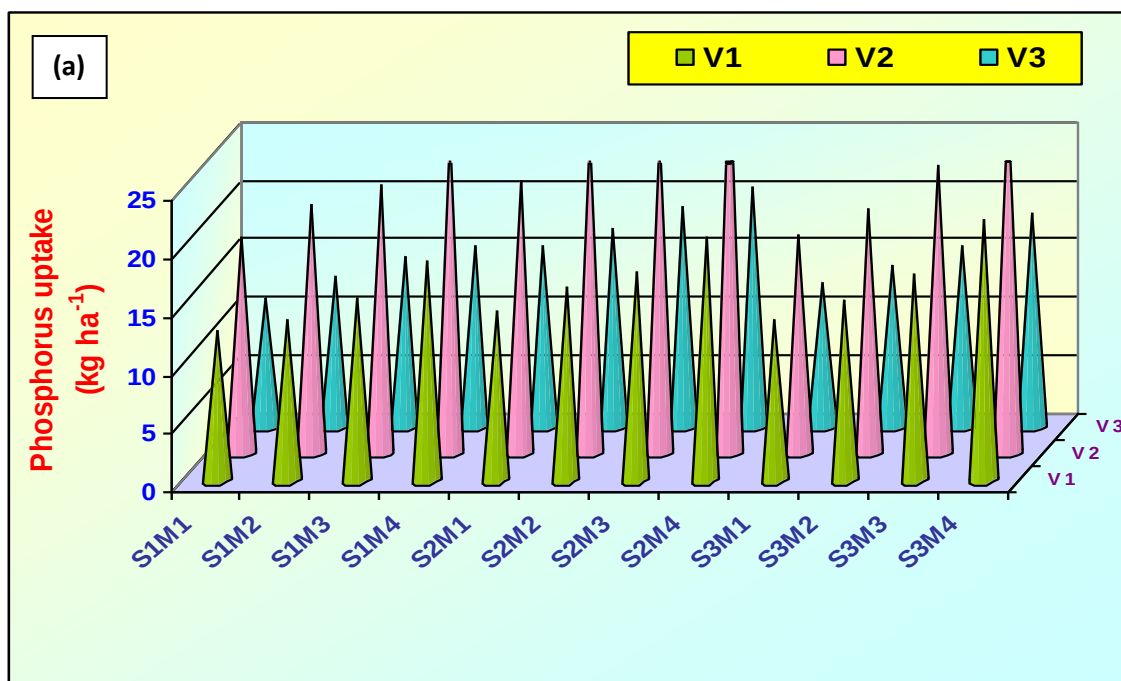
Overall, the three way interaction revealed significantly higher P uptake (31.8) with cv. MTU 1010 sown with 30 kg seed rate and applied with both FeSO₄ + ZnSO₄ (V₂S₂M₄), while the lowest P uptake (11.1) was recorded with BPT 5204 sown using 25 kg ha⁻¹ seed rate and supplied with no micro nutrient (V₃S₁M₁).

4.1.1.4.3 Potassium uptake (kg ha⁻¹) (c.f. Table 65 and Fig. 10b)

Similar to N and P, K uptake varied significantly due to cultivars, seed rates and use of micronutrients and their interactions during both the years and on pooled basis as well.

Among the varieties, cv. MTU 1010 (V₂) recorded significantly higher K uptake (116.0) followed by cvs. GGV 0501 (V₁) and BPT 5204 (V₃) (103.0 and 97.3 respectively); among seed rates higher K uptake (102.4) was observed with the seed rate of 30 kg ha⁻¹ (S₂) while lower K uptake (95.5) occurred with lower seed rate (S₁); and among micronutrient levels combined application FeSO₄ + ZnSO₄ to soil and to the foliage (M₄) resulted in higher K uptake (122.4), while no application of micronutrient (M₁) recorded significantly lowest K uptake (89.7).

Interactions between variety and seed rate were significant, and cv. MTU 1010 at 30 kg ha⁻¹ seed rate (V₂S₂) recorded higher K uptake (132.1) while lower K uptake (87.9) was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha⁻¹ (V₃S₁); among variety X micronutrient cv. MTU 1010 with combined application of FeSO₄ + ZnSO₄,



LEGEND

Varieties: V₁- GGV 0501, V₂- MTU 1010, V₃- BPT 5204;
 Seed Rate: S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
 Micronutrient: M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₄- FeSO₄ + ZnSO₄ (Each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

Fig. 10. Effect of genotypes, seed rates and micronutrients on (a) phosphorus uptake (kg ha⁻¹) and (b) potassium uptake (kg ha⁻¹) under direct seeded condition during rainy season

Table 65. Effect of genotypes, seed rates and micronutrients on potassium uptake (kg ha⁻¹) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	94.6 ^{j-o}	97.1 ^{l-n}	74.5 ^d	88.7^f	72.7 ^{op}	78.6 ^{m-p}	71.1 ^p	74.1^f	84.2 ^m	87.9 ^{k-m}	72.8 ^a	81.6ⁱ
	M ₂	100.8 ^{h-m}	100.7 ^{h-m}	79.4 ^{pq}	93.6^{ef}	77.9 ^{m-p}	98.5 ^{i-l}	89.9 ^{k-n}	88.8^d	89.4 ^{k-m}	99.6 ^{h-j}	84.6 ^{lm}	91.2^{gh}
	M ₃	103.3 ^{g-k}	120.6 ^{c-f}	84.5 ^{n-q}	102.cd^a	86.0 ^{l-p}	104.9 ^{b-k}	92.6 ^{j-m}	94.5^e	94.7 ^{i-l}	112.8 ^{f-g}	88.6 ^{k-m}	98.7^{ef}
	M ₄	105.2 ^{g-j}	120.1 ^{c-f}	93.4 ^{i-o}	106.2^{bc}	101.0 ^{i-l}	126.9 ^{c-f}	117.9 ^{e-h}	115.3^c	103.1 ^{hi}	123.5 ^{c-e}	105.6 ^{gh}	110.cd^a
S ₂	M ₁	83.5 ^{o-q}	125.2 ^{b-d}	94.6 ^{i-o}	101.1^{cd}	100.3 ^{i-l}	107.1 ^{h-j}	89.2 ^{k-n}	98.9^e	91.9 ^{j-m}	116.1 ^{d-f}	91.9 ^{j-m}	100.0^e
	M ₂	87.1 ^{n-p}	134.6 ^{ab}	108.5 ^{f-i}	110.1^b	112.2 ^{f-i}	124.4 ^{d-g}	117.7 ^{e-h}	118.1^c	99.6 ^{h-j}	129.5 ^{bc}	113.1 ^{fg}	114.c
	M ₃	97.0 ^{i-o}	124.5 ^{b-d}	114.6 ^{d-g}	112.0^b	131.7 ^{b-e}	143.1 ^{ab}	92.6 ^{j-m}	122.5^e	114.3 ^{e-g}	133.8 ^b	119.8 ^{d-f}	122.b^a
	M ₄	102.9 ^{g-l}	140.7 ^a	126.4 ^{b-d}	123.3^a	155.9 ^a	156.9 ^a	135.5 ^{b-d}	149.4^a	129.4 ^{bc}	148.8 ^a	130.9 ^{bc}	136.4^a
S ₃	M ₁	88.5 ^{m-p}	97.3 ^{l-n}	89.0 ^{m-p}	91.6^{ef}	96.9 ^{i-j}	76.4 ^{n-p}	76.7 ^{m-p}	83.3^e	92.7 ^{j-m}	86.9 ^{k-m}	82.9 ^m	87.5^b
	M ₂	89.7 ^{m-p}	111.7 ^{e-n}	90.9 ^{k-p}	97.4^{de}	101.i-j ^a	90.9 ^{k-n}	79.3 ^{m-p}	90.6^e	95.7 ^k	101.3 ^{h-j}	85.1 ^{lm}	94.0^{fg}
	M ₃	110.7 ^{f-h}	123.6 ^{b-e}	97.0 ⁱ⁻ⁿ	110.4^b	120.1 ^{e-h}	110.6 ^{g-i}	88.2 ^{l-o}	106.3^d	115.4 ^{ef}	117.1 ^{d-f}	92.6 ^{i-k}	108.d^a
	M ₄	110.1 ^{f-h}	131.1 ^{a-c}	90.1 ^{l-p}	110.4^b	140.2 ^{bc}	138.4 ^{b-d}	109.8 ^{g-i}	129.5^b	125.2 ^{b-d}	134.7 ^b	100.0 ^{h-j}	120.b^a
Variety		97.8^b	118.9^a	95.2^b		108.1^b	113.1^a	96.7^c		103.0^b	116.0^a	97.3^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	101.0 ^c	109.6 ^b	83.0 ^e	97.9^c	84.7 ^f	102.2 ^a	92.9 ^e	93.3^c	92.8 ^d	105.9 ^e	87.9 ^f	95.5^c
	S ₂	92.6 ^b	131.2 ^a	111.b ^a	111.6^a	125.0 ^b	132.9 ^d	116.9 ^c	124.9^a	108.8 ^{bc}	132.1 ^a	113.9 ^b	118.3^a
	S ₃	99.7 ^c	115.9 ^b	91.8 ^d	102.5^b	114.7 ^c	104.1 ^e	88.5 ^{ef}	102.4^b	107.2 ^c	110.0 ^{bc}	90.1 ^d	102.4^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	88.9 ^{gh}	106.5 ^d	86.0 ^b	93.8^d	90.3 ^{gh}	87.4 ^h	79.0 ⁱ	85.6^d	89.6 ^f	97.0 ^{de}	82.5 ^g	89.7^d
	M ₂	92.5 ^{f-h}	115.6 ^c	92.9 ^{fg}	100.3^d	97.3 ^{e-g}	104.6 ^e	95.6 ^{gh}	99.2^d	94.9 ^e	110.1 ^c	94.3 ^{ef}	99.8^c
	M ₃	103.7 ^{de}	122.9 ^b	98.7 ^{ef}	108.4^b	112.6 ^d	119.6 ^{cd}	102.0 ^{ef}	111.4^b	108.1 ^c	121.2 ^b	100.3 ^d	109.9^b
	M ₄	106.1 ^d	130.7 ^a	103.3 ^{de}	113.4^a	132.4 ^b	140.7 ^a	121.1 ^c	131.4^a	119.2 ^b	135.7 ^a	112.2 ^c	122.4^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		1.4				1.1				0.7			
Seed (S)		1.2				1.4				1.1			
Micro (M)		1.3				1.6				1.0			
V x S		2.1				2.4				1.8			
V x M		2.2				2.7				1.7			
S x M		2.2				2.7				1.7			
V x S x M		3.8				4.7				3.0			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

(V₂M₄) recorded higher K uptake (135.7) while cv. BPT 5204 without micronutrient supply (V₃M₁) registered lower K uptake (82.5), and among seed rates and micronutrients, 30 kg seed rate with application of FeSO₄ + ZnSO₄ (S₂M₄) recorded higher K uptake (136.4), while 25 kg ha⁻¹ seed rate without micronutrient (S₁M₁) recorded lower K uptake (81.6).

Overall, the three way interaction revealed significantly higher K uptake (148.8) with cv. MTU 1010 sown with 30 kg seed rate and applied with both FeSO₄ + ZnSO₄ (V₂S₂M₄), while the lower K uptake (72.8) was recorded with cv. BPT 5204 sown using 25 kg ha⁻¹ seed rate and supplied with no micronutrient (V₃S₁ M₁).

4.1.1.4.4 Iron uptake (g ha⁻¹) (c.f. Table 66 and Fig. 11a)

Iron (Fe) uptake varied significantly due to cultivars, seed rates and use of micronutrients and their interactions during both the years and on pooled basis as well.

MTU 1010 (V₂) among cultivars recorded significantly higher Fe uptake (1992.6) followed by cvs. GGV 0501 (V₁) and BPT 5204(V₃) (1369.5 and 989.4 respectively); among seed rates higher total Fe uptake (1649.9) was recorded with the seed rate of 30 kg ha⁻¹ while lower Fe uptake (1223.3) was observed with lower seed rate (S₁), and among levels of micronutrients combined application FeSO₄ + ZnSO₄ to soil and to the foliage (M₄) resulted in higher Fe uptake (1759.3), while no application of micronutrient (M₁) recorded significantly lower Fe uptake (1174.2).

Interactions due to V x S were significant, wherein cv. MTU 1010 at 30 kg ha⁻¹ seed rate (V₂S₂) recorded higher Fe uptake (2378.3); while the lower Fe uptake (746.7) was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha⁻¹ (V₃S₁); in V x M cv. MTU 1010 with combined application of FeSO₄ + ZnSO₄ (V₂M₄) recorded higher Fe uptake (2544.9) while cv. BPT 5204 without micronutrient (V₃M₁) registered lower uptake (734.4), and among S x M, 30 kg seed rate with application of FeSO₄ + ZnSO₄ (S₂M₄) recorded higher Fe uptake (1759.3), while 25 kg ha⁻¹ seed rate without supplementation of micronutrient (S₁M₁) recorded lower Fe uptake (1174.2).

Among V x T x M interactions, significantly higher Fe uptake (2527.3) was observed with cv. MTU 1010 sown with 30 kg seed rate and applied with both FeSO₄ + ZnSO₄ (V₂S₂M₄) and it was on par with V₂S₁₋₃M₄, while the lowest Fe uptake (518.1) was recorded with cv. BPT 5204 sown using 25 kg ha⁻¹ seed rate and supplied with no micronutrient (V₃S₁ M₁).

Table 66. Effect of genotypes, seed rates and micronutrients on iron uptake (g ha⁻¹) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	1415 ^{h-o}	1771 ^{g-j}	722.0 ^t	1302.7^f	857.6 ^{d-i}	883.5 ^{d-i}	314.0 ^{aij}	685.0^f	1136.3 ^{j-n}	1327.3 ^{f-j}	518.1 ^{pq}	993.9^g
	M ₂	1484 ^{k-n}	1849 ^{gh}	906.0 st	1413.0^f	967.5 ^{c-i}	1030.2 ^{c-h}	455.9 ^{b-j}	817.9^{ef}	1225.7 ^{i-m}	1439 ^{d-f}	681.1 ^{n-q}	1115.3^{fg}
	M ₃	1585 ^{h-m}	2354 ^e	1047 ^{q-s}	1662.0^e	957.2 ^{c-i}	1177.8 ^{c-f}	566.8 ^{d-i}	900.6^{ef}	1271.0 ^{h-l}	1765.0 ^{cd}	806.3 ^{l-p}	1281.0^{ef}
	M ₄	1710 ^{g-k}	2459 ^e	1083 ^{q-s}	1750.7^{de}	1045.3 ^{c-h}	1839.4 ^b	877.9 ^{g-j}	1254.bc^a	1377.9 ^{g-k}	2149. ^{a-f}	980.5 ^{o-q}	1502.6^d
S ₂	M ₁	1539 ^{i-m}	2512 ^{de}	981.0 ^s	1677.3^e	1018.6 ^{c-h}	1032.8 ^{c-h}	598.8 ^{c-i}	883.4^{ef}	1278.9 ^{h-l}	1772.4 ^{cd}	789.9 ^{k-o}	1280.4^{ef}
	M ₂	1674 ^{h-l}	2745 ^{cd}	1182 ^{o-r}	1867.0^{cd}	1130.5 ^{c-g}	1165.1 ^{c-f}	963.7 ^{c-e}	1086.c-e^a	1402.4 ^{g-k}	1955.2 ^b	1072.9 ^{h-l}	1476.8^d
	M ₃	1805 ^{k-i}	3230 ^a	1365 ^{m-p}	2133.3^b	1198.2 ^{cd}	1824.8 ^b	1193.4 ^{bc}	1405.5^b	1501.6 ^{e-i}	2527.3 ^a	1279.0 ^{f-j}	1769.3^b
	M ₄	1710 ^{g-k}	2459 ^e	1083 ^{q-s}	1750.7^a	1071.2 ^{c-h}	2953.5 ^a	1468.0 ^{e-j}	1830.9^a	1500.9 ^{i-l}	3258.e-h	1459.8 ^{m-p}	2073.0^a
S ₃	M ₁	1519 ^{j-n}	2548 ^{de}	1142 ^{p-s}	1736.3^{de}	984.4 ^{c-h}	648.5 ^{f-j}	658.4 ^{d-j}	763.8^f	1251.5 ^{g-k}	1598.0 ^{de}	895.3 ^{ak-o}	1248.3^{ef}
	M ₂	1719 ^{g-k}	2937 ^{bc}	1262 ^{n-q}	1972.7^c	1057.0 ^{c-h}	702.0 ^{d-j}	709.0 ^{d-j}	822.7^{ef}	1388.1 ^{f-j}	1819.6 ^{cd}	1072.9 ^{k-o}	1426.9^{de}
	M ₃	1949 ^{fg}	3139 ^{ab}	1365 ^{m-p}	2151.0^b	986.0 ^{c-h}	1005.0 ^{bc}	811.4 ^{e-j}	934.1^{d-f}	1467.4 ^{e-g}	2072.2 ^c	1069.2 ^{i-l}	1536.3^{cd}
	M ₄	2098 ^f	3023 ^{ab}	1534 ^{i-m}	2218.3^{ab}	1165.8 ^{c-f}	1431.0 ^j	961.8 ^{c-i}	1186.2^{b-d}	1632.0 ^{g-k}	2226.9 ^{ab}	1247.7 ^{j-l}	1702.2^{bc}
Variety		1683.9^b	2585.5^a	1139.3^c		1036.6^b	1307.8^a	798.3^c		1369.5^b	1992.6^a	989.4^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	1549 ^d	2108 ^b	940 ^f	1532.3^b	956.9 ^d	1232 ^b	553.7 ^f	914.2^b	1252.7 ^e	1670.5 ^c	746.7 ^h	1223.3^c
	S ₂	1737 ^c	3013 ^a	1240 ^{ea}	1998.3^a	1104.6 ^c	1744.0 ^a	1056.0 ^c	1301.5^a	1420.9 ^d	2378.3 ^a	1150.4 ^f	1649.9^a
	S ₃	1821 ^c	2912 ^a	1310 ^{ea}	2016.3^a	1048.3 ^c	946.6 ^d	782.6 ^e	925.8^b	1434.8 ^d	1929.2 ^b	1049.4 ^g	1471.1^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	1491 ^f	2277 ^c	948 ⁱ	1572^d	953.5 ^{cd}	854.9 ^{cd}	520.4 ^e	776.3^c	1222.2 ^f	1565.9 ^d	734.4 ^h	1174.2^d
	M ₂	1626 ^e	2511 ^b	1117 ^h	1751.3^c	1051.7 ^c	965.8 ^{cd}	709.5 ^{de}	909.0^c	1338.7 ^{ef}	1738.2 ^c	913.1 ^g	1330.0^c
	M ₃	1780 ^d	2908 ^a	1246 ^{gh}	1978.0^b	1047.1 ^c	1335.9 ^b	857.2 ^{cd}	1080.1^b	1413.3 ^{de}	2121.8 ^b	1051.7 ^g	1528.9^b
	M ₄	1913 ^d	3015 ^a	1356 ^g	2094.7^a	1094.1 ^{bc}	2074.7 ^a	1102.6 ^{bc}	1423.8^a	1503.6 ^{de}	2544.9 ⁱ	1229.3 ^{ef}	1759.3^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		24.4				11.8				12.8			
Seed (S)		20.8				11.8				12.5			
Micro (M)		27.4				51.0				33.9			
V x S		36.1				20.4				21.6			
V x M		47.5				88.4				58.7			
S x M		47.5				88.4				58.7			
V x S x M		82.3				153.1				101.7			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

4.1.1.4.5 Zinc uptake (g ha^{-1}) (c.f. Table 67 and Fig. 11b)

Variations in zinc (Zn) uptake due to cultivars, seed rates and use of micronutrients and their interactions were significant during both the years and pooled on basis as well.

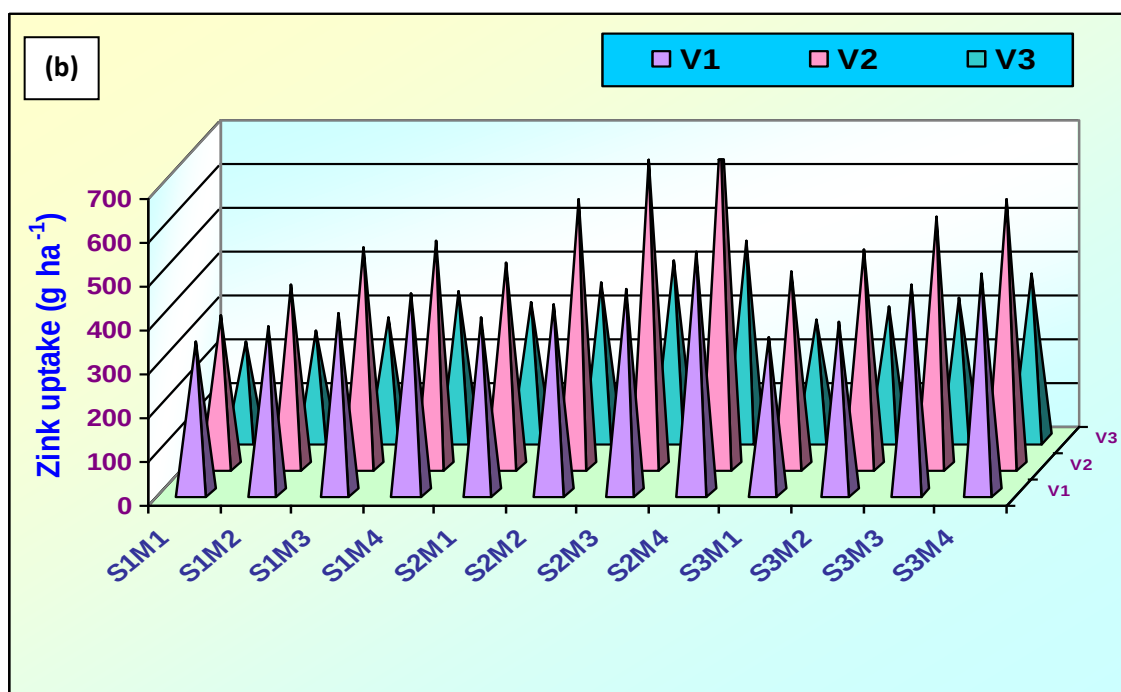
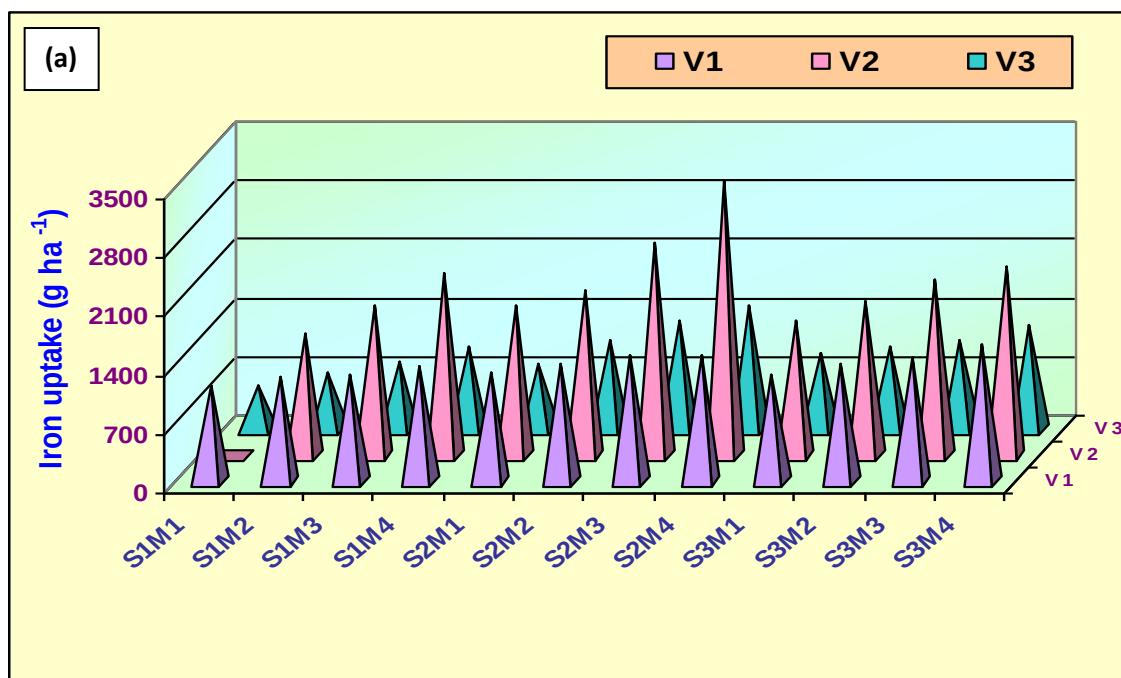
Among the varieties, cv.MTU 1010 recorded significantly higher Zn uptake (541.7) followed by cvs. GGV 0501 (V_1) and BPT 5204(V_3) (430.3 and 326.1, respectively); among seed rates higher Zn uptake (499.4) was recorded with the seed rate of 30 kg ha^{-1} while lower Zn uptake (372.2) was obtained with lower seed rate (S_1), and among micronutrients combined application $\text{FeSO}_4 + \text{ZnSO}_4$ (M_4) recorded higher Zn uptake (514.93), while no application of micronutrient (M_1) recorded significantly lower Zn uptake (351.7).

All the two way interactions were significant and among variety and seed rate x cv. MTU 1010 at 30 kg ha^{-1} seed rate (V_2S_2) recorded higher Zn uptake (651.7) while the lowest Zn uptake (273.9) was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha^{-1} (V_3S_1), among variety X micronutrient cv. MTU 1010 with combined application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_2M_4) recorded higher Zn uptake (649.2) while lower Zn uptake (270.4) was recorded with cv. BPT 5204 supplied with no micronutrient (V_3M_1), and among seed rates and micronutrients 30 kg ha^{-1} seed rate with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) recorded higher Zn uptake (649.2), while 35 kg ha^{-1} seed rate without supplementation of micronutrient (S_3M_1) recorded lower Zn uptake (270.4).

Overall , the three way interaction revealed significantly higher Zn uptake (821.4) with cv. MTU 1010 sown using 30 kg seed rate and applied with both $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_2S_2M_4$), while the lower total zinc uptake (223.9) was recorded with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micro nutrient ($V_3S_1M_1$).

4.1.1.4.6 Copper uptake (g ha^{-1}) (c.f. Table 68)

Copper (Cu) uptake varied significantly due to cultivars, seed rates and use of micronutrients and their interactions during both the years and on pooled basis as well. MTU 1010 (V_2) among cultivars recorded significantly higher Cu uptake (38.4) followed by cvs. GGV 0501 (V_1) and BPT 5204(V_3) (24.9 and 18.5 respectively); among seed rates higher Cu uptake (31.2) was recorded with the medium seed rate of 30 kg ha^{-1} while lower Cu uptake (22.5) occurred with lower seed rate (S_1), among levels of



LEGEND

Varieties: V₁- GGV 0501, V₂- MTU 1010, V₃- BPT 5204;
 Seed Rate: S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
 Micronutrient: M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₄- FeSO₄ + ZnSO₄ (Each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

Fig. 11. Effect of genotypes, seed rates and micronutrients on (a) iron uptake (g ha^{-1}) and (b) zinc uptake (g ha^{-1}) under direct seeded condition during rainy season

Table 67. Effect of genotypes, seed rates and micronutrients on zinc uptake (g ha⁻¹) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	495 ^{m-q}	558 ⁱ⁻ⁿ	341 ^s	464.7^h	196.6 ^{p-s}	131.7 ^t	106.9 ^t	145.1^h	345.9 ^{m-o}	344.8 ^{m-o}	223.9 ^s	304.9
	M ₂	515 ^{k-p}	584 ^{i-m}	375 ^{rs}	491.3^{gh}	241.0 ^a	247.2 ^{h-p}	121.9 ^t	203.4^{e-g}	378.0 ^{k-n}	415.6 ^{h-l}	248.6 ^{rs}	347.4
	M ₃	567 ^{j-n}	729 ^{e-g}	410 ^{q-s}	568.7^{ef}	253.3 ^{g-m}	275.5 ^{e-j}	152.4 st	227.1^{de}	410.3 ^{i-j}	502.2 ^{e-g}	281.2 ^{p-s}	397.9
	M ₄	617 ^{h-k}	754 ^{d-f}	425 ^{p-s}	598.7^{de}	296.1 ^{d-h}	280.1 ^{e-j}	258.9 ^{g-l}	278.4^c	456.4 ^{e-j}	517.0 ^{d-f}	341.9 ^{m-p}	438.4
S ₂	M ₁	603 ^{h-l}	809 ^{de}	416 ^{p-s}	609.3^{de}	200.5 ^{n-s}	116.5 ^t	214.0 ^{k-q}	177.0^g	401.6 ^{i-m}	462.6 ^{f-i}	314.9 ^{h-q}	393.0
	M ₂	650 ^{g-j}	952 ^c	466 ^{n-r}	689.3^c	207.7 ^{l-q}	265.5 ^{f-k}	249.7 ^{h-o}	241.0^d	428.7 ^{h-k}	608.7 ^c	358.0 ^{l-o}	465.1
	M ₃	688 ^{f-h}	111b ^a	536 ^{k-o}	778.3^b	241.2 ^{i-p}	316.5 ^{d-f}	286.3 ^{d-i}	281.3^c	464.8 ^{f-i}	713.9 ^b	411.1 ^{i-l}	529.9
	M ₄	731 ^{e-h}	1254 ^a	575 ^{j-m}	853.3^a	372.1 ^{bc}	389.1 ^b	336.0 ^{cd}	365.7^a	551.5 ^{ac-e}	821.4 ^a	455.6 ^{p-j}	609.5
S ₃	M ₁	512 ^{l-q}	656 ^{f-j}	388 ^{rs}	518.7^{fg}	197.4 ^{o-s}	232.3 ^{j-q}	156.6 ^{r-t}	195.4^{fg}	354.8 ^{l-o}	444.4 ^{g-j}	272.3 ^{q-s}	357.2
	M ₂	566 ^{j-n}	747 ^{e-g}	420 ^{p-s}	577.7^e	218.1 ^{k-q}	239.3 ^{j-q}	187.4 ^{q-s}	214.9^{d-f}	391.8 ^{j-m}	493.3 ^{e-j}	303.8 ^{o-r}	396.3
	M ₃	651 ^{g-j}	820 ^{de}	441 ^{o-s}	637.3^{cd}	303.9 ^{d-g}	315.5 ^{d-f}	204.4 ^{m-r}	274.6^c	477.7 ^{f-h}	567.9 ^{cd}	322.9 ^{h-q}	456.2
	M ₄	681 ^{f-i}	845 ^d	507 ^{l-q}	677.7^c	323.4 ^{de}	372.9 ^{bc}	250.6 ^{h-n}	315.6^b	502.4 ^{e-g}	609.0 ^c	378.8 ^{k-n}	496.7
Variety		606.3^b	818.3^a	441.7^c		254.3^b	265.2^a	210.4^c		430.3^b	541.7^a	326.1^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	549 ^e	656 ^e	388 ^h	531.0^c	246.7 ^{cd}	233.6 ^d	160.2 ^f	213.5^c	397.7 ^e	444.9 ^{cd}	273.9 ^g	372.2^c
	S ₂	668 ^c	1031 ^a	498 ^f	732.3^a	255.4 ^{bc}	271.9 ^{ab}	271.5 ^{ab}	266.3^a	461.7 ^d	651.7 ^a	384.9 ^e	499.4^a
	S ₃	603 ^d	767 ^b	439 ^b	603.0^b	260.7 ^{bc}	290.0 ^a	199.7 ^e	250.1^b	431.7 ^d	528.7 ^b	319.5 ^f	426.6^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	537 ^{ef}	674 ^d	382 ⁱ	531.0^d	198.2 ^{ef}	160.2 ^g	159.2 ^g	172.5^c	367.4 ^{fg}	417.3 ^e	270.4 ⁱ	351.7^d
	M ₂	577 ^e	761 ^c	421 ^{hi}	586.3^c	222.3 ^e	250.7 ^d	186.3 ^f	219.8^b	399.5 ^{ef}	505.9 ^e	303.5 ^h	403.0^c
	M ₃	636 ^d	887 ^b	462 ^{gh}	661.7^b	266.2 ^{cd}	302.5 ^b	214.4 ^e	261.0^a	450.9 ^d	594.7 ^b	338.4 ^g	461.3^b
	M ₄	676 ^d	951 ^a	502 ^{fg}	709.7^a	330.5 ^a	347.3 ^a	281.8 ^{bc}	319.9^a	503.4 ^c	649.2 ^a	392.1 ^{ef}	514.9^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		9.2				2.5				4.5			
Seed (S)		7.4				3.4				4.2			
Micro (M)		10.3				5.2				6.5			
V x S		12.9				5.9				7.3			
V x M		17.8				8.9				11.3			
S x M		17.8				8.9				11.3			
V x S x M		30.8				15.6				19.6			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 68. Effect of genotypes, seed rates and micronutrients on copper uptake (g ha⁻¹) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	20.3 ^{n-p}	33.8 ^{gh}	11.3 ^s	21.8^f	15.9 ^{pq}	20.5 ^{j-o}	9.5 ^r	15.3^f	18.1 ^{q-t}	27.2 ^{j-l}	10.4 ^v	18.6^g
	M ₂	21.7 ^{m-o}	34.6 ^{gh}	12.6 ^{rs}	23.0^f	18.4 ^{m-q}	27.3 ^{d-g}	14.5 ^q	20.1^e	20.0 ^{p-r}	31.0 ^{hi}	13.5 ^{uv}	21.5^f
	M ₃	23.8 ^{l-n}	40.3 ^{ef}	13.2 ^{q-s}	25.8^e	19.2 ^{l-p}	28.5 ^{c-f}	17.0 ^{n-q}	21.6^{dc}	21.5 ^{n-q}	34.4 ^{gh}	15.1 ^{tu}	23.7^e
	M ₄	25.5 ^{k-m}	43.6 ^e	14.0 ^{q-s}	27.7^e	25.1 ^{f-i}	32.4 ^{bc}	18.7 ^{m-q}	25.4^c	25.3 ^{k-m}	38.0 ^{ef}	16.4 ^{s-u}	26.6^d
S ₂	M ₁	25.6 ^{k-m}	50.4 ^d	14.2 ^{q-s}	30.1^d	19.9 ^{k-p}	23.5 ^{g-l}	22.4 ^{h-m}	21.9^{de}	22.8 ^{m-p}	36.9 ^{fg}	18.3 ^{q-t}	26.0^d
	M ₂	28.7 ^{i-k}	55.9 ^{bc}	16.5 ^{p-r}	33.7^c	20.1 ^{j-p}	31.0 ^{cd}	25.2 ^{f-i}	25.4^c	24.4 ^{l-n}	43.5 ^{cd}	20.8 ^{q-r}	29.6^c
	M ₃	30.7 ^{h-j}	59.6 ^b	19.4 ^{n-p}	36.6^b	23.8 ^{g-k}	35.3 ^{ab}	28.6 ^{c-f}	29.2^b	27.2 ^{j-l}	47.4 ^b	24.0 ^{l-o}	32.9^b
	M ₄	32.9 ^{hi}	65.2 ^a	21.3 ^{m-o}	39.8^a	29.5 ^{c-e}	38.2 ^a	31.9 ^{bc}	33.2^a	31.2 ^{hi}	51.7 ^a	26.6 ^{j-l}	36.5^a
S ₃	M ₁	23.8 ^{l-n}	40.4 ^{ef}	15.7 ^{p-s}	26.6^e	17.4 ^{n-q}	16.3 ^{o-q}	16.8 ^{o-q}	16.8^f	20.6 ^{o-r}	28.3 ^{j-k}	16.2 ^{s-u}	21.7^f
	M ₂	28.0 ^{i-l}	49.9 ^d	17.4 ^{o-q}	31.8^{cd}	21.3 ⁱ⁻ⁿ	22.2 ^{h-m}	18.2 ^{m-q}	20.6^e	24.7 ^{l-n}	36.0 ^{fg}	17.8 ^{r-t}	26.2^d
	M ₃	34.9 ^{gh}	55.1 ^c	19.1 ^{n-p}	36.4^b	24.3 ^{g-j}	26.3 ^{e-h}	20.4 ^{j-o}	23.7^{cd}	29.6 ^{ij}	40.7 ^{de}	19.7 ^{p-s}	30.0^c
	M ₄	38.1 ^{fg}	56.7 ^{bc}	21.6 ^{m-o}	38.8^{ab}	29.7 ^{c-e}	35.7 ^{ab}	23.9 ^{g-k}	29.8^b	33.9 ^{gh}	46.2 ^{bc}	22.7 ^{m-p}	34.3^b
Variety		27.8^b	48.8^a	16.4^c		22.1^b	28.1^a	20.6^c		24.9^b	38.4^a	18.5^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	22.8 ^e	38.1 ^c	12.8 ^g	24.6^c	19.7 ^e	27.2 ^b	14.9 ^f	20.6^c	21.2 ^e	32.6 ^c	13.8 ^g	22.5^c
	S ₂	29.5 ^d	57.8 ^a	17.8 ^f	35.0^a	23.3 ^d	32.0 ^a	27.0 ^b	27.4^a	26.4 ^d	44.9 ^a	22.4 ^e	31.2^a
	S ₃	31.2 ^d	50.2 ^b	18.4 ^f	33.3^b	23.2 ^d	25.1 ^c	19.8 ^e	22.7^b	27.2 ^d	37.8 ^b	19.1 ^f	28.0^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	23.3 ^g	41.5 ^d	13.7 ^j	26.2^d	17.7 ^{hi}	20.1 ^{fg}	16.2 ⁱ	18.0^d	20.5 ^{gh}	30.8 ^d	15.0 ^j	22.1^d
	M ₂	26.1 ^f	46.8 ^c	15.5 ^{ij}	29.5^c	19.9 ^{i-h}	26.8 ^{cd}	19.3 ^{gh}	22.0^c	23.0 ^f	36.8 ^c	17.4 ⁱ	25.7^c
	M ₃	29.8 ^e	51.7 ^b	17.2 ^{hi}	32.9^b	22.4 ^e	30.0 ^b	22.0 ^{ef}	24.8^b	26.1 ^e	40.8 ^b	19.6 ^h	28.8^b
	M ₄	32.1 ^e	55.2 ^a	19.0 ^b	35.4^a	28.1 ^{bc}	35.4 ^a	24.8 ^d	29.4^a	30.1 ^d	45.3 ^a	21.9 ^{fg}	32.4^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.4				0.2				0.2			
Seed (S)		0.4				0.3				0.2			
Micro (M)		0.4				0.4				0.4			
V x S		0.7				0.6				0.4			
V x M		0.8				0.7				0.6			
S x M		0.8				0.7				0.6			
V x S x M		1.4				1.3				1.1			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

micronutrients combined application $\text{FeSO}_4 + \text{ZnSO}_4$ to soil and to the foliage (M_4) resulted in higher Cu uptake (32.4), while no application of micronutrient (M_1) recorded significantly lower Cu uptake (22.1).

Interactions between variety and seed rate were significant wherein cv. MTU 1010 at 30 kg ha⁻¹ seed rate (V_2S_2) recorded higher Cu uptake (44.9) while lower Cu uptake (13.8) was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha⁻¹ (V_3S_1), among variety X micronutrient cv. MTU 1010 with combined application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_2M_4) recorded higher Cu uptake (45.3) while lower Cu uptake (15.0) was observed with cv. BPT 5204 supplied with no micronutrients (V_3M_1), and among seed rates and micronutrients, 30 kg seed rate with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) recorded higher Cu uptake (36.5) while 25 kg ha⁻¹ seed rate without supplementation of micronutrient (S_1M_1) recorded lower Cu uptake (18.6).

The three way interaction also revealed significantly higher total copper uptake (51.4) with cv. MTU 1010 sown with 30 kg seed rate and applied with both $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_2S_2M_4$), while the lower Cu uptake (10.4) was recorded with cv. BPT 5204 sown using 25 kg ha⁻¹ seed rate and supplied with no micro nutrient ($V_3S_1M_1$).

4.1.1.4.7 Manganese uptake (g ha⁻¹) (c.f. Table 69)

Manganese (Mn) uptake varied significantly due to cultivars, seed rates and use of micronutrients and their interactions during both the years and on pooled basis as well.

Among the varieties, cv. MTU 1010 (V_2) recorded significantly higher Mn uptake (4343.6) followed by cvs. GGV 0501 (V_1) and BPT 5204 (V_3) (3268.8 and 2434.7, respectively); among seed rates higher Mn uptake (3745.3) was recorded with the medium seed rate of 30 kg ha⁻¹ (S_2) while lower Mn uptake (2797.7) occurred with lower seed rate (S_1), among levels of micronutrients combined application $\text{FeSO}_4 + \text{ZnSO}_4$ to soil and to the foliage (M_4) resulted in higher Mn uptake (3856.9), while no application of micronutrient (M_1) recorded significantly lower Mn uptake (2822.2).

All two way interactions were significant. In variety X seed cv. MTU 1010 at 30 kg ha⁻¹ seed rate (V_2S_2) recorded higher Mn uptake (5106.8) while lower Mn uptake (2153.1) was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha⁻¹ (V_3S_1), among variety X micronutrient cv. MTU 1010 with combined application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_2M_4) recorded higher Mn uptake (5027.1) while lower Mn uptake (2052.4) was observed with cv. BPT 5204 supplied with any micronutrient (V_3M_1), and among seed

Table 69. Effect of genotypes, seed rates and micronutrients on manganese uptake (g ha⁻¹) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	2967.0 ^{p-t}	3710.0 ^{t-o}	2230.0 ^u	2969.0^f	1794.2 ^{op}	2025.6 ^{l-p}	1358.9 ^q	1726.2^b	2380.8 ^{n-p}	2868.0 ^{j-m}	1794.2 ^q	2347.7^b
	M ₂	3176.0 ^{o-s}	4012.0 ^{j-l}	2335.0 ^{tu}	3174.3^f	2101.0 ^{i-p}	2379.7 ^{h-m}	1948.8 ^{m-p}	2143.2^g	2638.4 ^{k-n}	3195.8 ^{ij}	2141.7 ^{pq}	2658.6^g
	M ₃	3336.0 ^{n-p}	5098.0 ^{i-h}	2572.0 ^{s-u}	3668.7^e	2327.3 ^{t-n}	2545.0 ^f	2002.9 ^{m-p}	1528.2^{fg}	2831.6 ^{j-m}	3822.1 ^{fg}	2287.2 ^{n-p}	2980.3^{ef}
	M ₄	3644.0 ^{l-o}	5278.0 ^{ef}	2646.0 ^{q-u}	3856.0^{de}	2649.8 ^{t-i}	2873.9 ^{e-g}	2133.0 ^{j-p}	2552.2^{de}	3147.1 ^{ij}	4075.9 ^{ef}	2389.4 ^{n-p}	3204.1^d
S ₂	M ₁	3688.0 ^{l-o}	5295.0 ^{ef}	2339.0 ^{tu}	3774.0^e	2225.7 ^{t-o}	3483.5 ^{cd}	2092.7 ^{j-p}	2600.6^{de}	2957.0 ^{j-l}	4389.3 ^{de}	2216.1 ^{op}	3187.5^{de}
	M ₂	3944.0 ^{k-n}	5786.0 ^{de}	2760.0 ^{p-u}	4163.3^{cd}	2351.0 ^{i-m}	4065.5 ^{ab}	2458.2 ^{g-l}	2958.2^c	3147.6 ^{ij}	4925.5 ^{bc}	2609.1 ^{l-o}	3560.7^c
	M ₃	4381.0 ^{i-k}	6398.0 ^{bc}	3243.0 ^r	4674.0^b	2805.2 ^{e-h}	4207.8 ^a	2541.2 ^{f-j}	3184.7^b	3592.9 ^{gh}	5302.7 ^b	2892.0 ^{j-m}	3929.2^b
	M ₄	4577.0 ^{g-j}	7188.0 ^a	3361.0 ^{m-p}	5042.0^a	3605.8 ^{cd}	4430.9 ^a	2659.5 ^{f-i}	3565.4^a	4091.6 ^{ef}	5809.5 ^a	3010.0 ^{i-l}	4303.7^a
S ₃	M ₁	3618.0 ^{l-o}	5173.0 ^{fg}	2604.0 ^r	3798.3^e	2475.0 ^{t-i}	2029.6 ^{k-p}	1690.6 ^{pq}	2065.1^g	3046.4 ^{i-k}	3601.5 ^{gh}	2147.1 ^{pq}	2931.7^f
	M ₂	3997.0 ^{j-m}	5937.0 ^{cd}	2807.0 ^{p-u}	4247.0^c	2819.7 ^{e-h}	2462.9 ^{g-l}	1893.1 ^{n-p}	2391.9^{ef}	3408.2 ^{hi}	4200.0 ^{ef}	2349.8 ^{n-p}	3319.3^d
	M ₃	4538.0 ^{h-k}	6563.0 ^b	2918.0 ^{p-r}	4673.0^b	3200.2 ^{de}	2909.6 ^{ef}	2086.5 ^{k-p}	2732.0^d	3869.3 ^{fg}	4736.4 ^{cd}	2502.0 ^{m-p}	3702.6^c
	M ₄	4731.0 ^{f-i}	6582.0 ^b	3273.0 ^{o-q}	4862.0^{ab}	3498.6 ^{cd}	3809.5 ^{bc}	2482.3 ^{f-k}	3263.5^b	4114.7 ^{ef}	5195.9 ^b	2877.7 ^{j-m}	4062.8^b
Variety		3883.1^b	5585.0^a	2757.3^c		2654.5^b	2911.1^a	2112.3^c		3268.8^b	4343.6^a	2434.7^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	3281.0 ^d	4524.0 ^b	2445.0 ^f	3416.7^b	2218.1 ^e	2456.4 ^d	1860.9 ^f	2178.5^c	2749.5 ^d	3490.5 ^c	2153.1 ^f	2797.7^c
	S ₂	4148.0 ^c	6167.0 ^a	2926.0 ^e	4413.7^a	2746.9 ^c	4046.9 ^a	2437.9 ^d	3077.2^a	3447.3 ^c	5106.8 ^a	2681.8 ^d	3745.3^a
	S ₃	4221.0 ^c	6064.0 ^a	2900.0 ^e	4395.0^a	2998.4 ^b	2802.9 ^c	2038.1 ^f	2613.1^b	3609.7 ^c	4433.5 ^b	2469.1 ^e	3504.1^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	3424.0 ^f	4726.0 ^d	2391.0 ⁱ	3513.7^d	2164.9 ^f	2512.9 ^d	1714.1 ^g	2130.6^d	2794.7 ^g	3619.6 ^{de}	2052.4 ^j	2822.2^d
	M ₂	3706.0 ^f	5245.0 ^c	2634.0 ^{hi}	3861.7^c	2423.9 ^{de}	2969.4 ^c	2100.0 ^f	2497.8^c	3064.7 ^f	4107.1 ^c	2366.9 ^j	3179.6^c
	M ₃	4085.0 ^e	6020.0 ^b	2911.0 ^{gh}	4338.7^b	2777.6 ^c	3221.3 ^b	2210.2 ^{ef}	2736.4^b	3431.3 ^e	4620.4 ^b	2560.4 ^{hi}	3537.4^b
	M ₄	4318.0 ^e	6349.0 ^a	3093.0 ^g	4586.7^a	3251.4 ^b	3704.8 ^a	2424.9 ^{de}	3127.0^a	3784.5 ^d	5027.1 ^a	2759.0 ^{gh}	3856.9^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		67.2				29.2				34.2			
Seed (S)		44.5				33.6				32.0			
Micro (M)		65.4				44.5				42.8			
V x S		77.1				58.2				55.5			
V x M		113.3				77.1				74.1			
S x M		113.3				77.1				74.1			
V x S x M		196.2				133.5				128.4			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

rates X micronutrients, 30 kg seed rate with application of $\text{FeSO}_4 + \text{ZnSO}_4$ ($S_2 M_4$) recorded higher Mn uptake (4303.7) while 25 kg ha^{-1} seed rate without supplementation of micronutrient ($S_1 M_1$) recorded lower Mn uptake (2347.6).

Overall, the three way interactions revealed significantly higher Mn uptake (5809.5) with cv. MTU 1010 sown with 30 kg seed rate and applied with both $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_2 S_2 M_4$), while the lower Mn uptake (1794.2) was recorded with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient ($V_3 S_1 M_1$).

4.1.1.5 Soil Chemical Properties at harvest

4.1.1.5.1 Soil reaction (pH) (c.f. Table 70)

pH of soil at crop harvest ranged from 7.85 to 8.06 and variations due to cultivars, seed rates and use of micronutrients and two way interactions were not significant during both the years and on pooled basis as well. Among variety X seed rate X micronutrients cv. GGV 0501 at 25 kg ha^{-1} supplied with micronutrient ($V_1 S_1 M_1$), cv. BPT 5204 at 25 kg ha^{-1} coupled with application ZnSO_4 ($V_3 S_1 M_3$) recorded higher soil pH (8.07 and 8.06, respectively) while lower soil pH was recorded in $V_1 S_2 M_2$ (7.85).

4.1.1.5.2 Soil EC (d Sm^{-1}) (c.f. Table 71)

Soil EC values at harvest ranged from 0.69 to 0.86 and were in safe limit. Variations were also not significant due to cultivars, seed rates and use of micronutrients and their interactions except $V \times M$ and $V \times S \times M$ during both the years and pooled basis as well.

Among variety X micronutrients cv. MTU 1010 receiving combined application of both the nutrients $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_2 M_4$) recorded higher EC (0.85) and was on par with $V_{1-2} M_{1-4}$; while lower soil EC (0.73) was recorded with cv. GGV 0501 supplied with FeSO_4 only ($V_1 M_2$). Among, variety X seed rate X micronutrients, cv. BPT 5204 at 30 kg ha^{-1} with application of both the nutrients $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_3 S_2 M_4$) had higher soil EC (0.92) and it was on par with $V_{1-3} S_{1-3} M_{1-4}$ while lower soil EC (0.69) was recorded with cv. GGV 0501 sown using medium seed rate and supplied with only FeSO_4 ($V_1 S_2 M_2$).

Table 70. Effect of genotypes, seed rates and micronutrients on soil pH under direct seeded condition after harvest during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	8.14 ^a	8.04 ^{a-c}	8.04 ^{a-c}	8.07^a	7.99 ^{a-d}	7.93 ^{a-d}	7.88 ^d	7.93^a	8.07 ^a	7.99 ^{a-c}	7.96 ^{a-c}	8.01^a
	M ₂	8.11 ^a	8.03 ^{a-c}	8.05 ^{a-c}	8.06^a	7.94 ^{a-d}	7.91 ^{a-d}	7.91 ^{b-d}	7.92^a	8.03 ^{ab}	7.97 ^{a-c}	7.98 ^{a-c}	7.99^a
	M ₃	8.06 ^{a-c}	8.04 ^{a-c}	8.08 ^{ab}	8.06^a	7.92 ^{a-d}	7.96 ^{a-d}	8.04 ^{ab}	7.97^a	7.99 ^{a-c}	8.00 ^{a-c}	8.06 ^a	8.02^a
	M ₄	7.78 ^c	8.08 ^{ab}	8.07 ^{ab}	7.98^a	7.99 ^{a-d}	7.98 ^{a-d}	7.99 ^{a-d}	7.99^a	7.89 ^{bc}	8.03 ^{ab}	8.03 ^{ab}	7.98^a
S ₂	M ₁	7.81 ^{bc}	8.07 ^{a-c}	8.07 ^{ab}	7.98^a	7.89 ^{cd}	7.93 ^{a-d}	7.98 ^{a-d}	7.93^a	7.85 ^c	8.00 ^{a-c}	8.03 ^{ab}	7.96^a
	M ₂	8.09 ^{ab}	8.11 ^a	7.95 ^{a-c}	8.05^a	7.98 ^{a-d}	8.01 ^{b-d}	7.97 ^{a-d}	7.99^a	8.04 ^{ab}	8.06 ^{ab}	7.96 ^{a-c}	8.02^a
	M ₃	8.12 ^a	8.09 ^{ab}	8.04 ^{a-c}	8.08^a	7.93 ^{a-d}	7.97 ^{a-d}	8.05 ^a	7.98^a	8.02 ^{ab}	8.03 ^{ab}	8.04 ^{ab}	8.03^a
	M ₄	8.11 ^a	8.08 ^a	8.02 ^{a-c}	8.07^a	7.93 ^{a-d}	7.92 ^{a-d}	7.96 ^{a-d}	7.94^a	8.02 ^{ab}	8.00 ^{a-c}	7.99 ^{a-c}	8.00^a
S ₃	M ₁	8.09 ^{ab}	8.05 ^{a-c}	8.03 ^{a-c}	8.06^a	7.91 ^{a-d}	7.90 ^{cd}	7.93 ^{a-d}	7.91^a	8.00 ^{a-c}	7.98 ^{a-c}	7.98 ^{a-c}	7.99^a
	M ₂	8.02 ^{a-c}	8.07 ^{a-c}	8.03 ^{a-c}	8.04^a	7.94 ^{a-d}	7.94 ^{a-d}	8.00 ^{a-d}	7.96^a	7.98 ^{a-c}	8.01 ^{ab}	8.02 ^{ab}	8.00^a
	M ₃	8.03 ^{a-cc}	8.13 ^a	8.00 ^{a-c}	8.05^a	7.94 ^{a-d}	7.88 ^d	8.02 ^{a-c}	7.95^a	8.02 ^{ab}	8.03 ^{ab}	8.04 ^{ab}	8.03^a
	M ₄	8.09 ^{ab}	8.05 ^{a-c}	8.05 ^{a-c}	8.06^a	7.89 ^{cd}	7.89 ^{cd}	8.00 ^{a-d}	7.93^a	7.99 ^{a-c}	7.96 ^{a-c}	8.03 ^{ab}	7.99^a
Variety		8.04^a	8.07^a	8.04^a		7.94^a	7.94^a	7.98^a		7.99^a	8.01^a	8.01^a	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	8.02 ^a	8.05 ^a	8.06 ^a	8.04^a	7.96 ^a	7.95 ^a	7.95 ^a	7.95^a	7.99 ^a	8.00 ^a	8.01 ^a	8.00^a
	S ₂	8.04 ^a	8.09 ^a	8.02 ^a	8.05^a	7.93 ^a	7.96 ^a	7.99 ^a	7.96^a	7.98 ^a	8.02 ^a	8.00 ^a	8.00^a
	S ₃	8.06 ^a	8.07 ^a	8.03 ^a	8.05^a	7.92 ^a	7.90 ^a	7.99 ^a	7.94^a	7.99 ^a	7.99 ^a	8.01 ^a	8.00^a
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M	M ₁	8.02 ^a	8.05 ^a	8.05 ^a	8.04^a	7.93 ^b	7.92 ^b	7.93 ^b	7.93^a	7.97 ^a	7.99 ^a	7.99 ^a	7.98^a
	M ₂	8.07 ^a	8.07 ^a	8.01 ^a	8.05^a	7.96 ^b	7.96 ^b	7.96 ^b	7.96^a	8.02 ^a	8.01 ^a	7.98 ^a	8.00^a
	M ₃	8.07 ^a	8.09 ^a	8.04 ^a	8.07^a	7.93 ^b	7.94 ^b	8.04 ^a	7.97^a	8.00 ^a	8.01 ^a	8.04 ^a	8.02^a
	M ₄	7.99 ^a	8.07 ^a	8.04 ^a	8.03^a	7.94 ^b	7.92 ^b	7.98 ^{ab}	7.95^a	7.97 ^a	8.00 ^a	8.01 ^a	7.99^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.07				0.05				0.05			
Seed (S)		0.02				0.02				0.01			
Micro (M)		0.03				0.01				0.01			
V x S		0.04				0.03				0.02			
V x M		0.05				0.02				0.03			
S x M		0.05				0.02				0.03			
V x S x M		0.08				0.04				0.04			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 71. Effect of genotypes, seed rates and micronutrients on soil EC (d Sm⁻¹) under direct seeded condition after harvest during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	0.68 ^{bc}	0.77 ^{a-c}	0.91 ^a	0.79^a	0.83 ^{a-c}	0.79 ^{a-c}	0.76 ^{bc}	0.79^a	0.75 ^{a-c}	0.78 ^{a-c}	0.83 ^{a-c}	0.79^a
	M ₂	0.72 ^{a-c}	0.67 ^{bc}	0.86 ^{ab}	0.75^a	0.81 ^{a-c}	0.93 ^{a-c}	0.78 ^{a-c}	0.84^a	0.77 ^{a-c}	0.80 ^{a-c}	0.82 ^{a-c}	0.80^a
	M ₃	0.74 ^{a-c}	0.72 ^{a-c}	0.92 ^a	0.79^a	0.88 ^{a-c}	0.82 ^{a-c}	0.81 ^{a-c}	0.84^a	0.81 ^{a-c}	0.77 ^{a-c}	0.87 ^{a-c}	0.82^a
	M ₄	0.72 ^{a-c}	0.70 ^{a-c}	0.82 ^{a-c}	0.75^a	0.91 ^{a-c}	0.90 ^{a-c}	0.87 ^{a-c}	0.89^a	0.81 ^{a-c}	0.80 ^{a-c}	0.84 ^{a-c}	0.82^a
S ₂	M ₁	0.70 ^{a-c}	0.71 ^{a-c}	0.71 ^{a-c}	0.71^a	0.91 ^{a-c}	1.08 ^a	0.76 ^{bc}	0.92^a	0.81 ^{a-c}	0.90 ^{ab}	0.74 ^{a-c}	0.82^a
	M ₂	0.63 ^c	0.77 ^{a-c}	0.76 ^{a-c}	0.72^a	0.74 ^{bc}	0.84 ^{a-c}	0.97 ^{a-c}	0.85^a	0.69 ^c	0.80 ^{a-c}	0.86 ^{a-c}	0.78^a
	M ₃	0.66 ^{bc}	0.73 ^{a-c}	0.79 ^{a-c}	0.73^a	1.01 ^{ab}	0.66 ^c	0.89 ^{a-c}	0.85^a	0.84 ^{a-c}	0.70 ^{bc}	0.84 ^{a-c}	0.80^a
	M ₄	0.72 ^{a-c}	0.87 ^{ab}	0.84 ^{ab}	0.81^a	0.81 ^{a-c}	0.82 ^{a-c}	0.88 ^{a-c}	0.84^a	0.76 ^{a-c}	0.84 ^{a-c}	0.86 ^{a-c}	0.82^a
S ₃	M ₁	0.81 ^{a-c}	0.77 ^{a-c}	0.81 ^{a-c}	0.80^a	0.69 ^c	0.78 ^{a-c}	1.03 ^{ab}	0.83^a	0.75 ^{a-c}	0.77 ^{a-c}	0.92 ^a	0.81^a
	M ₂	0.63 ^c	0.77 ^{a-c}	0.76 ^{a-c}	0.72^a	0.72 ^{bc}	0.79 ^{a-c}	0.82 ^{a-c}	0.78^a	0.72 ^{a-c}	0.80 ^{a-c}	0.74 ^{a-c}	0.75^a
	M ₃	0.76 ^{a-c}	0.73 ^{a-c}	0.79 ^{a-c}	0.78^a	0.75 ^{bc}	0.78 ^{a-c}	0.84 ^{a-c}	0.79^a	0.76 ^{a-c}	0.76 ^{a-c}	0.76 ^{a-c}	0.76^a
	M ₄	0.79 ^{a-c}	0.88 ^{ab}	0.78 ^{a-c}	0.82^a	0.85 ^{a-c}	0.91 ^{a-c}	0.74 ^{bc}	0.83^a	0.82 ^{a-c}	0.89 ^{a-c}	0.76 ^{a-c}	0.82^a
Variety		0.71^a	0.76^a	0.81^a		0.83^a	0.84^a	0.85^a		0.77^a	0.80^a	0.76^a	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	0.72 ^a	0.71 ^a	0.88 ^a	0.77^a	0.86 ^a	0.86 ^a	0.80 ^a	0.84^a	0.79 ^a	0.79 ^a	0.84 ^a	0.81^a
	S ₂	0.68 ^a	0.77 ^a	0.77 ^a	0.74^a	0.87 ^a	0.85 ^a	0.87 ^a	0.86^a	0.77 ^a	0.81 ^a	0.82 ^a	0.80^a
	S ₃	0.77 ^a	0.80 ^a	0.73 ^a	0.77^a	0.75 ^a	0.82 ^a	0.86 ^a	0.81^a	0.76 ^a	0.81 ^a	0.80 ^a	0.79^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	0.73 ^a	0.75 ^a	0.81 ^a	0.76^a	0.81 ^a	0.89 ^a	0.85 ^a	0.85^a	0.77 ^{ab}	0.82 ^{ab}	0.83 ^{ab}	0.81^a
	M ₂	0.70 ^a	0.75 ^a	0.76 ^a	0.74^a	0.75 ^a	0.86 ^a	0.86 ^a	0.82^a	0.73 ^b	0.80 ^{ab}	0.81 ^{ab}	0.78^a
	M ₃	0.72 ^a	0.73 ^a	0.80 ^a	0.75^a	0.88 ^a	0.76 ^a	0.85 ^a	0.83^a	0.80 ^{ab}	0.74 ^{ab}	0.82 ^{ab}	0.79^a
	M ₄	0.74 ^a	0.82 ^a	0.81 ^a	0.79^a	0.86 ^a	0.87 ^a	0.83 ^a	0.85^a	0.80 ^{ab}	0.85 ^a	0.82 ^{ab}	0.82^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.06				0.11				0.05			
Seed (S)		0.02				0.05				0.02			
Micro (M)		0.02				0.03				0.02			
V x S		0.04				0.08				0.04			
V x M		0.04				0.05				0.03			
S x M		0.04				0.05				0.03			
V x S x M		0.06				0.09				0.06			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

4.1.1.5.3 Soil organic carbon (%) (c.f. Table 72)

Soil OC at harvest ranged from 0.47 to 0.65 *i.e.* in low to medium range and variations in soil organic carbon (SOC) were non-significant due to cultivars and seed rates while remaining main effects and interactions were significant during both the years and on pooled basis as well. In the main effects due to levels of micronutrients no supply of micronutrient (M_1) had higher SOC (0.58) while it decreased with micronutrient supply either singly or together and supply of only $ZnSO_4$ (M_3) resulted in significantly lower SOC (0.54).

Interaction due to variety X seed rate revealed significant differences, wherein cv. GGV 0501 with 25 kg ha⁻¹ seed rate (V_1S_1) recorded higher SOC (0.61); while lower SOC (0.52) recorded with cv. BPT 5204 at 25 kg ha⁻¹ seed rate (V_3S_1), among variety X micronutrients cv. GGV 0501 with no application micronutrients (V_1M_1) recorded higher SOC (0.61) and it was on par with $V_{1-2}M_{1-3}$ while lower SOC (0.54) was recorded with cv. BPT 5204 supplied with $ZnSO_4$ (V_3M_3), and among seed rate X micronutrients lower seed rate 25 kg ha⁻¹ with no application of both the nutrients (S_1M_1) recorded higher SOC (0.60) while lower SOC (0.54) among all was recorded with medium seed rate and supply of $FeSO_4$ (S_2M_2).

Overall, in the three-way interaction significant differences were observed wherein cv. GGV 0501 at 25 kg ha⁻¹ seed rate but without micronutrient application ($V_1S_1M_1$) recorded significantly higher SOC (0.65), while lower SOC (0.47) was recorded with cv. BPT 5204 at 25 kg ha⁻¹ seed rate with application of $ZnSO_4$ ($V_3S_1M_3$).

4.1.1.5.4 Soil available nitrogen (kg ha⁻¹) (c.f. Table 73)

Variations in soil available N at crop harvest due to cultivars, seed rates and their interactions except main effects due to micronutrients were significant during both the years and on pooled basis as well.

Significantly higher available nitrogen (259.1) was recorded with the cv. BPT 5204 (V_3) among cultivars while lower soil N was recorded in cv. MTU 1010 (V_2); among the seed rates used, significantly higher N availability (254.9) was found with lower seed rate of 25 kg ha⁻¹ (S_1) and it was on par with S_3 , while lower content (246.4) was recorded with medium seed rate of 30 kg ha⁻¹.

Table 72. Effect of genotypes, seed rates and micronutrients on soil organic carbon (%) under direct seeded condition after harvest during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	0.64 ^a	0.48 ^b	0.49 ^b	0.54^a	0.65 ^{a-c}	0.65 ^{a-c}	0.67 ^{a-c}	0.66^a	0.65 ^a	0.57 ^{a-f}	0.58 ^{a-f}	0.60^a
	M ₂	0.51 ^{ab}	0.53 ^{ab}	0.48 ^b	0.51^a	0.65 ^{a-c}	0.64 ^{a-c}	0.58 ^{a-c}	0.62^a	0.58 ^{a-f}	0.59 ^{a-e}	0.53 ^{d-g}	0.57^{ab}
	M ₃	0.57 ^{ab}	0.50 ^{ab}	0.44 ^b	0.50^a	0.69 ^a	0.56 ^{a-c}	0.49 ^{a-c}	0.58^a	0.63 ^{ab}	0.53 ^{d-g}	0.47 ^g	0.54^b
	M ₄	0.53 ^{ab}	0.51 ^{ab}	0.48 ^b	0.51^a	0.60 ^c	0.65 ^{a-c}	0.53 ^{a-c}	0.59^a	0.57 ^{a-f}	0.58 ^{a-f}	0.50 ^{fg}	0.55^b
S ₂	M ₁	0.58 ^{ab}	0.50 ^{ab}	0.51 ^{ab}	0.53^a	0.64 ^{a-c}	0.63 ^{a-c}	0.56 ^{a-c}	0.61^a	0.61 ^{a-d}	0.56 ^{b-f}	0.54 ^{c-g}	0.57^{ab}
	M ₂	0.51 ^{ab}	0.46 ^b	0.52 ^{ab}	0.50^a	0.52 ^{bc}	0.58 ^{a-c}	0.60 ^{a-c}	0.57^a	0.52 ^{e-g}	0.52 ^{e-g}	0.56 ^{b-f}	0.53^b
	M ₃	0.52 ^{ab}	0.48 ^b	0.51 ^{ab}	0.50^a	0.62 ^{a-c}	0.61 ^{a-c}	0.52 ^{bc}	0.58^a	0.57 ^{a-f}	0.55 ^{b-g}	0.51 ^{e-g}	0.54^b
	M ₄	0.55 ^{ab}	0.47 ^b	0.50 ^{ab}	0.51^a	0.59 ^{a-c}	0.65 ^{a-c}	0.58 ^{a-c}	0.61^a	0.57 ^{a-f}	0.56 ^{b-f}	0.54 ^{c-g}	0.56^{ab}
S ₃	M ₁	0.53 ^{ab}	0.49 ^b	0.47 ^b	0.50^a	0.62 ^{a-c}	0.67 ^{ab}	0.61 ^{a-c}	0.63^a	0.58 ^{a-f}	0.58 ^{a-f}	0.54 ^{c-g}	0.57^{ab}
	M ₂	0.52 ^{ab}	0.49 ^b	0.49 ^b	0.50^a	0.60 ^{a-c}	0.64 ^{a-c}	0.55 ^{a-c}	0.60^a	0.56 ^{b-f}	0.56 ^{b-f}	0.52 ^{e-g}	0.55^b
	M ₃	0.47 ^b	0.47 ^b	0.51 ^{ab}	0.48^a	0.62 ^{a-c}	0.67 ^{ab}	0.53 ^{a-c}	0.61^a	0.54 ^{c-g}	0.57 ^{a-f}	0.52 ^{e-g}	0.54^b
	M ₄	0.58 ^{ab}	0.47 ^b	0.54 ^{ab}	0.53^a	0.67 ^{ab}	0.62 ^{a-c}	0.53 ^{a-c}	0.61^a	0.62 ^{a-c}	0.54 ^{c-g}	0.53 ^{d-g}	0.56^{ab}
Variety		0.54^a	0.49^a	0.50^a		0.62^a	0.63^a	0.56^a		0.58^a	0.56^a	0.53^a	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	0.56 ^a	0.50 ^{ab}	0.47 ^b	0.51^a	0.65 ^a	0.63 ^a	0.57 ^a	0.62^a	0.61 ^a	0.56 ^{ab}	0.52 ^b	0.56^a
	S ₂	0.54 ^{ab}	0.48 ^b	0.51 ^{ab}	0.51^a	0.59 ^a	0.62 ^a	0.57 ^a	0.59^a	0.57 ^{ab}	0.55 ^{ab}	0.54 ^b	0.55^a
	S ₃	0.53 ^{ab}	0.48 ^b	0.50 ^{ab}	0.50^a	0.63 ^a	0.65 ^a	0.55 ^a	0.61^a	0.58 ^{ab}	0.56 ^{ab}	0.53 ^b	0.56^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	0.59 ^a	0.49 ^b	0.49 ^b	0.52^a	0.64 ^a	0.65 ^a	0.61 ^{ab}	0.63^a	0.61 ^a	0.57 ^{a-d}	0.55 ^{b-d}	0.58^a
	M ₂	0.51 ^b	0.49 ^b	0.50 ^b	0.50^a	0.59 ^{a-c}	0.62 ^{ab}	0.58 ^{a-c}	0.60^a	0.55 ^{b-d}	0.56 ^{b-d}	0.54 ^{c-e}	0.55^b
	M ₃	0.52 ^{ab}	0.48 ^b	0.49 ^b	0.50^a	0.64 ^a	0.61 ^{ab}	0.51 ^c	0.59^a	0.58 ^{a-c}	0.55 ^{b-d}	0.50 ^e	0.54^b
	M ₄	0.55 ^{ab}	0.48 ^b	0.51 ^b	0.51^a	0.62 ^{ab}	0.64 ^a	0.54 ^{bc}	0.60^a	0.59 ^{ab}	0.56 ^{b-d}	0.53 ^{de}	0.56^{ab}
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.03				0.05				0.03			
Seed (S)		0.01				0.03				0.01			
Micro (M)		0.01				0.02				0.01			
V x S		0.02				0.04				0.02			
V x M		0.02				0.03				0.01			
S x M		0.02				0.03				0.01			
V x S x M		0.04				0.05				0.03			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 73. Effect of genotypes, seed rates and micronutrients on soil available nitrogen (kg ha⁻¹) under direct seeded condition after harvest during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	258.2 ^{a-h}	249.1 ^{e-j}	271.6 ^a	259.6 ^a	256.6 ^{a-e}	242.5 ^{a-e}	253.2 ^{a-e}	250.8 ^{ab}	257.4 ^{b-h}	245.8 ^{g-j}	262.4 ^{b-e}	255.2 ^a
	M ₂	258.1 ^{a-h}	248.9 ^{e-j}	270.0 ^{ab}	259.0 ^a	240.1 ^{b-e}	236.8 ^{c-e}	254.7 ^{a-e}	243.9 ^{ab}	249.1 ^{d-j}	242.8 ^{h-j}	262.3 ^{b-e}	251.4 ^{ab}
	M ₃	256.6 ^{b-i}	248.5 ^{e-j}	268.1 ^{a-c}	257.7 ^a	250.9 ^{a-e}	256.6 ^{a-e}	261.4 ^{a-c}	256.3 ^{ab}	253.7 ^{b-i}	252.5 ^{b-i}	264.7 ^{bc}	257.0 ^a
	M ₄	256.6 ^{b-i}	247.5 ^{f-j}	268.1 ^{a-c}	257.4 ^a	251.7 ^{a-e}	246.0 ^{a-e}	264.7 ^{ab}	254.1 ^{ab}	254.1 ^{b-i}	246.8 ^{f-j}	266.4 ^a	255.8 ^a
S ₂	M ₁	254.9 ^{c-i}	244.6 ^{h-j}	261.3 ^{a-f}	253.6 ^{ab}	247.0 ^{a-e}	257.1 ^{a-d}	250.5 ^{a-e}	251.5 ^{ab}	251.0 ^{b-i}	250.9 ^{c-j}	255.9 ^{b-h}	252.6 ^{ab}
	M ₂	253.9 ^{c-i}	243.0 ^{ij}	261.2 ^{a-f}	252.7 ^{ab}	261.8 ^{a-c}	230.1 ^e	263.0 ^{ab}	251.6 ^{ab}	257.9 ^{b-h}	236.6 ^j	262.1 ^{b-f}	252.2 ^{ab}
	M ₃	252.4 ^{d-i}	242.7 ^{ij}	261.2 ^{a-f}	252.1 ^{ab}	251.2 ^{a-e}	247.7 ^{a-e}	236.3 ^{c-e}	245.1 ^{ab}	251.8 ^{b-j}	245.2 ^{g-j}	248.7 ^{e-j}	248.6 ^{ab}
	M ₄	252.2 ^{d-i}	235.8 ^j	259.1 ^{a-g}	249.0 ^b	240.5 ^{b-e}	252.4 ^{a-e}	234.0 ^{de}	242.3 ^b	246.4 ^{g-j}	244.1 ^{h-j}	246.5 ^{g-j}	245.7 ^b
S ₃	M ₁	255.9 ^{b-i}	247.5 ^{f-j}	264.7 ^{a-d}	256.0 ^{ab}	253.0 ^{a-e}	230.1 ^e	259.5 ^{a-d}	247.5 ^{ab}	254.4 ^{b-h}	238.8 ^j	262.1 ^{b-f}	251.8 ^{ab}
	M ₂	255.5 ^{b-i}	246.1 ^{g-j}	264.5 ^{a-d}	255.4 ^{ab}	257.4 ^{a-d}	240.0 ^{b-e}	243.0 ^{a-e}	246.8 ^{ab}	256.5 ^{b-h}	243.1 ^{h-j}	253.7 ^{b-i}	251.1 ^{ab}
	M ₃	255.2 ^{c-i}	245.9 ^{g-j}	264.1 ^{a-d}	255.1 ^{ab}	245.7 ^{a-e}	259.5 ^{a-d}	264.5 ^{ab}	256.6 ^a	250.5 ^{c-j}	252.7 ^{b-i}	264.3 ^{b-d}	255.8 ^a
	M ₄	255.2 ^{c-i}	245.8 ^{g-j}	262.9 ^{a-c}	254.6 ^{ab}	236.1 ^{c-e}	268.3 ^a	257.6 ^{a-d}	254.0 ^{ab}	245.6 ^{g-j}	257.0 ^{b-h}	260.3 ^{b-g}	254.3 ^a
Variety		255.4 ^b	245.5 ^c	264.7 ^a		249.3 ^a	247.3 ^a	253.5 ^a		252.4 ^b	246.4 ^c	259.1 ^a	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	257.4 ^{cd}	248.5 ^e	269.4 ^a	258.4 ^a	249.8 ^a	245.5 ^a	258.5 ^a	251.3 ^a	253.6 ^{bc}	247.0 ^{cd}	264.0 ^a	254.9 ^a
	S ₂	253.4 ^d	241.5 ^f	260.7 ^{bc}	251.9 ^b	250.1 ^a	246.8 ^a	245.9 ^a	247.6 ^a	251.7 ^c	244.2 ^d	253.3 ^{bc}	249.7 ^b
	S ₃	255.5 ^d	246.3 ^e	264.1 ^b	255.3 ^a	248.0 ^a	249.5 ^a	256.2 ^a	251.2 ^a	251.7 ^c	247.9 ^{cd}	260.1 ^{ab}	253.2 ^{ab}
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M	M ₁	256.4 ^b	247.1 ^c	265.9 ^a	256.5 ^{ab}	252.2 ^a	243.2 ^{ab}	254.4 ^a	249.9 ^a	254.3 ^{a-c}	245.2 ^{de}	260.1 ^a	253.2 ^a
	M ₂	255.8 ^b	246.0 ^c	265.2 ^a	255.7 ^b	253.1 ^a	235.6 ^b	253.6 ^a	247.4 ^a	254.5 ^{a-c}	240.8 ^e	259.4 ^a	251.6 ^a
	M ₃	254.7 ^b	245.7 ^c	264.5 ^a	255.0 ^a	249.2 ^a	254.6 ^a	254.1 ^a	252.6 ^a	252.0 ^{a-c}	250.1 ^{b-d}	259.3 ^a	253.8 ^a
	M ₄	254.7 ^b	243.0 ^c	263.3 ^a	253.7 ^{ab}	242.7 ^{ab}	255.6 ^a	252.1 ^a	250.1 ^a	248.7 ^{cd}	249.3 ^{c-d}	257.7 ^{ab}	251.9 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		2.3				1.7				1.1			
Seed (S)		0.8				2.4				1.3			
Micro (M)		1.3				2.5				1.5			
V x S		1.4				4.1				2.1			
V x M		2.4				4.4				2.6			
S x M		2.4				4.4				2.6			
V x S x M		4.2				7.6				4.4			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

All the two factor interactions were significant wherein among variety X seed rate cv. BPT 5204 seeds sown at 25 kg ha⁻¹ (V₃S₁) recorded significantly higher available N (264.0), while lower N (244.2) was recorded with cv. MTU 1010 (V₂S₂) at the seed rate of 30 kg ha⁻¹; among variety X micronutrient cv. BPT 5204 supplied with neither FeSO₄ nor ZnSO₄ (V₃M₁) registered higher N (260.1) availability and was on par with V₁M₁₋₃ while lower N (240.8) was recorded with cv. MTU 1010 with application of FeSO₄ (V₂M₂), and among seed rates and micronutrients 25 kg seed rate with application of ZnSO₄ (V₁M₃) recorded higher N availability (257.0) and S₁₋₃M₁₋₃ were on par while 30 kg ha⁻¹ seed rate with supplementation of both the micronutrients (S₂M₄) recorded lower N availability (245.7).

Variety X seed rate X micronutrients interaction also revealed significant differences in N availability in soil wherein cv. BPT 5204 sown with 25 kg seed rate and applied with both FeSO₄ and ZnSO₄ (V₃S₁M₄) significantly higher (266.4) available N while lower soil available N (236.6) was recorded with cv. MTU 1010 sown using 30 kg ha⁻¹ seed rate and supplied with FeSO₄ (V₂S₂M₂).

4.1.1.5.5 Soil available phosphorus (kg ha⁻¹) (c.f. Table 74)

Available P in soil varied significantly due to cultivars, seed rates and their interactions except main effects due to micronutrients during both the years and on pooled basis as well.

Significantly higher available P (44.6) was recorded with the cv. BPT 5204 (V₃) among cultivars while lower P (29.4) occurred with cv. MTU 1010, and among the seed rates significantly higher available P (39.4) was found with lower seed rate of 25 kg ha⁻¹ (S₁) whereas lower P (33.9) was recorded with medium seed rate of 30 kg ha⁻¹.

Variety X seed rate interaction revealed significant differences wherein cv. BPT 5204 sown at 25 kg ha⁻¹ (V₃S₁) recorded significantly higher soil available P (48.4) while lower P (26.7) was recorded with cv. MTU 1010 with medium seed rate of 30 kg ha⁻¹ (V₂S₂); variations among variety X micronutrient were also significant wherein cv. BPT 5204 irrespective of micronutrient levels (V₃M₁₋₄) had higher soil P particularly with V₃M₁ (44.9) while lower P was recorded with cv. MTU 1010 irrespective of micronutrient levels (V₂M₁₋₄) especially with V₂M₄ (28.4), and among micronutrients and seed rates, lower seed rate of 25 kg ha⁻¹ with no application of micronutrients (S₁M₁)

Table 74. Effect of genotypes, seed rates and micronutrients on soil available phosphorus (kg ha⁻¹) under direct seeded condition after harvest during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	42.3 ^{b-h}	34.9 ^{b-h}	61.0 ^a	46.1 ^a	35.2 ^{e-g}	31.5 ^{g-j}	35.4 ^{e-g}	34.0 ^{a-c}	38.8 ^{c-h}	33.2 ^{g-l}	48.2 ^{ab}	40.1 ^a
	M ₂	41.7 ^{b-h}	34.8 ^{c-h}	53.9 ^{ab}	43.5 ^{ab}	36.3 ^{d-f}	29.6 ^{h-l}	42.2 ^{a-c}	36.0 ^a	39.0 ^{c-h}	32.2 ^{h-l}	48.0 ^{ab}	39.7 ^{ab}
	M ₃	41.6 ^{b-h}	34.6 ^{d-h}	53.8 ^{ab}	43.3 ^{ab}	30.7 ^{g-k}	28.1 ^{j-m}	45.0 ^a	34.6 ^{a-c}	36.1 ^{e-j}	31.3 ^{h-l}	49.4 ^a	38.9 ^{a-c}
	M ₄	41.3 ^{b-h}	34.2 ^{gh}	52.8 ^{b-g}	42.8 ^{ab}	34.2 ^{e-h}	27.1 ^{j-m}	43.3 ^{ab}	34.9 ^{ab}	37.8 ^{d-i}	30.6 ^l	48.1 ^{ab}	38.8 ^{a-c}
S ₂	M ₁	37.9 ^{c-h}	29.6 ^h	45.1 ^{b-g}	37.5 ^{ab}	29.5 ^{h-l}	25.0 ^{lm}	40.4 ^{b-d}	31.6 ^{cd}	33.7 ^{g-i}	27.3 ^{kl}	42.8 ^{a-f}	34.6 ^e
	M ₂	37.1 ^{c-h}	28.7 ^h	44.8 ^{b-g}	36.9 ^b	33.1 ^{f-i}	24.9 ^{lm}	40.1	32.7 ^{bc}	35.1 ^{f-k}	26.8 ^l	42.4 ^{a-f}	34.8 ^e
	M ₃	35.7 ^{c-h}	28.2 ^h	44.7 ^{b-h}	36.2 ^b	31.5 ^{g-j}	25.4 ^{lm}	38.0 ^{c-e}	31.6 ^{cd}	33.6 ^{g-l}	26.8 ^l	41.1 ^{b-g}	33.8 ^{de}
	M ₄	35.3 ^{c-h}	28.1 ^h	42.3 ^{a-c}	35.2 ^b	30.8 ^{g-k}	23.9 ^m	34.8 ^{e-g}	29.8 ^d	33.0 ^{h-l}	26.0 ^l	38.6 ^{c-h}	32.5 ^e
S ₃	M ₁	41.1 ^{b-h}	33.6 ^{f-h}	50.5 ^{a-d}	41.7 ^{ab}	30.7 ^{g-k}	28.7 ^{j-l}	36.8 ^{d-f}	32.1 ^{b-d}	35.9 ^{e-j}	31.2 ^{h-l}	43.7 ^{a-e}	36.9 ^{a-d}
	M ₂	41.0 ^{b-h}	32.8 ^{f-h}	49.9 ^{a-e}	41.2 ^{ab}	33.8 ^{e-h}	28.3 ^{j-m}	42.7 ^{ab}	34.9 ^{a-c}	37.4 ^{d-i}	30.6 ^l	46.3 ^{a-c}	38.1 ^{a-d}
	M ₃	40.6 ^{b-h}	30.9 ^{f-h}	48.7 ^{a-f}	40.1 ^{ab}	34.1 ^{e-h}	25.0 ^{k-m}	40.0 ^{b-d}	33.0 ^{b-c}	37.3 ^{d-i}	28.0 ^{kl}	44.3 ^{a-d}	36.5 ^{a-e}
	M ₄	39.0 ^{b-h}	30.6 ^{f-h}	46.2 ^{a-d}	38.6 ^{ab}	33.6 ^{e-h}	26.3 ^{j-m}	37.9 ^{c-e}	32.6 ^{b-d}	36.3 ^{e-j}	28.4 ^l	42.1 ^{a-f}	35.6 ^{b-e}
Variety		39.6 ^{ab}	31.8 ^b	49.5 ^a		32.8 ^b	27.0 ^c	39.7 ^a		36.2 ^b	29.4 ^c	44.6 ^a	
Variety x Seed rate		S			Variety x Seed rate			S			Variety x Seed rate		
S	S ₁	41.7 ^{cd}	34.6 ^{eg}	55.4 ^a	43.9 ^a	34.1 ^c	29.1 ^e	41.5 ^a	34.9 ^a	37.9 ^e	31.8 ^{ef}	48.4 ^a	39.4 ^a
	S ₂	36.5 ^{d-f}	28.7 ^g	44.2 ^{bc}	36.5 ^c	31.2 ^d	24.8 ^g	38.3 ^b	31.4 ^c	33.8 ^{de}	26.7 ^g	41.3 ^b	33.9 ^c
	S ₃	40.4 ^{c-e}	32.0 ^{fg}	48.8 ^b	40.4 ^b	33.0 ^c	27.1 ^f	39.3 ^b	33.1 ^b	36.7 ^{cd}	29.5 ^{fg}	44.1 ^b	36.8 ^b
Variety x Micro		M			Variety x Micro			M			Variety x Micro		
M	M ₁	40.4 ^b	32.7 ^{bc}	52.2 ^a	41.8 ^a	31.8 ^e	28.4 ^f	37.5 ^c	32.6 ^c	36.1 ^b	30.6 ^c	44.9 ^a	37.2 ^a
	M ₂	39.9 ^b	32.1 ^{bc}	49.6 ^a	40.5 ^a	34.4 ^d	27.6 ^{fg}	41.6 ^a	34.5 ^a	37.2 ^b	29.9 ^c	45.6 ^a	37.6 ^a
	M ₃	39.3 ^{bc}	31.2 ^c	49.1 ^a	39.9 ^a	32.1 ^{de}	26.1 ^{fg}	41.0 ^{ab}	33.1 ^b	35.7 ^b	28.7 ^c	45.0 ^a	36.5 ^a
	M ₄	38.5 ^{bc}	31.0 ^c	17.1 ^d	28.9 ^b	32.9 ^{de}	25.8 ^g	38.7 ^{bc}	32.5 ^{bc}	35.7 ^b	28.4 ^c	42.9 ^a	35.7 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		2.6				0.8				1.2			
Seed (S)		1.1				0.2				0.6			
Micro (M)		1.5				0.5				0.8			
V x S		1.9				0.4				1.0			
V x M		2.6				0.8				1.3			
S x M		2.6				0.8				1.3			
V x S x M		4.5				1.4				2.3			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

recorded higher soil available P, while medium seed rate 30 kg ha⁻¹ with supplementation of both the micronutrients (S₂M₄) recorded lower available P (32.5).

Overall, the three way interaction revealed significant differences in soil available P wherein cv. BPT 5204 sown with 25 kg seed rate and applied with ZnSO₄ (V₃S₁M₃) recorded significantly higher (49.4) soil available P and V₃S₁₋₃M₁₋₄ were at par while lower soil available P (26.0) was recorded with cv. MTU 1010 sown using 30 kg ha⁻¹ seed rate and supplied with both FeSO₄ and ZnSO₄ (V₂S₂M₄).

4.1.1.5.6 Soil available potassium (kg ha⁻¹) (c.f. Table 75)

Similar to P, soil available K varied significantly due to cultivars, seed rates and their interactions except due to main effects due to micronutrients during both the years and on pooled basis as well.

Among the main effects significantly higher available K (393.6) was recorded with the cv. BPT 5204 (V₃) among cultivars while lower K status (351.6) was recorded with cv. MTU 1010 (V₂); GGV 0501(V₁) was at par, and among the seed rates significantly higher K (379.3) was registered with lower seed rate of 25 kg ha⁻¹ (S₁) and it was on par with S₃ whereas lower available K (362.7) was recorded with medium seed rate of 30 kg ha⁻¹ (S₂).

Interaction due to Variety X seed rate revealed significant differences wherein cv. BPT 5204 seeds sown at 25 kg ha⁻¹ (V₃S₁) recorded significantly higher available K in soil (410.3) while lower K (346.4) occurred with cv. MTU 1010 with seed rate of 30 kg ha⁻¹ (V₂S₂); and among variety X micronutrient cv. BPT 5204 irrespective of micronutrient levels (V₃M₁₋₄) recorded lower soil K particularly with V₃M₁ (400.5) while lower K status (349.0) was recorded with cv. MTU 1010 with combined application of FeSO₄ + ZnSO₄ (V₂M₄), and among seed rates and micronutrients lower seed rate of 25 kg ha⁻¹ with no application of micronutrients (S₁M₁- 383.2) while higher seed rate of 35 kg ha⁻¹ with application of FeSO₄ + ZnSO₄ (S₃M₄) recorded lower available K (358.4).

Of the variety X seed rate X micronutrient combinations cv. BPT 5204 sown with 25 kg seed rate and applied with both FeSO₄ and ZnSO₄ (V₃S₁M₄) recorded significantly higher (418.6) soil available K while lower available K (341.3) was recorded with cv. MTU 1010 sown using 30 kg ha⁻¹ seed rate and receiving FeSO₄ + ZnSO₄ (V₂S₂M₄).

Table 75. Effect of genotypes, seed rates and micronutrients on soil available potassium (kg ha⁻¹) under direct seeded condition after harvest during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	367.0 ^{b-e}	353.3 ^{c-e}	422.3 ^a	380.9^a	381.8 ^{b-g}	360.0 ^{e-i}	414.8 ^a	385.5^a	374.4 ^{c-h}	356.6 ^{e-i}	418.6 ^a	383.2^a
	M ₂	366.7 ^{b-e}	352.7 ^{c-e}	420.0 ^a	379.8^a	379.1 ^{b-h}	359.9 ^{e-i}	399.3 ^{ab}	379.4^{ab}	372.9 ^{c-h}	356.3 ^{e-i}	409.6 ^{ab}	379.6^{ad}
	M ₃	366.4 ^{b-e}	352.7 ^{c-e}	417.5 ^{ab}	378.9^a	375.4 ^{b-i}	358.8 ^{e-i}	398.1 ^{a-c}	377.4^{ab}	370.9 ^{c-h}	355.7 ^{f-i}	407.8 ^{ab}	378.1^{ab}
	M ₄	362.6 ^{c-e}	352.0 ^{c-e}	415.4 ^{ab}	376.7^a	374.4 ^{b-i}	358.3 ^{e-i}	395.1 ^{a-c}	375.9^{ab}	368.5 ^{c-i}	355.2 ^{g-i}	405.3 ^{ab}	376.3^{a-c}
S ₂	M ₁	356.3 ^{c-e}	343.5 ^{c-e}	387.7 ^{a-e}	362.5^a	365.9 ^{d-i}	355.3 ^{f-i}	390.8 ^{a-d}	370.7^{ab}	361.1 ^{e-i}	349.4 ^{g-i}	389.2 ^{bd}	366.6^{b-d}
	M ₂	356.2 ^{c-e}	342.9 ^{c-e}	382.2 ^{a-e}	360.4^a	364.8 ^{d-i}	354.3 ^{g-i}	385.9 ^{b-e}	368.3^b	360.5 ^{e-i}	348.6 ^{g-i}	384.0 ^{b-f}	364.4^{b-d}
	M ₃	355.4 ^{c-e}	341.8 ^{de}	369.3 ^f	355.5^a	364.7 ^{d-i}	350.7 ^{hi}	385.8 ^{b-e}	367.1^b	360.1 ^{e-i}	346.3 ^{hi}	377.5 ^{c-g}	361.3^{cd}
	M ₄	355.3 ^{c-e}	335.7 ^e	367.6 ^{b-e}	352.9^a	360.4 ^{e-i}	346.9 ⁱ	384.6 ^{b-f}	364.0^b	357.9 ^{e-i}	341.3 ⁱ	376.1 ^{c-g}	358.4^d
S ₃	M ₁	360.8 ^{c-e}	351.3 ^{c-e}	395.1 ^{a-c}	369.1^a	373.9 ^{b-i}	358.0 ^{e-i}	392.4 ^{a-d}	374.8^{ab}	367.3 ^{e-i}	354.7 ^{g-i}	393.7 ^{a-c}	371.9^{a-d}
	M ₂	360.0 ^{c-e}	349.2 ^{c-e}	395.0 ^{a-d}	368.1^a	373.0 ^{b-i}	357.3 ^{e-i}	392.9 ^{a-d}	374.4^{ab}	366.5 ^{c-i}	353.2 ^{g-i}	393.5 ^{a-c}	371.1^{a-d}
	M ₃	359.8 ^{c-e}	345.7 ^{c-e}	388.9 ^{a-e}	364.8^a	371.1 ^{b-i}	357.0 ^{e-i}	391.9 ^{a-d}	373.3^{ab}	365.5 ^{c-i}	351.4 ^{g-i}	377.5 ^{c-g}	364.8^{b-d}
	M ₄	356.6 ^{c-e}	345.1 ^{c-e}	388.5 ^{a-e}	363.4^a	369.9 ^{c-i}	356.0 ^{f-i}	391.9 ^{a-d}	372.6^{ab}	363.3 ^{d-i}	350.5 ^{g-i}	390.2 ^{b-d}	368.0^{a-d}
Variety		360.3^b	347.2^c	395.8^a		371.2^a	356.0^a	393.6^a		365.7^b	351.6^b	393.6^a	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	365.7 ^{b-d}	352.7 ^{cd}	418.8 ^a	379.1^a	377.7 ^{b-d}	359.3 ^{e-f}	401.8 ^a	379.6^a	371.7 ^{cd}	356.0 ^{d-f}	410.3 ^a	379.3^a
	S ₂	355.8 ^{cd}	341.0 ^d	376.7 ^{bc}	357.8^b	364.0 ^{d-f}	351.8 ^f	386.6 ^{a-c}	367.5^b	359.9 ^{d-f}	346.4 ^f	381.7 ^{bc}	362.7^b
	S ₃	359.3 ^{cd}	347.8 ^{cd}	391.9 ^b	366.3^{ab}	372.0 ^{c-e}	357.1 ^{ef}	392.0 ^{ab}	373.7^{ab}	365.6 ^{c-e}	352.4 ^{ef}	392.0 ^b	370.0^{ab}
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	361.4 ^b	349.4 ^b	401.7 ^a	370.8^a	373.8 ^b	357.8 ^{c-e}	399.3 ^a	377.0^a	367.6 ^b	353.6 ^{b-d}	400.5 ^a	373.9^a
	M ₂	361.0 ^b	348.3 ^b	399.1 ^a	369.5^a	372.3 ^{bc}	357.2 ^{c-e}	392.4 ^a	374.0^a	366.6 ^b	352.7 ^{b-d}	395.7 ^a	371.7^a
	M ₃	360.5 ^b	346.7 ^b	391.9 ^a	366.4^a	370.4 ^{b-d}	355.5 ^{de}	392.0 ^a	372.6^a	365.5 ^{bc}	351.1 ^{cd}	391.9 ^a	369.5^a
	M ₄	358.2 ^b	344.3 ^b	390.5 ^a	364.3^a	368.2 ^{b-e}	353.7 ^e	390.5 ^a	370.8^a	363.2 ^{b-d}	349.0 ^d	390.5 ^a	367.6^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		3.0				10.7				5.0			
Seed (S)		5.0				3.0				3.1			
Micro (M)		5.1				2.8				2.7			
V x S		8.6				5.2				5.4			
V x M		8.8				5.0				4.7			
S x M		8.8				5.0				4.7			
V x S x M		15.1				8.5				8.2			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

4.1.1.5.7 Soil available iron (mg kg^{-1}) (c.f. Table 76)

Available Fe varied significantly due to main effects of cultivars and all interactions except S x M during both the years and on pooled basis as well. Significantly higher available Fe (14.6) was recorded with the cv. BPT 5204 (V_3) among cultivars while lower K (11.4) was recorded with cv. MTU 1010 (V_2).

Variety X seed rate interaction revealed significant differences wherein cv. BPT 5204 at all seed rates recorded higher available Fe particularly with 30 kg ha^{-1} (V_3S_2) (14.86) while lower Fe was recorded with cv. MTU 1010 especially with 25 kg ha^{-1} (V_1S_2) (11.13), and among variety X micronutrient cv. BPT 5204 with combined application of micronutrient (iron and zinc) (V_3M_4) recorded higher available Fe (14.91) and it was on par with V_3M_{1-3} ; while lower available Fe (11.04) was recorded with cv. MTU 1010 irrespective of at micronutrient levels (V_2M_{1-4}) especially with V_2M_1 (11.04).

Overall, the three way interaction revealed significant differences in soil available Fe wherein cv. BPT 5204 irrespective of the seed rates and micronutrient levels recorded higher available Fe particularly with $V_3S_2M_4$ (14.99) while lower availability of Fe was recorded with cv. MTU 1010 sown using 25 kg ha^{-1} seed rate but without application of micronutrient ($V_2S_1M_1$) (10.81).

4.1.1.5.8 Soil available zinc (mg kg^{-1}) (c.f. Table 77)

Available Zn varied significantly due to cultivars, seed rates and interactions except micronutrients during both the years and on pooled basis as well.

Significantly higher available Zn (3.91) was recorded with the cv. BPT 5204 (V_3) among cultivars while lower Fe (2.75) was recorded with cv. MTU 1010 (V_2); among the seed rates used, significantly higher available Fe (3.57) was with lower seed rate of 25 kg ha^{-1} (S_1) while lower available Fe (3.07) was recorded with seed rate of 30 kg ha^{-1} (S_2).

Interaction due to variety X seed rate revealed significant differences and cv. BPT 5204 sown at 25 kg ha^{-1} seed rate recorded significantly higher (4.31) availability of iron, while lower status (2.45) was recorded with cv. MTU 1010 at 30 kg ha^{-1} (V_2S_2). Interaction between Variety X micronutrient again revealed significant variations, in that cv. BPT 5204 with combined application of micronutrient (iron and zinc) (V_3M_4) had highest Zn availability (4.14); while lower Zn was recorded with cv. MTU 1010 without micronutrient application (V_2M_1 - 3.61).

Table 76. Effect of genotypes, seed rates and micronutrients on soil available iron (mg kg⁻¹) under direct seeded condition after harvest during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	11.98 ^{e-k}	8.96 ^k	13.84 ^{a-f}	11.59^e	13.57 ^a	12.66 ^a	14.65 ^a	13.62^a	12.77 ^{a-f}	10.81 ^f	14.24 ^{ab}	12.61^a
	M ₂	12.20 ^{d-j}	9.72 ^k	13.90 ^{a-e}	11.94^{de}	13.61 ^a	12.67 ^a	14.73 ^a	13.67^a	12.91 ^{a-f}	11.19 ^{ef}	14.32 ^a	12.81^a
	M ₃	12.70 ^{c-i}	9.72 ^k	14.00 ^{a-e}	12.14^{c-e}	13.78 ^a	12.71 ^a	15.01 ^a	13.83^a	13.24 ^{a-e}	11.21 ^{c-f}	14.50 ^a	12.99^a
	M ₄	13.67 ^c	9.86 ^{h-k}	14.30 ^{a-d}	10.11^f	13.95 ^a	12.73 ^a	15.25 ^a	13.97^a	13.39 ^{a-f}	11.29 ^{ef}	14.77 ^a	13.15^a
S ₂	M ₁	13.04 ^{b-h}	10.86 ^{g-k}	15.60 ^a	13.17^{a-c}	12.88 ^a	11.25 ^a	13.95 ^a	12.69^a	12.96 ^{a-f}	11.05 ^{c-f}	14.77 ^a	12.93^a
	M ₂	13.08 ^{b-h}	11.42 ^{f-k}	15.60 ^a	13.37^{ab}	13.25 ^a	11.86 ^a	13.95 ^a	13.02^a	13.17 ^{a-d}	11.64 ^{c-f}	14.78 ^a	13.19^a
	M ₃	13.50 ^{a-g}	11.54 ^{e-k}	15.70 ^a	13.58^{ab}	13.34 ^a	11.89 ^a	14.11 ^a	13.11^a	13.42 ^{a-f}	11.71 ^{b-f}	14.91 ^a	13.35^a
	M ₄	13.80 ^{a-f}	11.82 ^{j-k}	15.80 ^a	13.81^a	13.37 ^a	12.23 ^a	14.18 ^a	13.26^a	13.59 ^{a-f}	12.02 ^{d-f}	14.99 ^a	13.53^a
S ₃	M ₁	12.84 ^{c-h}	10.20 ^{i-k}	14.38 ^{a-d}	12.47^{b-e}	13.43 ^a	12.31 ^a	14.18 ^a	13.31^a	13.13 ^{a-e}	11.26 ^{c-f}	14.28 ^a	12.89^a
	M ₂	12.84 ^{c-h}	10.50 ^{h-k}	14.50 ^{a-d}	12.61^{b-e}	13.47 ^a	12.43 ^a	14.28 ^a	13.39^a	13.15 ^{a-e}	11.46 ^{c-f}	14.39 ^a	13.00^a
	M ₃	12.88 ^{c-h}	10.78 ^{h-k}	14.70 ^{a-c}	12.79^{a-e}	13.55 ^a	12.63 ^a	14.51 ^a	13.56^a	13.21 ^{a-e}	11.70 ^{c-f}	14.60 ^a	13.17^a
	M ₄	12.90 ^{c-i}	10.84 ^{h-k}	15.30 ^{ab}	13.01^{a-d}	13.57 ^a	12.65 ^a	14.61 ^a	13.61^a	13.23 ^{a-c}	11.75 ^{c-f}	14.96 ^a	13.31^a
Variety		12.30^c	10.50^b	14.80^a		13.48^a	12.33^b	14.45^a		13.18^b	11.43^c	14.63^a	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	10.76 ^q	9.57 ^f	14.01 ^{bc}	11.45^c	13.73 ^{a-c}	12.69 ^{a-c}	14.91 ^a	13.77^a	13.08 ^b	11.13 ^c	14.46 ^a	12.89^a
	S ₂	13.36 ^{cd}	11.41 ^e	15.68 ^a	13.48^a	13.21 ^{a-c}	11.81 ^c	14.05 ^{abc}	13.02^a	13.28 ^b	11.61 ^c	14.86 ^a	13.25^a
	S ₃	12.87 ^d	10.58 ^e	14.72 ^b	12.72^b	13.50 ^{a-c}	12.51 ^{bc}	14.40 ^{ab}	13.47^a	13.18 ^b	11.54 ^c	14.56 ^a	13.09^a
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M	M ₁	12.62 ^b	10.01 ^c	14.61 ^a	12.41^a	13.29 ^a	12.07 ^a	14.26 ^a	13.21^a	12.96 ^d	11.04 ^e	14.43 ^{a-c}	12.81^a
	M ₂	12.71 ^b	10.55 ^c	14.67 ^a	12.64^a	13.44 ^a	12.32 ^a	14.32 ^a	13.36^a	13.08 ^d	11.43 ^e	14.49 ^{a-c}	13.00^a
	M ₃	13.03 ^b	10.68 ^c	14.80 ^a	12.84^a	13.56 ^a	12.41 ^a	14.54 ^a	13.50^a	13.29 ^{cd}	11.54 ^e	14.67 ^{ab}	13.17^a
	M ₄	10.96 ^b	10.84 ^c	15.13 ^a	12.31^a	13.63 ^a	12.54 ^a	14.68 ^a	13.61^a	13.40 ^{b-d}	11.69 ^e	14.91 ^a	13.33^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.16				0.30				0.15			
Seed (S)		0.16				0.40				0.20			
Micro (M)		0.23				0.46				0.23			
V x S		0.28				0.69				0.34			
V x M		0.39				0.79				0.40			
S x M		0.39				0.79				0.40			
V x S x M		0.68				1.37				0.69			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 77. Effect of genotypes, seed rates and micronutrients on soil available zinc (mg kg⁻¹) under direct seeded condition after harvest during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	3.36 ^{f-i}	2.88 ^{j-m}	4.14 ^{b-c}	3.46^{b-d}	3.34 ^{ab}	2.99 ^{ab}	3.76 ^{ab}	3.36^{ab}	3.35 ^{c-h}	2.93 ^{d-i}	3.95 ^{bc}	3.41^{a-c}
	M ₂	3.42 ^{e-i}	2.88 ^{j-m}	4.36 ^{a-b}	3.55^{a-c}	3.40 ^{ab}	3.04 ^{ab}	3.87 ^{ab}	3.44^a	3.41 ^{b-g}	2.96 ^{d-i}	4.12 ^{ab}	3.50^{ab}
	M ₃	3.46 ^{d-i}	2.90 ^{j-m}	4.64 ^a	3.67^{ab}	3.41 ^{ab}	3.11 ^{ab}	4.03 ^{ab}	3.52^a	3.44 ^{b-g}	3.01 ^{c-i}	4.33 ^{ab}	3.59^{ab}
	M ₄	3.48 ^{d-i}	3.00 ^{j-m}	4.96 ^{b-c}	3.81^a	3.50 ^{ab}	3.12 ^{ab}	4.73 ^a	3.78^a	3.49 ^{b-f}	3.06 ^{c-i}	4.84 ^a	3.80^a
S ₂	M ₁	3.06 ^{i-m}	2.08 ^p	3.48 ^{d-i}	2.87^g	3.19 ^{ab}	2.29 ^b	3.53 ^{ab}	3.00^{ab}	3.13 ^{c-i}	2.19 ⁱ	3.50 ^{b-f}	2.94^c
	M ₂	3.08 ^{i-m}	2.28 ^{op}	3.64 ^{c-h}	3.00^{f-g}	3.20 ^{ab}	2.54 ^b	3.53 ^{ab}	3.09^{ab}	3.14 ^{c-i}	2.41 ^{g-i}	3.58 ^{b-f}	3.04^{a-c}
	M ₃	3.12 ^{i-m}	2.36 ^{n-p}	3.72 ^{c-g}	3.07^{e-g}	3.21 ^{ab}	2.62 ^b	3.53 ^{ab}	3.12^{ab}	3.17 ^{c-h}	2.49 ^{g-i}	3.63 ^{b-f}	3.10^{bc}
	M ₄	3.16 ^{h-m}	2.64 ^{m-o}	3.76 ^{c-f}	3.19^{d-f}	3.24 ^{ab}	2.76 ^{ab}	3.56 ^{ab}	3.19^{ab}	3.20 ^{c-h}	2.70 ^{f-i}	3.66 ^{b-e}	3.19^{bc}
S ₃	M ₁	3.22 ^{g-l}	2.66 ^{m-o}	3.90 ^{b-e}	3.26^{d-f}	3.25 ^b	2.79 ^{ab}	3.61 ^{ab}	3.22^{ab}	3.24 ^{c-h}	2.72 ^{f-i}	3.76 ^{b-e}	3.24^{bc}
	M ₂	3.24 ^{f-l}	2.72 ^{l-o}	3.96 ^{b-d}	3.31^{c-e}	3.28 ^{ab}	2.92 ^{ab}	3.62 ^{ab}	3.27^{ab}	3.26 ^{c-h}	2.82 ^{e-i}	3.79 ^{b-d}	3.29^{a-c}
	M ₃	3.30 ^{f-k}	2.76 ^{l-o}	4.08 ^{b-c}	3.38^{cd}	3.31 ^{ab}	2.93 ^{ab}	3.69 ^{ab}	3.31^b	3.31 ^{c-h}	2.85 ^{e-i}	3.89 ^{b-d}	3.35^{a-c}
	M ₄	3.32 ^{f-k}	2.82 ^{k-n}	4.12 ^{b-c}	3.42^{b-d}	3.33 ^{ab}	2.95 ^{ab}	3.71 ^{ab}	3.33^{ab}	3.32 ^{ch}	2.89 ^{ei}	3.91 ^{b-d}	3.37^{a-c}
Variety		3.27^b	2.67^c	4.06^a		3.31^a	2.84^a	3.76^a		3.29^b	2.75^c	3.91^a	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	3.43 ^{b-d}	2.92 ^{c-e}	4.53 ^a	3.63^a	3.41 ^{bc}	3.07 ^{b-d}	4.10 ^a	3.53^a	3.42 ^{cd}	2.99 ^{cd}	4.31 ^a	3.57^a
	S ₂	3.11 ^{c-e}	2.34 ^e	3.65 ^{bc}	3.03^c	3.21 ^{bc}	2.55 ^d	3.54 ^{a-c}	3.10^b	3.16 ^c	2.45 ^e	3.59 ^b	3.07^c
	S ₃	3.27 ^{b-d}	2.74 ^{d-e}	4.02 ^{ab}	3.34^b	3.29 ^{bc}	2.90 ^{cd}	3.66 ^{ab}	3.28^{ab}	3.28 ^c	2.82 ^d	3.84 ^b	3.31^b
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M	M ₁	3.21 ^d	2.54 ^f	3.84 ^c	3.20^c	3.26 ^{b-d}	2.69 ^d	3.63 ^{a-c}	3.19^a	3.24 ^{c-e}	2.61 ^f	3.74 ^{bc}	3.20^a
	M ₂	3.25 ^d	2.63 ^{ef}	3.99 ^{bc}	3.29^{bc}	3.29 ^{a-d}	2.83 ^d	3.67 ^{ab}	3.26^a	3.27 ^{c-e}	2.73 ^f	3.83 ^b	3.28^a
	M ₃	3.29 ^d	2.67 ^{ef}	4.15 ^{ab}	3.37^{ab}	3.31 ^{a-d}	2.89 ^d	3.75 ^{ab}	3.32^a	3.30 ^{cd}	2.78 ^{ef}	3.95 ^b	3.34^a
	M ₄	3.32 ^d	2.82 ^e	4.28 ^a	3.47^a	3.36 ^{a-d}	2.94 ^{cd}	4.00 ^a	3.43^a	3.34 ^{cd}	2.88 ^{d-f}	4.14 ^b	3.45^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.04				0.27				0.13			
Seed (S)		0.04				0.11				0.06			
Micro (M)		0.05				0.19				0.09			
V x S		0.07				0.20				0.10			
V x M		0.09				0.32				0.16			
S x M		0.09				0.32				0.16			
V x S x M		0.15				0.32				0.28			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

The three way interaction also revealed significant differences in zinc availability wherein cv. BPT 5204 at 25 kg ha⁻¹ seed rates and combined application of both the micronutrients (V₃S₁M₄) recorded significantly higher (4.84) availability of Zn and was on par with V₃S₁M₂₋₃, while lower availability of Zn was recorded with cv. MTU 1010 sown using 30kg ha⁻¹ seed rate and supplied no micronutrient (V₂S₂M₁)(2.19) .

4.1.1.5.9 Soil available copper (mg kg⁻¹) (c.f. Table 78)

Significant variations were observed in available Cu due to cultivars, seed rates and their interactions except main effects due to micronutrients during both the years and on pooled basis as well.

Significantly higher available Cu (3.33) was recorded with the cv. BPT 5204 (V₃) among cultivars while lower status (2.74) was recorded with cv. MTU 1010 (V₂); among the seed rates used, significantly higher Cu (3.15) was found with lower seed rate of 25 kg ha⁻¹ (S₁) while lower (2.92) available Cu was recorded with medium seed rate of 30 kg ha⁻¹ (S₂).

Variety X seed rate interactions were significant wherein cv. BPT 5204 seeds sown at 35 kg ha⁻¹ seed rates (V₃S₂) recorded significantly higher availability of Cu (3.28) while lower status (2.63) was recorded with cv. MTU 1010 at 30 kg ha⁻¹ (V₂S₂). Interaction between variety X micronutrient also revealed significant variations, in that cv. BPT 5204 irrespective of levels of micronutrient (V₃M₁₋₄) had higher Cu particularly with V₃M₄ (3.41) while lower status (2.70) was noticed with cv. MTU 1010 at all levels of micronutrients (V₂M₁₋₄) especially in V₂M₁.

Overall, the three way interaction also revealed significant differences in Cu availability in soil in which cv. BPT 5204 sown using 25 kg ha⁻¹ seed rate and supplied with combined application of both the micronutrient recorded significantly higher available Fe (V₃S₁M₄) (3.70) while lower available Cu was recorded with cv. MTU 1010 sown using 30 kg ha⁻¹ seed rate but not applied with any micronutrient (V₂S₂M₁)(2.59) .

4.1.1.5.10 Soil available manganese (mg kg⁻¹) (c.f. Table 79)

Available manganese (Mn) varied significantly due to interactions while main effects due to factors were not significant during both the years and on pooled basis as well.

Table 78. Effect of genotypes, seed rates and micronutrients on soil available copper (mg kg⁻¹) under direct seeded condition after harvest during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	3.00 ^{e-g}	2.70 ^{g-l}	3.48 ^{a-c}	3.06^{b-d}	3.09 ^{ab}	2.93 ^{ab}	3.23 ^{ab}	3.08^a	3.04 ^{d-l}	2.81 ^{h-n}	3.36 ^{b-e}	3.10^{a-c}
	M ₂	3.02 ^{e-g}	2.76 ^{g-l}	3.66 ^{ab}	3.15^{a-c}	3.09 ^{ab}	2.94 ^{ab}	3.35 ^{ab}	3.13^a	3.06 ^{d-k}	2.83 ^{h-n}	3.42 ^{b-d}	3.17^{ab}
	M ₃	3.10 ^{d-f}	2.76 ^{g-l}	3.66 ^{ab}	3.17^{ad}	3.10 ^{ab}	2.95 ^{ab}	3.46 ^{ab}	3.17^a	3.10 ^{d-j}	2.85 ^{g-n}	3.56 ^{bc}	3.25^a
	M ₄	3.22 ^{d-f}	2.80 ^{f-k}	3.77 ^a	3.26^a	3.12 ^{ab}	2.97 ^{ab}	3.63 ^a	3.24^a	3.17 ^{c-i}	2.89 ^{f-n}	3.70 ^a	2.89^c
S ₂	M ₁	2.82 ^{f-j}	2.46 ^l	3.22 ^{c-e}	2.83^f	2.99 ^{ab}	2.73 ^b	3.13 ^{ab}	2.95^a	2.91 ^{e-n}	2.59 ⁿ	3.17 ^{c-i}	2.92^c
	M ₂	2.86 ^{f-i}	2.46 ^l	3.26 ^{c-e}	2.86^{ef}	3.07 ^{ab}	2.85 ^b	3.18 ^{ab}	3.03^a	2.93 ^{f-n}	2.62 ^{mn}	3.20 ^{c-h}	2.93^c
	M ₃	2.86 ^{f-i}	2.48 ^{kl}	3.28 ^{c-e}	2.87^{ef}	3.01 ^{ab}	2.81 ^b	3.14 ^{ab}	2.99^a	2.93 ^{f-n}	2.64 ^{l-n}	3.21 ^{c-h}	2.94^c
	M ₄	2.88 ^{f-i}	2.50 ^{i-l}	3.28 ^{c-e}	2.89^{df}	3.03 ^{ab}	2.82 ^b	3.17 ^{ab}	3.01^a	2.95 ^{f-n}	2.66 ^{k-n}	3.22 ^{c-h}	2.98^{bc}
S ₃	M ₁	2.96 ^{e-g}	2.54 ^{i-l}	3.34 ^{cd}	2.95^{df}	3.04 ^{ab}	2.83 ^b	3.17 ^{ab}	3.01^a	3.00 ^{f-n}	2.68 ^{k-n}	3.25 ^{c-g}	3.00^{bc}
	M ₂	2.96 ^{e-g}	2.58 ^{h-l}	3.36 ^{b-d}	2.97^{df}	3.07 ^{ab}	2.85 ^b	3.18 ^{ab}	3.03^a	3.02 ^{e-n}	2.71 ^{j-n}	3.27 ^{c-f}	3.02^{bc}
	M ₃	2.98 ^{e-g}	2.62 ^{h-l}	3.38 ^{b-d}	2.99^{df}	3.08 ^{ab}	2.91 ^{ab}	3.19 ^{ab}	3.06^a	3.03 ^{d-m}	2.76 ⁱ⁻ⁿ	3.28 ^{c-f}	3.05^{a-c}
	M ₄	2.98 ^{e-g}	2.70 ^{g-l}	3.38 ^{b-d}	3.02^{b-e}	3.08 ^{ab}	2.91 ^{ab}	3.23 ^{ab}	3.07^a	3.03 ^{d-m}	2.81 ^{h-n}	3.30 ^{c-f}	3.10^{a-c}
Variety		2.97^b	2.61^c	3.42^a		3.06^{ab}	2.88^b	3.26^a		3.01^b	2.74^c	3.33^a	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	3.09 ^{b-d}	2.75 ^{c-e}	3.60 ^a	3.15^a	3.10 ^{ab}	2.95 ^b	3.42 ^a	3.16^a	3.09 ^{ab}	2.85 ^{c-e}	3.51 ^{bc}	3.15^a
	S ₂	2.86 ^{b-e}	2.48 ^e	3.26 ^{a-c}	2.87^c	3.01 ^b	2.78 ^b	3.14 ^{ab}	2.98^a	2.93 ^{b-d}	2.63 ^e	3.20 ^{bc}	2.92^c
	S ₃	2.97 ^{b-e}	2.61 ^{de}	3.37 ^{ab}	2.98^b	3.07 ^{ab}	2.87 ^b	3.19 ^b	3.04^a	3.02 ^{bc}	2.74 ^{de}	3.28 ^a	3.01^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	2.93 ^b	2.57 ^c	3.35 ^a	2.95^a	3.04 ^{ab}	2.83 ^b	3.18 ^{ab}	3.02^a	2.98 ^b	2.70 ^c	3.26 ^a	2.98^a
	M ₂	2.95 ^b	2.59 ^c	3.37 ^a	2.97^a	3.06 ^{ab}	2.85 ^{ab}	3.22 ^{ab}	3.04^a	3.00 ^d	2.72 ^c	3.30 ^a	3.01^a
	M ₃	2.98 ^b	2.62 ^c	3.44 ^a	3.01^a	3.06 ^{ab}	2.89 ^c	3.26 ^a	3.07^a	3.02 ^b	2.75 ^c	3.35 ^a	3.04^a
	M ₄	3.03 ^b	2.67 ^c	3.48 ^a	3.06^a	3.08 ^{ab}	2.90 ^{ab}	3.34 ^c	3.11^a	3.05 ^b	2.78 ^c	3.41 ^a	3.08
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.03				0.09				0.04			
Seed (S)		0.03				0.07				0.03			
Micro (M)		0.03				0.07				0.04			
V x S		0.05				0.12				0.05			
V x M		0.06				0.12				0.07			
S x M		0.06				0.12				0.07			
V x S x M		0.10				0.21				0.12			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 79. Effect of genotypes, seed rates and micronutrients on soil available manganese (mg kg⁻¹) under direct seeded condition after harvest during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	8.68 ^{a-i}	8.26 ^{e-j}	9.66 ^{a-d}	8.87^{a-c}	10.66 ^b	9.76 ^b	11.59 ^b	10.67^{ab}	9.67 ^{c-e}	9.01 ^{c-e}	10.62 ^{bc}	9.77^{a-d}
	M ₂	8.70 ^{a-i}	8.40 ^{d-i}	9.80 ^{a-c}	8.97^{a-c}	10.68 ^b	9.77 ^b	15.07 ^a	11.84^{ab}	9.69 ^{c-e}	9.08 ^{c-e}	12.43 ^{ab}	10.40^{a-c}
	M ₃	8.76 ^{a-h}	8.40 ^{d-i}	9.86 ^{ab}	9.01^{ab}	10.77 ^b	9.78 ^b	15.62 ^a	12.06^a	9.76 ^{c-e}	9.09 ^{c-e}	12.74 ^{ab}	10.53^{ad}
	M ₄	8.82 ^{a-h}	8.44 ^{d-i}	9.98 ^b	9.08^a	10.81 ^b	9.89 ^b	16.11 ^a	12.27^a	9.81 ^{c-e}	9.16 ^{c-e}	13.04 ^a	10.67^a
S ₂	M ₁	8.44 ^{d-i}	7.04 ⁱ	8.86 ^{a-h}	8.11^d	9.89 ^b	8.25 ^{bc}	10.88 ^b	9.67^b	9.17 ^{c-e}	7.64 ^{ef}	9.87 ^{cd}	8.89^d
	M ₂	8.46 ^{f-i}	7.38 ^{i-j}	8.92 ^{a-g}	8.25^{cd}	10.13 ^b	8.91 ^{bc}	10.99 ^b	10.01^{ab}	9.29 ^{c-e}	8.14 ^{d-f}	9.95 ^{cd}	9.13^{cd}
	M ₃	8.48 ^{c-i}	7.40 ^{i-j}	9.00 ^{a-f}	8.29^{b-d}	10.22 ^b	8.95 ^{bc}	11.17 ^b	10.11^{ab}	9.35 ^{c-e}	8.16 ^{d-f}	10.09 ^{cd}	9.20^{cd}
	M ₄	8.50 ^{c-i}	7.54 ^{h-j}	9.04 ^{a-f}	8.36^{a-d}	10.25 ^b	9.53 ^b	11.20 ^b	10.33^{ab}	9.38 ^{c-e}	8.53 ^{c-f}	10.12 ^{cd}	9.34^{b-d}
S ₃	M ₁	8.54 ^{b-i}	7.56 ^{h-j}	9.28 ^{a-f}	8.46^{a-d}	10.47 ^b	9.59 ^b	11.24 ^b	10.43^{ab}	9.51 ^{c-e}	8.57 ^{c-f}	10.26 ^{cd}	9.45^{b-d}
	M ₂	8.56 ^{b-i}	7.58 ^{g-j}	9.50 ^{a-e}	8.55^{a-d}	10.49 ^b	9.59 ^b	11.32 ^b	10.47^{ab}	9.52 ^{c-e}	8.59 ^{c-f}	10.41 ^c	9.51^{a-d}
	M ₃	8.62 ^{b-i}	7.98 ^{f-j}	9.60 ^{a-e}	8.73^{a-d}	10.59 ^b	9.68 ^b	11.55 ^b	10.61^{ab}	9.60 ^{c-e}	8.83 ^{c-f}	10.58 ^{bc}	9.67^{a-d}
	M ₄	8.66 ^{a-i}	8.16 ^{f-j}	9.62 ^{a-d}	8.81^{a-d}	10.63 ^b	9.71 ^b	11.56 ^b	10.63^{ab}	9.64 ^{c-e}	8.94 ^{c-f}	10.59 ^{bc}	9.72^{a-d}
Variety		8.60^b	7.85^c	9.43^a		10.47^b	9.45^a	12.36^a		9.53^a	8.65^a	10.89^a	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	8.74 ^c	8.38 ^{cd}	9.83 ^a	8.98^a	10.73 ^{ab}	9.80 ^{ab}	14.60 ^a	11.71^a	9.73 ^{ab}	9.09 ^b	12.21 ^a	10.34^a
	S ₂	8.47 ^c	7.34 ^e	8.96 ^{bc}	8.26^b	10.12 ^{ab}	8.91 ^b	11.06 ^{ab}	10.03^a	9.30 ^b	8.12 ^b	10.01 ^{ab}	9.14^a
	S ₃	8.60 ^c	7.82 ^{de}	9.50 ^{ad}	8.64^a	10.54 ^{ab}	9.64 ^{ab}	11.42 ^{ab}	10.53^a	9.57 ^b	8.73 ^b	10.46 ^{ab}	9.59^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	8.55 ^{cd}	7.62 ^e	9.27 ^{ab}	8.48^a	10.34 ^{bc}	9.20 ^c	11.24 ^{ac}	10.26^a	9.45 ^{bc}	8.41 ^c	10.25 ^{ab}	9.37^a
	M ₂	8.57 ^{cd}	7.79 ^e	9.41 ^a	8.59^a	10.43 ^{bc}	9.42 ^c	12.46 ^{ab}	10.77^a	9.50 ^{bc}	8.60 ^c	10.93 ^{ab}	9.68^a
	M ₃	8.62 ^{b-d}	7.93 ^{d-e}	9.49 ^a	8.68^a	10.52 ^{bc}	9.47 ^c	12.78 ^a	10.92^a	9.57 ^{bc}	8.70 ^c	11.13 ^{ab}	9.80^a
	M ₄	8.66 ^{bc}	8.05 ^{c-e}	9.55 ^a	8.75^a	10.56 ^{bc}	9.71 ^c	12.96 ^a	11.08^a	9.61 ^{bc}	8.88 ^c	11.25 ^a	9.91^a
Comparison		S.E.m±				S.E.m±				S.E.m±			
Variety (V)		0.11				1.44				0.74			
Seed (S)		0.11				0.90				0.45			
Micro (M)		0.13				0.40				0.21			
V x S		0.19				1.57				0.78			
V x M		0.22				0.69				0.37			
S x M		0.22				0.69				0.37			
V x S x M		0.39				1.20				0.64			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Interactions due to variety X seed rate varied significantly, in that cv. BPT 5204 seeds sown at 25 kg ha⁻¹ seed rates recorded significantly higher available Mn (12.21) and was on par with V₃S₂₋₃, while lower Mn status was recorded with cv. MTU 1010 at all the seed rates especially with of 30 kg ha⁻¹ (V₂S₂) (8.12). Interaction between variety X micronutrient also revealed significant variations wherein cv. BPT 5204 with combined application of micronutrient (iron and zinc) (V₃M₄) had higher Mn (11.25) while lower content was recorded with cv. MTU 1010 irrespective of micronutrient levels (V₂M₁₋₄) especially in V₂M₁ (8.41). Similarly, interactions due to seed rate and micronutrient levels revealed significant differences and lower seed rate of 25 kg ha⁻¹ with application of ferrous sulphate and zinc sulphate together recorded higher availability (10.67) and was on par with S₁M₁₋₃ and S₃M₂₋₄ while lower Mn was recorded with 30 kg ha⁻¹ without application of micronutrients (8.89).

Of the three factor combinations, significantly higher Mn availability in soil (13.04) was observed with cv. BPT 5204 at 25 kg ha⁻¹ seed rate and combined application of micronutrients (V₃S₁M₄) and V₃S₁M₂₋₃ were at par while lower available Mn was recorded with cv. MTU 1010 sown using 30 kg ha⁻¹ seed rate but without application of micronutrient (V₂S₂M₁).

4.1.1.6 Economics

4.1.1.6.1 Gross returns (₹ ha⁻¹) (c.f. Table 80)

Gross returns varied significantly due to cultivars, seed rates and use of micronutrients and their interactions during both the years and on pooled basis as well.

Among the varieties, cv. MTU 1010 (V₂) recorded significantly higher gross return (₹ 1,13,690 /-) followed by cvs. GGV 0501 (V₁) and BPT 5204 (V₃) ₹ 1,06,152/- and ₹ 1,05,763 /- respectively, and among seed rates higher gross returns ₹ 1,18,299/- was recorded with the seed rate of 30 kg ha⁻¹ (S₂); gross returns decreased with lower and higher seed rate (S₁ and S₃). Similarly, use of micronutrients revealed significant variations individually and with combined application wherein the latter (M₄) i.e. combined application FeSO₄ + ZnSO₄ to soil and to the foliage resulted in higher gross returns ₹ 1,19,331/-, while no application of micronutrient (M₁) recorded significantly lower gross returns ₹ 97,567/-.

Table 80. Effect of genotypes, seed rates and micronutrients on gross returns (₹ ha⁻¹) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	102075 ⁱ⁻ⁿ	103999 ^{g-n}	95280 ^{h-n}	100451^{f-h}	87015 ^a	93460 ^a	85246 ^a	88574^b	94929 ^{k-m}	99089 ^{i-m}	89551 ^{lm}	94523^{fg}
	M ₂	108323 ^{e-m}	105965 ^{g-n}	101428 ^{g-n}	105239^{e-g}	88500 ^a	99938 ^a	92297 ^a	93578^{ab}	98019 ^{i-m}	103626 ^{g-k}	96443 ^{i-m}	99362^{ef}
	M ₃	113375 ^{b-k}	116255 ^{a-j}	105843 ^{d-m}	111824^{c-e}	94364 ^a	100152 ^a	103047 ^a	99188^{ab}	103547 ^{g-k}	108328 ^{f-j}	104245 ^{g-k}	105373^{de}
	M ₄	119323 ^{a-h}	117974 ^{a-j}	109420 ⁿ	115472^{b-d}	106562 ^a	108410 ^a	112189 ^a	109053^{ab}	112613 ^{e-h}	112752 ^{e-h}	110347 ^{f-i}	111904^{cd}
S ₂	M ₁	91824 ⁿ	111686 ^{b-l}	90895 ^{b-k}	98135^{g-h}	98697 ^a	122506 ^a	123463 ^a	114889^{ab}	94152 ^{k-m}	116820 ^{c-g}	106636 ^{f-k}	10586d^{de}
	M ₂	113183 ^{b-k}	120532 ^{a-g}	112550 ^{a-i}	115422^{b-d}	100604 ^a	130767 ^a	123397 ^a	118256^{ab}	106489 ^{f-k}	125351 ^{a-e}	117846 ^{b-f}	116562^{bc}
	M ₃	117144 ^{aj}	123124 ^{a-f}	118537 ^{ab}	119602^{bc}	110351 ^a	131535 ^a	130601 ^a	124163^{ab}	113220 ^{e-h}	126850 ^{a-d}	123856 ^{a-e}	121309^b
	M ₄	126554 ^{a-c}	130306 ^a	128166 ^{mm}	128342^a	128855 ^a	134136 ^a	131932 ^a	131641^a	127224 ^{a-d}	131210 ^a	129929 ^{ab}	129454^a
S ₃	M ₁	95827 ^{l-m}	99037 ^{k-n}	93553 ^{m-n}	96139^h	95076 ^a	90119 ^a	81666 ^a	88954^b	94788 ^{k-m}	94739 ^{k-m}	87400 ^m	92309^g
	M ₂	103467 ^{h-m}	11357 ^{b-k}	106450 ^{f-n}	107830^{d-f}	99196 ^a	90260 ^a	82951 ^a	90802^b	100837 ^{h-l}	101688 ^{h-l}	94348 ^{k-m}	98958^{e-q}
	M ₃	117750 ^{a-j}	123072 ^{a-f}	110276 ^{c-l}	117033^{bc}	113663 ^a	108360 ^a	90638 ^a	104220^{ab}	115080 ^{d-g}	115470 ^{d-g}	99933 ^{h-m}	110161^{cd}
	M ₄	124333 ^{a-e}	125422 ^{a-d}	114384 ^{a-k}	121380^{ab}	117047 ^a	130764 ^a	104532 ^a	117448^{ab}	112930 ^{e-h}	128358 ^{a-c}	108619 ^{f-j}	116636^{bc}
Variety		111098^b	115887^a	107231^b		103328^b	111701^a	105163^b		106152 ^b	113690 ^a	105763 ^b	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	110774 ^{bc}	110973 ^{bc}	102993 ^d	108246^b	94110 ^a	100490 ^a	98195 ^a	97598^b	102277 ^e	105949 ^d	100147 ^f	102791^c
	S ₂	112179 ^{bc}	121412 ^a	112537 ^{bc}	115375^a	109627 ^a	129736 ^a	127348 ^a	122237^a	110271 ^c	125058 ^a	119567 ^b	118299^a
	S ₃	110344 ^{bc}	115276 ^{ab}	106166 ^{cd}	110595^b	106245 ^a	104876 ^a	89947 ^a	100356^b	105909 ^d	110064 ^c	97575 ^g	104516^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	96575 ^e	104907 ^d	93243 ^e	98241^d	93596 ^a	102028 ^a	96792 ^a	97472^d	94623 ^h	103549 ^{e-g}	94529 ^h	97567^d
	M ₂	108324 ^{cd}	113357 ^{b-d}	106809 ^d	109497^c	96100 ^a	106988 ^a	99548 ^a	100878^c	101782 ^g	110222 ^{c-e}	102879 ^{fg}	104961^c
	M ₃	116090 ^{a-c}	120817 ^{ab}	111552 ^{b-d}	116153^b	106126 ^a	113349 ^a	108095 ^a	109190^b	110615 ^{cd}	116883 ^{bc}	109345 ^{d-f}	112281^b
	M ₄	123403 ^a	124467 ^a	117323 ^{ab}	121731^a	117488 ^a	124436 ^a	116217 ^a	119380^a	117589 ^b	124107 ^a	116298 ^{bc}	119331^a
Comparison		S.E.m±				S.E.m±				S.E.m±			
Variety (V)		1198				1361				1089			
Seed (S)		1262				2901				1234			
Micro (M)		1614				2136				1303			
V x S		2185				5026				2137			
V x M		2795				3700				2257			
S x M		2795				3700				2257			
V x S x M		4842				6408				11085			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Interactions between variety and seed rate were significant, among all cvs. MTU 1010 (V_2S_2) at 30 kg ha^{-1} seed rate recorded higher gross returns ₹ 1, 25,058/- ; while the lower gross return was recorded with cv.BPT 5204 with higher seed rate of 35 kg ha^{-1} (V_3S_3) ₹ 97,575/-. Variety X micronutrient again revealed significant variations, in that cv. MTU 1010 with combined application of $FeSO_4 + ZnSO_4$ (V_2M_4) recorded higher gross return ₹ 1,24,107 /-while lower gross return was obtained with cvs. BPT 5204 (V_3M_1) and GGV 0501(V_1M_1) supplied with no micronutrients (₹ 94,529/- and 94623/-, respectively) and both were at par. Similarly, interactions due to seed rates and micronutrients were significant, wherein 30 kg seed rate with application of $FeSO_4 + ZnSO_4$ (S_2M_4) recorded higher gross return ₹ 1,29,454/-, while 35 kg ha^{-1} seed rate without supplementation of micronutrient (S_3M_1) recorded lower gross returns (₹ 92,309/-).

Overall, the three way interactions revealed significantly higher gross returns with cv. MTU 1010 sown with 30 kg seed rate and applied with both $FeSO_4$ and $ZnSO_4$ ($V_{2-3}S_2M_4$) (₹ 1,31,210) and was on par with cvs. GGV 0501 and BPT 5204 with same combinations; while the lower gross return (₹ 87,400 /-) was recorded with BPT 5204 sown using 35 kg ha^{-1} seed rate and supplied with no micronutrient ($V_3S_3 M_1$) among all.

4.1.1.6.2 Net returns (₹ ha^{-1}) (c.f. Table 81 and Fig. 12a)

Net returns also varied significantly and mostly followed trends in gross returns due to cultivars, seed rates and use of micronutrients and their interactions during both the years and on pooled basis as well.

Cv. MTU 1010 (V_2) among the cultivars recorded significantly higher net return (₹ 61,402 /-) followed by cvs. GGV 0501 (V_1) and BPT 5204(V_3) both were at par (₹ 53,594 /- and ₹ 53,204 /-, respectively), and among seed rates higher net return (₹ 65830/-) was recorded with medium seed rate of 30 kg ha^{-1} (S_2); net returns decreased with lower and higher seed rates S_1 and S_3 . Similarly, use of micronutrients revealed significant variations individually and with combined application wherein the latter (M_4) i.e. combined application $FeSO_4 + ZnSO_4$ to soil and to the foliage resulted in higher net returns ₹ 66,025/- while no application of micronutrient (M_1) recorded significantly lower net return ₹ 45,836/-.

Table 81. Effect of genotypes, seed rates and micronutrients on net returns (₹ ha⁻¹) under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	50939 ^{g-k}	53088 ^{f-k}	44144 ^{i-k}	49390^{eg}	34879 ^a	41549 ^a	33110 ^a	36513^b	43293 ^{k-m}	47678 ^{h-n}	37915 ^{mm}	42962^f
	M ₂	56437 ^{e-i}	54304 ^{f-j}	49542 ^{b-k}	53428^{d-f}	35614 ^a	47277 ^a	39411 ^a	40767^{ab}	45633 ^{j-n}	51465 ^{f-l}	44057 ^{j-n}	47051^{ef}
	M ₃	61614 ^{b-h}	64719 ^{a-g}	54082 ^{f-j}	60138^{cd}	41603 ^a	47616 ^a	50286 ^a	46502^{ab}	51286 ^{f-l}	56292 ^{e-k}	51984 ^{e-l}	53187^{de}
	M ₄	66612 ^{a-f}	65188 ^{a-g}	56709 ^{e-i}	62836^{bc}	52851 ^a	54924 ^a	58478 ^a	55417^{ab}	59402 ^{d-i}	59766 ^{d-i}	57136 ^{e-l}	58768^{cd}
S ₂	M ₁	40503 ^{j-k}	60635 ^{c-h}	39574 ^k	46904^{f-g}	46376 ^a	70455 ^a	71142 ^a	62658^{ab}	42331 ^{i-m}	65269 ^{a-e}	54815 ^{e-l}	54138^d
	M ₂	61112 ^{b-h}	68731 ^{a-e}	60479 ^{c-h}	63441^{bc}	47533 ^a	77966 ^a	70326 ^a	65275^{ab}	53918 ^{e-l}	73050 ^{a-c}	65275 ^{a-e}	64081^{bc}
	M ₃	65198 ^{a-g}	71448 ^{a-d}	66591 ^{a-f}	67746^b	57405 ^a	78859 ^a	77655 ^a	71307^{ab}	60774 ^{c-h}	74674 ^{ab}	71410 ^{a-d}	68953^b
	M ₄	73658 ^{a-c}	77680 ^a	75270 ^{ab}	75536^a	74959 ^a	80510 ^a	78036 ^a	77835^a	73828 ^{ab}	78084 ^a	76533 ^a	76148^a
S ₃	M ₁	44321 ^{i-k}	47846 ^{h-k}	42047 ^{jk}	44738^g	42570 ^a	37928 ^a	29160 ^a	36553^b	42782 ^{i-m}	43048 ^{k-n}	35394 ⁿ	40408^f
	M ₂	51211 ^{g-k}	61633 ^{b-h}	54194 ^{f-j}	55679^{de}	45940 ^a	37319 ^a	29695 ^a	37651^b	48081 ^{h-n}	49247 ^{g-m}	41592 ⁱ⁻ⁿ	46307^f
	M ₃	65619 ^{a-f}	71256 ^{a-d}	58145 ^{d-i}	65007^{bc}	60532 ^a	55544 ^a	37507 ^a	51194^{ab}	62449 ^{b-g}	63154 ^{b-f}	47302 ⁱ⁻ⁿ	57635^{cd}
	M ₄	71252 ^{a-d}	72656 ^{a-c}	61303 ^{b-h}	68404^b	62966 ^a	76998 ^a	50451 ^a	63472^{ab}	59349 ^{d-i}	75092 ^{ab}	55038 ^{e-l}	63160^{bc}
Variety		59040^b	64099^a	55173^b		50269^b	58912^a	52105^b		53594^b	61402^a	53204^b	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	58900 ^{bc}	59325 ^{bc}	51119 ^d	56448^b	41237 ^a	47841 ^a	45321 ^a	44800^b	49903 ^e	53800 ^d	47773 ^f	50492^c
	S ₂	60118 ^{bc}	69623 ^a	60479 ^{bc}	63407^a	56568 ^a	76947 ^a	74290 ^a	69269^a	57713 ^c	72769 ^a	67008 ^b	65830^a
	S ₃	58101 ^{b-d}	63348 ^{ab}	53922 ^{cd}	58457^b	45321 ^a	74290 ^a	36703 ^a	47217^b	53165 ^d	57635 ^c	44831 ^g	51877^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	45254 ^f	53856 ^e	41922 ^f	47011^d	41275 ^a	49977 ^a	44471 ^a	45241^d	42802 ^g	51998 ^{d-f}	42708 ^g	45836^d
	M ₂	56253 ^{de}	61556 ^{cd}	54738 ^{de}	57516^c	43029 ^a	54187 ^a	46477 ^a	47898^c	49211 ^f	57921 ^{b-d}	50308 ^{ef}	52480^c
	M ₃	64144 ^{bc}	69141 ^{ab}	59606 ^{c-e}	64297^b	53180 ^a	60673 ^a	55149 ^a	56334^b	58169 ^{b-d}	64707 ^{ab}	56899 ^{c-e}	59925^b
	M ₄	70507 ^{ab}	71841 ^a	64427 ^{bc}	68925^a	63592 ^a	70810 ^a	62321 ^a	65575^a	64193 ^b	70981 ^a	62902 ^{bc}	66025^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		1198				1361				1089			
Seed (S)		1262				2901				1234			
Micro (M)		1614				2136				1303			
V x S		2185				5026				2137			
V x M		2795				3700				2257			
S x M		2795				3700				2257			
V x S x M		4842				6408				3910			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

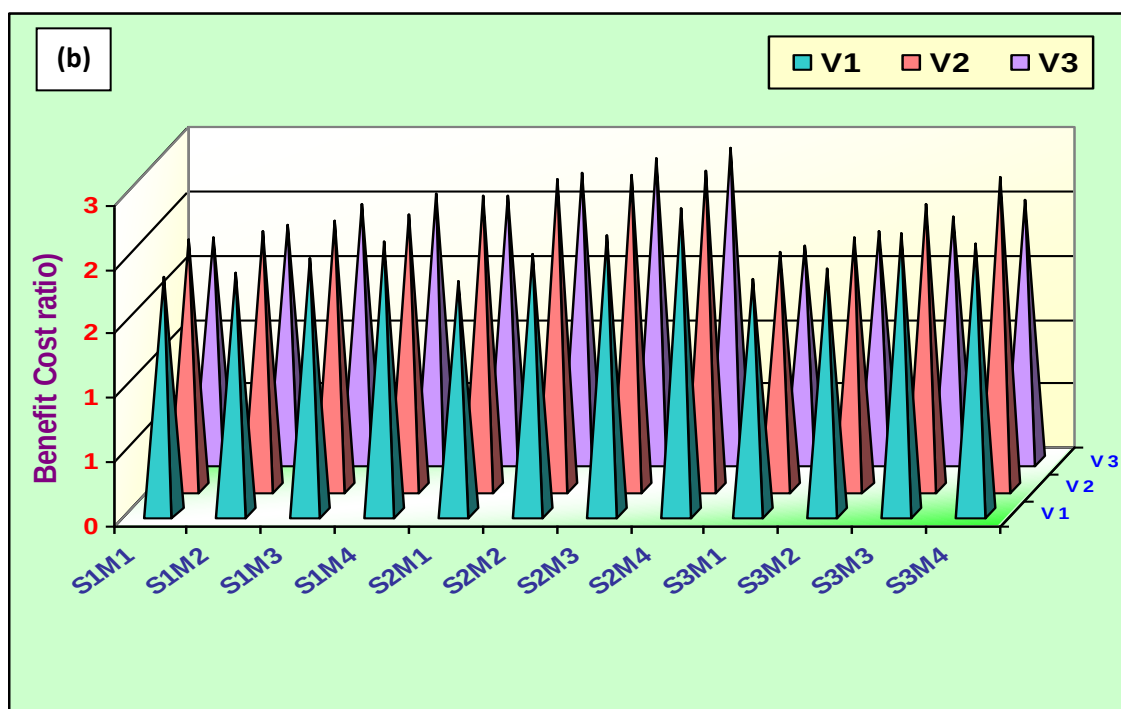
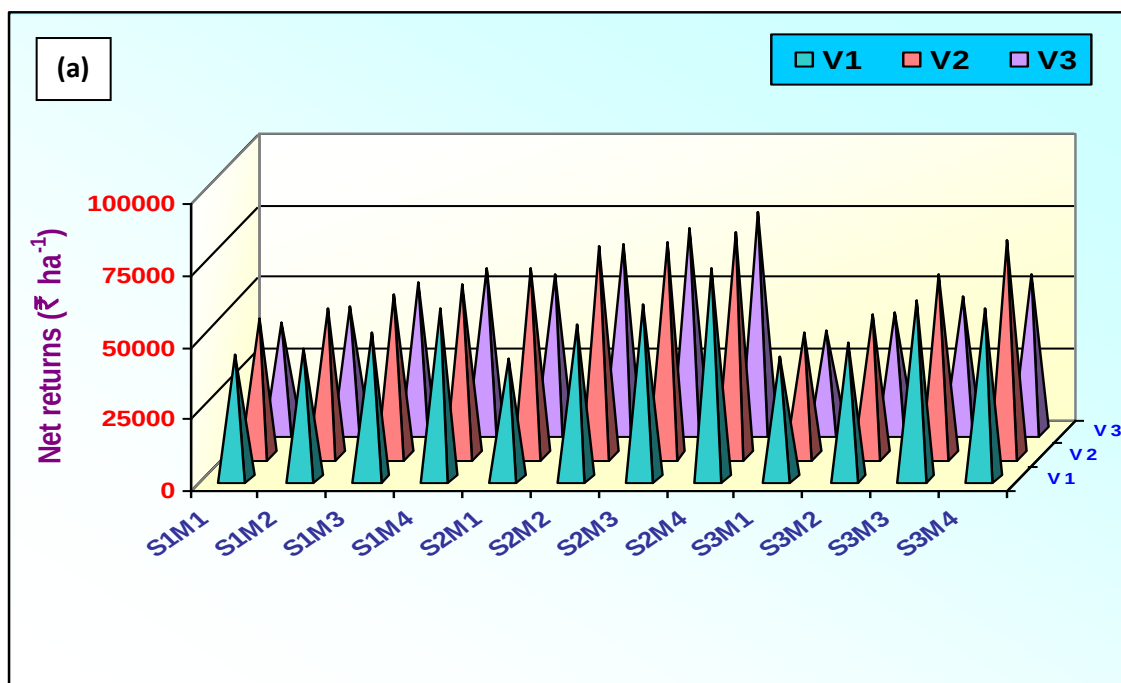
Interactions between variety and seed rate were significant wherein cv. MTU 1010 with medium seed rate of 30 kg ha⁻¹ seed rate (V₂S₂) recorded higher net returns (₹ 72,769/-) while lower net return was recorded with cv. BPT 5204 with higher seed rate of 35 kg ha⁻¹ (V₃S₃) ₹ 44,831/-. Variety X micronutrient also revealed significant variations, in that cv. MTU 1010 with combined application of FeSO₄ + ZnSO₄ (V₂M₄) recorded higher net returns (₹ 70,981) /- while lower net return was obtained with no supplementation of micronutrients cvs. BPT 5204 (V₃M₁) and GGV 0501 (V₁M₁) (₹ 42,108/- and 42,802/-, respectively) and both were at par. Similarly, interactions due to seed rates and micronutrients were significant wherein medium seed rate of 30 kg ha⁻¹ with application of FeSO₄ + ZnSO₄ (S₂M₄) recorded higher net return ₹ 76,148/-, while 25 and 35 kg ha⁻¹ seed rates without supplementation of micronutrient (S_{1&3}M₁) recorded lower net returns and both were at par.

Overall, the three way interaction revealed significantly higher net returns with cvs. MTU 1010 and s BPT 5204 own with 30 kg seed rate and applied with both FeSO₄ + ZnSO₄ (V_{2&3}S₂M₄) (₹ 78,084 and ₹ 76533/-, respectively), while lower net returns ₹ 35394/- was recorded with cv. BPT 5204 sown using 35kg ha⁻¹ seed rate and supplied with no micronutrient (V₃S₃M₁) among all.

4.1.1.6.3 B: C ratio (c.f. Table 82 and Fig. 12b)

Benefit cost ratio also varied significantly due to cultivars, seed rates and use of micronutrients and their interactions during both the years and on pooled basis as well.

Among the varieties, cv. MTU 1010 (V₂) recorded significantly higher B: C ratio (2.10) followed by cvs. GGV 0501 (V₁) and BPT 5204 (V₃) both were at par (2.02 and 2.01, respectively), and among seed rates higher B: C ratio (2.25) was recorded with medium seed rate of 30 kg ha⁻¹ (S₂) while B: C ratio decreased with lower and higher seed rates and both were at par seed rate (S₁ and S₃). Similarly, use of micronutrients revealed significant variations individually and with combined application wherein the latter (M₄) *i.e.* combined application Fe



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Varieties: V₁- GGV 0501, V₂- MTU 1010, V₃- BPT 5204;
 Seed Rate: S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
 Micronutrient: M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₄- FeSO₄ + ZnSO₄ (Each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

Fig. 12. Effect of genotypes, seed rates and micronutrients on (a) net returns (₹ ha⁻¹) and (b) B:C ratio under direct seeded condition during rainy season

Table 82. Effect of genotypes, seed rates and micronutrients on B: C under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	2.00 ^{e-j}	2.04 ^{d-j}	1.86 ^{b-j}	1.97^{ef}	1.67 ^{b-k}	1.80 ^{b-k}	1.64 ^{jk}	1.70^f	1.84 ^{b-p}	1.93 ^{b-p}	1.73 ^{op}	1.83^g
	M ₂	2.09 ^{c-j}	2.05 ^{d-j}	1.95 ^{f-j}	2.03^{d-f}	1.67 ^{b-k}	1.90 ^{b-k}	1.75 ^{b-k}	1.77^{ef}	1.87 ^{b-p}	1.99 ^{f-n}	1.84 ^{b-p}	1.90^{fg}
	M ₃	2.19 ^{a-g}	2.26 ^{a-f}	2.04 ^{d-j}	2.16^{b-d}	1.79 ^{b-k}	1.91 ^{b-k}	1.95 ^{f-k}	1.88^{d-f}	1.98 ^{g-o}	2.08 ^{e-l}	1.99 ^{f-n}	2.02^{ef}
	M ₄	2.26 ^{a-f}	2.24 ^{a-g}	2.08 ^{c-j}	2.19^{b-d}	1.98 ^{e-j}	2.03 ^{d-j}	2.09 ^{a-i}	2.03^{cd}	2.12 ^{d-k}	2.13 ^{d-j}	2.07 ^{e-m}	2.11^{c-e}
S ₂	M ₁	1.79 ^j	2.19 ^{a-g}	1.77 ^j	1.92^{ef}	1.89 ^{b-k}	2.35 ^{a-f}	2.36 ^{a-e}	2.20^{bc}	1.82 ^{m-p}	2.27 ^{a-e}	2.06 ^{e-m}	2.05^{de}
	M ₂	2.17 ^{a-h}	2.33 ^{a-d}	2.16 ^{a-h}	2.22^{bc}	1.90 ^{b-k}	2.48 ^{ab}	2.33 ^{a-g}	2.23^{bc}	2.03 ^{e-n}	2.40 ^{a-c}	2.24 ^{a-f}	2.22^{bc}
	M ₃	2.26 ^{a-f}	2.38 ^{a-c}	2.28 ^{a-e}	2.31^{ab}	2.08 ^{b-i}	2.50 ^a	2.47 ^{ab}	2.35^{ab}	2.16 ^{b-i}	2.43 ^{ab}	2.36 ^{a-d}	2.32^{ab}
	M ₄	2.39 ^{a-c}	2.48 ^a	2.42 ^{ab}	2.43^a	2.39 ^{a-d}	2.50 ^a	2.45 ^{a-c}	2.45^a	2.38 ^{a-c}	2.47 ^a	2.43 ^{ad}	2.43^a
S ₃	M ₁	1.86 ^{b-j}	1.93 ^{g-j}	1.82 ^{ij}	1.87^f	1.81 ^{b-k}	1.73 ^{i-k}	1.56 ^k	1.70^f	1.82 ^{m-p}	1.83 ^{b-p}	1.68 ^p	1.78^g
	M ₂	1.98 ^{e-j}	2.19 ^{a-g}	2.04 ^{d-j}	2.07^{c-e}	1.86 ^{b-k}	1.70 ^{i-k}	1.56 ^k	1.71^f	1.91 ^{b-p}	1.94 ^{b-o}	1.79 ^{n-p}	1.88^g
	M ₃	2.26 ^{a-f}	2.38 ^{a-c}	2.12 ^{b-i}	2.25^b	2.4 ^{a-d}	2.05 ^{c-j}	1.70 ^{i-k}	1.97^{de}	2.19 ^{b-h}	2.21 ^{b-g}	1.90 ^{j-p}	2.10^{c-e}
	M ₄	2.34 ^{a-d}	2.38 ^{a-c}	2.15 ^{b-h}	2.29^{ab}	2.16 ^{a-h}	2.43 ^{a-d}	1.93 ^{g-k}	2.18^{bc}	2.11 ^{e-k}	2.41 ^{ab}	2.03 ^{e-n}	2.18^{cd}
Variety		2.13^b	2.24^a	2.06^b		1.95^b	2.11^a	1.98^b		2.02^b	2.17^a	2.01^b	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	2.13 ^{bc}	2.15 ^{bc}	1.98 ^d	2.09^b	1.78 ^{bc}	1.91 ^{bc}	1.86 ^b	1.85^b	1.95 ^{cd}	2.03 ^{bc}	1.91 ^{cd}	1.96^b
	S ₂	2.15 ^{bc}	2.34 ^a	2.16 ^{bc}	2.22^a	2.06 ^b	2.46 ^a	2.40 ^a	2.31^a	2.10 ^b	2.39 ^a	2.27 ^a	2.25^a
	S ₃	2.11 ^{b-d}	2.22 ^{ab}	2.03 ^{cd}	2.12^b	1.99 ^{bc}	1.98 ^{bc}	1.69 ^c	1.89^b	2.01 ^{bc}	2.10 ^b	1.85 ^d	1.98^b
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	1.88 ^e	2.06 ^{cd}	1.82 ^e	1.92^c	1.79 ^e	1.96 ^{b-e}	1.85 ^{c-e}	1.87^c	1.83 ^f	2.01 ^{de}	1.82 ^f	1.89^d
	M ₂	2.08 ^{cd}	2.19 ^{b-d}	2.05 ^d	2.11^b	1.81 ^{de}	2.03 ^{b-d}	1.88 ^{c-e}	1.90^c	1.94 ^{ef}	2.11 ^{b-d}	1.96 ^e	2.00^c
	M ₃	2.23 ^{a-c}	2.34 ^{ab}	2.15 ^{cd}	2.24^a	2.00 ^{b-e}	2.15 ^{ab}	2.04 ^{bc}	2.07^b	2.11 ^{b-d}	2.24 ^{ab}	2.09 ^{cd}	2.14^b
	M ₄	2.33 ^{ab}	2.37 ^a	2.22 ^{a-d}	2.31^a	2.18 ^{ab}	2.32 ^a	2.16 ^{ab}	2.22^a	2.20 ^{bc}	2.34 ^a	2.18 ^{bc}	2.24^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.02				0.03				0.02			
Seed (S)		0.02				0.05				0.02			
Micro (M)		0.03				0.04				0.02			
V x S		0.04				0.10				0.04			
V x M		0.05				0.07				0.04			
S x M		0.05				0.07				0.04			
V x S x M		0.09				0.12				0.07			

Varieties (V) : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

$\text{SO}_4 + \text{ZnSO}_4$ to soil and to the foliage resulted in higher B: C ratio (2.24), while no application of micronutrient (M_1) recorded lower B: C ratio (1.89).

All the two-way interactions were significant. Among cultivars and seed rates, MTU 1010 and BPT 5204 (V_{2-3}S_2) with 30 kg ha⁻¹ seed rate recorded higher B: C ratio (2.39 and 2.27, respectively) while lower B: C ratio (1.85) was recorded with cv. BPT 5204 with higher seed rate of 35 kg ha⁻¹ (V_3S_3). Variety X micronutrient also revealed significant variations, in that cv. MTU 1010 with combined application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_2M_4) recorded higher B: C ratio (2.34). In the absence of micronutrient application B: C ratio decreased irrespective of cultivars used and recorded lower B: C ratio with cv. GGV 0501 (V_1M_1) (2.09). Similarly, interactions due to seed rates and micronutrients were significant, wherein medium seed rate of 30 kg seed rate with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) recorded higher B: C ratio (2.43) and was at par with S_2M_3 , while 35 kg ha⁻¹ seed rate without supplementation of micronutrient ($\text{S}_{1\&3}\text{M}_1$) recorded lower B: C ratio and both were at par.

Overall, the three way interaction also revealed significant variations and higher B: C ratios were obtained with cvs. MTU 1010 and BPT 5204 own with 30 kg seed rate and applied with both $\text{FeSO}_4 + \text{ZnSO}_4$ ($\text{V}_{2-3}\text{S}_2\text{M}_4$) (2.47 and 2.2.43, respectively), while the lower B: C ratio (1.68) was recorded with cv. BPT 5204 sown using 35 kg ha⁻¹ seed rate and supplied with no micronutrient ($\text{V}_3\text{S}_3 \text{M}_1$) among all.

4.1.2 Summer Season

4.1.2.1 Growth parameters

The data on growth components of rice viz., plant height, number of tillers m^{-1} , number of tillers m^{-2} , leaf area, leaf area index, dry matter production and its accumulation in leaves, stem and panicles, SPAD, Green seeker values as influenced by different treatments are presented here.

4.1.2.1.1 Plant height (cm) (c.f. Table 83)

Plant height was profoundly influenced due to cultivars, seed rates and use of micronutrients and their interactions at all the stages of growth during summer season.

Among all cultivars plant height differed significantly at all stages of crop growth except at 45 DAS wherein cv. GGV 0501 (V_1) recorded significantly taller plants (92.5 and 105.8, respectively at 90 DAS and at harvest), while lower plant height was recorded with cv. BPT 5204 at both the stages (72.8 and 79.8, respectively at 90 DAS and at harvest). Plant height did not differ significantly due to seed rates at all stages of crop growth while use of micronutrients resulted in significant variations at 45 and 90 DAS while at harvest the variations narrowed down and became non-significant. At 45 and 90 DAS combined application of $\text{FeSO}_4 + \text{ZnSO}_4$ (M_4) produced taller plants (36.1 and 88.9, respectively) while lower height was recorded when no micronutrients were applied (31.4 and 75.4, respectively).

Interactions due to variety and seed rate were significant and among all cv. GGV 0501 (V_1) with medium seed rate of 30 kg ha^{-1} (V_1S_2) recorded taller plants (35.9, 93.1 and 106.4, at 45 and 90 DAS and at harvest respectively) closely followed by $V_1S_{1\&3}$ which were on par while lower plant height was observed with cv. BPT 5204 irrespective of seed rates particularly with 25 kg ha^{-1} seed rate (32.1, 73.0 and 79.3 at 45 and 90 DAS and at harvest respectively). Variety X micronutrient also produced significant variations, in that cv. GGV 0501 with combined application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_1M_4) rerecorded higher plant height throughout (38.1, 97.1 and 110, at 45 and 90 DAS and at harvest respectively) and with age differences due to levels of micronutrients narrowed down and were at par at harvest, whereas in the absence of micronutrient application plant height decreased particularly with cv. BPT 5204 (V_3M_1) (29.9, 66.0 and 77.7, at 45 and 90 DAS and at harvest respectively) wherein again the differences narrowed down

Table 83. Effect of genotypes, seed rates and micronutrients on plant height (cm) under direct seeded condition during summer season

V x S x M		45 DAS				90 DAS				At harvest			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	29.7 ^{de}	32.3 ^{a-e}	30.3 ^{c-e}	30.8^c	86.2 ^{b-h}	80.4 ^{c-k}	67.4 ^{k-l}	78.0^c	106.6 ^{a-d}	97.5 ^{d-g}	79.2 ⁱ	94.4^{ab}
	M ₂	33.0 ^{a-e}	33.3 ^{a-e}	32.0 ^{b-e}	32.8^{bc}	90.8 ^{a-f}	86.8 ^{a-h}	73.4 ^{g-l}	83.7^{a-c}	106.7 ^{a-d}	94.2 ^{gh}	81.1 ⁱ	94.0^{ab}
	M ₃	35.0 ^{a-e}	33.8 ^{a-e}	32.8 ^{a-e}	33.9^{a-c}	92.8 ^{a-d}	88.4 ^{a-g}	74.9 ^{f-l}	85.4^{a-c}	109.7 ^{ab}	98.9 ^{c-g}	76.9 ⁱ	95.2^{ab}
	M ₄	36.0 ^{a-e}	35.2 ^{a-e}	33.3 ^{a-e}	34.8^{a-c}	93.8 ^{a-d}	89.5 ^{a-f}	76.4 ^{e-l}	86.6^{a-c}	108.9 ^{ab}	94.3 ^{f-h}	80.0 ⁱ	94.4^{ab}
S ₂	M ₁	31.7 ^{b-e}	32.0 ^{b-e}	29.0 ^e	30.9^c	89.9 ^{a-f}	76.8 ^{e-l}	67.8 ^{j-l}	78.2^c	107.3 ^{a-c}	99.0 ^{c-g}	77.1 ⁱ	94.5^{ab}
	M ₂	35.0 ^{a-e}	32.4 ^{a-e}	30.2 ^{c-e}	32.5^{bc}	90.9 ^{a-e}	84.3 ^{a-i}	68.8 ^{j-l}	81.3^{bc}	103.4 ^{a-g}	99.0 ^{c-g}	80.1 ⁱ	94.2^{ab}
	M ₃	37.0 ^{a-d}	33 ^{a-e}	34.7 ^{a-e}	34.9^{a-c}	92.0 ^{a-e}	88.3 ^{a-g}	76.6 ^{e-l}	85.6^{a-c}	103.7 ^{a-f}	100.0 ^{b-g}	81.9 ⁱ	95.2^{ab}
	M ₄	39.8 ^a	37.7 ^{a-c}	36.2 ^{a-e}	37.9^a	99.7 ^a	90.3 ^{a-f}	83.1 ^{f-j}	91.0^a	111.1 ^a	100.3 ^{b-g}	86.1 ^{hi}	99.2^a
S ₃	M ₁	34.0 ^{a-e}	33.2 ^{a-e}	30.4 ^{c-e}	32.5^{bc}	85.6 ^{b-h}	61.8 ^l	62.8 ^l	70.1^d	102.5 ^{a-g}	97.0 ^{e-g}	76.8 ⁱ	92.1^b
	M ₂	34.7 ^{a-e}	33.6 ^{a-e}	30.3 ^{c-e}	32.9^{bc}	94.4 ^{a-d}	80.3 ^{c-k}	72.4 ^{h-l}	82.4^{a-c}	107.7 ^{a-c}	97.6 ^{d-g}	79.1 ⁱ	94.8^{ab}
	M ₃	35.7 ^{a-e}	34.0 ^{a-e}	34.7 ^{a-e}	34.8^{a-c}	95.8 ^{a-c}	89.3 ^{a-f}	70.4 ^{e-l}	85.2^{ab}	104.7 ^{a-e}	100.3 ^{b-g}	80.1 ⁱ	95.0^{ab}
	M ₄	38.3 ^{ab}	36 ^{a-e}	32.7 ^{a-e}	35.7^{ab}	97.8 ^{ab}	90.4 ^{a-f}	79.0 ^{d-k}	89.1^{ab}	109.8 ^{ab}	95.2 ^{fg}	81.9 ⁱ	89.1^{ab}
Variety		35.0^a	33.9^a	32.2^a		92.5^a	83.9^b	72.8^c		105.8^a	97.4^b	79.8^c	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	33.4 ^{a-c}	33.7 ^{a-c}	32.1 ^c	33.1^a	90.9 ^b	82.2 ^c	73.0 ^d	82.0^a	108.0 ^{ab}	96.2 ^b	79.3 ^c	94.5^a
	S ₂	35.9 ^a	33.8 ^{a-c}	32.5 ^{bc}	34.1^a	93.1 ^a	84.9 ^{bc}	74.0 ^d	84.0^a	106.4 ^a	99.6 ^b	81.3 ^c	95.8^a
	S ₃	35.7 ^{ab}	34.2 ^{a-c}	31.4 ^c	33.8^a	93.4 ^a	80.4 ^{cd}	72.6 ^d	82.1^a	106.2 ^a	97.6 ^b	79.5 ^c	94.4^a
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M4	M ₁	31.8 ^{c-e}	32.5 ^{b-e}	29.9 ^e	31.4^d	87.2 ^{b-d}	73.0 ^{ef}	66.0 ^f	75.4^c	105.4 ^{ab}	97.8 ^b	77.7 ^c	93.6^a
	M ₂	34.2 ^{b-d}	33.1 ^{b-e}	30.8 ^{de}	32.7^c	92.0 ^{a-c}	83.8 ^{cd}	71.5 ^{ef}	82.4^b	105.9 ^{ab}	97.0 ^b	80.1 ^c	94.3^a
	M ₃	35.9 ^{a-c}	33.6 ^{b-e}	33.3 ^{b-e}	34.3^b	93.5 ^{ab}	88.6 ^{bc}	79.9 ^{de}	87.3^{ab}	106.0 ^{ab}	99.5 ^b	79.6 ^c	95.0^a
	M ₄	38.1 ^a	36.3 ^{ab}	34.0 ^{b-e}	36.1^a	97.1 ^a	90.1 ^{a-c}	79.5 ^{de}	88.9^a	110.0 ^a	96.6 ^b	82.0 ^c	96.2^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.8				1.1				1.8			
Seed (S)		0.6				1.4				0.8			
Micro (M)		0.7				1.5				0.9			
V x S		1.0				2.4				1.4			
V x M		1.3				2.6				1.6			
S x M		1.3				2.6				1.6			
V x S x M		2.2				4.6				2.8			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

with age and all levels of micronutrients were at par irrespective of the cultivar used. Similarly, interactions due to micronutrients and seed rates were significant wherein 30 kg seed rate with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) recorded higher plant height throughout (37.9, 85.6 and 99.2, at 45 and 90 DAS and at harvest respectively) closely followed by S_3M_4 . Again the differences narrowed down with age and seed rates were at par within the micronutrient level, while lower plant height more or less throughout was recorded by lower seed rate and no supplementation of micronutrients (S_1M_1 – 30.8, 78.0 and 94.4, at 45 and 90 DAS and at harvest respectively).

Among the three factor interactions, significantly taller plants occurred with cv. GGV 0501 sown using medium seed rate and supplied with both the micronutrients ($V_1S_2M_4$) throughout (39.8, 99.7 and 111.1, at 45 and 90 DAS and at harvest respectively) while lower height was recorded with cv. BPT 5204 with higher seed rate and no supplementation of any micronutrient ($V_3S_3M_1$) (30.4, 62.8 and 76.8, at 45 and 90 DAS and at harvest respectively) closely followed by $V_3S_2M_1$ which was on par while other combinations fell between these extremes.

4.1.2.1.2 Tiller count (no. m^{-1} length) (c.f. Table 84)

Variations in tiller count due to cultivars, seed rates and use of micronutrients and their interactions during summer season were significant throughout the course of observation.

Cv. GGV 0501 among cultivars recorded more tillers throughout (64.9, 130.7 and 143.5, at 45 and 90 DAS and at harvest respectively) followed by cvs. RNR 15048 (V_2) and BPT 5204 (V_3) which were at par with each other while the latter cultivar (V_3) had lower tiller count (65.1, 103.9 and 116.9, at 45 and 90 DAS and at harvest respectively). Among the seed rates, medium seed rate of 30 kg ha^{-1} (S_2) recorded more tiller count throughout (66.0, 113.9 and 133.9, at 45 and 90 DAS and at harvest respectively) closely followed by S_3 which was on par at harvest while lower seed rate (S_1) recorded less tiller count (6.1, 108.3 and 117.4, at 45 and 90 DAS and at harvest respectively). Again levels of micronutrients resulted in significant variations wherein combined application of $\text{FeSO}_4 + \text{ZnSO}_4$ (M_4) recorded more tillers throughout (70.6, 133.8 and 147.6, 6.1, 108.3 and 117.4, at 45 and 90 DAS and at harvest respectively) while lower tiller count occurred when no micronutrients were applied (55.8, 97.2 and 110.7, 6.1, 108.3 and 117.4, at 45 and 90 DAS and at harvest respectively).

Table 84. Effect of genotypes, seed rates and micronutrients on number of tillers m⁻¹ under direct seeded condition during summer season

V x S x M		45 DAS				90 DAS				At harvest			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	56.0 ^{c-g}	58.0 ^{d-g}	54.3 ^{fg}	56.1 ^{de}	119.7 ^{d-g}	82.0 ^{kl}	84.4 ^{kl}	95.4 ^{gh}	124.7 ^{c-i}	87.0 ^k	99.7 ^{i-k}	103.8 ^f
	M ₂	57.3 ^{d-g}	62.7 ^{b-g}	56.7 ^{d-g}	58.9 ^{de}	125.3 ^{c-g}	85.3 ^{kl}	94.1 ^{h-l}	101.6 ^{fh}	136.7 ^{c-g}	91.7 ^{jk}	106 ^{h-k}	111.5 ^{ef}
	M ₃	68.0 ^{a-f}	65.0 ^{a-g}	83.3 ^{d-g}	72.1 ^{f-d}	133.3 ^{a-c}	102.7 ^{g-k}	102.7 ^{g-k}	112.9 ^{d-f}	140.3 ^{h-k}	115.0 ^{f-k}	108.7 ^{g-k}	121.3 ^{de}
	M ₄	76.0 ^{a-c}	65.7 ^{a-g}	63.0 ^{a-g}	68.2 ^{a-c}	151.0 ^{ab}	111.1 ^{e-j}	105.7 ^{f-k}	122.6 ^{cd}	166.0 ^{ab}	117.7 ^{e-j}	114.7 ^{f-k}	132.8 ^{b-d}
S ₂	M ₁	59.0 ^{d-g}	57.0 ^{d-g}	54.3 ^{fg}	56.8 ^{dc}	102.7 ^{g-k}	83.5 ^{kl}	92.1 ^{i-l}	92.8 ^h	107.7 ^{g-k}	121.0 ^{e-j}	114.1 ^{f-k}	114.3 ^{ef}
	M ₂	67.3 ^{a-f}	61.7 ^{b-g}	64.0 ^{a-g}	64.3 ^{b-d}	120.8 ^{d-g}	91.0 ^{i-l}	113.3 ^{e-j}	108.4 ^{e-g}	126.7 ^{e-i}	122.7 ^{e-i}	119.0 ^{e-j}	122.8 ^{de}
	M ₃	70.7 ^{a-c}	63.3 ^{a-g}	70.3 ^{a-f}	68.1 ^{a-c}	134.9 ^{a-c}	113.0 ^{e-j}	115.3 ^{d-i}	121.1 ^{c-e}	158.5 ^{a-d}	125.7 ^{e-i}	125.6 ^{e-i}	136.6 ^{b-d}
	M ₄	78.7 ^a	69.3 ^{a-f}	76.7 ^{ab}	74.9 ^a	154.3 ^a	139.4 ^{a-d}	130.7 ^{a-f}	141.5 ^a	176.3 ^a	163.7 ^{a-c}	145.3 ^{b-c}	161.8 ^a
S ₃	M ₁	57.7 ^{d-g}	49.7 ^g	55.7 ^{c-g}	54.4 ^e	117.5 ^{d-h}	119.9 ^{d-g}	71.3 ^l	102.9 ^{fh}	127.7 ^{e-i}	127.3 ^{e-i}	87.2 ^k	114.1 ^{ef}
	M ₂	60.3 ^{c-g}	55.3 ^{c-f}	64.7 ^{a-g}	60.1 ^{c-e}	120.5 ^{d-g}	124.7 ^{c-g}	88.7 ^{j-l}	111.3 ^{d-f}	131.3 ^{d-h}	128.3 ^{e-i}	116.7 ^{e-j}	125.4 ^{c-e}
	M ₃	60.0 ^{c-g}	54.3 ^{fg}	65.0 ^{a-g}	59.8 ^{c-e}	139.1 ^{a-d}	125.3 ^{c-g}	119.3 ^{d-g}	127.9 ^{bc}	159.7 ^{s-d}	132.9 ^{d-h}	128.9 ^{e-i}	140.5 ^{bc}
	M ₄	68.0 ^{a-f}	65.7 ^{a-g}	72.7 ^{a-d}	68.8 ^{ab}	149.4 ^{a-c}	133.7 ^{a-c}	129.3 ^{b-f}	137.5 ^{ab}	166 ^{ab}	142 ^{b-f}	136.8 ^{c-g}	148.3 ^{ab}
Variety		64.9 ^a	60.6 ^b	65.1 ^a		130.7 ^a	109.3 ^b	103.9 ^b		143.5 ^a	122.9 ^b	116.9 ^b	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	64.3 ^{ab}	62.8 ^{bc}	58.1 ^{cd}	61.7 ^b	132.3 ^a	95.3 ^c	97.2 ^c	108.3 ^c	141.9 ^a	102.9 ^d	107.3 ^d	117.4 ^b
	S ₂	68.9 ^a	62.8 ^{bc}	66.3 ^{ab}	66.0 ^a	128.2 ^a	100.7 ^c	112.9 ^a	113.9 ^b	142.3 ^a	133.3 ^{ab}	126.0 ^{bc}	133.9 ^a
	S ₃	61.5 ^{bc}	56.3 ^d	64.5 ^{ab}	60.8 ^b	132.1 ^{ab}	125.9 ^a	102.2 ^b	120.1 ^a	146.2 ^a	132.6 ^{ab}	117.4 ^{cd}	132.1 ^{ab}
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M ₄	M ₁	57.6 ^{de}	54.9 ^e	54.8 ^c	55.8 ^c	113.3 ^d	95.1 ^{ef}	83.3 ^f	97.2 ^d	120.0 ^{de}	111.8 ^{ef}	100.4 ^f	110.7 ^d
	M ₂	61.7 ^{c-c}	59.9 ^{c-c}	61.8 ^{c-c}	61.1 ^b	122.9 ^{cd}	100.3 ^c	98.7 ^e	107.3 ^c	131.6 ^{cd}	114.2 ^{ef}	113.9 ^{ef}	119.9 ^c
	M ₃	66.2 ^{a-d}	60.9 ^{c-c}	64.6 ^{b-d}	63.9 ^b	135.7 ^b	113.7 ^d	112.4 ^d	120.6 ^b	152.8 ^b	124.5 ^{de}	121.1 ^{de}	132.8 ^b
	M ₄	74.2 ^a	66.9 ^{a-c}	70.8 ^{ab}	70.6 ^a	151.6 ^a	128.0 ^{bc}	121.9 ^{cd}	133.8 ^a	169.4 ^a	141.1 ^{fc}	132.3 ^{cd}	147.6 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.6				2.9				3.5			
Seed (S)		0.9				1.8				2.6			
Micro (M)		1.5				2.0				2.9			
V x S		1.5				3.1				9.5			
V x M		2.7				4.2				5.0			
S x M		2.7				4.2				5.0			
V x S x M		4.6				7.3				8.7			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

All two way interactions were significant. In variety and seed rate cv. GGV 0501 (V_1) with higher seed rate of 35 kg ha^{-1} (V_3S_2) recorded more number of tillers except at 45 DAS (61.5, 132.1 and 146.2, at 45 and 90 DAS and at harvest respectively), however, with age differences among seed rate in V_1 narrowed down and became comparable while cv. RNR 15048 had lower tiller count particularly with 25 kg ha^{-1} seed rate except at 45 DAS (V_2S_1) (62.8, 95.3 and 102.9, at 45 and 90 DAS and at harvest respectively). Variety X micronutrient also produced significant variations, in that cv. GGV 0501 with combined application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_1M_4) rerecorded higher tiller count throughout (74.2, 151.6 and 169.4, at 45 and 90 DAS and at harvest respectively), whereas in the absence of micronutrient application plant height decreased particularly with cv. BPT 5204 (V_3M_1) (54.8, 83.3 and 100.4, at 45 and 90 DAS and at harvest respectively) closely followed by RNR 15048 with no micronutrient supplementation (V_2M_1). Similarly, interactions due to micronutrients and seed rates were significant wherein medium seed rate of 30 kg with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) recorded more tillers throughout (74.9, 114.4 and 161.8, at 45 and 90 DAS and at harvest respectively) closely followed by S_3M_4 , while lower tiller count occurred with no micronutrient supplementation (M_1) irrespective of seed rates used (S_3 -54.3, S_2 -92.8 and S_1 -103.8, at 45 and 90 DAS and at harvest respectively).

Among the three factor interactions, significantly higher tiller count occurred with cv. GGV 0501 sown using medium seed rate and supplied with both the micronutrients ($V_1S_2M_4$) throughout (78.7, 154.3 and 176.3, at 45 and 90 DAS and at harvest respectively) while lower count was recorded with cv. RNR 15048 with medium seed rate and no supply of micronutrients at 45 DAS (49.7) while cv. BPT 5204 with no micronutrients had next lower value and was at par while during subsequent stages it recorded lower tiller count with higher seed rate ($V_3S_3M_1$) (71.3 and 87.2, respectively at 90 DAS and at harvest).

4.1.2.1.3 Leaf area ($\text{cm}^2 \text{ plant}^{-1}$) (c.f. Table 85)

Leaf area (LA) increased up to 90 DAS and thereafter decreased due to senescence and variation in LA due to cultivars, seed rates and use of micronutrients and their interactions were significant during summer season except the main effects due to levels of micronutrients.

Among the cultivars. LA differed significantly at all stages of crop growth wherein cv. GGV 0501 (V_1) recorded significantly larger LA (514.4, 1286.7 and 771.7, respectively at 45 and 90 DAS and at harvest), while lower LA was recorded with cv. BPT 5204 at all the stages (447.9, 1076.0 and 703.5, respectively at 45 and 90 DAS and at harvest). Among seed rates, LA was significantly higher with medium seed rate (S_2) throughout (492.9, 1226.3 and 756.2, respectively at 45 and 90 DAS and at harvest) followed closely by S_3 with higher seed rate which was at par while lower seed rate (S_1) recorded lower LA throughout (468.4, 1150.5 and 718.6, respectively at 45 and 90 DAS and at harvest). Variations in LA due to levels of micronutrients did not differ significantly throughout.

In the two factor combinations, interactions due to variety and seed rate were significant and cv. GGV 0501 (V_1) with medium seed rate of 30 kg ha^{-1} (V_1S_2) recorded larger LA throughout (525.5, 1320.8 and 804.4, at 45 and 90 DAS and at harvest respectively) closely followed by V_1S_3 which was on par while lower LA was observed with cv. BPT 5204 particularly with 25 kg ha^{-1} seed rate (428.9, 1023.2 and 676.1 at 45 and 90 DAS and at harvest respectively). Variety X micronutrient also produced significant variations; in that cv. GGV 0501 with combined application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_1M_4) rerecorded higher LA throughout (519.3, 1302.2 and 787.1, at 45 and 90 DAS and at harvest respectively) and with age differences due to levels of micronutrients narrowed down with cvs. RNR 15048 and BPT 5204 and the latter cultivar with no supplementation of micronutrients produced lower LA throughout (440.0, 1043.7 and 687.9, respectively at 45 and 90 DAS and at harvest). Similarly, interactions due to micronutrients and seed rates were significant wherein 30 kg seed rate with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) recorded higher LA throughout (497.8, 1244.1 and 769.6, at 45 and 90 DAS and at harvest respectively) closely followed by S_3M_4 which was at par, while lower LA throughout was recorded by lower seed rate and no supplementation of micronutrients (S_1M_1) (460.8, 1119.6 and 702.3, at 45 and 90 DAS and at harvest respectively).

Among the three factor interactions, significantly larger LA occurred with cv. GGV 0501 sown using medium seed rate and supplied with both the micronutrients ($V_1S_2M_4$) throughout (535.0, 1345.4 and 840.7. at 45 and 90 DAS and at harvest respectively) while lower LA was recorded with cv. BPT 5204 with lower seed rate and no supplementation of any micronutrient ($V_3S_1M_1$) (411.5, 960.1 and 636.3, at 45 and

Table 85. Effect of genotypes, seed rates and micronutrients on leaf area (cm² plant⁻¹) under direct seeded condition during summer season

V x S x M		45 DAS				90 DAS				At harvest			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	499.0 ^{a-g}	472.0 ^{c-h}	411.5 ^j	460.8^c	1250.7 ^{a-f}	1147.9 ^{c-i}	960.1 ^j	1119.6^c	744.7 ^{c-e}	726.3 ^{c-e}	636.3 ^f	702.4^d
	M ₂	502.5 ^{a-f}	472.0 ^{c-h}	412.5 ^{ij}	462.3^{bc}	1254.1 ^{a-f}	1171.1 ^{b-i}	1009.8 ^{ij}	1145.0^{bc}	746.7 ^{c-e}	730.5 ^{c-e}	673.2 ^{ef}	716.8^{cd}
	M ₃	505.0 ^{a-e}	474.0 ^{c-h}	441.5 ^{h-j}	473.5^{a-c}	1265.1 ^{a-e}	1171.3 ^{b-i}	1055.6 ^{h-j}	1164.0^{a-c}	749.5 ^{c-e}	733.4 ^{c-e}	691.4 ^{d-f}	724.8^{b-c}
	M ₄	506.0 ^{a-d}	474.5 ^{c-h}	450.0 ^{g-j}	476.8^{a-c}	1269.0 ^{a-c}	1184.5 ^{a-h}	1067.3 ^{g-j}	1173.6^{a-c}	754.5 ^{b-d}	733.6 ^{c-e}	703.7 ^{d-f}	730.6^{a-d}
S ₂	M ₁	518.0 ^{a-c}	490.5 ^{a-h}	457.0 ^{d-j}	488.5^{ab}	1292.8 ^{a-d}	1221.1 ^{a-h}	1103.6 ^{e-j}	1205.8^{b-c}	766.5 ^{b-d}	741.4 ^{c-e}	718.7 ^{c-e}	742.2^{a-d}
	M ₂	520.0 ^{a-c}	492.0 ^{a-g}	459.0 ^{d-i}	490.3^a	1317.5 ^{a-c}	1227.6 ^{a-h}	1120.1 ^{d-j}	1221.7^{ab}	783.4 ^{a-c}	742.7 ^{c-e}	720.5 ^{c-e}	748.9^{a-c}
	M ₃	529.0^{ab}	493.5 ^{a-g}	462.5 ^{d-h}	495.0^a	1327.7 ^{ab}	1233.7 ^{a-g}	1140.7 ^{d-i}	1234.0^{ab}	826.8 ^{ab}	743.2 ^{c-e}	722.1 ^{c-e}	764.0^{ab}
	M ₄	535.0 ^a	496.0 ^{a-g}	462.5 ^{d-h}	497.8^a	1345.4 ^a	1243.6 ^{a-f}	1143.2 ^{c-i}	1244.1^a	840.7 ^a	743.9 ^{c-e}	724.2 ^{c-e}	769.6^a
S ₃	M ₁	512.0 ^{a-c}	474.5 ^{c-h}	451.5 ^{g-j}	479.3^{a-c}	1270.0 ^{a-e}	1187.4 ^{a-h}	1067.5 ^{g-j}	1175.0^c	755.5 ^{b-d}	734.7 ^{c-e}	708.7 ^{c-e}	733.0^{a-d}
	M ₂	514.0 ^{a-c}	474.5 ^{c-h}	455.0 ^{f-j}	481.2^{a-c}	1276.3 ^{a-e}	1198.5 ^{a-h}	1067.6 ^{g-j}	1180.8^{b-c}	762.8 ^{b-d}	734.8 ^{c-e}	709.8 ^{c-e}	735.8^{a-d}
	M ₃	515.5 ^{a-c}	475.5 ^{c-h}	456.0 ^{e-j}	482.3^{a-c}	1279.8 ^{a-d}	1198.9 ^{a-h}	1084.7 ^{f-j}	1187.8^{a-c}	763.5 ^{b-d}	736.0 ^{c-e}	714.8 ^{c-e}	738.1^{a-d}
	M ₄	517.0 ^{a-c}	480.0 ^{b-h}	456.0 ^{e-j}	484.3^{a-c}	1292.2 ^{a-d}	1206.6 ^{a-h}	1091.6 ^{f-j}	1196.8^{a-c}	766.3 ^{b-d}	739.5 ^{c-e}	718.5 ^{c-e}	741.4^{a-d}
Variety		514.4^a	480.8^b	447.9^c		1286.7^a	1199.4^b	1076.0^c		771.7^a	736.7^b	703.5^c	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	503.1 ^b	473.1 ^{cd}	428.9 ^e	468.4 ^b	1259.7 ^{a-c}	1168.7 ^{de}	1023.2 ^g	1150.5 ^b	748.7 ^{bc}	730.9 ^{bc}	676.1 ^d	718.6 ^b
	S ₂	525.5 ^a	493.0 ^{bc}	460.3 ^d	492.9 ^a	1320.8 ^a	1231.3 ^{b-d} _d	1126.9 ^{ef}	1226.3 ^a	804.4 ^a	742.8 ^{bc}	721.3 ^{bc}	756.2 ^a
	S ₃	514.6 ^{ab}	476.1 ^{cd}	454.6 ^d	481.8 ^{ab}	1279.6 ^{ab}	1197.9 ^{cd}	1077.9 ^{fg}	1185.1 ^{ab}	762.0 ^b	736.2 ^{bc}	713.0 ^{cd}	737.1 ^{ab}
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M ₄	M ₁	509.7 ^b	479.0 ^{bc}	440.0 ^d	476.2 ^a	1271.2 ^{b-c}	1185.5 ^c	1043.7 ^d	1166.8 ^a	755.5 ^{b-d}	734.1 ^{b-d}	687.9 ^e	725.8 ^a
	M ₂	512.2 ^{ab}	479.5 ^{bc}	442.2 ^d	478.0 ^a	1282.6 ^{ab}	1199.1 ^{bc}	1065.8 ^d	1182.5 ^a	764.3 ^{ab}	736.0 ^{b-d}	701.2 ^{de}	733.8 ^a
	M ₃	516.5 ^{ab}	481.0 ^{bc}	453.3 ^d	483.6 ^a	1290.8 ^{ab}	1201.1 ^{bc}	1093.7 ^d	1195.2 ^a	779.9 ^{ab}	737.5 ^{b-d}	709.4 ^{de}	742.3 ^a
	M ₄	519.3 ^a	483.5 ^{bc}	456.2 ^{cd}	486.3 ^a	1302.2 ^a	1211.6 ^{bc}	1100.7 ^d	1204.8 ^a	787.1 ^a	739.0 ^{b-d}	715.5 ^{c-e}	747.2 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		1.8				8.9				6.3			
Seed (S)		4.4				12.7				7.4			
Micro (M)		4.8				16.7				7.4			
V x S		7.7				22.0				12.8			
V x M		8.2				28.9				12.8			
S x M		8.2				28.9				12.8			
V x S x M		14.3				50.0				22.8			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

90 DAS and at harvest respectively) closely followed by $V_3S_1M_2$ which was on par while other combinations fell between these extremes.

4.1.2.1.4 Leaf area index (c.f. Table 86)

Leaf area index (LAI) increased with age up to 90 DAS and thereafter the values decreased and followed more or less trends in LA. Variation LAI due to cultivars, seed rates and use of micronutrients and their interactions during summer season revealed significant variations except the main effects due to levels of micronutrients.

Among the cultivars, LAI differed significantly at all stages of crop growth wherein cv. GGV 0501 (V_1) recorded significantly larger LAI (2.57, 6.43 and 3.86, respectively at 45 and 90 DAS and at harvest), while lower LAI was recorded with cv. BPT 5204 at all the stages (2.24, 5.38 and 3.52, respectively at 45 and 90 DAS and at harvest). Among seed rates, LAI was significantly higher with medium seed rate (S_2) throughout (2.47, 6.13 and 3.78, respectively at 45 and 90 DAS and at harvest) followed closely by S_3 with higher seed rate which was at par while lower seed rate (S_1) recorded lower LAI throughout (2.34, 5.75 and 3.59, respectively at 45 and 90 DAS and at harvest).

In the two factor combinations, interactions due to variety and seed rate were significant and cv. GGV 0501 (V_1) with medium seed rate of 30 kg ha^{-1} (V_1S_2) recorded larger LAI throughout (2.63, 6.60 and 4.02, at 45 and 90 DAS and at harvest respectively) closely followed by V_1S_3 while lower LAI was observed with cv. BPT 5204 particularly with 25 kg ha^{-1} seed rate (2.14, 5.12 and 3.38 at 45 and 90 DAS and at harvest respectively). Variety X micronutrient also produced significant variations, in that cv. GGV 0501 with combined application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_1M_4) recorded higher LAI throughout (2.59, 6.51 and 3.94, at 45 and 90 DAS and at harvest respectively) and with age differences due to levels of micronutrients narrowed down with cvs, RNR 15048 and BPT 5204 and the latter cultivar with no supplementation of micronutrients produced lower LAI throughout (V_3M_1 -2.20, 5.22 and 3.44, respectively at 45 and 90 DAS and at harvest). Similarly, interactions due to micronutrients and seed rates were significant wherein 30 kg seed rate with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) recorded higher LAI throughout (2.49, 6.22 and 3.85, at 45 and 90 DAS and at harvest respectively) closely followed by S_3M_4 which was at par, while lower LAI throughout

Table 86. Effect of genotypes, seed rates and micronutrients on leaf area index under direct seeded condition during summer season

V x S x M		45 DAS				90 DAS				At harvest			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	2.50 ^{b-c}	2.36 ^{b-g}	2.06 ^h	2.31^b	6.25 ^{a-f}	5.74 ^{c-i}	4.80 ^j	5.60^c	3.72 ^{c-e}	3.63 ^{c-e}	3.18 ^g	3.51^c
	M ₂	2.51 ^{b-g}	2.36 ^{b-g}	2.06 ^h	2.30^b	6.27 ^{a-f}	5.86 ^{b-i}	5.05 ^{ij}	5.73^{bc}	3.73 ^{c-e}	3.65 ^{c-e}	3.37 ^{ef}	3.58^c
	M ₃	2.53 ^{b-g}	2.37 ^{b-g}	2.21 ^{gh}	2.37^{ab}	6.33 ^{a-e}	5.86 ^{b-i}	5.28 ^{h-j}	5.82^{a-c}	3.75 ^{c-e}	3.67 ^{c-e}	3.46 ^{d-f}	3.63^{bc}
	M ₄	2.53 ^{b-g}	2.37 ^{b-g}	2.25 ^{f-h}	2.38^{ab}	6.34 ^{a-e}	5.92 ^{a-h}	5.34 ^{g-j}	5.87^{a-c}	3.77 ^{b-d}	3.67 ^{c-e}	3.52 ^{d-f}	3.65^{a-c}
S ₂	M ₁	2.59 ^{b-g}	2.45 ^{b-c}	2.29 ^{c-h}	2.44^{ab}	6.46 ^{a-d}	6.11 ^{a-h}	5.52 ^{e-j}	6.03^{a-c}	3.83 ^{b-d}	3.71 ^{c-e}	3.59 ^{c-e}	3.71^{a-c}
	M ₂	2.60 ^{ab}	2.46 ^{b-g}	2.30 ^{b-g}	2.45^a	6.59 ^{a-c}	6.14 ^{a-h}	5.60 ^{d-j}	6.11^{ab}	3.92 ^{a-c}	3.71 ^{c-e}	3.60 ^{c-e}	3.74^{a-c}
	M ₃	2.65 ^{ab}	2.47 ^{b-g}	2.31 ^{c-g}	2.48^a	6.64 ^{ab}	6.17 ^{a-g}	5.70 ^{d-i}	6.17^{ab}	4.13 ^{ab}	3.72 ^{c-e}	3.61 ^{c-e}	3.82^{ab}
	M ₄	2.68 ^a	2.48 ^{b-g}	2.31 ^{c-g}	2.49^a	6.73 ^a	6.22 ^{a-f}	5.72 ^{d-i}	6.22^a	4.20 ^a	3.72 ^g	3.62 ^{c-e}	3.85^a
S ₃	M ₁	2.56 ^{b-g}	2.37 ^{b-g}	2.26 ^{e-h}	2.40^{ab}	6.35 ^{a-e}	5.94 ^{a-h}	5.34 ^{g-j}	5.88^{a-c}	3.78 ^{b-d}	3.67 ^{c-e}	3.54 ^{c-e}	3.66^{a-c}
	M ₂	2.57 ^{b-g}	2.37 ^{b-g}	2.28 ^{d-h}	2.41^{ab}	6.38 ^{a-e}	5.99 ^{a-h}	5.34 ^{g-j}	5.90^{a-c}	3.81 ^{b-d}	3.67 ^{c-e}	3.55 ^{c-e}	3.68^d
	M ₃	2.58 ^{b-g}	2.38 ^{b-g}	2.28 ^{d-h}	2.41^{ab}	6.40 ^{a-d}	5.99 ^{a-h}	5.42 ^{f-j}	5.94^{a-c}	3.82 ^{b-d}	3.68 ^{c-e}	3.57 ^{c-e}	3.69^{a-c}
	M ₄	2.59 ^{b-g}	2.40 ^{b-g}	2.28 ^{d-h}	2.42^{ab}	6.46 ^{a-d}	6.03 ^{a-h}	5.46 ^{f-j}	5.98^{a-c}	3.83 ^{b-d}	3.70 ^{c-e}	3.59 ^{c-e}	3.71^{a-c}
Variety		2.57 ^a	2.40 ^b	2.24 ^c		6.43 ^a	6.00 ^b	5.38 ^c		3.86 ^a	3.68 ^b	3.52 ^c	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	2.52 ^{ab}	2.37 ^{cd}	2.14 ^e	2.34 ^c	6.30 ^b	5.84 ^e	5.12 ^h	5.75 ^c	3.74 ^{bc}	3.65 ^{bc}	3.38 ^d	3.59 ^b
	S ₂	2.63 ^a	2.47 ^{bc}	2.30 ^d	2.47 ^a	6.60 ^a	6.16 ^c	5.63 ^f	6.13 ^a	4.02 ^a	3.71 ^{bc}	3.61 ^{bc}	3.78 ^a
	S ₃	2.57 ^{ab}	2.38 ^{cd}	2.27 ^d	2.41 ^b	6.40 ^b	5.99^d	5.39 ^g	5.93 ^b	3.81 ^b	3.68 ^{bc}	3.56 ^{cd}	3.68 ^{ab}
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M ₄	M ₁	2.55 ^{ab}	2.40 ^{ec}	2.20 ^e	2.38 ^a	6.36 ^{bc}	5.93 ^c	5.22 ^d	5.84 ^a	3.78 ^{bc}	3.67 ^{bc}	3.44 ^d	3.63 ^a
	M ₂	2.56 ^{ab}	2.40 ^{ec}	2.21 ^d	2.39 ^a	6.41 ^{ab}	6.00 ^{bc}	5.33 ^d	5.91 ^a	3.82 ^{ab}	3.68 ^{bc}	3.51 ^{cd}	3.67 ^a
	M ₃	2.58 ^a	2.41 ^b	2.27 ^d	2.42 ^a	6.45 ^{ab}	6.01 ^{bc}	5.47 ^d	5.98 ^a	3.90 ^{ab}	3.69 ^{bc}	3.55 ^{cd}	3.71 ^a
	M ₄	2.59 ^a	2.42 ^b	2.28 ^{cd}	2.43 ^a	6.51 ^a	6.06 ^{b-c}	5.50 ^d	6.02 ^a	3.94 ^a	3.69 ^{bc}	3.58 ^{cd}	3.74 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.01				0.04				0.03			
Seed (S)		0.02				0.06				0.04			
Micro (M)		0.02				0.08				0.04			
V x S		0.04				0.11				0.06			
V x M		0.04				0.14				0.06			
S x M		0.04				0.14				0.06			
V x S x M		0.07				0.25				0.11			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

(2.30, 5.60 and 3.51, at 45 and 90 DAS and at harvest respectively) was recorded by lower seed rate and no supplementation of micronutrients (S_1M_1).

Among the three factor interactions, significantly larger LAI occurred with cv. GGV 0501 sown using medium seed rate and supplied with both the micronutrients ($V_1S_2M_4$) throughout (2.68, 6.73 and 4.20, at 45 and 90 DAS and at harvest respectively) while lower LAI was recorded with cv. BPT 5204 with lower seed rate and no supplementation of any micronutrient ($V_3S_1M_1$) (2.06, 4.80 and 3.18, at 45 and 90 DAS and at harvest respectively) closely followed by $V_3S_1M_2$ which was on par while other combinations fell between these extremes.

4.1.2.1.5 Dry matter accumulation in leaves (g plant^{-1}) (c.f. Table 87 and Fig. 13a)

Dry matter (DM) in leaf almost followed LA and DM accumulations in leaf increased with age up to 90 DAS and thereafter the values decreased due to senescence and variation in DM due to cultivars, seed rates and use of micronutrients and their interactions during summer season revealed significant differences.

DM in leaf differed significantly at all stages of crop growth wherein cv. GGV 0501 (V_1) recorded significantly larger DM (1.8, 12.3 and 13.6, respectively at 45 and 90 DAS and at harvest), while lower DM was recorded with cv. BPT 5204 at all the stages (1.4, 11.6 and 10.6, respectively at 45 and 90 DAS and at harvest) while RNR 15048 behaved parallel with it. Among seed rates, DM was significantly higher with medium seed rate (S_2) throughout (1.6, 12.2 and 13.2, respectively at 45 and 90 DAS and at harvest) followed closely by S_3 with higher seed rate which was at par while lower seed rate (S_1) recorded lower DM in leaf throughout (1.4, 11.3 and 10.2, respectively at 45 and 90 DAS and at harvest). Variations due to levels of micronutrients were significant and supplementation of both FeSO_4 and ZnSO_4 (M_4) registered higher DM in leaf throughout (1.9, 12.5 and 14.6, at 45 and 90 DAS and at harvest respectively) while no supplementation (M_1) recorded lower DM throughout (1.2, 10.8 and 8.3, respectively at 45 and 90 DAS and at harvest).

In the two factor combinations, interactions due to variety and seed rate were significant and cv. GGV 0501 (V_1) with medium seed rate of 30 kg ha^{-1} (V_1S_2) recorded larger DM in leaf throughout (1.8, 13.0 and 15.9, at 45 and 90 DAS and at harvest respectively) except at 45 DAS closely followed by V_1S_3 while lower DM in leaf was

Table 87. Effect of genotypes, seed rates and micronutrients on dry matter accumulation in leaves (g plant⁻¹) under direct seeded condition during summer season

V x S x M		45 DAS				90 DAS				At harvest			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	1.0 ^{ij}	0.6 ^j	1.1 ^{h-j}	0.9^e	10.7 ^{b-d}	10.3 ^d	10.3 ^d	10.4^c	8.4 ^{j-l}	5.7 ^m	5.8 ^m	6.6^g
	M ₂	1.2 ^{h-j}	1.2 ^{e-i}	1.4 ^{e-i}	1.3^{de}	10.9 ^{b-d}	10.9 ^{b-d}	10.6 ^{b-d}	10.8^{bc}	10.0 ^{h-j}	9.8 ^{i-k}	7.7 ^{k-m}	9.2^{ef}
	M ₃	1.8 ^{b-i}	1.6 ^{c-i}	1.3 ^{e-j}	1.6^{b-e}	12.4 ^{a-d}	12.3 ^{a-d}	11.3 ^{a-d}	12.0^{ab}	13.9 ^{c-f}	11.8 ^{f-i}	10.7 ^{g-i}	12.1^c
	M ₄	2.0 ^{a-f}	1.5 ^{e-i}	1.4 ^{e-i}	1.6^{b-e}	12.6 ^{a-d}	12.1 ^{a-d}	11.4 ^{a-d}	12.0^{ab}	14.3 ^{c-e}	12.7 ^{d-g}	10.8 ^{g-i}	12.6^{bc}
S ₂	M ₁	1.2 ^{h-j}	1.3 ^{e-j}	1.2 ^{g-j}	1.2^{ef}	12.4 ^{a-d}	10.3 ^d	10.9 ^{b-d}	11.2^{bc}	12.8 ^{d-g}	5.7 ^m	11.8 ^{f-i}	10.1^{de}
	M ₂	1.2 ^{g-j}	1.5 ^{e-i}	1.2 ^{f-j}	1.3^{de}	12.7 ^{a-d}	11.8 ^{a-d}	11.9 ^{a-d}	12.1^{ab}	15.7 ^{bc}	10.7 ^{g-i}	12.3 ^{e-h}	12.9^{bc}
	M ₃	2.4 ^{ab}	1.4 ^{e-i}	1.8 ^{b-i}	1.9^{a-c}	13.5 ^a	12.1 ^{a-d}	12.4 ^{a-d}	12.7^a	17.1 ^{ab}	11.7 ^{f-i}	12.7 ^{d-g}	13.8^b
	M ₄	2.2 ^{a-c}	2.0 ^{a-e}	2.0 ^{a-g}	2.1^a	13.5 ^a	12.3 ^{a-d}	12.9 ^{a-c}	12.9^a	17.9 ^a	15.7 ^{bc}	14.3 ^{c-e}	16.0^a
S ₃	M ₁	1.7 ^{b-i}	1.4 ^{e-i}	1.3 ^{e-j}	1.5^{c-e}	11.1 ^{a-d}	10.5 ^{cd}	10.3 ^d	10.6^c	10.1 ^{h-j}	7.8 ^{k-m}	6.5 ^{lm}	8.1^f
	M ₂	2.1 ^{h-j}	1.5 ^{c-i}	1.3 ^{a-j}	1.7^{b-d}	11.2 ^{a-d}	11.9 ^{a-d}	12.0 ^{a-d}	11.7^{a-c}	10.3 ^{h-j}	11.1 ^{g-i}	10.7 ^{g-i}	10.7^d
	M ₃	2.5 ^a	1.5 ^{d-i}	1.5 ^{c-i}	1.8^{a-c}	13.1 ^{ab}	11.8 ^{a-d}	12.9 ^{a-c}	12.6^a	14.5 ^{c-e}	12.7 ^{d-g}	11.2 ^{g-i}	12.8^{bc}
	M ₄	2.2 ^{a-d}	1.6 ^{c-i}	1.8 ^{a-h}	1.9^{ab}	13.1 ^{ab}	12.2 ^{a-d}	12.5 ^{a-d}	12.6^a	17.7 ^{ab}	14.8 ^{cd}	12.8 ^{d-g}	15.1^a
Variety		1.8^a	1.4^b	1.4^b		12.3^a	11.5^b	11.6^b		13.6^a	10.9^b	10.6^b	
Variety x Seed rate		S				S				S			
S	S ₁	1.5 ^c	1.2 ^c	1.3 ^c	1.4 ^b	11.7 ^b	11.4 ^{bc}	10.9 ^c	11.3 ^b	11.7 ^c	10.0 ^f	8.8 ^g	10.2 ^c
	S ₂	1.8 ^b	1.5 ^c	1.5 ^c	1.6 ^a	13.0 ^a	11.6 ^{bc}	12.0 ^b	12.2 ^a	15.9 ^a	10.9 ^{de}	12.8 ^b	13.2 ^a
	S ₃	2.1 ^a	1.5 ^c	1.5 ^c	1.7 ^a	12.1 ^b	11.6 ^{bc}	11.9 ^b	11.9 ^a	13.1 ^b	11.6 ^{cd}	10.3 ^{ef}	11.7 ^b
Variety x Micro		M				M				M			
M ₄	M ₁	1.3 ^c	1.1 ^c	1.2 ^c	1.2 ^b	11.4 ^{bc}	10.4 ^c	10.5 ^c	10.8 ^c	10.4 ^{de}	6.4 ^g	8.1 ^f	8.3 ^d
	M ₂	1.5 ^{bc}	1.5 ^{bc}	1.3 ^c	1.4 ^b	11.6 ^{bc}	11.5 ^{bc}	11.5 ^{bc}	11.5 ^b	12.0 ^c	10.5 ^{de}	10.2 ^e	10.9 ^c
	M ₃	2.2 ^a	1.5 ^{bc}	1.5 ^{bc}	1.9 ^a	13.0 ^a	12.1 ^{ab}	12.2 ^{ab}	12.4 ^a	15.2 ^b	12.1 ^c	11.5 ^{cd}	12.9 ^b
	M ₄	2.1 ^a	1.7 ^b	1.7 ^b	1.9 ^a	13.1 ^a	12.2 ^{ab}	12.3 ^{ab}	12.5 ^a	16.6 ^a	14.4 ^b	12.7 ^c	14.6 ^a
Comparison		S.E.m±				S.E.m±				S.E.m±			
Variety (V)		0.1				0.1				0.1			
Seed (S)		0.2				0.1				0.1			
Micro (M)		0.1				0.2				0.2			
V x S		0.1				0.2				0.2			
V x M		0.1				0.4				0.4			
S x M		0.1				0.4				0.4			
V x S x M		0.2				0.7				0.7			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

observed with cv. BPT 5204 particularly with 25 kg ha⁻¹ seed rate (1.3, 10.9 and 8.8 at 45 and 90 DAS and at harvest respectively). Variety X micronutrient also produced significant variations, in that cv. GGV 0501 with combined application of FeSO₄ + ZnSO₄ (V₁M₄) rerecorded higher DM throughout (2.1, 13.1 and 16.6, at 45 and 90 DAS and at harvest respectively) closely followed by V₁M₃ and with age differences due to levels of micronutrients narrowed down with cvs. RNR 15048 (1.1, 10.4 and 6.4, at 45 and 90 DAS and at harvest respectively) and BPT 5204 and both the cultivars with no supplementation of micronutrients produced lower DM in leaf throughout (V₃M_{1-1.2}, 10.5 and 8.1, respectively at 45 and 90 DAS and at harvest). Similarly, interactions due to micronutrients and seed rates were significant wherein 30 kg seed rate with application of FeSO₄ + ZnSO₄ (S₂M₄) recorded higher LAI throughout (2.0, 12.9 and 16.0, at 45 and 90 DAS and at harvest respectively) closely followed by S₃M₄ which was at par, while lower DM in leaf throughout (0.9, 10.4 and 6.7, at 45 and 90 DAS and at harvest respectively) was recorded by lower seed rate and no supplementation of micronutrients (S₁M₁).

Among the three factor interactions, significantly larger DM in leaf occurred with cv. GGV 0501 sown using medium seed rate and supplied with both the micronutrients (V₁S₂M₄) throughout (2.2, 13.5 and 17.9, at 45 and 90 DAS and at harvest respectively) except at 45 DAS while lower DM was recorded with cvs. RNR 15048 and BPT 5204 with lower seed rate and no supplementation of any micronutrient (V_{2&3}S₁M₁) (0.6 and 1.1, 10.3 each and 5.7 and 5.8 with RNR 15048 and BPT 5204, at 45 and 90 DAS and at harvest respectively).

4.1.2.1.6 Dry matter accumulation in stem (g plant⁻¹) (c.f. Table 88 and Fig. 13b)

DM in stem increased throughout and variation in DM due to cultivars, seed rates and use of micronutrients and their interactions during summer season revealed significant differences.

Dry matter in stem differed significantly at all stages of crop growth due to main factors. Among cultivars GGV 0501 (V₁) recorded significantly higher DM (2.4, 24.1 and 34.0, respectively at 45 and 90 DAS and at harvest), while lower DM was recorded with cv. BPT 5204 at all the stages (2.4, 25.2 and 27.6, respectively at 45 and 90 DAS and at harvest) while RNR 15048 behaved parallel with it. Among seed rates, DM was significantly higher with medium seed rate (S₂) throughout (2.5, 25.9 and 32.3

Table 88. Effect of genotypes, seed rates and micronutrients on dry matter accumulation in stem (g plant⁻¹) under direct seeded condition during summer season

V x S x M		45 DAS				90 DAS				At harvest			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	1.3 ^f	1.6 ^{c-f}	1.3 ^f	1.4^d	16.4 ^{n-p}	14.7 ^q	18.7 ^{k-o}	16.6^e	26.7 ^{g-j}	38.8 ^{ab}	21.4 ^k	29.0^{ef}
	M ₂	1.4 ^{d-f}	1.6 ^{c-f}	1.8 ^{b-f}	1.6^{cd}	19.1 ^{j-o}	23.5 ^{g-l}	21.4 ^{h-n}	21.3^d	29.4 ^{f-i}	26.7 ^{g-j}	24.1 ^{h-j}	23.4^e
	M ₃	2.8 ^{ab}	2.3 ^{a-c}	2.5 ^{a-c}	2.5^a	21.5 ^{h-n}	25.7 ^{d-i}	23.5 ^{g-l}	23.6^{cd}	31.5 ^{c-g}	31.5 ^{c-g}	26.5 ^{g-j}	29.8^d
	M ₄	2.9 ^{ab}	2.7 ^{ab}	2.6 ^{ab}	2.7^a	32.7 ^{a-c}	30.8 ^{a-f}	28.4 ^{a-g}	30.6^a	36.4 ^{a-e}	33.3 ^{a-f}	32.1 ^{b-g}	33.9^{bc}
S ₂	M ₁	2.5 ^{a-c}	1.4 ^{d-f}	2.2 ^c	2.0^{bc}	12.4 ^p	16.8 ^p	18.7 ^{k-o}	16.0^e	26.7 ^{g-j}	21.8 ^{jk}	16.7 ^k	21.7^f
	M ₂	2.5 ^{a-c}	2.1 ^{a-e}	2.6 ^{ab}	2.4^{ab}	26.4 ^{c-i}	28.3 ^{a-g}	25.2 ^{d-j}	26.6^{bc}	37.1 ^{a-c}	36.3 ^{a-e}	27.2 ^{f-j}	33.5^{bc}
	M ₃	2.7 ^{ab}	2.9 ^a	2.8 ^{ab}	2.8^a	27.1 ^{b-h}	30.7 ^{a-f}	29.1 ^{a-g}	29.0^{ab}	39.1 ^a	37.5 ^{a-c}	30.4 ^{e-g}	35.7^{ab}
	M ₄	3.0 ^a	2.8 ^a	2.8 ^{ab}	2.9^a	33.1 ^a	31.5 ^{a-d}	31.2 ^{a-d}	31.9^a	39.2 ^a	38.2 ^{ab}	37.1 ^{a-c}	38.2^a
S ₃	M ₁	2.3 ^{b-c}	1.2 ^g	1.3 ^{ef}	1.6^{cd}	17.5 ^{l-p}	24.6 ^{e-k}	20.0 ^{i-o}	20.7^d	29.4 ^{f-i}	26.7 ^{g-j}	21.5 ^{jk}	25.9^e
	M ₂	2.4 ^{a-c}	2.3 ^{b-c}	2.8 ^{ab}	2.5^a	23.1 ^{g-m}	25.7 ^{d-i}	26.4 ^{c-i}	25.1^c	36.5 ^{a-d}	30.7 ^{d-g}	27.1 ^{g-j}	31.4^{cd}
	M ₃	2.7 ^{ab}	2.6 ^{ab}	2.8 ^{ab}	2.7^a	26.2 ^{c-i}	24.3 ^{f-k}	28.8 ^{a-g}	26.4^{bc}	37.7 ^{ab}	29.3 ^{f-i}	30.2 ^{f-h}	32.4^{cd}
	M ₄	2.8 ^{ab}	2.6 ^{ab}	2.6 ^{ab}	2.7^a	33.6 ^{ab}	30.9 ^{a-e}	30.5 ^{a-f}	31.7^a	38.5 ^{ab}	37.7 ^{ab}	36.3 ^{a-e}	37.5^a
Variety		2.4^a	2.2^a	2.4^a		24.1^b	25.6^a	25.2^{ab}		34.0^a	31.5^b	27.6^c	
Variety x Seed rate		S				S				S			
S	S ₁	2.1 ^a	2.1 ^a	2.1 ^a	2.1 ^b	22.4 ^c	23.7 ^{bc}	23.0 ^c	23.0 ^b	31.0 ^{bc}	30.1 ^{de}	26.1 ^e	29.1 ^b
	S ₂	2.7 ^a	2.3 ^a	2.6 ^a	2.5 ^a	24.8 ^{a-c}	26.8 ^a	26.1 ^a	25.9 ^a	35.6 ^a	33.5 ^{ab}	27.9 ^{de}	32.3 ^a
	S ₃	2.6 ^a	2.2 ^a	2.4 ^a	2.4 ^{ab}	25.1 ^{a-c}	26.4 ^{ab}	26.4 ^a	26.0 ^a	35.6 ^a	31.1 ^{bc}	28.8 ^{cd}	31.8 ^{ab}
Variety x Micro		M				M				M			
M ₄	M ₁	2.00 ^{bc}	1.41 ^d	1.62 ^{cd}	1.7 ^c	15.5 ^f	18.7 ^e	19.2 ^e	17.8 ^d	27.6 ^{ef}	29.1 ^g	19.9 ^h	25.5 ^d
	M ₂	2.10 ^b	2.01 ^{bc}	2.42 ^{ab}	2.2 ^b	22.9 ^d	25.9 ^{cd}	24.3 ^{cd}	24.4 ^c	34.4 ^{bc}	27.9 ^{de}	26.2 ^{eg}	29.5 ^c
	M ₃	2.74 ^a	2.59 ^a	2.7 ^a	2.7 ^a	25 ^{cd}	26.9 ^{bc}	27.1 ^{bc}	26.3 ^b	36.1 ^{ab}	32.8 ^{cd}	29.1 ^{ef}	32.7 ^b
	M ₄	2.80 ^a	2.7 ^a	2.67 ^a	2.7 ^a	33.1 ^a	31.1 ^{ab}	30.1 ^{ab}	31.4 ^a	38.1 ^a	36.4 ^{ab}	35.2 ^{a-c}	36.6 ^a
Comparison		S.E.m±				S.E.m±				S.E.m±			
Variety (V)		0.0				0.2				0.6			
Seed (S)		0.1				0.4				0.4			
Micro (M)		0.0				0.6				0.7			
V x S		0.1				0.8				0.8			
V x M		0.1				1.1				1.2			
S x M		0.1				1.1				1.2			
V x S x M		0.268				1.9				2.2			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

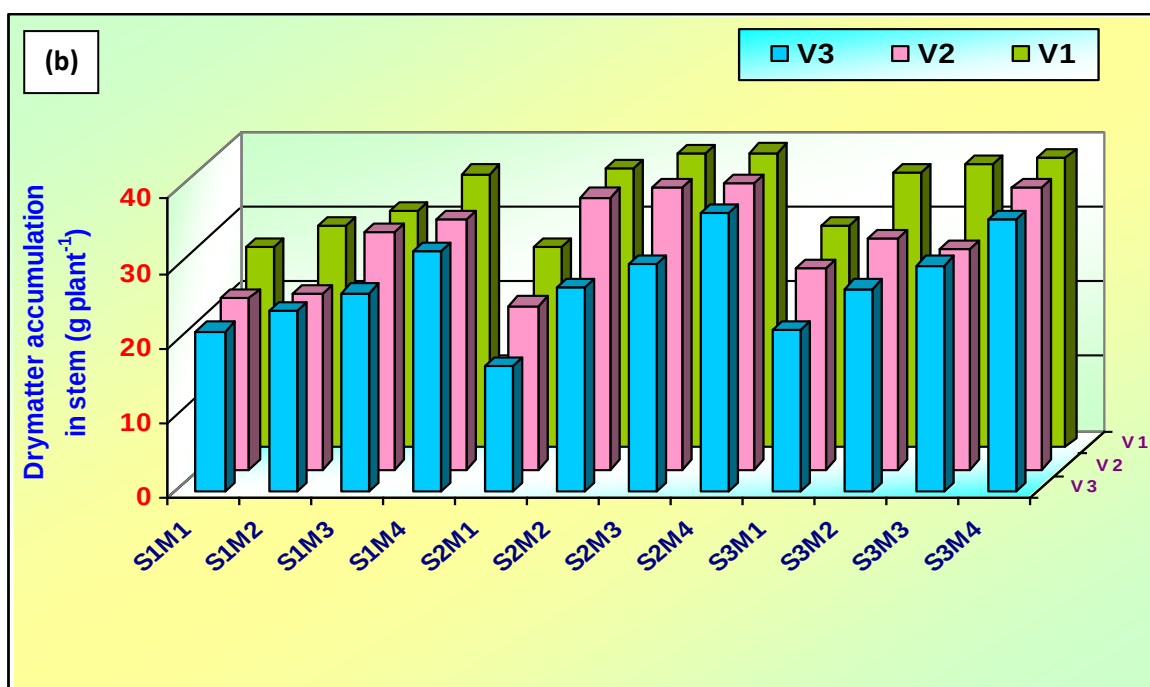
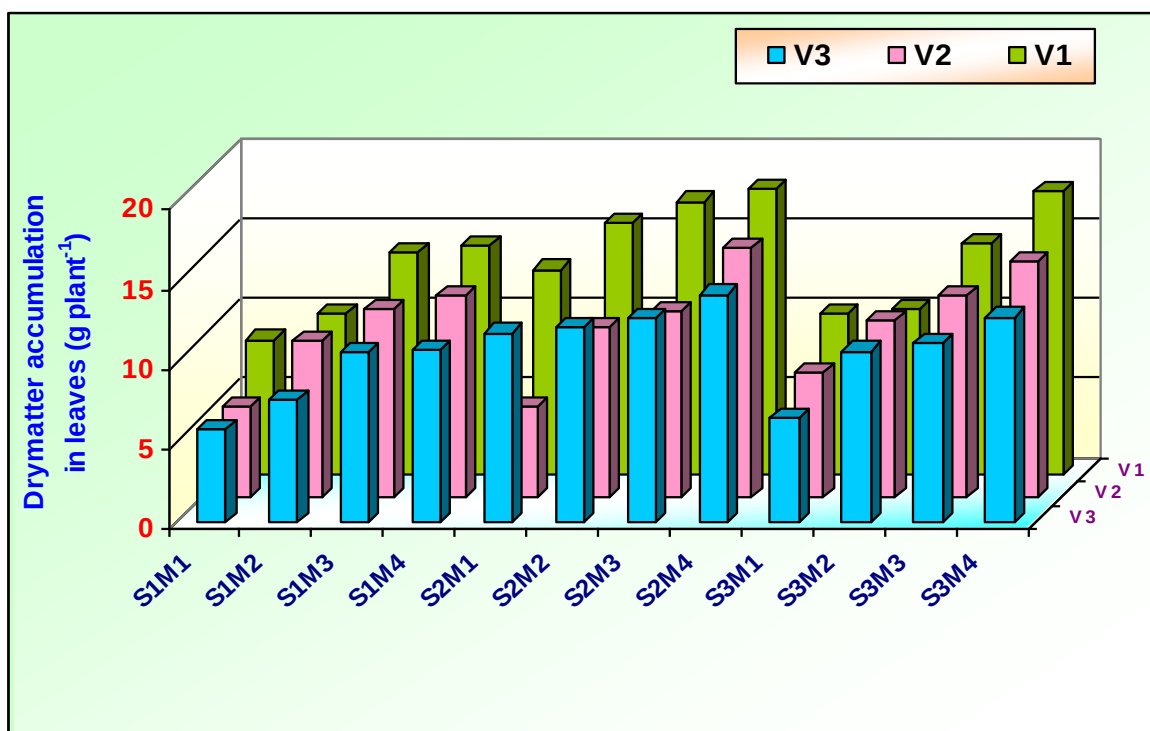
M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

respectively at 45 and 90 DAS and at harvest) followed closely by S_3 with higher seed rate which was at par while lower seed rate (S_1) recorded lower DM in stem throughout (2.1, 23.0 and 29.1, respectively at 45 and 90 DAS and at harvest). Variations due to levels of micronutrients were significant and supplementation of both $FeSO_4$ and $ZnSO_4$ (M_4) registered higher DM in stem throughout (2.7, 31.4 and 36.6, at 45 and 90 DAS and at harvest respectively) while no supplementation recorded lower DM throughout (1.7, 17.8 and 25.5, respectively at 45 and 90 DAS and at harvest).

In the two factor combinations, interactions due to variety and seed rate were significant and cv. GGV 0501 (V_1) with medium seed rate of 30 kg ha^{-1} (V_1S_2) recorded larger DM in stem throughout (2.7, 24.8 and 35.6, at 45 and 90 DAS and at harvest respectively) closely followed by V_1S_3 , while lower DM in stem was observed with cv. BPT 5204 particularly with 25 kg ha^{-1} seed rate (2.1, 23.0 and 26.1 at 45 and 90 DAS and at harvest respectively); other cultivars with similar seed rate were at par. Variety X micronutrient also produced significant variations, in that cv. GGV 0501 with combined application of $FeSO_4 + ZnSO_4$ (V_1M_4) rerecorded higher DM throughout (2.80, 33.1 and 38.1, at 45 and 90 DAS and at harvest respectively) closely followed by V_1M_3 and with age differences due to levels of micronutrients narrowed down with cvs, RNR 15048 and BPT 5204; both were comparable and with no supplementation of micronutrients these cultivars accumulated lower DM in stem throughout (1.7, 17.8 and 19.9, respectively with BPT 5204 at 45 and 90 DAS and at harvest). Similarly, interactions due to micronutrients and seed rates were significant wherein 30 kg seed rate with application of $FeSO_4 + ZnSO_4$ (S_2M_4) accumulated higher DM throughout (2.8, 32.0 and 38.2, at 45 and 90 DAS and at harvest respectively) closely followed by S_3M_4 which was at par, while lower DM in stem throughout (2.0, 16.0 and 21.8, at 45 and 90 DAS and at harvest respectively) was recorded by medium seed rate and no supplementation of micronutrients (S_2M_1) closely followed by S_1M_1 .

Among the three factor interactions, significantly larger DM in stem occurred with cv. GGV 0501 sown using medium seed rate and supplied with both the micronutrients ($V_1S_2M_4$) throughout (3.0, 33.1 and 39.2, at 45 and 90 DAS and at harvest respectively) while lower DM was recorded with cvs. RNR 15048 and BPT 5204 with lower seed rate and no supplementation of any micronutrient ($V_{2\&3}S_1M_1$) (1.6 and 1.3, 14.7 and 18.7 and 18.8 and 21.4 with RNR 15048 and BPT 5204, at 45 and 90 DAS and at harvest respectively).



LEGEND

Varieties: V₁- GGV 0501, V₂- RNR 15048, V₃- BPT 5204;
 Seed Rate: S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
 Micronutrient: M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₄- FeSO₄ + ZnSO₄ (Each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

Fig. 13. Effect of genotypes, seed rates and micronutrients on dry matter accumulation in (a) leaves (g plant⁻²) and (b) stem (g plant⁻¹) at harvest under direct seeded condition during summer season

4.1.2.1.7 Dry matter accumulation in panicles (g plant⁻¹) (c.f. Table 89 and Fig. 14a)

DM in panicle at harvest varied significantly due to cultivars, seed rates and use of micronutrients and their interactions during summer season.

In the main effects, DM in panicles differed significantly among cultivars and GGV 0501 (V₁) recorded significantly higher DM (41.4), while lower DM was recorded with cv. BPT 5204 (26.6) while RNR 15048 fared in between. Among seed rates, DM was significantly higher with medium seed rate (S₂) 35.2) followed closely by S₃ with higher seed rate, while lower seed rate (S₁) recorded lower DM in panicles (30.6). Variations due to levels of micronutrients were significant and supplementation of both FeSO₄ and ZnSO₄ (M₄) registered higher DM in panicles (37.4) closely followed by application of ZnSO₄ (35.2) which was at par, while no supplementation (M₁) recorded lower DM (27.8).

In the two factor combinations, interactions due to variety and seed rate were significant and cv. GGV 0501 (V₁) with medium seed rate of 30 kg ha⁻¹ (V₁S₂) recorded larger DM in panicles (45.5) closely followed by V₁S₃ (39.9), while lower DM in panicles was observed with cvs. RNR 15048 with 25 kg ha⁻¹ seed rate (V₂S₁- 25.3) and BPT 5204 with 30 kg seed rate (V₃S₂- 25.0). Variety X micronutrient also produced significant variations, in that cv. GGV 0501 with combined application of FeSO₄ + ZnSO₄ (V₁M₄) rerecorded higher DM (47.7) closely followed by V₁M₃ which was at par, while cv. BPT 5204 with no supplementation of micronutrients accumulated lower DM panicles (22.4). Similarly, interactions due to micronutrients and seed rates were significant wherein 30 kg seed rate with application of FeSO₄ + ZnSO₄ (S₂M₄) accumulated higher DM (40.8) closely followed by S₂M₃ which was at par, while lower DM panicles (23.9) was recorded by lower seed rate and no supplementation of micronutrients (S₁M₁) closely followed by S₁M₂.

Among the three factor interactions, significantly larger DM in panicles occurred with cv. GGV 0501 sown using medium seed rate and supplied with both the micronutrients (V₁S₂M₄) (50.1) closely followed by V₁S₂M₃ (49.7) and V₁S₃M₄ (47.2) which were on par, while lower DM was recorded with cvs. RNR 15048 (20.1) and BPT 5204 (23.5) with lower seed rate and no supplementation of any micronutrient (V_{2&3}S₁M₁).

Table 89. Effect of genotypes, seed rates and micronutrients on dry matter accumulation in panicle (g plant⁻¹) at harvest under direct seeded condition during summer season

V x S x M		Dry matter accumulation in panicle			
		V ₁	V ₂	V ₃	S x M
S ₁	M ₁	28.1 ^{g-i}	20.1 ^{kl}	23.5 ^{i-k}	23.9 ^f
	M ₂	35.7 ^{d-g}	22.6 ^{j-l}	22.3 ^{j-l}	29.1 ^e
	M ₃	45.8 ^{a-c}	27.3 ^{h-k}	29.7 ^{f-j}	34.3 ^{b-d}
	M ₄	45.8 ^{a-c}	31.1 ^{e-i}	28.0 ^{g-j}	34.9 ^{b-d}
S ₂	M ₁	37.3 ^{d-f}	32.2 ^{d-h}	15.8 ^l	28.4 ^e
	M ₂	44.8 ^{a-c}	33.8 ^{d-h}	22.3 ^{j-l}	33.6 ^{ce}
	M ₃	49.7 ^a	34.1 ^{d-h}	29.7 ^{f-j}	37.9 ^{ab}
	M ₄	50.1 ^a	40.0 ^{b-d}	32.4 ^{d-h}	40.8 ^a
S ₃	M ₁	35.7 ^{d-g}	29.7 ^{f-j}	28.0 ^{g-j}	31.1 ^{de}
	M ₂	37.6 ^{de}	29.7 ^{f-j}	28.1 ^{g-j}	31.8 ^{de}
	M ₃	39.0 ^{cd}	32.2 ^{d-h}	29.4 ^{f-j}	33.5 ^{cd}
	M ₄	47.2 ^{ab}	32.2 ^{d-h}	29.7 ^{f-j}	36.4 ^{bc}
Variety		41.4 ^a	30.4 ^b	26.6 ^c	
Variety x Seed rate					S
S	S ₁	38.7 ^b	25.3 ^e	27.7 ^{de}	30.6 ^c
	S ₂	45.5 ^a	35.0 ^c	25.0 ^e	35.2 ^a
	S ₃	39.9 ^b	30.9 ^d	28.8 ^d	33.2 ^b
Variety x Micro					M
M4	M ₁	33.7 ^{cd}	27.3 ^{ef}	22.4 ^g	27.8 ^c
	M ₂	39.1 ^b	28.7 ^{ef}	26.7 ^f	31.5 ^b
	M ₃	44.8 ^a	31.2 ^{a-e}	29.6 ^{d-f}	35.2 ^a
	M ₄	47.7 ^a	34.4 ^c	30.0 ^{d-f}	37.4 ^a
Comparison		S.E.m±			
Variety (V)		0.7			
Seed (S)		0.6			
Micro (M)		0.8			
V x S		1.0			
V x M		1.3			
S x M		1.3			
V x S x M		2.3			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

4.1.2.1.8 Total dry matter production (g plant⁻¹) (c.f. Table 90 and Fig. 14b)

Total dry matter production (TDMP) increased throughout and variation in TDM due to cultivars, seed rates and use of micronutrients and their interactions during summer season revealed significant differences.

Total dry matter in stem differed significantly at all stages of crop growth due to main factors. Among cultivars, GGV 0501 (V_1) recorded significantly higher TDM (4.2, 36.2 and 89.9, respectively at 45 and 90 DAS and at harvest), while lower TDM was recorded with cv. BPT 5204 at all the stages (3.8, 36.8 and 65.9, respectively at 45 and 90 DAS and at harvest) while RNR 15048 behaved parallel with it. Among seed rates, TDM was significantly higher with medium seed rate (S_2) throughout (4.1, 38.3 and 80.9, respectively at 45 and 90 DAS and at harvest) followed closely by S_3 with higher seed rate which was at par up to 90 DAS, while lower seed rate (S_1) recorded lower TDM throughout (3.434.4 and 69.8, respectively at 45 and 90 DAS and at harvest). Variations due to levels of micronutrients were significant and supplementation of both $FeSO_4$ and $ZnSO_4$ (M_4) registered higher TDM throughout (4.6, 44.1 and 88.6, at 45 and 90 DAS and at harvest respectively) while no supplementation recorded lower TDM throughout (2.9, 28.1 and 61.7, respectively at 45 and 90 DAS and at harvest).

In the two factor combinations, interactions due to variety and seed rate were significant and cv. GGV 0501 (V_1) with medium seed rate of 30 kg ha⁻¹ (V_1S_2) recorded larger TDM at harvest (4.4, 37.6 and 96.9, at 45 and 90 DAS and at harvest respectively); at 45 DAS it was GGV 0501 with 35 kg seed rate (4.7) and RNR 15048 with 30 kg seed rate at 90 DAS (38.3), while lower TDM was observed with cv. RNR 15048 (3.3) at 45 DAS and BPT 5204 (33.9 and 62.5, respectively) at 90 DAS and at harvest with 25 kg ha⁻¹ seed rate. Variety X micronutrient also produced significant variations, in that cv. GGV 0501 with combined application of $FeSO_4 + ZnSO_4$ (V_1M_4) rerecorded higher TDM throughout (5.0, 45.8 and 102.4, at 45 and 90 DAS and at harvest respectively) closely followed by V_1M_3 , while no supplementation of micronutrients with cv. BPT 5204 recorded lower TDM throughout (2.8, 29.7 and 50.4, respectively) closely followed by RNR 15048 with no micronutrient supply. Similarly, interactions due to micronutrients and seed rates were significant wherein 30 kg seed rate with application of $FeSO_4 + ZnSO_4$ (S_2M_4) produced higher TDM throughout (4.91, 45.6

Table 90. Effect of genotypes, seed rates and micronutrients on total dry matter production (g plant⁻¹) under direct seeded condition during summer season

V x S x M		45 DAS				90 DAS				At harvest			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	2.5 ^{jk}	2.2 ^k	2.5 ^{jk}	2.4 ^f	27.1 ^{l-m}	25.0 ^m	29.0 ^{k-m}	27.0 ^f	63.3 ^{lm}	64.7 ^{k-m}	50.7 ^{no}	59.6 ^e
	M ₂	2.4 ^{jk}	3.0 ^{g-k}	3.2 ^{f-k}	2.9 ^{ef}	30.1 ^{j-m}	34.5 ^{g-k}	32.0 ^{i-l}	32.2 ^e	74.5 ^{g-k}	49.1 ^o	61.5 ^m	61.7 ^e
	M ₃	4.6 ^{a-e}	3.9 ^{b-h}	3.8 ^{c-i}	4.1 ^{bc}	33.9 ^{h-k}	37.9 ^{d-i}	34.8 ^{g-k}	35.5 ^d	91.2 ^{d-f}	70.6 ^{j-m}	66.9 ^{j-m}	76.2 ^{cd}
	M ₄	4.8 ^{a-d}	4.2 ^{a-g}	4.0 ^{a-g}	4.3 ^{a-c}	45.3 ^{a-c}	43.0 ^{a-e}	39.8 ^{b-h}	42.7 ^{ab}	96.5 ^{b-d}	77.1 ^{g-j}	70.9 ^{i-m}	81.5 ^c
S ₂	M ₁	3.6 ^{d-j}	2.7 ^{h-k}	3.4 ^{e-j}	3.3 ^{de}	24.1 ^m	27.1 ^{lm}	29.7 ^{j-m}	27.0 ^f	76.8 ^{g-j}	59.8 ^{mm}	44.3 ^o	60.3 ^e
	M ₂	3.7 ^{d-i}	3.6 ^{d-j}	3.9 ^{e-h}	3.7 ^{cd}	39.2 ^{c-h}	40.1 ^{a-h}	37.1 ^{e-i}	38.8 ^{cd}	97.6 ^{a-d}	80.8 ^{f-i}	61.8 ^{lm}	80.1 ^c
	M ₃	5.1 ^{ab}	4.3 ^{a-f}	4.6 ^{a-e}	4.7 ^{ab}	40.6 ^{a-g}	43.4 ^{a-e}	41.6 ^{a-f}	41.9 ^{bc}	105.9 ^{ab}	84.6 ^{e-g}	72.9 ^{h-l}	87.8 ^b
	M ₄	5.2 ^a	4.8 ^{a-d}	4.7 ^{a-d}	4.9 ^a	46.7 ^a	46.1 ^{ab}	44.2 ^{a-d}	45.7 ^a	107.2 ^a	94.9 ^{c-e}	83.7 ^{f-h}	95.3 ^a
S ₃	M ₁	4.0 ^b	2.7 ^{h-k}	2.6 ^{i-k}	3.1 ^{de}	28.7 ^{k-m}	32.2 ^{i-l}	30.3 ^{j-m}	30.4 ^e	75.2 ^{g-k}	49.1 ^o	61.5 ^m	61.9 ^e
	M ₂	4.5 ^{a-e}	3.8 ^{c-i}	4.1 ^{a-g}	4.2 ^{bc}	34.3 ^{g-k}	37.6 ^{d-i}	38.4 ^{d-i}	36.8 ^d	91.2 ^{d-f}	70.6 ^{j-m}	66.9 ^{j-m}	76.2 ^d
	M ₃	5.2 ^a	4.1 ^{a-g}	4.3 ^{a-f}	4.5 ^{ab}	39.3 ^{c-h}	36.1 ^{f-j}	41.6 ^{a-f}	39.0 ^{cd}	96.5 ^{b-d}	77.1 ^{g-j}	70.9 ^{i-m}	81.5 ^{cd}
	M ₄	5.0 ^{a-c}	4.2 ^{a-g}	4.5 ^{a-e}	4.6 ^{ab}	45.4 ^{a-c}	43.8 ^{a-d}	43.0 ^{a-e}	44.1 ^{ab}	103.4 ^{a-c}	84.7 ^{e-g}	78.8 ^{g-i}	89.0 ^b
Variety		4.2 ^a	3.6 ^b	3.8 ^b		36.2 ^b	37.2 ^a	36.8 ^{ab}		89.9 ^a	71.9 ^b	65.9 ^c	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	3.6 ^{b-d}	3.3 ^d	3.4 ^{cd}	3.4 ^b	34.1 ^{cd}	35.1 ^{b-d}	33.9 ^d	34.4 ^b	81.4 ^c	65.4 ^{ef}	62.5 ^f	69.8 ^c
	S ₂	4.4 ^{ab}	3.9 ^{a-d}	4.2 ^{a-c}	4.1 ^a	37.6 ^{a-c}	39.2 ^a	38.1 ^{ab}	38.3 ^a	96.9 ^a	80.0 ^c	65.7 ^{ef}	80.9 ^a
	S ₃	4.7 ^a	3.7 ^{b-d}	3.9 ^{a-d}	4.1 ^a	36.9 ^{a-d}	37.4 ^{a-d}	38.3 ^{ab}	37.5 ^a	88.6 ^b	73.7 ^d	67.9 ^e	76.7 ^b
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M ₄	M ₁	3.4 ^e	2.5 ^f	2.8 ^f	2.9 ^c	26.6 ^f	28.1 ^f	29.7 ^f	28.1 ^d	71.8 ^{ef}	62.9 ^g	50.4 ^h	61.7 ^d
	M ₂	3.5 ^{de}	3.5 ^{de}	3.7 ^{c-e}	3.6 ^b	34.5 ^e	37.4 ^{de}	35.8 ^{de}	35.9 ^c	85.5 ^c	67.2 ^{fg}	63.1 ^g	71.9 ^c
	M ₃	4.9 ^{ab}	4.1 ^{b-d}	4.2 ^{bc}	4.4 ^a	38.0 ^d	39.2 ^{cd}	39.3 ^{cd}	38.8 ^b	96.1 ^b	76.5 ^{de}	70.2 ^f	80.9 ^b
	M ₄	5.0 ^a	4.4 ^{ab}	4.4 ^{ab}	4.6 ^a	45.8 ^a	44.3 ^{ab}	42.3 ^{bc}	44.1 ^a	102.4 ^a	85.6 ^c	77.8 ^d	88.6 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.1				0.2				1.0			
Seed (S)		0.2				0.6				0.7			
Micro (M)		0.1				0.6				1.1			
V x S		0.3				1.1				1.3			
V x M		0.2				1.1				1.9			
S x M		0.2				1.1				1.9			
V x S x M		0.4				1.9				3.4			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

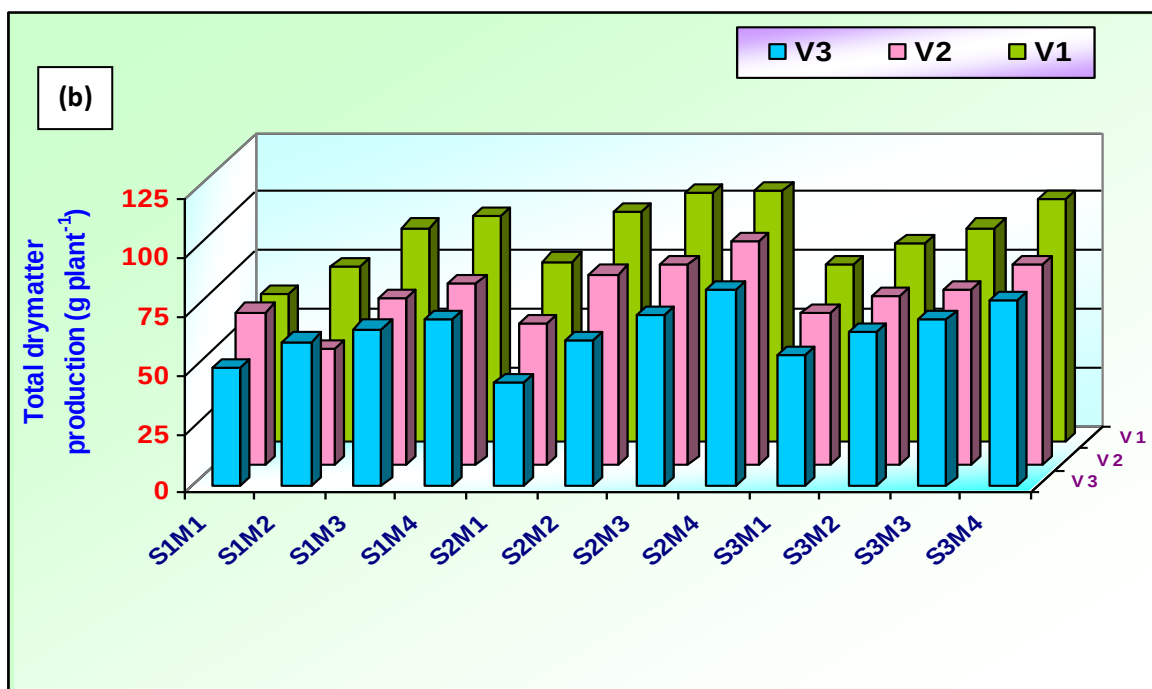
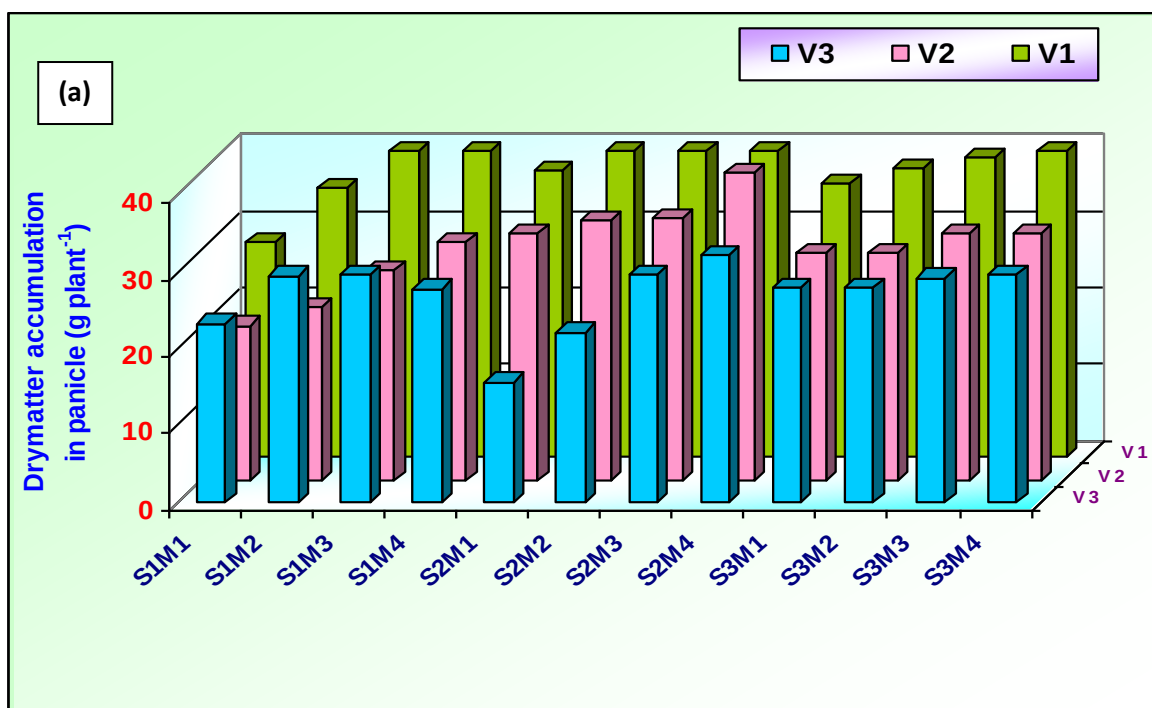
Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT



LEGEND

Varieties: V₁- GGV 0501, V₂- RNR 15048, V₃- BPT 5204;
 Seed Rate: S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
 Micronutrient: M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₄- FeSO₄ + ZnSO₄ (Each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

Fig. 14. Effect of genotypes, seed rates and micronutrients on (a) dry matter accumulation in panicles (g plant^{-1}) and (b) total dry matter production (g plant^{-1}) at harvest under direct seeded condition during summer season

and 95.2, at 45 and 90 DAS and at harvest respectively) closely followed by S_3M_4 which was next in order, while lower TDM throughout (2.4, 27.0 and 59.6, at 45 and 90 DAS and at harvest respectively) was recorded by lower seed rate and no supplementation of micronutrients (S_1M_1) closely followed by medium seed rate and no micronutrient supply (S_2M_1).

Among the three factor interactions, significantly larger TDM occurred with cv. GGV 0501 sown using medium seed rate and supplied with both the micronutrients ($V_1S_2M_4$) throughout (3.0, 33.1 and 39.2, at 45 and 90 DAS and at harvest respectively) while lower TDM was recorded with cvs. RNR 15048 and BPT 5204 with lower seed rate and no supplementation of any micronutrient ($V_{2\&3}S_1M_1$) (1.6 and 1.3, 14.7 and 18.7 and 18.8 and 21.4 with RNR 15048 and BPT 5204, at 45 and 90 DAS and at harvest respectively).

4.1.2.1.9 Spectral indices

4.1.2.1.9.1 SPAD values (leaf chlorophyll) (c.f. Table 91)

SPAD reading varied significantly due to use of micronutrients and interactions except $S \times M$ only at 45 DAS and no significant difference occurred due to any factor or combinations at 90DAS.

At 45 DAS, among micronutrient levels significantly higher SPAD values (34.7) were obtained with the application of both the micronutrients (M_4), while lower values (31.6) were recorded with M_1 receiving no application of any micronutrient. In the two way interactions, among variety X seed rate cv. BPT 5204 sown using 35 kg ha⁻¹ seed rate (V_1S_1) recorded higher SPAD value (35.3) and it was on par with $V_{1-3}S_{1-3}$, while lower SPAD value was recorded with cv. RNR 15048 irrespective of seed rates used particularly with lower seed rate of 25kg ha⁻¹ (V_2S_1) (30.9). Among variety X micronutrient cv. BPT 5204 provided with both the micronutrients (V_3M_4) recorded significantly higher SPAD value (34.7) while lower value (29.9) was observed with cv. RNR 15048 without application of any micronutrient (V_2M_1). There was no significant effect due to seed rate x micronutrient combination. On the whole, the three way interaction revealed significantly higher SPAD value (35.8) with cv. BPT 5204 sown using 30 kg ha⁻¹ seed rate and provided with $FeSO_4 + ZnSO_4$ ($V_3S_2M_2$) and was on par with ($V_{1-3}S_{2-3}M_{2-4}$), while lower SPAD value (29.1) was recorded with cv. RNR 15048 with 30 kg seed rate and no micronutrient application ($V_2S_2M_1$).

Table 91. Effect of genotypes, seed rates and micronutrients on SPAD value under direct seeded condition during summer season

V x S x M		45 DAS				90 DAS			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	30.6 ^{b-e}	30.2 ^{de}	31.9 ^{a-e}	30.9^a	28.0 ^a	29.3 ^a	28.9 ^a	28.7^a
	M ₂	31.3 ^{a-e}	30.4 ^{c-e}	33.1 ^{a-e}	31.6^a	32.2 ^a	31.8 ^a	32.1 ^a	32.0^a
	M ₃	33.0 ^{a-e}	31.7 ^{a-e}	33.3 ^{a-e}	32.7^a	33.0 ^a	31.1 ^a	30.2 ^a	31.4^a
	M ₄	32.9 ^{a-e}	31.2 ^{a-e}	33.1 ^{a-e}	32.4^a	33.1 ^a	32.1 ^a	30.9 ^a	32.0^a
S ₂	M ₁	33.1 ^{a-e}	29.1 ^e	32.0 ^{a-e}	31.4^a	29.0 ^a	28.8 ^a	28.5 ^a	28.8^a
	M ₂	34.0 ^{a-d}	32.2 ^{a-e}	32.4 ^{a-e}	32.9^a	34.4 ^a	31.6 ^a	28.5 ^a	31.5^a
	M ₃	34.9 ^{a-d}	35.1 ^{a-c}	30.5 ^{b-e}	33.5^a	34.3 ^a	35.4 ^a	30.3 ^a	33.3^a
	M ₄	33.1 ^{a-e}	31.5 ^{a-e}	35.8 ^a	33.5^a	33.5 ^a	33.2 ^a	30.7 ^a	32.5^a
S ₃	M ₁	32.8 ^{a-e}	30.5 ^{b-e}	34.2 ^{a-d}	32.5^a	28.5 ^a	29.5 ^a	29.4 ^a	29.1^a
	M ₂	33.2 ^{a-e}	33.0 ^{a-e}	32.5 ^{a-e}	32.9^a	32.4 ^a	33.7 ^a	31.4 ^a	32.5^a
	M ₃	31.9 ^{a-e}	33.1 ^{a-e}	33.8 ^{a-e}	32.9^a	33.9 ^a	32.3 ^a	30.0 ^a	32.1^a
	M ₄	32.4 ^{a-e}	32.3 ^{a-e}	35.3 ^{ab}	33.3^a	35.0 ^a	31 ^a	31.4 ^a	32.5^a
Variety		32.8^a	31.7^a	33.2^a		32.3^a	31.7^a	30.2^a	
		Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	32.0 ^{bc}	30.9 ^c	32.9 ^{a-c}	31.9 ^a	31.6 ^a	31.1 ^a	30.5 ^a	31.1 ^a
	S ₂	33.8 ^{ab}	32.0 ^{bc}	32.7 ^{a-c}	32.8 ^a	32.8 ^a	32.3 ^a	29.6 ^a	31.6 ^a
	S ₃	32.6 ^{a-c}	32.3 ^{bc}	35.3 ^a	33.4 ^a	32.4 ^a	31.6 ^a	30.5 ^a	31.5 ^a
		Variety x Micro			M	Variety x Micro			M
V	M ₁	32.2 ^{a-c}	29.9 ^c	32.7 ^{ab}	31.6 ^b	28.5 ^a	29.2 ^a	28.9 ^a	28.9 ^a
	M ₂	32.8 ^{ab}	31.9 ^{bc}	32.7 ^{ab}	32.5 ^{ab}	33.0 ^a	32.4 ^a	30.8 ^a	32.1 ^a
	M ₃	33.3 ^{ab}	33.3 ^{ab}	32.5 ^b	33.0 ^a	33.8 ^a	33.0 ^a	30.2 ^a	32.3 ^a
	M ₄	32.8 ^{ab}	31.7 ^{bc}	34.7 ^a	33.1 ^a	33.9 ^a	32.1 ^a	31.0 ^a	32.3 ^a
Comparison		S.Em±				S.Em±			
Variety (V)		1.0				0.6			
Seed (S)		0.5				0.7			
Micro (M)		0.5				1.2			
V x S		0.8				1.2			
V x M		0.8				2.1			
S x M		0.8				2.1			
V x S x M		1.4				3.7			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

At 90 DAS the values were marginally lower and the differences narrowed and different treatments were at parity. The values ranged from 28.0 with cv. GGV 0501 sown using lower seed rate and not supplied with any micronutrient ($V_1S_1M_1$) to 35.4 with RNR 15048 sown using medium seed rate and supplied with $ZnSO_4$ ($V_2S_2M_3$).

4.1.2.1.9.2 NDVI (Green seeker) readings (c.f. Table 92)

Green seeker reading varied significantly due to use of micronutrients and interactions except $S \times M$ only at 45 DAS and no significant differences occurred due to any factor or combinations except $V \times S$ at 90 DAS.

At 45 DAS, among micronutrient levels significantly higher Green seeker values (0.46) were obtained with the application of both $FeSO_4$ and $ZnSO_4$ (M_4), while lower values (0.42) were recorded with M_1 receiving no application of any micronutrient. In the two way interactions, among variety $\times$ seed rate cv. BPT 5204 sown using 30 kg ha⁻¹ seed rate (V_1S_1) recorded higher Green seeker value (0.47), while lower Green seeker value was recorded with cv. RNR 15048 with medium seed rate of 30 kg ha⁻¹ (V_2S_2) (0.38). Among variety $\times$ micronutrient cv. BPT 5204 provided with $FeSO_4$ (V_3M_2) recorded significantly higher Green seeker value (0.48) while lower value was observed with cv. RNR 15048 without application of any micronutrient (V_2M_1) or application of $ZnSO_4$ (V_2M_3) (0.38 each). There was no significant effect due to seed rate $\times$ micronutrient combination. On the whole, the three way interaction revealed significantly higher Green seeker value (0.54) with cv. BPT 5204 sown using 25 kg ha⁻¹ seed rate and provided with $FeSO_4$ ($V_3S_1M_2$), while lower Green seeker value (0.33) was recorded with cv. RNR 15048 with 30 kg seed rate and $ZnSO_4$ application ($V_2S_2M_3$).

At 90 DAS the values increased, ranged from 0.52 ($V_3S_1M_1$) to 0.70 ($V_2S_2M_3$) and the differences narrowed and different treatments were almost at parity except main effects due to micronutrients and $V \times S$ and $V \times M$ interactions. Among main effects due to micronutrients, supply of $ZnSO_4$ (M_3) resulted in higher Green seeker value (0.63) while lower Green seeker value (0.58) was observed with no application of micronutrients (M_1).

Among interactions, in $V \times S$, cv. GGV 0501 irrespective of seed rates recorded higher value particularly with S_1 and S_3 seed rate ($V_1S_{1\&3}$ —0.64 each) while lower Green

Table 92. Effect of genotypes, seed rates and micronutrients on NDVI (green seeker) reading under direct seeded condition during summer season

V x S x M		45 DAS				90 DAS			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	0.43 ^{a-d}	0.45 ^{a-d}	0.42 ^{a-d}	0.43^a	0.59 ^a	0.55 ^a	0.52 ^a	0.55^a
	M ₂	0.42 ^{a-d}	0.40 ^{a-d}	0.54 ^a	0.45^a	0.65 ^a	0.63 ^a	0.54 ^a	0.61^a
	M ₃	0.44 ^{a-d}	0.40 ^{a-d}	0.46 ^{a-d}	0.43^a	0.65 ^a	0.65 ^a	0.55 ^a	0.62^a
	M ₄	0.42 ^{a-d}	0.46 ^{a-d}	0.46 ^{a-d}	0.45^a	0.65 ^a	0.65 ^a	0.58 ^a	0.63^a
S ₂	M ₁	0.42 ^{a-d}	0.35 ^{cd}	0.47 ^{a-d}	0.41^a	0.59 ^a	0.60 ^a	0.58 ^a	0.59^a
	M ₂	0.46 ^{a-d}	0.48 ^{a-c}	0.47 ^{a-d}	0.47^a	0.63 ^a	0.65 ^a	0.56 ^a	0.61^a
	M ₃	0.43 ^{a-d}	0.33 ^d	0.45 ^{a-d}	0.40^a	0.62 ^a	0.70 ^a	0.61 ^a	0.64^a
	M ₄	0.50 ^{ab}	0.37 ^{b-d}	0.43 ^{a-d}	0.43^a	0.64 ^a	0.61 ^a	0.59 ^a	0.61^a
S ₃	M ₁	0.43 ^{a-d}	0.34 ^{cd}	0.43 ^{a-d}	0.40^a	0.59 ^a	0.61 ^a	0.55 ^a	0.58^a
	M ₂	0.48 ^{a-c}	0.48 ^{a-c}	0.44 ^{a-d}	0.47^a	0.65 ^a	0.69 ^a	0.63 ^a	0.66^a
	M ₃	0.43 ^{a-d}	0.40 ^{a-d}	0.46 ^{a-d}	0.43^a	0.67 ^a	0.69 ^a	0.62 ^a	0.66^a
	M ₄	0.44 ^{a-d}	0.37 ^{b-d}	0.42 ^{cd}	0.41^a	0.64 ^a	0.65 ^a	0.59 ^a	0.63^a
Variety		0.44^a	0.40^a	0.45^a		0.63^a	0.64^a	0.58^a	
		Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	0.43 ^{ab}	0.43 ^{ab}	0.47 ^a	0.44 ^a	0.64 ^a	0.62 ^{ab}	0.55 ^b	0.60^a
	S ₂	0.45 ^{ab}	0.38 ^b	0.42 ^{ab}	0.42 ^a	0.62 ^{ab}	0.64 ^a	0.58 ^{ab}	0.61 ^a
	S ₃	0.45 ^{ab}	0.40 ^{ab}	0.43 ^{ab}	0.43 ^a	0.64 ^a	0.66 ^a	0.60 ^{ab}	0.63 ^a
		Variety x Micro			M	Variety x Micro			M
V	M ₁	0.43 ^{ab}	0.38 ^{ab}	0.44 ^{ab}	0.42 ^b	0.59 ^{ab}	0.59 ^{ab}	0.56 ^b	0.58 ^c
	M ₂	0.45 ^{ab}	0.45 ^{ab}	0.48 ^a	0.46 ^a	0.64 ^{ab}	0.66 ^{ab}	0.58 ^{ab}	0.62 ^b
	M ₃	0.44 ^{ab}	0.38 ^b	0.45 ^{ab}	0.42 ^b	0.64 ^{ab}	0.68 ^a	0.59 ^{ab}	0.63 ^a
	M ₄	0.45 ^{ab}	0.40 ^b	0.44 ^{ab}	0.43 ^{ab}	0.64 ^{ab}	0.64 ^{ab}	0.58 ^{ab}	0.62 ^b
Comparison		S.E.m±				S.E.m±			
Variety (V)		0.02				0.02			
Seed (S)		0.01				0.02			
Micro (M)		0.01				0.02			
V x S		0.02				0.03			
V x M		0.02				0.03			
S x M		0.02				0.03			
V x S x M		0.04				0.05			

DAS – Days after sowing

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

seeker value (0.55) was observed with cv. BPT 5204 sown using 25 kg ha⁻¹ seed rate (V₃S₁), and among V x M, cvs. GVG 0501 and RNR 15048 irrespective of micronutrient levels were at par but among them RNR 15048 with FeSO₄ (V₂M₂) recorded higher Green seeker value (0.68), while lower value (0.56) was recorded with cv. BPT 5204 supplied with none of the micronutrients (V₃M₁).

4.1.2.1.10 Days to 50 per cent flowering (days) (c.f. Table 93)

Days to 50 per cent flowering due to cultivars, micronutrients and interactions revealed significant variations during summer.

Among the cultivars, BPT 5204 (V₃) took significantly more days to peak flowering (114.6) while cv. RNR 15048 (V₂) took lesser days (86.6) and GGV 0501 (V₁) was intermediate (96.4) and among levels of micronutrients, supply of both the nutrients (M₄ – FeSO₄ and ZnSO₄) took significantly more days for peak flowering (101.9); M₃ with ZnSO₄ was on par (100.9), while no supplementation of micronutrients (M₁) took fewer days (96.3).

Among the two-way interactions, irrespective of seed rates used cv. BPT 5204(V₃) took more days for peak flowering (113.2 to 114.4) while cv. RNR 15048 (V₃S₁₋₃) took fewer days (85.8 to 88.1); GGV 0501 was intermediate, among variety X micronutrient, again cv. BPT 5204 took more days to 50 % flowering particularly with supplementation of both FeSO₄ and ZnSO₄ (V₃M₄- 117.8); M₃ and M₂ within the cultivar were at par, while fewer days for peak flowering (83.5) was taken by cv. RNR 15048 when not supplied with any micronutrient (V₂M₁).

Of the V x S x M interactions cv. BPT 5204 irrespective of seed rate and micronutrient application particularly with V₃S₂M₄ took more days to 50% flowering (118.8), while fewer days to fifty percent flowering (82.6) was recorded with cv. RNR 15048 sown using 35 kg ha⁻¹ seed rate and not supplemented with micronutrients (V₂S₃M₁); rest of the treatment combinations fared in between.

4.1.2.1.11 Heat use efficiency (g GDD⁻¹) (c.f. Table 94 and Fig. 15a)

Heat use efficiency (HUE) varied significantly due to cultivars, seed rates and use of micronutrients and their interactions.

Among the varieties, cv. GGV 0501 (V₂) recorded significantly higher HUE (1.84) followed by cvs. RNR 15048 (V₂) and BPT 5204 (V₃) (1.65 and 1.31,

Table 93. Effect of genotypes, seed rates and micronutrients on 50 per cent flowering (days) under direct seeded condition during summer season

V x S x M		50 per cent flowering (days)			
		V ₁	V ₂	V ₃	S x M
S ₁	M ₁	94.6 ^{d-e}	83.3 ^{hi}	110.6 ^{ab}	96.2 ^d
	M ₂	95.2 ^{d-h}	86.9 ^{ei}	112.9 ^a	98.3 ^{a-c}
	M ₃	95.6 ^{d-g}	90.1 ^{d-i}	118.1 ^a	101.3 ^{b-d}
	M ₄	96.3 ^{c-g}	85.0 ^{f-i}	116.2 ^a	99.2 ^{a-c}
S ₂	M ₁	94.9 ^{d-h}	84.5 ^{g-i}	115.2 ^a	98.2 ^{a-c}
	M ₂	95.5 ^{d-g}	86.6 ^{e-i}	116.2 ^a	99.4 ^{a-c}
	M ₃	100.8 ^{b-d}	87.8 ^{e-i}	116.8 ^a	101.8 ^{ab}
	M ₄	101.6 ^{b-d}	93.4 ^{d-i}	118.8 ^a	104.6 ^a
S ₃	M ₁	93.7 ^{d-i}	82.6 ⁱ	107.3 ^{a-c}	94.5 ^{cd}
	M ₂	95.3 ^{d-h}	84.5 ^{g-i}	111.2 ^{ab}	97.0 ^{b-d}
	M ₃	96.9 ^{c-f}	87.8 ^{e-i}	116.8 ^a	100.5 ^{a-c}
	M ₄	97.3 ^{c-e}	90.0 ^{d-i}	118.4 ^a	101.9 ^{ab}
Variety		96.4 ^b	86.6 ^c	114.6 ^a	
	Variety x Seed rate				S
S	S ₁	95.4 ^b	86.3 ^c	114.4 ^a	98.7 ^a
	S ₂	98.2 ^b	88.1 ^c	116.7 ^a	101.0 ^a
	S ₃	95.8 ^b	85.8 ^c	113.2 ^a	98.3 ^a
	Variety x Micro				M
M ₄	M ₁	94.4 ^d	83.5 ^e	111.0 ^b	96.3 ^c
	M ₂	95.3 ^{cd}	86.0 ^e	113.4 ^a	98.2 ^{bc}
	M ₃	97.8 ^c	87.9 ^e	116.9 ^a	100.9 ^{ab}
	M ₄	98.4 ^c	89.5 ^{de}	117.8 ^a	101.9 ^a
Comparison		S.E.m±			
Variety (V)		2.4			
Seed (S)		1.1			
Micro (M)		1.2			
V x S		2.0			
V x M		2.0			
S x M		2.0			
V x S x M		3.5			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

respectively); among seed rates higher HUE (1.57) was recorded with medium seed rate of 30 kg ha⁻¹ (S₂); HUE decreased both with lower or higher seed rate (S₁ and S₃) and both were at par. Similarly, use of micronutrients produced significant variations individually and with combined application wherein the latter (M₄) *i.e.* combined application FeSO₄ and ZnSO₄ to soil and to the foliage resulted in higher HUE (1.76), while no application of micronutrient (M₁) recorded significantly lower HUE (1.42).

Interactions due to variety and seed rate were significant and among all cv. GGV 0501 at 30 kg ha⁻¹ seed rate (V₁S₂) recorded highest HUE (1.97); while lower HUE among all was recorded with cv. BPT 5204 irrespective of seed rates used particularly with higher seed rate of 35 kg ha⁻¹ (V₃S₃) (1.30). Variety X micronutrient again revealed significant variations, in that cv. GGV 0501 with combined application of FeSO₄ and ZnSO₄ (V₁M₄) rerecorded higher HUE (2.01). In the absence of micronutrient application HUE decreased irrespective of cultivars used and recorded lower HUE with cv. BPT 5204 (V₃M₁) (1.26). Similarly, interaction due to micronutrients and seed rates were significant wherein 30 kg seed rate with application of FeSO₄ + ZnSO₄ (S₂ M₄) recorded higher HUE (1.84) while 35 kg ha⁻¹ seed rate with no supplementation (S₃M₁) of or supplementation of both the micronutrients (S₃M₄) recorded lower HUE (1.38 each).

The three way interaction revealed significantly higher HUE (2.07) with cv. GGV 0501 sown with 30 kg seed rate and applied with both FeSO₄ and ZnSO₄ (V₂S₂M₄), while the lowest HUE (1.25) was recorded with cv. BPT 5204 sown using 25 kg ha⁻¹ seed rate and supplied with no micro nutrient (V₃S₁ M₁) among all.

4.1.2.2 Yield parameter

The data on yield components of rice *viz.*, number of tillers m⁻², productive tillers or panicles m⁻², productive tillers m⁻², panicle length (cm), filled grains per panicle, unfilled grains per panicle, total grains per panicle, sterility percentage, thousand-grain weight, grain yield, straw yield and harvest index as influenced by different treatments are presented here.

4.1.2.2.1 Unproductive tillers or panicles at harvest (no. m⁻²) (c.f. Table 95)

During summer, unproductive tillers count varied significantly due to cultivars, and seed rates and use of micronutrients and their interactions.

Table 94. Effect of genotypes, seed rates and micronutrients on heat use efficiency (g GDD⁻¹) under direct seeded condition during summer season

V x S x M		Heat use efficiency (g GDD ⁻¹)			
		V ₁	V ₂	V ₃	S x M
S ₁	M ₁	1.57 ^{e-l}	1.31 ^{kl}	1.25 ^l	1.38 ^f
	M ₂	1.62 ^{e-k}	1.49 ^{h-l}	1.32 ^{kl}	1.48 ^{ef}
	M ₃	1.87 ^{a-f}	1.71 ^{c-i}	1.33 ^{kl}	1.64 ^{b-e}
	M ₄	1.95 ^{c-i}	1.84 ^{a-g}	1.33 ^{kl}	1.71 ^{a-c}
S ₂	M ₁	1.72 ^{c-l}	1.56 ^{f-l}	1.27 ^l	1.52 ^{c-f}
	M ₂	1.99 ^{ab}	1.68 ^{d-j}	1.27 ^l	1.65 ^{b-e}
	M ₃	2.07 ^{ab}	1.81 ^{a-h}	1.33 ^{kl}	1.74 ^{ab}
	M ₄	2.09 ^a	2.02 ^{a-c}	1.40 ^{j-l}	1.84 ^a
S ₃	M ₁	1.51 ^{b-h}	1.36 ^{i-l}	1.26 ^l	1.38 ^f
	M ₂	1.74 ^{a-d}	1.49 ^{h-l}	1.27 ^l	1.50 ^{d-f}
	M ₃	1.96 ^{a-d}	1.74 ^{b-h}	1.31 ^{kl}	1.67 ^{a-d}
	M ₄	1.99 ^{a-d}	1.83 ^{a-g}	1.36 ^{j-l}	1.73 ^{ab}
Variety		1.84 ^a	1.65 ^b	1.31 ^c	1.84 ^a
Variety x Seed rate					S
S	S ₁	1.75 ^b	1.59 ^c	1.31 ^d	1.55 ^b
	S ₂	1.97 ^a	1.77 ^b	1.32 ^d	1.69 ^a
	S ₃	1.80 ^b	1.61 ^c	1.30 ^d	1.57 ^b
Variety x Micro					M
M4	M ₁	1.60 ^{de}	1.41 ^{fg}	1.26 ^g	1.42 ^c
	M ₂	1.78 ^{bc}	1.56 ^{ef}	1.29 ^g	1.54 ^b
	M ₃	1.7 ^{c-e}	1.76 ^{b-d}	1.32 ^g	1.59 ^b
	M ₄	2.01 ^a	1.90 ^{ab}	1.36 ^g	1.76 ^a
Comparison		S.E.m±			
Variety (V)		0.03			
Seed (S)		0.03			
Micro (M)		0.03			
V x S		0.04			
V x M		0.06			
S x M		0.06			
V x S x M		0.10			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Among the cultivars, significantly higher unproductive tillers were recorded with cvs. GGV 0501(V_1) and BPT 5204 (V_3) (30.4 and 29.2, respectively), while significantly lower unproductive tillers occurred with cv. RNR 15048 (25.0), among seed the rates, higher level of 35 kg ha⁻¹(S_3) recorded higher unproductive tillers (36.7) while lower seed rate of 25 kg ha⁻¹ (S_1) recorded lower number of unproductive tillers (20.7) and among micronutrients application FeSO₄+ ZnSO₄ to soil and to the foliage (M_4) recorded higher unproductive tillers, while significantly lower unproductive tillers (23.9) were recorded with sole application of FeSO₄ micronutrient (M_2).

Interactions due to variety and seed rate were significant and among all cv. GGV 0501 at 35 kg ha⁻¹seed rate (V_1S_3) recorded higher unproductive tillers with (43.5) and it was on par with V_1S_1 ; while the lower unproductive tillers among all was recorded with cvs. GGV 0501(V_1S_1)) and RNR 15048(V_2S_2) at 25 and 30 kg ha⁻¹ seed rate particularly with V_2S_2 (16.0), in variety X micronutrient cv. BPT 5204 with application of FeSO₄ + ZnSO₄ (V_3M_4) recorded higher unproductive tillers (37.0), which was on par with V_1M_{3-4} and V_1M_1 , while significantly lower unproductive tiller count (21.4) was recorded with cv. GGV 0501 supplied with FeSO₄ (V_1M_2), and among seed rate and micronutrients medium seed rate of 35 kg but without application of micronutrients (S_2M_1) recorded higher unproductive tiller count (53.3), while 25 and 30 kg ha⁻¹seed rates with supplementation of no micronutrient recorded lower unproductive tillers particularly with $S_2M_{1\&2}$ (15.5 and 17.8, respectively).

On the whole, three way interaction revealed significantly higher unproductive tillers with cv. GGV 0501 sown using 35 kg ha⁻¹seed rate but without application of micronutrient ($V_1S_3M_1$ -75.8) and 30 kg ha⁻¹seed rate with application of ZnSO₄ ($V_1S_2M_3$ - 75.1), while the lower unproductive tillers were recorded with cv. GGV 0501 at 25 kg ha⁻¹seed rate and application of ZnSO₄ ($V_1S_1 M_3$) (2.3).

4.1.2.2.2 Productive tillers or panicles at harvest (no. m⁻²) (c.f. Table 95 and Fig. 15b)

Variations in productive tillers/panicles due to cultivars, seed rates and use of micronutrients and their interactions during summer were significant.

Significantly higher panicles (328.2) were recorded with cv. GGV 0501 (V_1) followed by cvs. RNR 15048 and BPT 5204(282.2 and 263.1, respectively) among

cultivars, while higher panicles (307.5) among seed rates were recorded with medium seed rate of 30 kg ha⁻¹ (S₂) which was on par with S₃; panicles decreased (272.6) with lower seed rate (S₁), and among levels of application FeSO₄ + ZnSO₄ to soil and to the foliage resulted in higher panicles (337.6), while significantly lower count (247.8) was recorded in no application of micronutrient (M₁).

In the interaction due to variety and seed rate cv. GGV 0501 at 30 kg ha⁻¹ (V₁S₁) recorded highest (338.4) panicles m⁻² and which was on par with V₁S₂₋₃; while lower panicle count was recorded with cv. BPT 5204 irrespective of seed rates used particularly with lower seed rate of 25 kg ha⁻¹ (V₃S₁) (241.8), among variety X micronutrient cv. GGV 0501 with application of FeSO₄ + ZnSO₄ (V₁M₄) rerecorded higher panicles m⁻² (391.3), while without application of any micronutrient with cv. BPT 5204 (V₃M₁) lower count was recorded (224.4), and among seed rates and micronutrients medium seed rate of 30 kg ha⁻¹ with application of FeSO₄ + ZnSO₄ (S₂M₄) recorded higher panicle count (370.3) which was on par with S₃M₄, while 25 kg ha⁻¹ seed rate without supplementation of micronutrient (S₁M₁) recorded lower panicle number (241.2).

In the three way interaction, significantly higher panicle (411.5) were recorded with cv. GGV 0501 sown using 30 kg seed rate and applied with both FeSO₄ and ZnSO₄ (V₁S₂M₄) and V₁S₂₋₃M₃₋₄ were on par with it, while the lower count (202.7) was recorded with cv. RNR 15048 irrespective of seed rate and no micronutrient application (V₂S₁M₁).

4.1.2.2.3 Total tiller count at harvest (no. m⁻²) (c.f. Table 95)

Number of tillers m⁻² at harvest varied significantly due to cultivars, and seed rates and use of micronutrients and their interactions during summer season.

Among the cultivars, significantly higher number of tillers (350.3) was recorded with cv. GGV 0501 (V₁), while significantly lower number of tillers (292.3 and 307.3, respectively) were recorded with cvs. BPT 5204 and RNR 15048 and both were at par. Among seed rates, 30 (S₂) and 35 (S₃) kg ha⁻¹ recorded higher tiller count (307.5 and 293.4, respectively), while lower number of tillers (272.6) occurred with lower seed rate (S₁). Similarly, among levels of micronutrients, FeSO₄ + ZnSO₄ (M₄- 352.3) to soil and to the foliage and ZnSO₄ (M₃-332.0) resulted in higher number of tillers and both were at

Table 95. Effect of genotypes, seed rates and micronutrients on total number of tillers, productive tillers and unproductive tillers (m⁻²) under direct seeded condition during summer season

V x S x M		Number of tillers m ⁻²				Panicles or productive tillers m ⁻²				Unproductive tillers m ⁻²			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	311.7 ^{f-l}	217.5 ^m	249.5 ^{j-m}	259.6 ^f	297.9 ^{d-k}	202.7 ^m	223 ^{i-m}	241.2 ^f	13.7 ^{kl}	14.8 ^{kl}	26.3 ^{e-j}	18.3 ^f
	M ₂	241.7 ^{k-m}	229.3 ^{lm}	265 ^{i-m}	245.3 ^{ef}	329.2 ^{b-g}	217.3 ^{k-m}	234.7 ^{i-m}	260.4 ^{d-f}	12.5 ^{k-m}	12.0 ^{k-m}	30.3 ^{c-i}	18.3 ^f
	M ₃	350.7 ^{b-h}	287.5 ^{f-m}	271.7 ^{g-m}	303.3 ^{d-f}	348.4 ^{a-f}	256.3 ^{g-m}	250 ^{g-m}	284.9 ^{c-e}	2.3 ^m	31.2 ^{c-h}	21.7 ^{f-k}	18.4 ^f
	M ₄	415.0 ^{ab}	294.2 ^{f-m}	286.7 ^{f-m}	332.0 ^{b-d}	378.2 ^{a-d}	273.9 ^{f-l}	259.7 ^{g-m}	303.9 ^{b-d}	36.8 ^{c-e}	20.2 ^{h-l}	27.0 ^{e-j}	28.0 ^{de}
S ₂	M ₁	269.3 ^{h-m}	302.5 ^{f-l}	285.3 ^{f-m}	285.7 ^{ef}	259.1 ^{g-m}	287.5 ^{f-k}	264 ^{f-m}	270.2 ^{d-f}	10.2 ^{lm}	15.0 ^{kl}	21.3 ^{g-l}	15.5 ^f
	M ₂	316.8 ^{e-k}	306.7 ^{f-l}	297.5 ^{f-m}	307.0 ^{de}	305.7 ^{c-j}	292.0 ^{e-k}	269.8 ^{f-l}	289.2 ^{cd}	11.1 ^{k-m}	14.7 ^{kl}	27.7 ^{d-j}	17.8 ^f
	M ₃	396.3 ^{a-e}	314.2 ^{e-k}	314 ^{e-k}	341.5 ^{b-d}	321.2 ^{b-h}	299.7 ^{d-k}	280.3 ^{f-l}	300.4 ^{f-d}	75.1 ^a	14.5 ^{kl}	33.7 ^{c-e}	41.1 ^b
	M ₄	440.7 ^a	409.2 ^{a-c}	363.2 ^{a-f}	404.4 ^a	411.5 ^a	389.2 ^{ab}	310.1 ^{b-i}	370.3 ^a	29.2 ^{d-j}	19.9 ^{i-l}	53.2 ^b	34.1 ^c
S ₃	M ₁	319.2 ^{d-k}	318.3 ^{d-k}	218.0 ^m	285.2 ^{ef}	243.4 ^{h-m}	266 ^{f-m}	186.3 ^m	231.9 ^f	75.8 ^a	52.3 ^b	31.7 ^{c-g}	53.3 ^a
	M ₂	328.3 ^{d-j}	320.8 ^{d-k}	291.7 ^{f-m}	313.6 ^{c-e}	287.7 ^{f-k}	282.3 ^{f-l}	263.7 ^{f-m}	277.9 ^{de}	40.6 ^c	38.5 ^{cd}	27.9 ^{d-j}	35.7 ^{bc}
	M ₃	399.2 ^{a-d}	332.2 ^{c-j}	322.3 ^{d-k}	351.2 ^{bc}	372 ^{a-e}	299.3 ^{d-k}	303.7 ^{c-j}	325.0 ^{bc}	27.1 ^{e-j}	32.8 ^{c-f}	18.5 ^{j-l}	26.1 ^e
	M ₄	415 ^{ab}	355 ^{b-g}	342.1 ^{b-i}	370.7 ^{ab}	384.3 ^{a-c}	320.7 ^{b-h}	311.3 ^{b-i}	338.8 ^{ab}	30.7 ^{c-i}	34.3 ^{c-e}	30.8 ^{c-i}	31.9 ^{cd}
Variety		350.3 ^a	307.3 ^b	292.3 ^b		328.2 ^a	282.2 ^b	263.1 ^b		30.4 ^a	25.0 ^b	29.2 ^a	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	354.8 ^a	257.1 ^d	268.2 ^d	293.4 ^b	338.4 ^a	237.6 ^e	241.8 ^e	272.6 ^b	16.3 ^f	19.6 ^e	26.3 ^d	20.7 ^c
	S ₂	355.8 ^a	333.1 ^{ab}	315.1 ^{bc}	334.7 ^a	324.4 ^{ab}	317.1 ^{a-c}	281.1 ^{cd}	307.5 ^a	31.4 ^c	16.0 ^f	34 ^c	27.1 ^b
	S ₃	365.4 ^a	331.6 ^{a-c}	293.5 ^{cd}	330.2 ^a	321.9 ^{ab}	292.1 ^{b-d}	266.3 ^{de}	293.4 ^{ab}	43.5 ^a	39.5 ^b	27.2 ^d	36.7 ^a
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M ₄	M ₁	300.1 ^{c-e}	279.4 ^{ef}	250.9 ^f	276.8 ^c	266.8 ^{d-f}	252.1 ^{ef}	224.4 ^f	247.8 ^d	33.2 ^{ab}	27.4 ^{b-e}	26.4 ^{c-e}	29.0 ^a
	M ₂	328.9 ^{cd}	285.6 ^{c-f}	284.7 ^{d-f}	299.7 ^b	307.6 ^{b-d}	263.9 ^{d-f}	256.1 ^{ef}	275.9 ^c	21.4 ^e	21.7 ^e	28.7 ^{b-d}	23.9 ^b
	M ₃	382.1 ^b	311.3 ^{c-e}	302.6 ^{c-e}	332.0 ^a	347.2 ^b	285.1 ^{c-e}	278 ^{de}	303.4 ^b	34.8 ^{ab}	26.2 ^{c-e}	24.6 ^{de}	28.5 ^a
	M ₄	423.6 ^a	302.6 ^{c-e}	330.7 ^c	352.3 ^a	391.3 ^a	327.9 ^{bc}	293.7 ^{c-e}	337.6 ^a	32.2 ^{a-c}	24.8 ^{de}	37.0 ^a	31.3 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		9.5				9.5				0.6			
Seed (S)		6.9				6.7				0.6			
Micro (M)		8.1				8.1				1.1			
V x S		11.9				11.9				1.0			
V x M		14				14.1				1.9			
S x M		14				14.1				1.9			
V x S x M		24				24.4				3.3			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

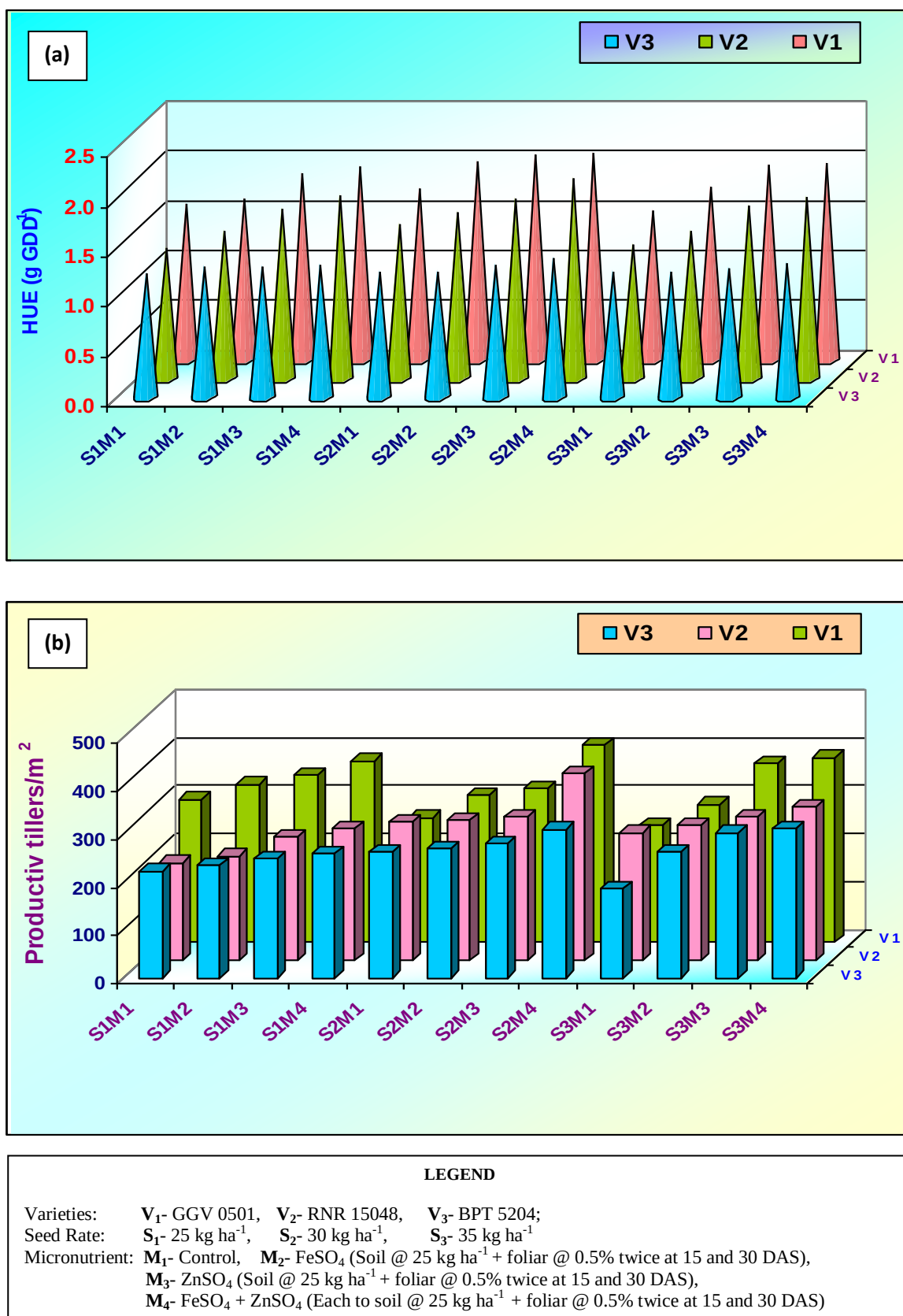


Fig. 15. Effect of genotypes, seed rates and micronutrients on (a) heat use efficiency (g GDD⁻¹) and (b) productive tillers or panicles m⁻² at harvest under direct seeded condition during summer season

par, while significantly lower number of tillers (279.6) was recorded with no application of micronutrient (M_1).

In the two way combinations, among variety and seed rate cv. GGV 0501 at all seed rates recorded highest number of tillers particularly with V_1S_3 (365.8) followed by V_1S_2 and they were on par with V_2S_{2-3} ; while lower number of tillers among all was recorded with cvs. BPT 5204 (V_1S_1) and RNR 15048 (V_2S_1) with 25 kg ha⁻¹ seed rate particularly with the latter (257.1). In variety X micronutrient cv. GGV 0501 (V_1M_4) with application of $FeSO_4 + ZnSO_4$ recorded higher number of tillers (423.6), while lower number of tillers (276.8) was recorded with cv. BPT 5204 (V_3M_1), and among seed rates and micronutrients 30 kg seed rate with application of $FeSO_4 + ZnSO_4$ (S_2M_4) recorded higher number of tillers (404.4) which was on par with S_3M_4 , while 25 kg ha⁻¹ seed rate without supplementation of micronutrient (S_1M_1) recorded lower number of tillers (259.5).

Higher number of tillers (440.7) among $V \times S \times M$ occurred with cv. GGV 0501 sown using 30 kg seed rate and applied with both $FeSO_4 + ZnSO_4$ ($V_2S_2M_4$) and which was on par with $V_1S_1M_4$, $V_{1-3}S_{2-3}M_{3-4}$; while the lower tiller count was recorded with cvs. RNR 15048 and BPT 5204 irrespective of seed rates and no micronutrient application ($V_2S_1M_1$ - 217.5 and $V_3S_2M_1$ - 218.0).

4.1.2.2.4 Panicle length (cm) (c.f. Table 97)

Variations in panicle length revealed significant differences due to cultivars and use of micronutrients and their interactions except main effects due to seed rate during summer season.

GGV 0501 (V_1) among the cultivars recorded significantly higher panicle length (26.4) followed by cvs. RNR 15048 and BPT 5204 (25.4 and 20.2 respectively). Similarly, application $FeSO_4 + ZnSO_4$ to soil and to the foliage (M_4) resulted in higher panicle length (25.0); M_3 receiving $ZnSO_4$ (24.5) only was at par, while significantly lower panicle length (23.0) was recorded with no application of micronutrient (M_1).

In variety X seed rate, cv. GGV 0501 at 30 kg ha⁻¹ seed rate (V_1S_2) recorded higher panicle length (26.9) and was on par with V_1S_{1-3} and V_2S_2 , while lower panicle length among all was recorded with cv. BPT 5204 irrespective of seed rates used

Table 96. Effect of genotypes, seed rates and micronutrients on filled, unfilled and total grains per panicle under direct seeded condition during summer season

V x S x M		Filled grains panicle ⁻¹				Unfilled grains panicle ⁻¹				Total grains panicle ⁻¹			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	83.9 ^{gh}	34.3 ⁿ	38.2 ^{mn}	52.1 ^e	11.6 ^{kl}	41.7 ^b	15.8 ^{jk}	23.0 ^{de}	95.5 ^{i-m}	76.0 ^{n-q}	53.9 ^r	75.1 ^f
	M ₂	111.4 ^{c-e}	56.7 ^{jk}	56.5 ^{jk}	74.9 ^d	10.0 ^{kl}	31.3 ^{d-g}	25.2 ^{f-i}	22.2 ^{d-f}	121.3 ^{c-g}	87.9 ^{l-o}	81.7 ^{l-p}	97.0 ^d
	M ₃	120.1 ^{bc}	105.9 ^{c-f}	46.6 ^{k-n}	90.9 ^c	8.9 ^{kl}	27.4 ^{e-i}	21.8 ^{h-j}	19.4 ^{ef}	129.0 ^{f-e}	133.3 ^{bc}	68.4 ^{p-r}	110.2 ^c
	M ₄	127.9 ^b	103.3 ^{d-f}	55.8 ^{jk}	95.7 ^{bc}	5.6 ^l	27.5 ^{e-i}	20.8 ^{i-j}	18.0 ^f	133.5 ^{bc}	130.9 ^{b-d}	76.6 ^{n-q}	113.7 ^{bc}
S ₂	M ₁	77.4 ^{hi}	55.1 ^{j-l}	56.0 ^{jk}	62.8 ^e	21.6 ^{h-j}	30.7 ^{d-g}	36.1 ^{f-d}	29.5 ^b	99.0 ^{h-l}	85.8 ^{l-p}	61.6 ^{q-r}	82.1 ^{ef}
	M ₂	102.1 ^{d-f}	79.6 ^{hi}	39.3 ^{l-n}	73.7 ^d	8.4 ^{kl}	29.5 ^{d-h}	33.1 ^{c-f}	23.7 ^{de}	110.5 ^{f-j}	109.1 ^{g-k}	72.4 ^{o-q}	97.3 ^d
	M ₃	117.7 ^{b-d}	84.8 ^{gh}	68.3 ^{ij}	90.3 ^c	10.3 ^{kl}	26.9 ^{e-i}	24.3 ^{g-i}	20.5 ^{d-f}	128.1 ^{b-f}	111.7 ^{e-i}	92.6 ^{k-n}	110.8 ^{bc}
	M ₄	151.5 ^a	118 ^{b-d}	98.2 ^{e-g}	122.6 ^a	5.5 ^l	24.9 ^{f-i}	31.5 ^{d-g}	20.6 ^{d-f}	156.9 ^a	143.0 ^{ab}	129.0 ^{b-e}	143.0 ^a
S ₃	M ₁	91.5 ^{f-h}	43.8 ^{k-n}	31.6 ⁿ	55.6 ^e	16.3 ^{jk}	36.3 ^{b-d}	52.9 ^a	35.2 ^a	107.7 ^{g-k}	80.1 ^{m-p}	84.5 ^{l-p}	90.8 ^{de}
	M ₂	101.5 ^{d-f}	58.5 ^{jk}	47.4 ^{k-n}	69.1 ^d	10.9 ^{kl}	34.4 ^{b-e}	40.9 ^{bc}	28.7 ^{bc}	112.5 ^{e-i}	92.9 ^{k-n}	88.3 ^{l-o}	97.9 ^d
	M ₃	102.9 ^{d-f}	53.9 ^{j-m}	65.9 ^{ij}	74.2 ^d	10.3 ^{kl}	36.0 ^{b-d}	28.1 ^{d-i}	24.8 ^{cd}	113.2 ^{d-h}	89.9 ^{l-o}	94.1 ^{j-n}	99.1 ^d
	M ₄	106.2 ^{c-f}	96.2 ^{e-g}	96.7 ^{e-g}	99.7 ^b	9.1 ^{kl}	25.6 ^{f-i}	26.0 ^{f-i}	20.2 ^{d-f}	115.3 ^{d-h}	121.8 ^{c-g}	122.7 ^{c-g}	119.9 ^b
Variety		107.8 ^a	74.2 ^b	58.4 ^c		10.7 ^b	31.0 ^a	29.7 ^a		118.5 ^a	105.2 ^b	85.5 ^c	
Variety x Seed rate		S				S				S			
S	S ₁	110.8 ^a	75.1 ^d	49.3 ^f	78.4 ^b	9.0 ^f	32.0 ^b	20.9 ^d	20.6 ^c	119.8 ^a	107.0 ^b	70.2 ^e	99.0 ^b
	S ₂	112.2 ^a	84.4 ^c	57.8 ^e	84.8 ^a	11.5 ^{ef}	28.0 ^c	31.2 ^b	23.6 ^b	123.6 ^a	112.4 ^b	89.1 ^d	108.4 ^a
	S ₃	100.5 ^b	63.1 ^e	60 ^e	74.5 ^c	11.7 ^e	33.1 ^b	37.0 ^a	27.3 ^a	112.2 ^b	96.2 ^c	97.4 ^c	101.9 ^b
Variety x Micro		M				M				M			
M ₄	M ₁	84.2 ^c	44.4 ^e	31.8 ^f	53.5 ^d	16.5 ^f	36.2 ^a	34.4 ^{ab}	29.2 ^a	100.7 ^e	80.7 ^f	66.7 ^g	82.7 ^d
	M ₂	105.0 ^b	64.9 ^d	47.7 ^e	72.5 ^c	9.80 ^g	31.7 ^{b-c}	33.1 ^{ac}	24.9 ^b	114.8 ^{cd}	96.6 ^e	80.8 ^f	97.4 ^c
	M ₃	113.6 ^b	81.5 ^c	60.3 ^d	85.1 ^b	9.80 ^g	30.1 ^{cd}	24.8 ^e	21.6 ^b	123.4 ^{bc}	111.6 ^d	85.0 ^f	106.7 ^b
	M ₄	128.5 ^a	105.9 ^b	83.6 ^c	106.0 ^a	6.70 ^g	26.0 ^{de}	26.1 ^{de}	19.6 ^c	135.2 ^a	131.9 ^{ab}	109.7 ^d	125.6 ^a
Comparison		S.E.m±				S.E.m±				S.E.m±			
Variety (V)		2.2				0.6				1.9			
Seed (S)		1.1				0.5				1.1			
Micro (M)		1.7				0.8				1.8			
V x S		2.0				0.8				1.9			
V x M		2.9				1.4				3.1			
S x M		2.9				1.4				3.1			
V x S x M		5.1				2.5				5.4			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 97. Effect of genotypes, seed rates and micronutrients on sterility percentage, panicle length and test weight under direct seeded condition during summer season

V x S x M		Sterility (%)				Panicle length (cm)				Test weight (g)			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	12.1 ^{l-o}	55.6 ^{bc}	40.6 ^{a-d}	36.1^{bc}	25.3 ^{a-e}	25.0 ^{b-e}	19.5 ^{gh}	23.3^{cd}	22.1 ^{a-f}	17.4 ^f	18.7 ^{c-f}	19.4^{ab}
	M ₂	8.3 ^{m-o}	36.2 ^{d-h}	31.2 ^{f-j}	25.2^{d-f}	25.5 ^{a-e}	25.2 ^{b-e}	19.9 ^{gh}	23.5^{b-d}	23.0 ^{a-f}	17.7 ^{ef}	19.5 ^{c-f}	20.1^{ab}
	M ₃	7.0 ^{no}	20.6 ⁱ⁻ⁿ	32.3 ^{e-i}	20.0^{e-g}	26.2 ^{a-d}	25.3 ^{a-e}	20.2 ^{gh}	23.9^{b-d}	23.4 ^{a-f}	18.5 ^{ef}	20.5 ^{c-f}	20.8^{ab}
	M ₄	4.3 ^o	21.3 ⁱ⁻ⁿ	27.4 ^{f-k}	17.7^g	26.6 ^{a-d}	25.7 ^{a-d}	20.2 ^{gh}	24.2^{b-d}	24.7 ^{a-e}	19.2 ^{c-f}	20.6 ^{b-f}	21.5^{ab}
S ₂	M ₁	21.9 ^{h-m}	36.2 ^{d-h}	86.8 ^a	48.3^a	25.2 ^{b-e}	24.0 ^{c-e}	19.8 ^{gh}	23.0^c	25.6 ^{a-d}	19.7 ^{c-f}	17.7 ^{ef}	21.0^{ab}
	M ₂	7.5 ^{m-o}	27.2 ^{f-k}	46.9 ^{cd}	27.2^{de}	25.7 ^{a-d}	25.2 ^{b-e}	20.5 ^{gh}	23.8^{ab}	25.7 ^{a-c}	20.3 ^{c-f}	18.6 ^{d-f}	21.5^{ab}
	M ₃	8.4 ^{m-o}	24.4 ^{g-l}	26.4 ^{f-l}	19.7^{e-g}	28.1 ^{ab}	27.0 ^{a-c}	20.5 ^{gh}	25.2^{ab}	27.5 ^{ab}	20.9 ^{a-f}	20.1 ^{c-f}	22.8^a
	M ₄	3.5 ^o	17.4 ^{j-o}	24.5 ^{g-l}	15.1^g	28.5 ^a	27.0 ^{a-c}	22.4 ^{e-g}	26.0^a	27.6 ^a	21.1 ^{a-f}	21.1 ^{a-f}	23.3^a
S ₃	M ₁	15.4 ^{k-o}	45.4 ^{c-e}	62.6 ^b	41.1^b	25.7 ^{a-d}	23.7 ^{d-f}	18.7 ^h	22.7^{b-d}	21.2 ^{a-f}	18.0 ^{ef}	16.9 ^f	18.7^b
	M ₂	9.9 ^{m-o}	37.6 ^{d-g}	46.4 ^{cd}	31.3^{cd}	26.0 ^{a-d}	25.4 ^{a-e}	19.3 ^{gh}	23.6^{a-d}	22.2 ^{a-f}	19.9 ^{c-f}	20.5 ^{c-f}	20.9^{ab}
	M ₃	9.4 ^{m-o}	40.3 ^{d-f}	30.0 ^{f-j}	26.6^{de}	26.7 ^{a-d}	25.8 ^{a-d}	20.9 ^{f-h}	24.5^{a-d}	23.7 ^{a-f}	19.6 ^{c-f}	21.1 ^{a-f}	21.5^{ab}
	M ₄	7.9 ^{m-o}	21.2 ⁱ⁻ⁿ	21.4 ⁱ⁻ⁿ	16.8^g	27.0 ^{a-c}	25.8 ^{a-d}	21.0 ^{f-h}	24.6^{a-c}	25.7 ^{a-c}	20.6 ^{b-f}	20.7 ^{a-f}	22.3^{ab}
Variety		9.6^c	32.0^b	39.7^a		26.4^a	25.4^a	20.2^b		24.4^a	19.4^b	19.7^b	
Variety x Seed rate		S				S				S			
S	S ₁	7.9 ^e	33.4 ^c	32.9 ^c	24.7 ^b	25.9 ^{ab}	25.3 ^b	19.9 ^c	23.7 ^a	23.3 ^b	18.2 ^c	19.8 ^c	20.4 ^b
	S ₂	10.3 ^e	26.3 ^d	36.1 ^{bc}	24.2 ^b	26.9 ^a	25.8 ^{a-b}	20.8 ^c	24.5 ^a	26.6 ^a	20.5 ^c	19.4 ^c	22.2 ^a
	S ₃	32.9 ^c	46.1 ^d	40.1 ^a	39.7 ^a	26.3 ^{ab}	25.2 ^b	20.0 ^c	23.8 ^a	23.2 ^b	19.5 ^c	19.8 ^c	20.8 ^b
Variety x Micro		M				M				M			
M ₄	M ₁	16.5 ^f	45.7 ^b	63.3 ^a	41.8 ^a	25.4 ^{bc}	24.2 ^c	19.3 ^e	23.0 ^{b-c}	23.0 ^{a-c}	18.4 ^d	17.8 ^d	19.7 ^b
	M ₂	8.6 ^g	33.7 ^c	41.5 ^b	27.9 ^b	25.7 ^{a-c}	25.3 ^{bc}	19.9 ^{de}	23.6 ^b	23.6 ^{ab}	19.3 ^{cd}	19.5 ^{cd}	20.8 ^b
	M ₃	8.3 ^g	28.4 ^{cd}	29.6 ^{cd}	22.1 ^c	27.0 ^{ab}	26.0 ^{ab}	20.5 ^{de}	24.5 ^a	24.9 ^a	19.7 ^{cd}	20.6 ^{b-d}	21.7 ^{ab}
	M ₄	5.2 ^g	19.9 ^{ef}	24.5 ^{de}	16.5 ^d	27.4 ^a	26.2 ^{ab}	21.5 ^d	25.0 ^a	26.0 ^a	20.3 ^{b-d}	20.8 ^{b-d}	22.4 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.7				0.6				0.5			
Seed (S)		1.0				0.2				0.4			
Micro (M)		1.4				0.3				0.7			
V x S		1.7				0.4				0.8			
V x M		2.5				0.6				1.2			
S x M		2.5				0.6				1.2			
V x S x M		4.3				0.9				2.0			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

particularly with lower seed rate of 25 kg ha⁻¹(V₃S₁) (19.9). Variety X micronutrient revealed that cv. GGV 0501 supplied with FeSO₄ + ZnSO₄ (V₂M₄) rerecorded higher panicle length (27.4) which was on par with V₁M₂₋₃ and V₂M₃₋₄, while without application of micronutrient panicle length decreased irrespective of cultivars used and recorded lower panicle length with cv. BPT 5204 (V₃M₁) (19.3). Similarly, among seed rate and micronutrients 30 kg seed rate with application of FeSO₄ + ZnSO₄ (S₂M₄) recorded higher panicle length (26.0), while 30 kg ha⁻¹ seed rate without supplementation of micronutrient (S₂M₁) recorded lower panicle length (23.0).

On the whole, the three way interaction revealed significantly higher panicle length (28.1) with cv. GGV 0501 sown with 30 kg seed rate and applied with both FeSO₄ and ZnSO₄ (V₁S₂M₄) which was on par with V₁₋₂S₁₋₂M₁₋₄, while lower panicle length was recorded with BPT 5204 irrespective of seed rates but without micronutrient application (V₃S₁₋₃ M₁₋₄) particularly with V₃S₃M₁ (18.7).

4.1.2.2.5 Unfilled grains per panicle (no.) (c.f. Table 96)

Unfilled grains per panicle varied significantly due to cultivars, seed rates and use of micronutrients and their interactions during summer season.

Among the cultivars, cvs. RNR 15048 (V₂) and .BPT 5204 (V₃) recorded significantly higher unfilled grains per panicle (31.0 and 29.7, respectively); while lower unfilled grains (10.7) were recorded with cv. GGV 0501, among seed rates higher seed rate of 35 kg ha⁻¹ (S₃) recorded significantly higher unfilled grains (27.3) while lower count (20.6) was recorded with lower seed rate of 25 kg ha⁻¹(S₁), and among micronutrient levels, significantly higher unfilled grains (29.2) were recorded when no supplementation of micronutrient was done (M₁), while lower count (19.6) was recorded with combined application of FeSO₄ and ZnSO₄(M₄).

Interactions due to variety and seed rates were significant, cv. BPT 5204 at 35 kg ha⁻¹ seed rate recorded higher unfilled grains (37.0), while cv. GGV 0501 with lower seed rate (V₁S₁) had lower unfilled grains (9.0), in variety x micronutrient cv. RNR 15048 and no application of micronutrient (V₂M₁) recorded significantly higher unfilled grains (36.2), while cv. GGV 0501 with micronutrient application individually and combined application of FeSO₄ + ZnSO₄ recorded lower unfilled grains particularly with V₁M₄ (6.7), and among seed rate x micronutrient levels irrespective of

seed rates no supplementation of micronutrient particularly with lower seed rate (S_3M_1) recorded significantly higher unfilled grains (35.2), while significantly lower unfilled grains (18.0) occurred with combined application of micronutrient (S_1M_4).

In $V \times S \times M$, significantly higher unfilled grains (52.9) were recorded with cv. BPT 5204 sown using 35 kg seed rate but with no application of micronutrients ($V_3S_3M_1$), while the lower unfilled grains (5.6) was recorded with cv. GGV 0501 sown using 25 kg ha⁻¹ seed rate and supplied both the micronutrient ($V_1S_1M_4$) among all.

4.1.2.2.6 Filled grains per panicle (no.) (c.f. Table 96 and Fig. 16a)

Data revealed significant differences in filled grains due to cultivars, seed rates and use of micronutrients and their interactions during summer season.

GGV 0501 (V_1) among the cultivars recorded significantly higher filled grains (107.8) followed by cv. RNR 15048 while lowest was in BPT 5204 (58.4), among seed rates higher filled grains (84.8) were recorded with medium seed rate of 30 kg ha⁻¹ (S_2) while filled grains were lower (74.5) with higher seed rate (S_3), and among micronutrients $FeSO_4 + ZnSO_4$ (M_4) to soil and to the foliage resulted in higher filled grains (106.0), while no application of micronutrient (M_1) recorded significantly lower filled grains (53.5).

In variety and seed rate cv. GGV 0501 at 30 and 25 kg ha⁻¹ seed rate (V_1S_{1-2}) recorded higher filled grains (112.2 and 110.8, respectively); while lower filled grains were recorded with cv. BPT 5204 irrespective of seed rates used particularly with lower seed rate of 25 kg ha⁻¹ (V_3S_1) (49.3), among variety X micronutrient cv. GGV 0501 with combined application of $FeSO_4$ and $ZnSO_4$ (V_1M_4) rerecorded higher filled grains (128.5); in the absence of micronutrient application filled grains decreased irrespective of cultivars used and recorded lower filled grains with cv. BPT 5204 (V_3M_1) (31.8), and among seed rate and micronutrient 30 kg seed rate with the application of $FeSO_4 + ZnSO_4$ (S_2M_4) recorded higher filled grains (122.6); while irrespective of seed rate no supplementation of micronutrient recorded lower filled grains particularly with S_1M_1 (52.1).

Significantly higher filled grains among the three way interactions were observed with cv. GGV 0501 sown with 30 kg ha⁻¹ seed rate and applied with both $FeSO_4$ and $ZnSO_4$ ($V_1S_2M_4$) (151.5), while the lower filled grains (34.3) was recorded with cv. RNR

15048 sown using 25 kg ha⁻¹ seed rate and no supplementation of micronutrient (V₂S₁M₁) among all.

4.1.2.2.7 Total grains per panicle (no.) (c.f. Table 96)

Variations in total grains per panicle were significant due to cultivars, seed rates and use of micronutrients and their interactions during summer season.

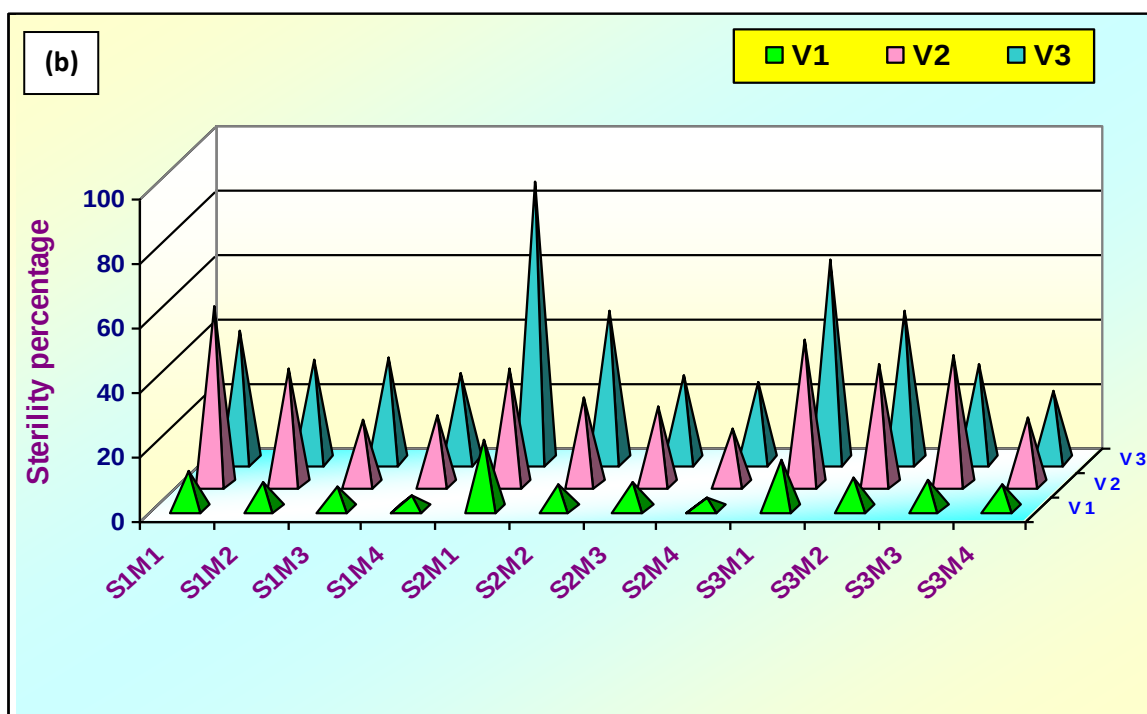
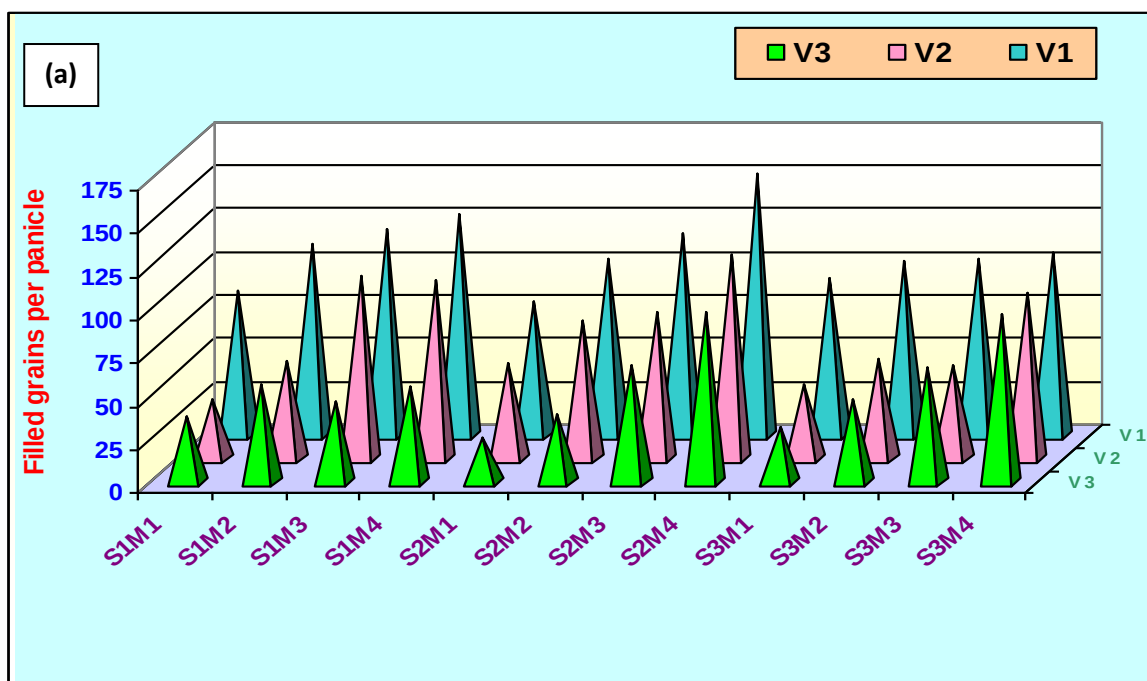
Among all cultivars, cv. GGV 0501(V₁) recorded significantly higher grains per panicle (118.5), while lower grains (85.5) were recorded with cv. BPT 5204 (V₃): among seed rates higher grains per panicle (108.4) was recorded with the seed rate of 30 kg ha⁻¹ (S₂); grains per panicle decreased with lower and higher seed rate (S₁ and S₃), and among micronutrient application, significantly higher grains (125.6) were recorded with combined supplement of micronutrient (M₄) and lower total grain number (82.7) was recorded with no application of micronutrient (M₁).

In variety and seed rate combination, cvs. GGV 0501(V₁) at 30 and 25 kg ha⁻¹ recorded significantly higher total grains (123.6 and 119.8, respectively), while, cv. BPT 5204 (V₃) with lower seed rate (S₁) recorded significantly lower grains (70.2), among variety x micronutrient combined application of micronutrient recorded significantly higher grains irrespective of cultivars particularly with V₁M₄ (135.2) which was on par with V₂M₄, while no supplementation of micronutrient recorded lower grains in all the cultivars (V₁₋₃M₁) particularly with V₃M₁ (66.7), and among seed rate x micronutrient medium seed rate supplemented with both the micronutrients (S₂M₄) recorded significantly higher grains (143.2) while significantly lower number of total grains were recorded (75.1) with lower seed rate and no application of micronutrient (S₁M₁).

GGV 0510 sown using 30 kg seed rate and applied with both FeSO₄ and ZnSO₄ (V₁S₂M₄) recorded significantly higher total grain number (156.9), while the lower count of grains (53.9) was recorded with cv. BPT 5204 sown using 25 kg ha⁻¹ seed rate and supplied with no micronutrient (V₃S₁M₁) among all.

4.1.2.2.8 Sterility percentage (%) (c.f. Table 97 and Fig. 16b)

Sterility percentage varied significantly due to cultivars, and use of micronutrients and their interactions except main effects due to seed rates during summer season.



LEGEND

Varieties: V₁- GGV 0501, V₂- RNR 15048, V₃- BPT 5204;
 Seed Rate: S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
 Micronutrient: M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₄- FeSO₄ + ZnSO₄ (Each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

Fig. 16. Effect of genotypes, seed rates and micronutrients on (a) filled grains per panicles and (b) sterility percentage at harvest under direct seeded condition during summer season

Among all cultivars, cv. BPT 5204 (V_3) recorded significantly higher sterility percentage (39.7), while lower sterility percentage (9.6) was recorded with cv. GGV 0501(V_1), among the seed rates higher seed rate (S_3) recorded significantly higher sterility percentage (39.7) while seed rates of 25 and 30 kg ha⁻¹ recorded lower sterility percentages (24.2 and 24.7, respectively), and among micronutrient application, significantly higher sterility percentage (41.8) was recorded with no supplementation of micronutrient (M_1) while and lower spikelet sterility (16.5) was recorded with combined application of FeSO₄ and ZnSO₄ (M_4).

Interactions due to variety and seed rates were significant wherein cv. BPT 5204 when sown with 35 kg ha⁻¹ recorded higher sterility percentage (40.1), while lower sterility percentages (7.9 and 10.3, respectively) were recorded with cv. GGV 0501 at seed rates of 25 and 30 kg ha⁻¹ (V_1S_{1-2}), among variety x micronutrient interaction cv. BPT 5204 with no application of micronutrient (V_3M_1) recorded significantly higher sterility percentage (63.3), while cv. GGV 0501 whether or not supplied with micronutrient and more so with combined application of FeSO₄ and ZnSO₄ recorded lower sterility percentage (5.2), and among seed rate x micronutrient levels irrespective of seed rate no supply of micronutrient and particularly S_2M_1 recorded significantly higher sterility percentage (48.3), while lower sterility percentage recorded with combined application of micronutrient irrespective of seed rates ($S_{1-3}M_4$) and particularly in S_2M_4 (15.1).

In all, V x S x M interactions revealed significantly higher sterility percentage (86.8) with cv. BPT 5204 sown with 30 kg seed rate and without application of micronutrients $V_3S_2M_1$, while lower sterility percentage was recorded with cv. GGV 0501 sown using 25 and 30 kg ha⁻¹ seed rates and supplied with both the micronutrients ($V_1S_{1-2}M_4$) among all combinations.

4.1.2.2.9 Test weight (1000-grain weight) (g) (c.f. Table 97)

Among the varieties, cv. GGV 0501 (V_1) recorded significantly higher test weight followed by cvs. BPT 5204 (V_3) and RNR 15048 (V_2) (24.4, 19.7 and 19.4, respectively); among seed rates higher test weight (22.2) was recorded with the seed rate of 30 kg ha⁻¹ and it decreased with both higher and lower seed rates which were on par with each other. Similarly, use of micronutrients had revealed significant variations individually and with combined application wherein the latter (M_4) i.e. combined

application $\text{FeSO}_4 + \text{ZnSO}_4$ to soil and to the foliage resulted in higher test weight (22.4); M_3 was on par, while no application of micronutrient (M_1) recorded significantly lower test weight (19.7).

Interactions due to variety and seed rate were significant and among all cv. GGV 0501 sown with 30 kg ha^{-1} seed rate (V_1S_2) recorded higher test weight (26.6); cv. RNR 15048 and BPT 5204 were at par and recorded lower test weight irrespective of seed rates used particularly the former cultivar with lower seed rate of 25 kg ha^{-1} (V_3S_1) (18.2). Variety X micronutrient again revealed significant variations, in that cv. GGV 0501 with combined application of FeSO_4 and ZnSO_4 (V_1M_4) rerecorded higher test weight (26.0) and it was at par with V_1M_{2-3} , while cv. BPT 5204 not supplied with any micronutrient (V_3M_1) revealed lower test weight (17.8). Similarly, interactions due to micronutrients and seed rates were significant wherein 30 kg seed rate with the application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) and ZnSO_4 (S_2M_3) were on par and recorded higher test weight (23.3 and 22.8, respectively), while 35 kg ha^{-1} seed rate with no supplementation of micronutrient (S_3M_1) recorded lower test weight (18.7).

Significantly higher test weight (27.6) among $V \times S \times M$ combinations was recorded with cv. GGV 0501 sown using 30 kg seed rate and supplied with both FeSO_4 and ZnSO_4 ($V_2S_2M_4$), while lower test weight was recorded with cvs. BPT 5204 and RNR 15048 sown using 35 and 25 kg ha^{-1} seed rate, respectively and supplied with no micronutrient (16.9 and 17.4, respectively with $V_3S_3M_1$ and $V_2S_1M_1$) among all.

4.2.2.2.10 Grain yield (g plant^{-1}) (c.f. Table 98)

During summer grain weight varied significantly due to cultivars, seed rates and use of micronutrients and their interactions.

GGV 0501 (V_1) among cultivars recorded significantly higher grain weight followed by cvs. RNR 15048 (V_2) and BPT 5204 (V_3) (32.7, 29.4 and 28.9, respectively); among seed rates higher grain weight (32.0) was recorded with medium seed rate of 30 kg ha^{-1} (S_2) and S_3 was on par with it; while lower grain weight (28.9) was recorded with lower seed rate (S_1). Similarly, use of micronutrients produced significant variations individually and with combined application wherein the latter (M_4) resulted in higher yield (34.3), while no application of micronutrient (M_1) recorded significantly lower yield (26.0).

Table 98. Effect of genotypes, seed rates and micronutrients on grain weight (g plant⁻¹) under direct seeded condition during summer season

V x S x M		Grain weight plant ⁻¹ (g)			
		V ₁	V ₂	V ₃	S x M
S ₁	M ₁	26.3 ^{g-k}	19.9 ^k	25.4 ^{h-k}	23.9 ^f
	M ₂	31.7 ^{c-i}	26.6 ^{g-j}	28.6 ^{d-j}	29.0 ^{de}
	M ₃	32.4 ^{c-h}	27.3 ^{f-j}	29.1 ^{d-j}	29.6 ^{c-e}
	M ₄	35.6 ^{a-d}	33.7 ^{a-f}	30.1 ^{c-j}	33.1 ^{a-c}
S ₂	M ₁	28.7 ^{d-j}	25.1 ^{i-k}	29.0 ^{d-j}	27.6 ^e
	M ₂	31.1 ^{c-j}	26.7 ^{f-j}	29.5 ^{c-j}	30.1 ^{c-e}
	M ₃	39.3 ^{ab}	32.9 ^{b-g}	31.4 ^{c-j}	34.5 ^{ab}
	M ₄	40.0 ^a	35.6 ^{a-d}	32.3 ^{c-h}	36.0 ^a
S ₃	M ₁	28.0 ^{e-j}	27.3 ^{f-j}	24.5 ^{jk}	26.6 ^{ef}
	M ₂	31.3 ^{c-j}	30.4 ^{c-j}	24.9 ^{i-k}	28.8 ^{de}
	M ₃	31.4 ^{c-j}	32.2 ^{c-h}	30.7 ^{c-j}	31.4 ^{b-d}
	M ₄	36.4 ^{a-c}	34.5 ^{a-e}	31.0 ^{c-j}	33.9 ^{ab}
Variety		32.7 ^a	29.4 ^b	28.9 ^b	
Variety x Seed rate					S
S	S ₁	31.5 ^b	26.9 ^c	28.3 ^{bc}	28.9 ^b
	S ₂	35.5 ^a	30.1 ^{bc}	30.5 ^{bc}	32.0 ^a
	S ₃	31.8 ^b	31.1 ^b	27.8 ^{bc}	30.2 ^{ab}
Variety x Micro					M
M ₄	M ₁	27.7 ^{e-g}	24.1 ^g	26.3 ^{fg}	26.0 ^d
	M ₂	32.4 ^{b-d}	27.9 ^{ef}	27.7 ^{e-g}	29.3 ^c
	M ₃	34.4 ^{a-c}	30.8 ^{c-e}	30.4 ^{de}	31.9 ^b
	M ₄	37.3 ^a	34.6 ^{ab}	31.1 ^{b-e}	34.3 ^a
Comparison		S.E.m±			
Variety (V)		0.6			
Seed (S)		0.7			
Micro (M)		0.7			
V x S		1.2			
V x M		1.2			
S x M		1.2			
V x S x M		2.0			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)
M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Again cv. GGV 0501 with 30 kg ha⁻¹ seed rate (V₁S₂) recorded higher yield (35.5); while lower seed yield among all was recorded with cv. RNR 15048 irrespective of seed rates used particularly with lower seed rate of 25 kg ha⁻¹ (V₂S₁) (26.9). Variety X micronutrient revealed higher yield per plant (37.4) with cv. GGV 0501 + combined application of FeSO₄ and ZnSO₄ (V₁M₄); V₂M₄ was at par, in the absence of micronutrient application yield decreased across cultivars and recorded lower grain weight (24.1) with cv. RNR 15048 (V₂M₁). Similarly, among seed rate X micronutrients 30 kg seed rate with the application of FeSO₄ + ZnSO₄ (S₂ M₄) recorded higher grain weight (36.0) and S₂₋₃M₃₋₄ were on par with it, while 25 ha⁻¹ seed rate without supplementation of micronutrient S₁M₁ recorded lower grain weight (23.9).

Overall, the three way interaction revealed significantly higher yield (40.0) with cv. GGV 0501 sown with 30 kg seed rate and applied with both FeSO₄ + ZnSO₄ (V₁S₂M₄), closely followed by V₁₋₃S₂₋₃M₃₋₄, while lower grain weight (19.9) was recorded with cv. RNR 15048 sown using 25 kg ha⁻¹ seed rate and supplied with no micronutrient (V₂S₁ M₁) among all.

4.1.2.2.11 Grain yield (kg ha⁻¹) (c.f. Table 99 and Fig. 17a)

Grain yield varied significantly due to cultivars, seed rates and use of micronutrients and their interactions during summer season.

Among the varieties, cv. GGV 0501 (V₁) recorded significantly higher grain yield (5524) followed by cvs. RNR 15048 (V₂) and BPT 5204 (V₃) (4429 and 4270, respectively), among seed rates higher grain yield (4984) was recorded with medium seed rate of 30 kg ha⁻¹ (S₂); yield decreased both with lower or higher seed rate (S₁ and S₃) and both were at par, and among levels of micronutrient M₄ receiving both FeSO₄ and ZnSO₄ resulted in higher grain yield (5185); M₃ receiving ZnSO₄ only was at par, while no application of micronutrient supply (M₁) recorded significantly lower yield (4234).

Interactions due to variety and seed rate were significant and among them cv. GGV 0501 sown using 30 kg ha⁻¹ seed rate (V₁S₂) recorded higher yield (5912), while lower grain yield among all was recorded with cv. BPT 5204 irrespective of seed rates used particularly with higher seed rate of 35 kg ha⁻¹ (V₃S₃) (4245). Variety X micronutrient also revealed significant variations, in that cv. GGV 0501 with combined

application of FeSO_4 and ZnSO_4 (V_1M_4) recorded higher grain yield (6029) and in the absence of micronutrient application yield decreased irrespective of cultivars used and recorded lower yield with cv. RNR 15048 (V_2M_1) (3779). Similarly, interactions due to micronutrients and seed rates were significant wherein 30 kg seed rate with the application of $\text{FeSO}_4 + \text{ZnSO}_4$ ($S_2 M_4$) recorded higher grain yield (5419) while 25 and 35 kg ha^{-1} seed rate without supplementation of micronutrient ($S_{1\&3}M_1$) recorded lower grain yield (4108 and 4095, respectively).

The three factor combination revealed significantly higher yield (6277) with cv. GGV 0501 sown using 30 kg seed rate and supplied with both FeSO_4 and ZnSO_4 ($V_1S_2M_4$), closely followed by $V_1S_2M_3$ (6215), while the lowest grain yield (3513) was recorded with cv. RNR 15048 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient ($V_2S_1 M_1$) among all.

4.1.2.2.12 Straw yield (kg ha^{-1}) (c.f. Table 99 and Fig. 17b)

Straw yield more or less followed trends in grain yield and revealed significant differences due to cultivars, seed rates and use of micronutrients and their interactions during summer season.

Cv. GGV 0501 (V_1) among the varieties recorded significantly higher straw yield (6409) followed by cvs. RNR 15048 (V_2) and BPT 5204 (V_3) (6269 and 5767, respectively); among seed rates higher straw yield (6301) was recorded with medium seed rate of 30 kg ha^{-1} (S_2) which was on par with S_3 , while significantly lower straw yield (5938) was recorded with lower seed rate of 25 kg ha^{-1} (S_1), and among levels of micronutrients M_4 with combined application FeSO_4 and ZnSO_4 to soil and to the foliage resulted in higher straw yield (7164), while no application of micronutrient (M_1) recorded significantly lower yield (5203).

Cv. GGV 0501 at 30 kg ha^{-1} seed rate (V_1S_2) among variety and seed rate recorded significantly higher yield (7351), while lower straw yield (5645) was recorded with cv. BPT 5204 with seed rate of 30 kg ha^{-1} (V_3S_2), among variety X micronutrient cv. GGV 0501 with combined application of FeSO_4 and ZnSO_4 (V_1M_4) recorded higher straw yield (7373), while lower yield (4614) was recorded with cv. BPT 5204 with no micronutrients supply (V_3M_1), and among combinations of seed rates and micronutrients medium seed rate of 30 kg ha^{-1} combined with $\text{FeSO}_4 + \text{ZnSO}_4$ to soil and to the foliage

(S₂M₄) resulted in higher straw yield (7631), while 25 kg ha⁻¹ seed rate with no supplementation of micronutrient (S₁M₁) recorded lower straw yield (5219).

Among variety X seed rate X micronutrient, significantly higher straw yield (8241) was recorded with cv. GV 0501 sown using medium seed rate 30 kg seed rate and supplied with both FeSO₄ and ZnSO₄ (V₁S₂M₄), while lower straw yield (4131) was recorded with cv. BPT 5204 sown using 35 kg ha⁻¹ seed rate and supplied with no micronutrient (V₃S₃M₁) among all.

4.1.2.2.13 Harvest index (c.f. Table 99)

Harvest index (HI) varied significantly due to cultivars, micronutrients and their interaction except seed rates during summer season. Among the cultivars, cv. GGV 0501 (V₁) recorded significantly higher HI (0.46), while the other two cultivars were at par (V₂- 0.41 and V₃- 0.42). Similarly, use of micronutrients produced significant variations individually and no application of micronutrient (M₁) recorded significantly higher HI (0.45) and was on par with application of FeSO₄ to soil and to the foliage, while significantly lower (0.41) HI was recorded in combined application of FeSO₄ + ZnSO₄.

Interactions due to variety and seed rate were significant. GGV 0501 at 25 kg ha⁻¹ seed rate (V₁S₁) recorded higher HI (0.48) which was on par with V₁S₃, while lower (0.39) HI was recorded with cv. RNR 15048 with seed rate of 35 kg ha⁻¹ (V₂S₁). Variety X micronutrient also revealed significant variations, in that cv. GGV 0501 with all levels of micronutrients and cv. BPT 5204 without application of micronutrient recorded higher HI (0.47). Combined application FeSO₄ + ZnSO₄ to soil and to the foliage in cv. BPT 5204 (V₃M₁) recorded lower HI (0.39). Similarly, interactions due to micronutrients and seed rates were significant wherein 30 kg seed rate with without any micronutrient (S₂M₁) recorded higher HI (0.46), while S₂M₄ with 30 kg ha⁻¹ seed rate and FeSO₄ + ZnSO₄ (S₂M₄) recorded lower HI (0.41).

Of the three way interactions, significantly higher HI (0.50) was observed with cv. BPT 5204 sown with 35 kg seed rate without application of micronutrients (V₃S₃M₁), while lower harvest index (0.36) was recorded with cv. RNR 15048 sown using 35 kg ha⁻¹ seed rate and supplied with FeSO₄ micronutrient (V₂S₃M₂) among all.

Table 99. Effect of genotypes, seed rates and micronutrients on grain yield, straw yield and harvest index under direct seeded condition during summer season

V x S x M		Grain yield (kg ha ⁻¹)				Straw yield (kg ha ⁻¹)				Harvest index			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	4714 ^{d-h}	3513 ^j	4095 ^{h-j}	4107^e	4909 ^{n-p}	5692 ⁱ⁻ⁿ	5055 ^{l-p}	5219^h	0.49 ^{ab}	0.38 ^{gh}	0.45 ^{a-f}	0.44^{a-c}
	M ₂	4857 ^{d-h}	3989 ^{h-j}	4295 ^{f-j}	4380^{de}	5580 ^{j-n}	5908 ^{h-m}	5578 ^{j-n}	5687^{eg}	0.47 ^{ab}	0.40 ^{e-h}	0.43 ^{b-g}	0.44^{a-c}
	M ₃	5626 ^{a-d}	4578 ^{e-i}	4327 ^{f-j}	4844^{b-d}	6026 ^{f-k}	6090 ^{e-k}	6107 ^{e-k}	6074^{de}	0.49 ^{ab}	0.43 ^{b-g}	0.42 ^{c-h}	0.44^{a-c}
	M ₄	5843 ^{a-c}	4924 ^{c-h}	4337 ^{f-j}	5035^{ab}	6681 ^{b-h}	7085 ^{f-d}	6550 ^{b-i}	6772^{bc}	0.47 ^{a-d}	0.41 ^{d-h}	0.40 ^{e-h}	0.43^{a-c}
S ₂	M ₁	5173 ^{f-g}	4184 ^{g-h}	4140 ^{h-j}	4499^{c-e}	7043 ^{b-e}	4273 ^p	4656 ^{op}	5324^{f-h}	0.42 ^{c-h}	0.49 ^{ab}	0.47 ^{a-d}	0.46^a
	M ₂	5981 ^{ab}	4507 ^{e-j}	4152 ^{h-j}	4880^{b-d}	7031 ^{b-e}	5008 ^{m-p}	5270 ^p	5770^{ef}	0.46 ^{a-e}	0.47 ^{a-d}	0.44 ^{a-g}	0.46^a
	M ₃	6215 ^a	4858 ^{d-h}	4337 ^{f-j}	5137^{ab}	7089 ^{b-d}	6941 ^{b-f}	5409 ^{k-o}	6480^{cd}	0.47 ^{a-d}	0.41 ^{d-h}	0.44 ^{a-g}	0.44^{a-c}
	M ₄	6277 ^a	5400 ^{a-e}	4580 ^{e-i}	5419^a	8241 ^a	7407 ^b	7246 ^{bc}	7631^a	0.43 ^{b-g}	0.42 ^{c-h}	0.39 ^{f-h}	0.41^c
S ₃	M ₁	4519 ^{e-i}	3639 ^{ij}	4127 ^{h-j}	4095^e	4634 ^p	6434 ^{c-j}	4131 ^p	5066^h	0.494 ^{ab}	0.36 ^h	0.50 ^a	0.45^{ab}
	M ₂	5237 ^{b-f}	3993 ^{h-j}	4147 ^{h-j}	4459^{c-e}	5678 ⁱ⁻ⁿ	6444 ^{c-j}	5974 ^{g-l}	6032^{de}	0.48 ^{a-c}	0.38 ^{gh}	0.41 ^{d-h}	0.42^{bc}
	M ₃	5880 ^{ab}	4659 ^{d-h}	4270 ^{f-j}	4936^{a-c}	6802 ^{b-h}	6742 ^{b-h}	6350 ^{c-k}	6631^{bc}	0.46 ^{a-e}	0.41 ^{d-h}	0.40 ^{e-h}	0.42^{bc}
	M ₄	5966 ^{ab}	4899 ^{d-h}	4435 ^{e-j}	5100^{ab}	7197 ^{bc}	7198 ^{d-k}	6874 ^{b-g}	7090^b	0.45 ^{a-f}	0.40 ^{e-h}	0.39 ^{f-h}	0.42^{bc}
Variety		5524 ^a	4429 ^b	4270 ^b		6409 ^a	6269 ^a	5767 ^b		0.46 ^a	0.41 ^b	0.42 ^b	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	5260 ^b	4252 ^d	4264 ^d	4592 ^b	5799 ^{cd}	6193 ^c	5823 ^{cd}	5938 ^b	0.48 ^a	0.41 ^{de}	0.42 ^{cd}	0.43 ^a
	S ₂	5912 ^a	4737 ^c	4302 ^d	4984 ^a	7351 ^a	5907 ^{cd}	5645 ^d	6301 ^a	0.45 ^{bc}	0.45 ^{bc}	0.44 ^c	0.44 ^a
	S ₃	5401 ^b	4298 ^d	4245 ^d	4648 ^b	6078 ^{cd}	6705 ^b	5832 ^{cd}	6205 ^{ab}	0.47 ^{ab}	0.39 ^e	0.44 ^{cd}	0.43 ^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M ₄	M ₁	4802 ^{cd}	3779 ^g	4121 ^{fg}	4234 ^c	5528 ^e	5466 ^e	4614 ^f	5203 ^d	0.47 ^a	0.41 ^{cd}	0.47 ^a	0.45 ^a
	M ₂	5358 ^b	4163 ^{fg}	4198 ^{eg}	4573 ^b	6096 ^d	5785 ^{de}	5608 ^{dc}	5830 ^c	0.47 ^a	0.42 ^{b-d}	0.43 ^{bc}	0.44 ^{ab}
	M ₃	5907 ^{ab}	4699 ^{c-e}	4311 ^{d-f}	4972 ^{ab}	6639 ^c	6591 ^c	5956 ^{dc}	6395 ^b	0.47 ^a	0.42 ^{b-d}	0.42 ^d	0.43 ^b
	M ₄	6029 ^a	5074 ^{bc}	4451 ^{d-f}	5185 ^a	7373 ^a	7230 ^{ab}	6890 ^{bc}	7164 ^a	0.47 ^a	0.41 ^{cd}	0.39 ^d	0.41 ^c
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		104				109				0.010			
Seed (S)		73				87				0.011			
Micro (M)		96				94				0.009			
V x S		126				152				0.019			
V x M		167				164				0.015			
S x M		167				164				0.015			
V x S x M		290				284				0.026			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

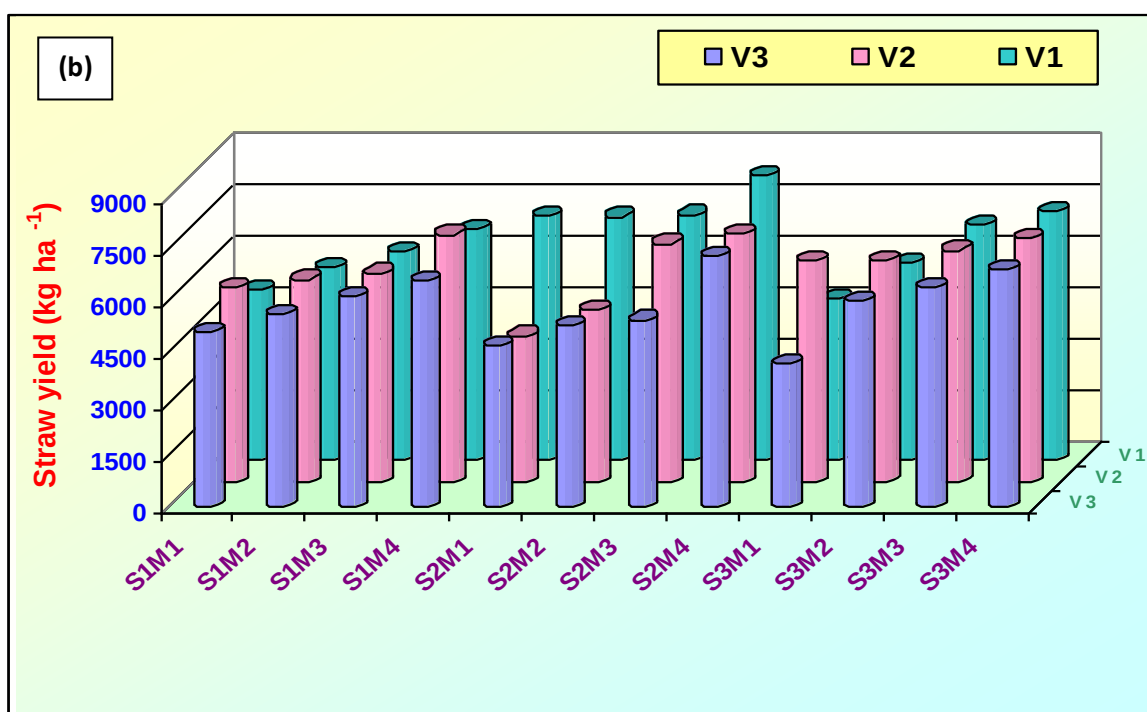
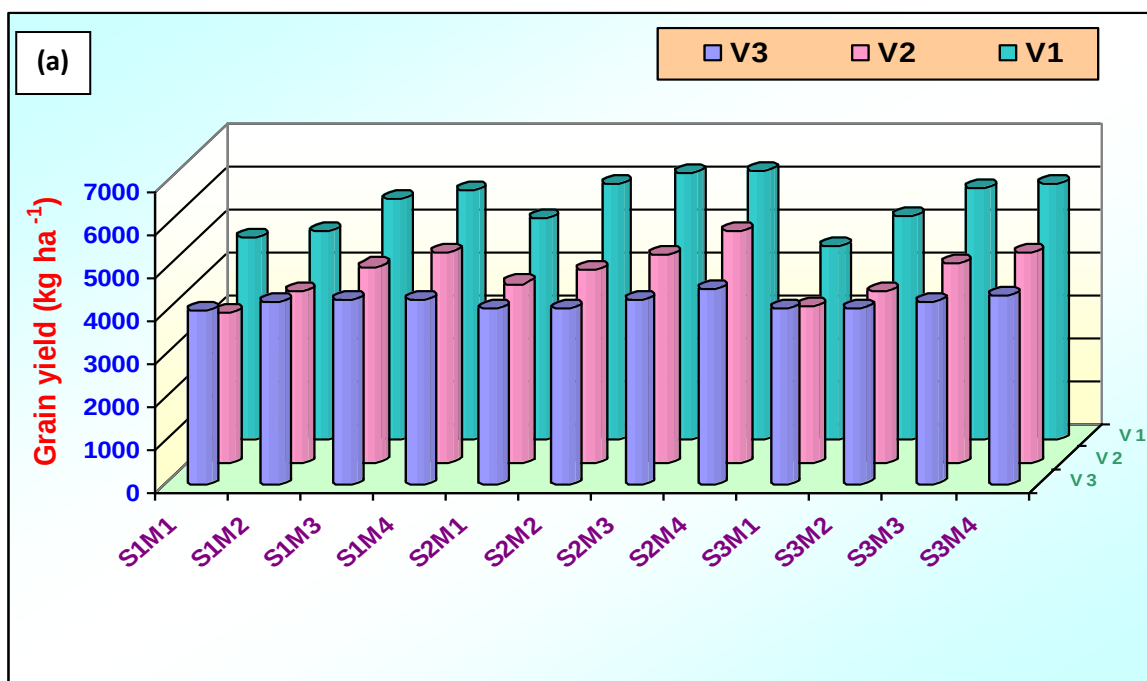
Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT



LEGEND

Varieties: V₁- GGV 0501, V₂- RNR 15048, V₃- BPT 5204;
 Seed Rate: S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
 Micronutrient: M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₄- FeSO₄ + ZnSO₄ (Each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

Fig. 17. Effect of genotypes, seed rates and micronutrients on (a) grain yield (kg ha⁻¹) and (b) straw yield (kg ha⁻¹) under direct seeded condition during summer season

4.1.2.3 Grain composition

4.1.2.3.1 Grain nitrogen (%) (c.f. Table 100)

Grain content of N content varied significantly due to cultivars, seed rates and their interactions except main effects due to micronutrient levels and two-way interaction due to seed rate and levels of micronutrients during summer season.

Among the cultivars, GGV 0501 (V_1) recorded significantly higher N content in grain (1.29) and was on par with cv. RNR 15048 (V_2) while significantly lower N content (1.13) was recorded with cv. BPT 5204 (V_3) and among seed rates higher N content in grain (1.20) was recorded with medium seed rate of 30 (S_2) which was on par with 35 kg ha⁻¹ (S_3); N content in grain (1.14) decreased with lower seed rate (S_1).

Among variety and seed rate, cv. GGV 0501 (V_1) at 30 kg ha⁻¹ seed rate (V_1S_2) recorded higher N content in grain (1.34); while lower seed N content (1.08) was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha⁻¹ (V_1S_1). In variety X micronutrient cv. GGV 0501 (V_1) with combined application of FeSO₄ and ZnSO₄ (V_1M_4) recorded higher N content in grain (1.31) and was on par with V_1M_{2-3} , while lower N content (1.11) was observed with cv. BPT 5204 when not supplied with micronutrients (V_3M_1).

Of combination of all factors, higher N content in grain (1.37) was obtained with cv. GGV 0501 (V_1) sown with 30 kg seed rate and supplied with FeSO₄ + ZnSO₄ ($V_1S_2M_4$), while the lowest N content (1.07) was recorded with cv. BPT 5204 sown using 25 kg ha⁻¹ seed rate and supplied with no micro nutrient ($V_3S_1M_1$).

4.1.2.3.2 Grain phosphorus (%) (c.f. Table 100)

P content in grain varied significantly due to cultivars, and their interactions except seed rates, micronutrient levels and interaction of seed rate X micronutrient during summer season. GGV 0501 (V_1) recorded significantly higher P content (0.29) in grain and was on par with cv. RNR 15048 (V_2), while significantly lower P content (0.23) was recorded with cv. BPT 5204 (V_3).

Interactions between variety and seed rate were significant wherein cv. GGV 0501 (V_1) at 30 kg ha⁻¹ seed rate (V_1S_2) recorded higher P content in grain (0.31) which was on par with $V_{1-2}S_{1-3}$ and V_2S_2 ; while lower P content (0.21) was recorded with cv.

Table 100. Effect of genotypes, seed rates and micronutrients on grain nitrogen, phosphorus and potassium content (%) under direct seeded condition during summer season

V x S x M		Nitrogen (%)				Phosphorus (%)				Potassium (%)			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	1.25 ^{a-f}	1.18 ^{b-f}	1.07 ^f	1.17^a	0.28 ^{a-c}	0.25 ^{a-c}	0.20 ^c	0.24^a	0.42 ^{a-c}	0.40 ^c	0.38 ^c	0.40^a
	M ₂	1.26 ^{a-f}	1.18 ^{b-f}	1.09 ^f	1.18^a	0.28 ^{a-c}	0.25 ^{a-c}	0.20 ^c	0.24^a	0.42 ^{a-c}	0.40 ^c	0.38 ^c	0.40^a
	M ₃	1.26 ^{a-f}	1.19 ^{b-f}	1.11 ^{ef}	1.19^a	0.29 ^{a-c}	0.25 ^{a-c}	0.21 ^{bc}	0.25^a	0.42 ^{a-c}	0.40 ^c	0.38 ^c	0.40^a
	M ₄	1.27 ^{a-e}	1.20 ^{b-f}	1.11 ^{ef}	1.19^a	0.29 ^{a-c}	0.26 ^{a-c}	0.22 ^{a-c}	0.26^a	0.42 ^{a-c}	0.40 ^c	0.39 ^c	0.40^a
S ₂	M ₁	1.32 ^{a-c}	1.21 ^{a-f}	1.16 ^{cf}	1.23^a	0.30 ^{ab}	0.27 ^{a-c}	0.24 ^{a-c}	0.27^a	0.43 ^{a-c}	0.41 ^{bc}	0.39 ^c	0.41^a
	M ₂	1.32 ^{a-c}	1.22 ^{a-f}	1.16 ^{cf}	1.23^a	0.30 ^{ab}	0.27 ^{a-c}	0.24 ^{a-c}	0.27^a	0.43 ^{a-c}	0.41 ^{bc}	0.39 ^c	0.41^a
	M ₃	1.34 ^{ab}	1.23 ^{a-f}	1.17 ^{bf}	1.25^a	0.31 ^a	0.28 ^{a-c}	0.25 ^{a-c}	0.28^a	0.46 ^{ab}	0.41 ^{bc}	0.39 ^c	0.42^a
	M ₄	1.37 ^a	1.24 ^{a-f}	1.17 ^{bf}	1.26^a	0.31 ^a	0.28 ^{a-c}	0.25 ^{a-c}	0.28^a	0.47 ^a	0.41 ^{bc}	0.40 ^c	0.43^a
S ₃	M ₁	1.27 ^{a-e}	1.20 ^{a-f}	1.11 ^{ef}	1.19^a	0.29 ^{a-c}	0.26 ^{a-c}	0.23 ^{a-c}	0.26^a	0.42 ^{a-c}	0.41 ^{bc}	0.39 ^c	0.41^a
	M ₂	1.28 ^{a-e}	1.21 ^{a-f}	1.12 ^{d-f}	1.20^a	0.29 ^{a-c}	0.26 ^{a-c}	0.23 ^{a-c}	0.26^a	0.42 ^{a-c}	0.41 ^{bc}	0.39 ^c	0.41^a
	M ₃	1.29 ^{a-d}	1.21 ^{a-f}	1.15 ^{c-f}	1.22^a	0.29 ^{a-c}	0.26 ^{a-c}	0.23 ^{a-c}	0.26^a	0.43 ^{a-c}	0.41 ^{bc}	0.39 ^c	0.41^a
	M ₄	1.30 ^{a-c}	1.21 ^{a-f}	1.15 ^{c-f}	1.22^a	0.29 ^{a-c}	0.26 ^{a-c}	0.24 ^{a-c}	0.26^a	0.43 ^{a-c}	0.41 ^{bc}	0.39 ^c	0.41^a
Variety		1.29^a	1.21^{ab}	1.13^b		0.29^a	0.26^{ab}	0.23^b		0.43^a	0.41^b	0.36^c	
Variety x Seed rate		S				S				S			
S	S ₁	1.26 ^{bc}	1.18 ^{d-f}	1.10 ^g	1.14 ^b	0.28 ^{ab}	0.26 ^{a-c}	0.21 ^c	0.24 ^a	0.42 ^b	0.40 ^{bc}	0.38 ^c	0.39 ^b
	S ₂	1.34 ^a	1.23 ^{b-d}	1.17 ^{ef}	1.20 ^{ba}	0.31 ^a	0.27 ^{a-c}	0.25 ^{a-c}	0.26 ^a	0.45 ^a	0.41 ^{bc}	0.40 ^{bc}	0.41 ^a
	S ₃	1.28 ^b	1.21 ^{c-e}	1.13 ^{fg}	1.17 ^{ab}	0.29 ^{ab}	0.26^{a-c}	0.23 ^{bc}	0.25 ^a	0.42 ^b	0.41^{bc}	0.39 ^{bc}	0.40 ^{ab}
Variety x Micro		M				M				M			
M ₄	M ₁	1.28 ^{b-c}	1.20 ^{c-f}	1.11 ^f	1.16 ^a	0.26 ^{a-c}	0.26 ^{b-c}	0.22 ^c	0.24 ^a	0.42 ^{bc}	0.41 ^{bc}	0.39 ^c	0.40 ^a
	M ₂	1.29^{a-c}	1.20 ^{c-f}	1.12 ^{ef}	1.16 ^a	0.29 ^{ab}	0.26 ^{b-c}	0.23 ^c	0.25 ^a	0.42 ^{bc}	0.41 ^{bc}	0.39 ^c	0.40 ^a
	M ₃	1.30 ^{ab}	1.21 ^{b-e}	1.14 ^{df}	1.18 ^a	0.29 ^{ab}	0.26 ^{b-c}	0.23 ^c	0.25 ^a	0.43 ^{ab}	0.41 ^{bc}	0.39 ^c	0.40 ^a
	M ₄	1.31 ^a	1.22 ^{b-c}	1.14 ^{df}	1.18 ^a	0.30 ^a	0.27 ^{a-c}	0.24 ^c	0.26 ^a	0.44 ^a	0.41 ^{bc}	0.39 ^c	0.40 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.03				0.01				0.01			
Seed (S)		0.01				0.01				0.01			
Micro (M)		0.02				0.01				0.01			
V x S		0.02				0.02				0.01			
V x M		0.03				0.02				0.01			
S x M		0.03				0.02				0.01			
V x S x M		0.05				0.03				0.02			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

BPT 5204 with lower seed rate of 25kg ha⁻¹(V₁S₁). Variety X micronutrient again revealed significant variations, in that cv. GGV 0501 with FeSO₄ + ZnSO₄ (V₁M₄) recorded higher P content in grain (1.31) and was on par with V₁M₂₋₃. All micronutrient levels with cv. BPT 5204 recorded significantly lower P content in grain especially in V₃M₁ (0.22).

Of the three way interactions significantly higher P content in grain (0.31each) was observed with cv. GGV 0501 sown using 30 kg seed rate and supplied with both FeSO₄ and ZnSO₄ (V₁S₂M₄) and so was V₁S₂M₃M₃, while significantly lower P content (0.20) was recorded with cv. BPT 5204 sown using 25 kg ha⁻¹ seed rate and supplied with no micro nutrient (V₃S₁M₁).

4.1.2.3.3 Grain potassium (%) (c.f. Table 100)

Variations in K content in grain were significant due to cultivars, seed rates and their interactions. However, non-significant differences were found due to main effects due to micronutrients and interaction due to seed rate X levels of micronutrient during summer.

Genotype GGV 0501(V₁) recorded significantly higher K content (0.43) while significantly lower content (0.36) was recorded with the cv. BPT 5204 (V₃); among the seed rates, 30 kg ha⁻¹(S₂) recorded higher K content (0.41) and it was on par with the higher seed rate (S₃), while lower K content (0.39) was recorded with lower seed rate (S₁).

Among variety and seed rate cv. GGV 0501sown with the seed rate of 30 kg ha⁻¹ (V₁S₂) recorded significantly higher K (0.45) while lower K content in grain (0.38) was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha⁻¹ (V₃S₁). Variety X micronutrient again revealed significant variations, in that cv. GGV 0501 (V₁) with FeSO₄ + ZnSO₄ (V₁M₄) recorded higher K content in grain (0.44) and was on par with V₁M₃, while lower grain K (0.39 each) was observed in cv. BPT 5204 irrespective of levels of micronutrients (V₃M₁₋₄).

Among V x S x M, significantly higher K content in grain (0.47) with cv. GGV 0501sown with 30 kg seed rate and applied with FeSO₄ + ZnSO₄ (V₁S₂M₄) and V₁S₂M₃ was at par, while the lower K content in grain (0.38) was recorded with cv. BPT 5204 sown using 25 kg ha⁻¹ seed rate whether micronutrients are supplied or not (V₁S₁M₁₋₄).

4.1.2.3.4 Grain iron (mg kg⁻¹) (c.f. Table 101)

Iron (Fe) content in grain varied significantly due to cultivars, seed rates and their interactions but use of micronutrients and their interaction were not significant during summer.

Significantly higher content of Fe in grain (32.3) among cultivars was recorded with cv. GGV 0501(V₁), while lower Fe content was obtained with cvs. RNR 15048 (V₂) and BPT 5204 (V₃) and both were at par. Among seed rates, higher Fe content (26.4) in grain was recorded with the seed rate of 30 kg ha⁻¹ (S₂) and it was at par with S₃, Fe content in grain (23.8) decreased with lower seed rate (S₁). Interaction between variety and seed rate were significant wherein cv. GGV 0501 at 30 and 35 kg ha⁻¹ seed rate (V₁S₂₋₃) recorded higher Fe content in grain (34.7 and 33.2, respectively); while lower Fe content in grain (19.0) was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha⁻¹ (V₃S₁).

4.1.2.3.5 Grain zinc (mg kg⁻¹) (c.f. Table 101)

Zinc content in grain varied significantly due to cultivars, and their interactions; however non-significant differences were noted with regard to seed rate and use of micronutrients during summer season.

Among the varieties, cv. GGV 0501(V₁) recorded significantly higher (14.8) zinc content in grain while other two cultivars viz., RNR 15048 (V₂) and BPT 5204 (V₃) recorded lower Zn contents (13.7 and 12.7, respectively) and were on par with each other.

Interactions between variety and seed rate were significant, among all cv. GGV 0501 at 30 kg ha⁻¹ seed rate (V₁S₂) recorded higher Zn content in grain (15.4) and was on par with V₁₋₂S₁₋₃, while lower Zn content in grain (12.1) was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha⁻¹ (V₃S₁). Variety X micronutrient revealed significant variations, in that cv. GGV 0501 with combined application of FeSO₄ and ZnSO₄ (V₁M₄) recorded higher zinc content in grain (15.4) and was on par with V₁M₃. In the absence of micronutrient application Zn content in grain decreased among all cultivars and recorded lower Zn (12.4) with cv. BPT 5204 (V₃M₁).

Table 101. Effect of genotypes, seed rates and micronutrients on grain iron and zinc (mg kg⁻¹) content under direct seeded condition during summer season

V x S x M		Iron (mg kg ⁻¹)				Zinc (mg kg ⁻¹)			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	28.6 ^a	25.9 ^a	19.0 ^a	24.5 ^a	14.0 ^{ab}	13.2 ^{ab}	11.5 ^b	12.9 ^a
	M ₂	29.5 ^a	26.5 ^a	22.5 ^a	26.2 ^a	14.3 ^{ab}	13.3 ^{ab}	11.9 ^b	13.2 ^a
	M ₃	29.0 ^a	26.1 ^a	21.2 ^a	25.4 ^a	14.5 ^{ab}	13.4 ^{ab}	12.5 ^b	13.5 ^a
	M ₄	29.6 ^a	26.5 ^a	22.6 ^a	26.2 ^a	14.5 ^{ab}	13.5 ^{ab}	12.5 ^b	13.5 ^a
S ₂	M ₁	34.8 ^a	26.9 ^a	24.7 ^a	28.8 ^a	14.8 ^{ab}	13.8 ^{ab}	13.2 ^{ab}	13.9 ^a
	M ₂	33.1 ^a	27.7 ^a	25.6 ^a	28.8 ^a	14.9 ^{ab}	13.8 ^{ab}	13.2 ^{ab}	14.0 ^a
	M ₃	35.6 ^a	26.9 ^a	25.4 ^a	29.3 ^a	15.1 ^{ab}	13.9 ^{ab}	13.2 ^{ab}	14.1 ^a
	M ₄	35.2 ^a	28.3 ^a	25.8 ^a	29.8 ^a	16.9 ^a	14.0 ^{ab}	13.2 ^{ab}	14.7 ^a
S ₃	M ₁	31.5 ^a	26.6 ^a	23.0 ^a	27.0 ^a	14.5 ^{ab}	13.7 ^{ab}	12.6 ^b	13.6 ^a
	M ₂	34.1 ^a	26.6 ^a	23.1 ^a	27.9 ^a	14.5 ^{ab}	13.7 ^{ab}	12.9 ^{ab}	13.7 ^a
	M ₃	32.5 ^a	26.6 ^a	23.8 ^a	27.6 ^a	14.6 ^{ab}	13.7 ^{ab}	13.0 ^{ab}	13.8 ^a
	M ₄	34.6 ^a	26.7 ^a	23.9 ^a	28.4 ^a	14.7 ^{ab}	13.8 ^{ab}	13.2 ^{ab}	13.9 ^a
Variety		32.3 ^a	26.8 ^b	23.4 ^b		14.8 ^a	13.7 ^b	12.7 ^b	
		Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	29.2 ^b	26.3 ^{b-d}	21.3 ^e	23.8 ^b	14.3 ^{ab}	13.4 ^{ab}	12.1 ^b	12.8 ^a
	S ₂	34.7 ^a	27.4 ^{bc}	25.4 ^{cd}	26.4 ^a	15.4 ^a	13.9 ^{ab}	13.2 ^{ab}	13.6 ^a
	S ₃	33.2 ^a	26.6 ^{bc}	23.4 ^{de}	25.0 ^{ab}	14.6 ^{ab}	13.7 ^{ab}	12.9 ^{ab}	13.3 ^a
		Variety x Micro			M	Variety x Micro			M
V	M ₁	31.6 ^a	26.4 ^a	22.2 ^a	24.3 ^a	14.4 ^{b-c}	13.6 ^d	12.4 ^e	13.0 ^a
	M ₂	32.2 ^a	26.9 ^a	23.7 ^a	25.3 ^a	14.6 ^{b-c}	13.6 ^d	12.7 ^d	13.2 ^a
	M ₃	32.4 ^a	26.5 ^a	23.5 ^a	25.0 ^a	14.7 ^{ab}	13.7 ^d	12.9 ^d	13.3 ^a
	M ₄	33.1 ^a	27.2 ^a	24.1 ^a	25.7 ^a	15.4 ^a	13.7 ^d	13.0 ^d	13.4 ^a
Comparison		S.E.m±				S.E.m±			
Variety (V)		1.2				0.3			
Seed (S)		0.5				0.4			
Micro (M)		1.9				0.4			
V x S		0.9				0.7			
V x M		3.2				0.7			
S x M		3.2				0.7			
V x S x M		5.6				1.2			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

4.1.2.3.6 Grain copper (mg kg^{-1}) (c.f. Table 102)

Variations in copper (Cu) contents in grain were not significant due to cultivars (1.65 to 2.44), seed rates (1.67 to 2.00) and use of micronutrients (1.76 to 1.90), however significant differences were observed due to all interactions during summer

Among variety and seed rate cv. GGV 0501 (V_1) sown using 30 kg ha^{-1} seed rate (V_1S_2) recorded higher copper content in grain (2.81) which was on par with $V_{1-2}S_{1-3}$; while lower copper content in grain (1.34) was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha^{-1} (V_3S_1). Cv. GGV 0501 with combined application of FeSO_4 and ZnSO_4 (V_1M_4) recorded higher copper content in grain (2.65) among variety X micronutrient and it was on par with V_1M_{1-4} , while lower content (1.49) occurred with cv. BPT 5204 not supplied with micronutrients (V_3M_1). Similarly, interactions due to micronutrients and seed rates were significant, wherein 30 kg seed rate with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) recorded higher Cu content in grain (2.48) and it was at par with $S_{2-3} M_{2-4}$, while 25 kg ha^{-1} seed rate without supplementation of micronutrient (S_1M_1) recorded lower Cu content in grain (1.77).

Again, significantly higher Cu content in grain (3.27) among $V \times S \times M$ was obtained with cv. GGV 0501 sown with 30 kg seed rate and applied with both FeSO_4 and ZnSO_4 ($V_1S_2M_4$), while lower content (1.19) was recorded with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient ($V_3S_1M_1$) among all.

4.1.2.3.7 Grain manganese (mg kg^{-1}) (c.f. Table 102)

Mn content did not present significant variations due to cultivars (26.11 to 35.38), seed rates (26.70 to 30.01) and use of micronutrients (27.70 to 28.86) and $V \times S$ (24.45 to 37.13) interactions; however significant differences were observed in other interactions during summer.

Variety X micronutrient revealed significant variations, in that cv. GGV 0501 with all levels of micronutrient application were par and recorded higher Mn content in grain particularly with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_1M_4) (36.07), while lower Mn content (25.58) was recorded with cv. BPT 5204 with no supplementation of micronutrients (V_3M_1). Similarly, interaction due to micronutrients and seed rates were significant, wherein 30 kg seed rate with application of ZnSO_4 only (S_2M_3) and $\text{FeSO}_4 + \text{ZnSO}_4$ ($S_2 M_4$) recorded higher Mn content in grain (33.23 and 33.13, respectively) and

Table 102. Effect of genotypes, seed rates and micronutrients on grain copper and manganese (mg kg⁻¹) content under direct seeded condition during summer season

V x S x M		Copper (mg kg ⁻¹)				Manganese (mg kg ⁻¹)			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	2.16 ^{b-d}	1.95 ^{b-e}	1.19 ^e	1.77^b	33.10 ^{a-h}	28.70 ^{e-k}	24.10 ^k	28.63^c
	M ₂	2.19 ^{b-d}	1.98 ^{b-e}	1.36 ^{de}	1.84^b	33.20 ^{a-h}	28.90 ^{e-k}	24.20 ^{jk}	28.77^c
	M ₃	2.23 ^{b-d}	2.02 ^{b-e}	1.87 ^{b-e}	2.04^{ab}	33.60 ^{a-g}	29.10 ^{e-k}	24.60 ^{jk}	29.10^{bc}
	M ₄	2.25 ^{b-d}	2.04 ^{b-e}	1.44 ^{de}	1.91^b	34.10 ^{a-f}	29.10 ^{e-k}	24.90 ^{jk}	29.37^{bc}
S ₂	M ₁	2.47 ^{ab}	2.09 ^{b-e}	1.84 ^{b-e}	2.13^{ab}	36.40 ^{a-c}	31.00 ^{c-i}	27.60 ^{h-k}	31.67^{a-c}
	M ₂	2.47 ^{ab}	2.09 ^{b-e}	1.84 ^{b-e}	2.13^{ab}	37.00 ^{ab}	31.80 ^{b-h}	27.80 ^{g-k}	32.20^{ab}
	M ₃	2.69 ^{ab}	2.12 ^{b-e}	1.87 ^{b-e}	2.23^{ab}	37.30 ^{ab}	34.60 ^{a-e}	27.80 ^{g-k}	33.23^a
	M ₄	3.27 ^a	2.27 ^{b-d}	1.89 ^{b-e}	2.48^a	37.80 ^a	33.00 ^{a-h}	28.60 ^{f-k}	33.13^a
S ₃	M ₁	2.29 ^{b-d}	2.04 ^{b-e}	1.45 ^{de}	1.93^b	35.10 ^{a-d}	29.80 ^{d-k}	25.10 ^{i-k}	30.00^{a-c}
	M ₂	2.31 ^{b-d}	2.05 ^{b-e}	1.50 ^{c-e}	1.95^b	35.30 ^{a-d}	30.00 ^{d-k}	25.30 ^{i-k}	30.20^{a-c}
	M ₃	2.44 ^{a-c}	2.05 ^{b-e}	1.76 ^{b-e}	2.08^{ab}	35.40 ^{a-d}	30.10 ^{d-j}	25.80 ^{i-k}	30.43^{a-c}
	M ₄	2.45 ^{a-c}	2.08 ^{b-e}	1.80 ^{b-e}	2.11^{ab}	36.30 ^{a-c}	30.10 ^{d-j}	27.50 ^{h-k}	31.30^{a-c}
Variety		2.44^a	2.07^a	1.65^a		35.38^a	30.52^a	26.11^a	
		Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	2.21 ^{a-c}	2.00 ^{a-c}	1.34 ^c	1.67 ^a	33.49 ^a	28.95 ^a	24.45 ^a	26.70 ^a
	S ₂	2.81 ^a	2.12 ^{a-c}	1.87 ^{bc}	2.00 ^a	37.13 ^a	32.09 ^a	27.93 ^a	30.01 ^a
	S ₃	2.37 ^{ab}	2.06 ^{a-c}	1.63 ^{bc}	1.85 ^a	35.52 ^a	29.97^a	25.91 ^a	27.94 ^a
		Variety x Micro			M	Variety x Micro			M
V	M ₁	2.31 ^b	2.02 ^{bc}	1.49 ^d	1.76 ^a	34.83 ^a	29.81 ^{bc}	25.58 ^d	27.70 ^a
	M ₂	2.40 ^{ab}	2.05 ^{bc}	1.58 ^{cd}	1.82 ^a	35.19 ^a	30.26 ^b	25.75 ^d	28.01 ^a
	M ₃	2.49 ^{ab}	2.07 ^{bc}	1.66 ^{cd}	1.87 ^a	35.44 ^a	30.57 ^b	26.05 ^d	28.31 ^a
	M ₄	2.65 ^a	2.09 ^{bc}	1.71 ^{cd}	1.90 ^a	36.07 ^a	30.71 ^b	27.00 ^{cd}	28.86 ^a
Comparison		S.Em±				S.Em±			
Variety (V)		0.32				2.64			
Seed (S)		0.15				0.80			
Micro (M)		0.09				0.57			
V x S		0.26				1.39			
V x M		0.16				0.99			
S x M		0.16				0.99			
V x S x M		0.27				1.72			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

was at par with $S_{2-3}M_{3-4}$, while 25 kg ha⁻¹ seed rate without supplementation of micronutrient (S_1M_1) recorded lower Mn content in grain (28.63).

Overall, in the three way interactions significantly higher manganese content in grain (37.80) was observed with cv. GGV 0501 sown with 30 kg seed rate and supplied with both FeSO₄ and Zn SO₄ ($V_1S_2M_4$), while lower Mn content in grain (24.10) was recorded with cv. BPT 5204 sown using 25 kg ha⁻¹ seed rate and supplied with no micro nutrient ($V_3S_1M_1$).

4.1.2.3.8 Grain protein (%) (c.f. Table 103 and Fig. 18a)

Data on grain protein content revealed significant variations due to cultivars, seed rates and their interactions except main effects due to micronutrient (7.11 to 7.27) and its interaction with seed rate (6.92 to 7.49).

Among the varieties, cv. GGV 0501 (V_1) recorded significantly higher (7.69) protein content in grain while lower grain protein was recorded in cv. BPT 5204 (V_3) (6.73), and among seed rates higher protein content in grain (7.39) was recorded with the seed rate of 30 kg ha⁻¹; protein content in grain (7.01) decreased with lower seed rate (S_1).

Interactions between variety and seed rate were significant wherein cv. GGV 0501 at 30 kg ha⁻¹ seed rate (V_1S_2) recorded higher protein content in grain (7.94), while lower seed protein content in grain (6.51) was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha⁻¹ (V_3S_1). Variety X micronutrient also revealed significant variations; in that cv. GGV 0501 with combined application of FeSO₄ and ZnSO₄ (V_1M_4) recorded higher protein content in grain (7.78) and was on par with V_1M_{1-3} . In the absence of micronutrient application protein content in grain decreased across cultivars and lower protein content (6.62) was recorded with cv. BPT 5204 (V_3M_1).

Among three factor combinations, significantly higher protein content in grain (8.11) was observed with cv. GGV 0501 sown with 30 kg seed rate and applied with both FeSO₄ and ZnSO₄ ($V_1S_2M_4$); while lower protein content in grain (6.36) was recorded with cv. BPT 5204 sown using 25 kg ha⁻¹ seed rate and supplied with no micro nutrient ($V_3S_1M_1$).

Table 103. Effect of genotypes, seed rates and micronutrients on grain protein content (%) under direct seeded condition during summer season

V x S x M		Grain protein content (%)			
		V ₁	V ₂	V ₃	S x M
S ₁	M ₁	7.42 ^{a-g}	6.98 ^{b-h}	6.36 ^h	6.92 ^a
	M ₂	7.49 ^{a-g}	7.02 ^{b-h}	6.50 ^{gh}	7.00 ^a
	M ₃	7.51 ^{a-g}	7.04 ^{b-h}	6.59 ^{f-h}	7.05 ^a
	M ₄	7.52 ^{a-g}	7.10 ^{a-h}	6.59 ^{f-h}	7.07 ^a
S ₂	M ₁	7.82 ^{a-d}	7.20 ^{a-h}	6.89 ^{c-h}	7.30 ^a
	M ₂	7.86 ^{a-c}	7.26 ^{a-h}	6.91 ^{c-h}	7.34 ^a
	M ₃	7.98 ^{ab}	7.29 ^{a-h}	6.93 ^{c-h}	7.40 ^a
	M ₄	8.11 ^a	7.39 ^{a-h}	6.98 ^{b-h}	7.49 ^a
S ₃	M ₁	7.56 ^{a-f}	7.15 ^{a-h}	6.60 ^{f-h}	7.10 ^a
	M ₂	7.60 ^{a-f}	7.17 ^{a-h}	6.63 ^{e-h}	7.13 ^a
	M ₃	7.65 ^{a-e}	7.18 ^{a-h}	6.91 ^{c-h}	7.25 ^a
	M ₄	7.70 ^{a-d}	7.19 ^{a-h}	6.81 ^{c-h}	7.23 ^a
Variety		7.69 ^a	7.16 ^b	6.73 ^c	
	Variety x Seed rate				S
S	S ₁	7.48 ^c	7.04 ^{d-f}	6.51 ^g	7.01 ^c
	S ₂	7.94 ^a	7.29 ^{cd}	6.93 ^{ef}	7.39 ^a
	S ₃	7.63 ^{ab}	7.17 ^{c-e}	6.71 ^{fg}	7.17 ^b
	Variety x Micro				M
M4	M ₁	7.60 ^{a-c}	7.11 ^{c-e}	6.62 ^e	7.11 ^a
	M ₂	7.65 ^{a-c}	7.15 ^{c-e}	6.68 ^{de}	7.16 ^a
	M ₃	7.72 ^{ab}	7.17 ^{c-e}	6.77 ^{de}	7.22 ^a
	M ₄	7.78 ^a	7.23 ^{b-d}	6.79 ^{de}	7.27 ^a
Comparison		S.E.m±			
Variety (V)		0.16			
Seed (S)		0.06			
Micro (M)		0.10			
V x S		0.11			
V x M		0.17			
S x M		0.17			
V x S x M		0.30			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

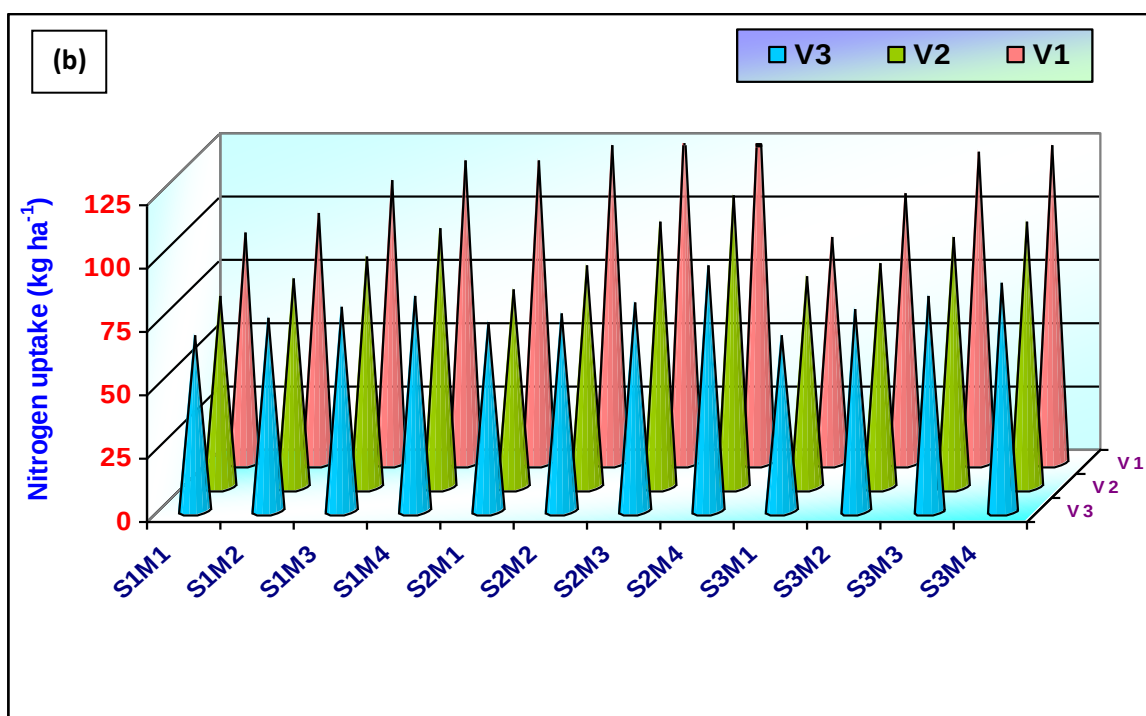
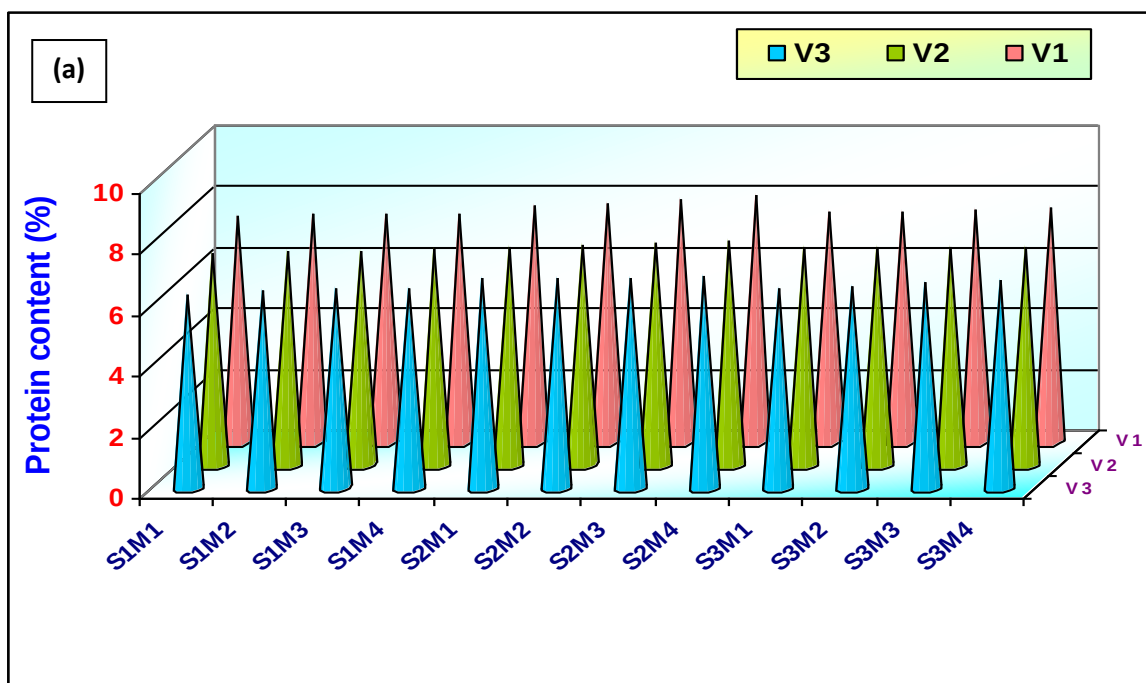
Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT



LEGEND

Varieties: V₁- GGV 0501, V₂- RNR 15048, V₃- BPT 5204;
 Seed Rate: S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
 Micronutrient: M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₄- FeSO₄ + ZnSO₄ (Each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

Fig. 18. Effect of genotypes, seed rates and micronutrients on (a) grain protein content (%) and (b) nitrogen uptake (kg ha⁻¹) under direct seeded condition during summer season

4.1.2.4 Total nutrient uptake

4.1.2.4.1 Nitrogen uptake (kg ha^{-1}) (c.f. Table 104 and Fig. 18b)

Total N uptake varied significantly due to cultivars, seed rates and use of micronutrients and their interactions during summer season.

GGV 0501 (V_1) among the cultivars recorded significantly higher (116.7) N uptake while cv. BPT 5204 (V_3) recorded lower N uptake (79.4), among seed rates higher N uptake (104.1) was recorded with the seed rate of 30 kg ha^{-1} (S_2); while lower N uptake (90.0) was observed with lower seed rate (S_1), and among levels of micronutrients combined application FeSO_4 and ZnSO_4 to soil and to the foliage (M_4) resulted in higher N uptake (109.9), while no application of micronutrient (M_1) recorded lower N uptake (83.1).

Among $V \times S$, cv. GGV 0501 at 30 kg ha^{-1} seed rate (V_1S_2) recorded higher N uptake (133.4); while lower N uptake (77.5) was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha^{-1} (V_3S_1). In variety $\times$ micronutrient cv. GGV 0501 with combined application of FeSO_4 and ZnSO_4 (V_1M_4) recorded higher N uptake (132.2). In the absence of micronutrient application total N uptake decreased and recorded lower total N uptake (70.8) with cv. BPT 5204 (V_3M_1). Similarly, among micronutrients and seed rates 30 kg seed rate with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) recorded higher N uptake (120.0), while 25 kg ha^{-1} seed rate without supplementation of micronutrient (S_1M_1) recorded lower N uptake (78.6).

Among three way interactions, higher N uptake (148.2) was observed with cv. GGV 0501 sown with 30 kg ha^{-1} seed rate and applied with both $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_1S_2M_4$), while the lower N uptake (69.3) occurred with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micro nutrient ($V_3S_1M_1$) among all.

4.1.2.4.2 Phosphorus uptake (kg ha^{-1}) (c.f. Table 104 and Fig. 19a)

Variations in P uptake due to cultivars, seed rates and use of micronutrients and their interactions were significant during summer season. Among the cultivars, cv. GGV 0501 (V_1) recorded significantly higher P uptake (21.7) while cv. BPT 5204 (V_3) recorded lower P uptake (12.0); among seed rates higher P uptake (18.4) was recorded with medium seed rate of 30 kg ha^{-1} (S_2), while lower P uptake (14.8) was recorded with lower seed rate (S_1), and among levels of micronutrients combined

application FeSO_4 and ZnSO_4 to soil and to the foliage (M_4) resulted in higher P uptake (18.8), while no application of micronutrient (M_1) recorded significantly lower P uptake (14.1).

In variety and seed rate combinations, cv. GGV 0501 with medium seed rate of 30 kg ha^{-1} (V_1S_2) recorded higher P uptake (25.2); while lower P uptake (11.0) was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha^{-1} (V_3S_1), among variety X micronutrient cv. GGV 0501 with combined application of FeSO_4 and ZnSO_4 (V_1M_4) recorded higher total P uptake (24.7). In the absence of micronutrient application, P uptake decreased irrespective of cultivars used and recorded lower uptake (11.0) with cv. BPT 5204 (V_3M_1), and among seed rate and micronutrients medium seed rate of 30 kg ha^{-1} with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) recorded higher P uptake (21.2), while 25 kg ha^{-1} seed rate without supplementation of micronutrient (S_1M_1) recorded lower P uptake (12.8).

GGV 0501 (V_1) sown with 30 kg ha^{-1} seed rate and applied with both FeSO_4 and ZnSO_4 ($V_1S_2M_4$) among three factor combinations recorded higher P uptake (28.6) which was on par with $V_1S_2M_3$, while lower P uptake (9.9) was recorded with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micro nutrient ($V_3S_1M_1$).

4.1.2.4.3 Potassium uptake (kg ha^{-1}) (c.f. Table 104 and Fig. 19b)

Total K uptake varied significantly due to cultivars, seed rates and use of micronutrients and their interactions during summer season.

Among the varieties, cv. GGV 0501 (V_1) recorded significantly higher (124.5) K uptake while cv. BPT 5204 (V_3) recorded significantly lower K uptake (91.3); among seed rates higher K uptake (115.3) was recorded with the seed rate of 30 kg ha^{-1} (S_2), while lower K uptake (99.4) occurred with lower seed rate (S_1), and among levels of micronutrients combined application of FeSO_4 and ZnSO_4 (M_4) to soil and to the foliage resulted in higher total potassium uptake (126.4), while no application of micronutrient (M_1) recorded significantly lower K uptake (89.9).

Interaction between variety and seed rate were significant wherein cv. GGV 0501 (V_1) at 30 kg ha^{-1} seed rate (V_1S_2) recorded higher K uptake (149.0), while lower K uptake was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha^{-1} (V_3S_1)

Table 104. Effect of genotypes, seed rates and micronutrients on uptake of nitrogen, phosphorus and potassium under direct seeded condition during summer season

V x S x M		Nitrogen (kg ha ⁻¹)				Phosphorus (kg ha ⁻¹)				Potassium (kg ha ⁻¹)			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	91.3 ^{g-l}	75.2 ^{n-p}	69.3 ^q	78.6^h	16.5 ^{g-j}	11.9 ^{l-o}	9.9 ^o	12.8^g	91.3 ^{l-p}	91.4 ^{l-p}	73.8 ^{qf}	85.5^f
	M ₂	98.2 ^{f-j}	83.3 ^{k-p}	68.9 ^p	83.5^{gh}	17.7 ^{f-h}	13.3 ^{k-n}	10.7 ^{no}	13.9^{hg}	101.7 ^{i-m}	96.5 ^{k-o}	84.2 ^{o-r}	94.1^{de}
	M ₃	111.1 ^{de}	90.9 ^{g-l}	80.1 ^{l-p}	94.0^{d-f}	20.5 ^{de}	15.0 ^{h-k}	11.5 ^{l-o}	15.7^{de}	113.2 ^{f-j}	103.0 ^{i-m}	91.3 ^{l-p}	102.5^c
	M ₄	119.2 ^{cd}	102.0 ^{e-h}	84.6 ^{i-o}	101.9^{bc}	21.8 ^{cd}	16.9 ^{g-i}	12.0 ^{l-o}	16.9^{c-e}	125.2 ^{c-f}	120.7 ^{d-h}	101.3 ⁱ⁻ⁿ	115.7^b
S ₂	M ₁	119.1 ^{cd}	78.0 ^{l-p}	74.3 ^{op}	90.5^{f-g}	21.6 ^{cd}	14.1 ^{i-m}	12.0 ^{l-o}	15.9^{d-e}	132.2 ^{cd}	78.4 ^{p-r}	78.2 ^{p-r}	96.3^{cd}
	M ₂	130.6 ^{bc}	87.3 ^{i-o}	76.1 ^{m-p}	98.0^{c-f}	24.3 ^{bc}	13.3 ^{k-n}	10.7 ^{no}	16.1^{de}	135.7 ^{bc}	90.4 ^{l-p}	87.2 ^{n-q}	104.4^c
	M ₃	135.7^b	104.9 ^{ef}	81.9 ^{k-p}	107.5^b	26.5 ^{ab}	18.1 ^{e-g}	13.0 ^{k-n}	19.2^b	148.5 ^b	119.8 ^{d-h}	90.4 ^{l-p}	119.6^b
	M ₄	148.2 ^a	115.0 ^{de}	96.7 ^{f-k}	120.0^a	28.6 ^a	20.0 ^{d-f}	15.1 ^{h-k}	21.2^a	179.5 ^a	126.7 ^{l-f}	116.5 ^{e-i}	140.9^a
S ₃	M ₁	88.9 ^{h-n}	83.3 ^{k-p}	68.9 ^p	80.4^{gh}	16.5 ^{g-j}	13.2 ^{k-n}	11.1 ^{m-o}	13.6^{gh}	89.3 ^{m-p}	105.0 ^{h-l}	70.1 ^r	88.1^{ef}
	M ₂	105.9 ^{e-f}	88.4 ^{l-o}	79.8 ^{l-p}	91.4^{ef}	19.8 ^{d-f}	14.3 ^{i-l}	11.9 ^{l-o}	15.3^{ef}	108.8 ^{g-k}	107.0 ^{g-k}	94.6 ^{k-o}	103.5^c
	M ₃	122.9 ^{b-d}	98.8 ^{f-i}	81.9 ^{k-p}	101.2^{b-d}	22.6 ^{c-d}	16.4 ^{g-j}	12.5 ^{k-o}	17.2^{cd}	130.7 ^{c-e}	114.7 ^{f-j}	100.2 ^{j-n}	115.5^b
	M ₄	129.2 ^{bc}	104.4 ^{e-g}	89.7 ^{h-m}	107.8^b	23.5 ^c	17.6 ^{f-h}	13.6 ⁱ⁻ⁿ	18.2^{bc}	137.5 ^{bc}	121.5 ^{d-g}	108.3 ^{g-k}	122.4^b
Variety		116.7^a	92.6^b	79.4^c		21.7^a	15.3^b	12.0^c		124.5^a	106.3^b	91.3^c	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	104.9 ^b	87.6 ^d	77.5 ^e	90.0 ^c	19.1 ^c	14.2 ^f	11.0 ^h	14.8 ^c	107.8 ^{cd}	102.9 ^d	87.6 ^e	99.4 ^c
	S ₂	133.4 ^a	96.3 ^c	82.7 ^{de}	104.1 ^a	25.2 ^a	16.9 ^d	13.2 ^{fg}	18.4 ^a	149.0 ^a	103.8 ^d	93.1 ^e	115.3 ^a
	S ₃	111.7 ^b	93.7 ^c	80.8 ^e	95.4 ^b	20.6 ^b	15.4 ^e	12.3 ^g	16.1 ^b	116.6 ^b	112.0^{bc}	93.3 ^e	107.3 ^b
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M ₄	M ₁	99.7 ^d	78.8 ^{f-g}	70.8 ^h	83.1 ^d	18.2 ^d	13.1 ^{f-h}	11.0 ⁱ	14.1 ^d	104.2 ^{ef}	91.6 ^{gh}	74.0 ⁱ	89.9 ^d
	M ₂	111.6 ^c	86.0 ^{e-f}	78.0 ^g	91.9 ^c	20.6 ^c	14.4 ^f	11.7 ^{hi}	15.6 ^c	115.4 ^d	97.9 ^{fg}	88.7 ^h	100.7 ^c
	M ₃	123.2 ^b	98.1 ^d	82.2 ^{f-g}	101.2 ^b	23.2 ^b	16.5 ^e	12.3 ^{g-i}	17.3 ^b	130.8 ^b	112.5 ^d	93.9 ^{gh}	112.4 ^b
	M ₄	132.2 ^a	107.1 ^c	90.3 ^e	109.9 ^a	24.7 ^a	18.1 ^d	13.6 ^{fg}	18.8 ^a	147.5 ^a	123.0 ^c	108.7 ^{de}	126.4 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		1.4				0.3				1.6			
Seed (S)		0.9				0.2				1.2			
Micro (M)		1.4				0.3				1.5			
V x S		1.7				0.3				2.2			
V x M		2.4				0.5				2.6			
S x M		2.4				0.5				2.6			
V x S x M		4.2				0.9				4.6			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

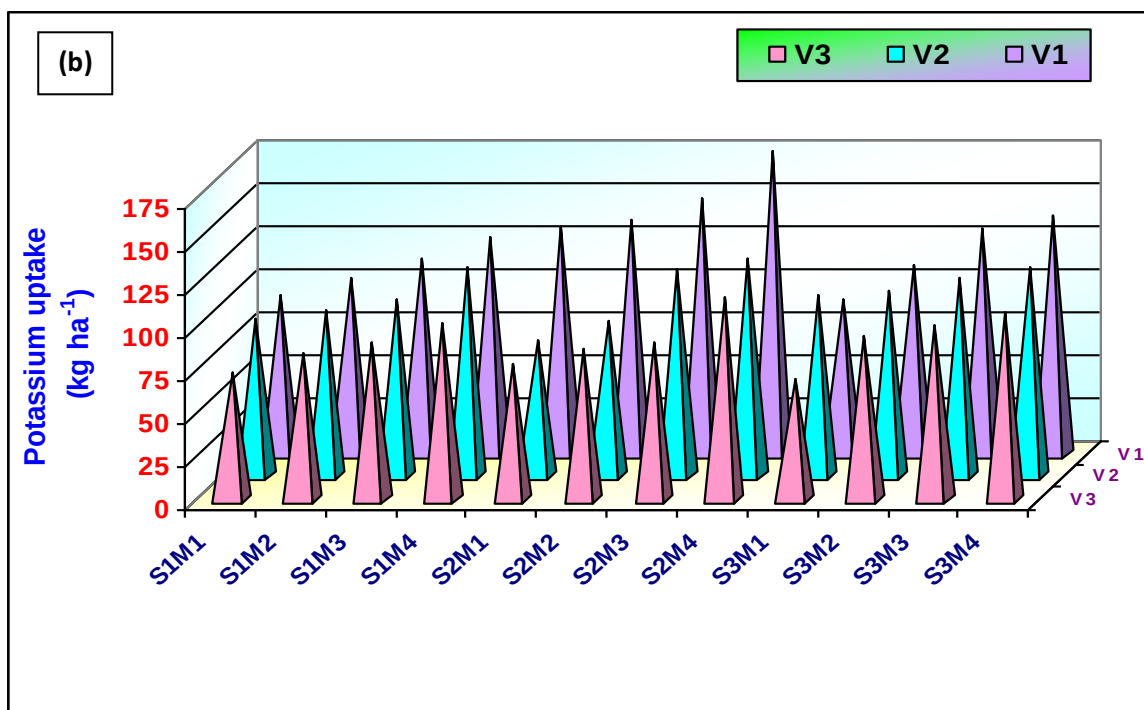
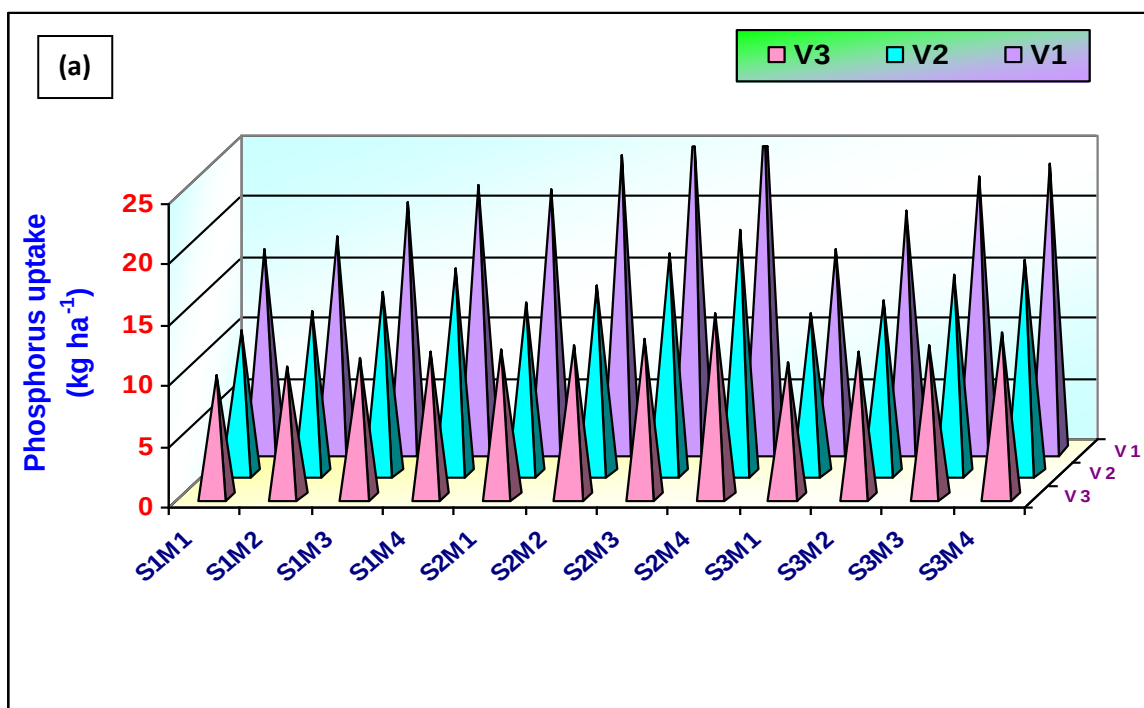
Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT



LEGEND

Varieties: V₁- GGV 0501, V₂- RNR 15048, V₃- BPT 5204;
 Seed Rate: S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
 Micronutrient: M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₄- FeSO₄ + ZnSO₄ (Each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

Fig. 19. Effect of genotypes, seed rates and micronutrients on (a) phosphorus uptake (kg ha⁻¹) and (b) potassium uptake (kg ha⁻¹) under direct seeded condition during summer season

(87.6). Variety X micronutrient also revealed significant variations, in that cv. GGV 0501 with combined application of FeSO_4 and ZnSO_4 (V_2M_4) recorded higher total potassium uptake (147.5). In the absence of micronutrient application K uptake decreased across cultivars and recorded lower K uptake with cv. BPT 5204 (V_3M_1) (74.0). Similarly, interaction due to seed rates and micronutrients were significant, wherein 30 kg seed rate with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) recorded higher K uptake (140.9), while 25 kg ha^{-1} seed rate without supplementation of micronutrient (S_1M_1) recorded lower K uptake (85.5).

GGV 0501 sown with 30 kg seed rate and applied with both $\text{FeSO}_4 + \text{ZnSO}_4$ ($V_1S_2M_4$) among all treatment combinations, recorded significantly higher K uptake (179.5), while lower K uptake (70.1) was recorded with cv. BPT 5204 sown using 35 kg ha^{-1} seed rate and supplied with no micronutrient ($V_3S_3M_1$).

4.1.2.4.4 Iron uptake (g ha^{-1}) (c.f. Table 105 and Fig. 20a)

Iron (Fe) uptake revealed significant variations due to cultivars, seed rates and use of micronutrients and their interactions during summer season.

Among the varieties, cv. GGV 0501 (V_1) recorded significantly higher (1176.8) Fe uptake followed by cvs. RNR 15048 (V_2) and BPT 5204 (V_3) (857.9 and 702.0, respectively), among seed rates higher Fe uptake of 806.9 and 789.9 were recorded with the seed rate of 30 (S_2) and 35 kg ha^{-1} (S_3) respectively, while lower Fe uptake (743.2) was observed with lower seed rate (S_1), and among levels of micronutrients application $\text{FeSO}_4 + \text{ZnSO}_4$ to soil and to the foliage (M_4) resulted in higher (M_4) uptake (918.1), while no application of micronutrient (M_1) recorded significantly lower (M_4) uptake (645.1).

GGV 0501 (V_1) at 30 kg ha^{-1} seed rate (V_1S_2) among variety and seed rate recorded highest total iron uptake (1508.4), while lower Fe uptake (666.0) was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha^{-1} (V_3S_1). Variety X micronutrient also revealed significant variations, in that cv. GGV 0501 (V_1) with combined application of FeSO_4 and ZnSO_4 (V_1M_4) recorded higher total iron uptake (1503.9). In the absence of micronutrient application Fe uptake decreased across cultivars and recorded lower uptake with cv. BPT 5204 (V_3M_1) (559.7). Similarly, interaction due to micronutrients and seed rates were significant, wherein 30 kg seed rate with application

of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) recorded higher Fe uptake (1360.8), while 25 kg ha⁻¹ seed rate without supplementation of micronutrient (S_1M_1) recorded lower total iron uptake (680.3).

Among all, significantly higher Fe uptake (2114.8) was recorded with cv. GGV 0501 (V_1) sown using medium seed rate 30 kg and supplied with both FeSO_4 and ZnSO_4 ($\text{V}_1\text{S}_2\text{M}_4$) and was on par with $\text{V}_2\text{S}_{1-3}\text{M}_4$, while lower Fe uptake (518.1) was recorded with cv. BPT 5204 sown using 35 kg ha⁻¹ seed rate and supplied with no micro nutrient ($\text{V}_3\text{S}_3\text{M}_1$).

4.1.2.4.5 Zinc uptake (g ha⁻¹) (c.f. Table 105 and Fig. 20b)

Total zinc (Zn) uptake varied significantly due to cultivars, seed rates and use of micronutrients and their interactions during summer season. Among the varieties, cv. GGV 0501 (V_1) recorded significantly higher (267.2) Zn uptake followed by cvs. RNR 15048 (V_2) and BPT 5204 (V_3) (225.6 and 183.8, respectively), among seed rates higher total zinc uptake was recorded with medium (30 kg) and high seed rates (35 kg ha⁻¹) (212.9 and 208.7, respectively), while lower Zn uptake (192.6) occurred with lower seed rate (S_1). Similarly, use of micronutrients revealed significant variations individually and with combined application wherein the latter (M_4) i.e. $\text{FeSO}_4 + \text{ZnSO}_4$ to soil and to the foliage resulted in higher Zn uptake (239.1), while no application of micronutrient (M_1) recorded significantly lower Zn uptake (172.0).

Interaction between variety and seed rate were significant. Cv. GGV 0501 with 30 kg ha⁻¹ seed rate (V_1S_2) recorded higher Zn uptake (323.8), while lower Zn uptake (174.3) was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha⁻¹ (V_3S_1). Variety X micronutrient revealed significant variations, in that cv. GGV 0501 (V_1) with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (V_1M_4) recorded higher Zn uptake (317.4), while lower Zn uptake (151.5) was recorded with cv. BPT 5204 provided with no micronutrient (V_3M_1). Similarly, interaction due to micronutrients and seed rates were significant, wherein 30 kg seed rate with application of $\text{FeSO}_4 + \text{ZnSO}_4$ (S_2M_4) recorded higher Zn uptake (292.7), while 35 kg ha⁻¹ seed rate without supplementation of micronutrient (S_3M_1) recorded lower Zn uptake (178.4).

Among the three factor combinations, significantly higher Zn uptake (369.4) was observed with cv. GGV 0501 sown with 30 kg seed rate and applied with $\text{FeSO}_4 +$

Table 105. Effect of genotypes, seed rates and micronutrients on uptake of iron and zinc under direct seeded condition during summer season

V x S x M		Iron (g ha ⁻¹)				Zinc (g ha ⁻¹)			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	772.2 ^{h-o}	719.7 ^{j-p}	548.9 ^{pq}	680.3^g	203.8 ^{k-q}	183.8 ^{p-s}	147.5 ^{s-t}	178.4ⁱ
	M ₂	906.1 ^{e-k}	778.5 ^{h-o}	642.0 ^{m-q}	775.5^{fg}	230.7 ^{g-c}	196.5 ^{n-r}	168.1 ^{s-t}	198.4^{gh}
	M ₃	994.8 ^{e-g}	817.3 ^{f-n}	713.1 ^{k-p}	841.7^{d-f}	155.8 st	210.7 ^{k-p}	184.6 ^{p-s}	183.7^{hi}
	M ₄	1099.3 ^{c-e}	965.6 ^{e-h}	759.9 ^{i-q}	941.6^{b-d}	278.de	251.9 ^{e-h}	197.0 ^{m-r}	242.6^{cd}
S ₂	M ₁	1269.4 ^{bc}	628.8 ^{n-q}	610.0 ^{o-q}	836.1^{e-f}	294.0 ^{b-d}	174.5 ^{q-t}	163.2 st	210.6^{f-g}
	M ₂	1310.5 ^b	733.1 ^{i-p}	680.7 ^{l-q}	908.1^{c-e}	311.8 ^{bc}	200.3 ^{l-q}	178.3 ^{q-s}	230.1^{de}
	M ₃	1339.0 ^b	993.5 ^{e-g}	705.2 ^{l-q}	1012.6^b	319.9 ^b	258.9 ^{e-h}	185.1 ^{q-s}	254.6^{bc}
	M ₄	2114.8 ^a	1052.7 ^{de}	915.0 ^{e-j}	1360.8^a	369.4 ^a	275.6 ^{d-f}	233.2 ^{g-k}	292.7^a
S ₃	M ₁	802.9 ^{g-o}	843.2 ^{f-l}	520.2 ^q	722.1^{gf}	202.1 ^{l-q}	218.7 ⁱ⁻ⁿ	143.8 ^t	188.2^{hi}
	M ₂	1006.5 ^{ef}	857.9 ^{f-l}	720.7 ^{j-p}	861.7^{d-f}	245.8 ^{f-j}	228.6 ^{h-m}	187.5 ^{n-s}	220.6^{ef}
	M ₃	1207.9 ^{b-d}	926.6 ^{e-i}	770.6 ^{h-o}	968.4^{bc}	289.6 ^{b-d}	247.1 ^{f-i}	200.9 ^{l-q}	245.9^{bd}
	M ₄	1297.6 ^b	978.3 ^{e-g}	837.1 ^{f-m}	1037.7^b	304.0 ^{b-d}	260.2 ^{e-g}	216.3 ^{j-o}	260.2^b
Variety		1176.8^a	857.9^b	702.0^c		267.2^a	225.6^b	183.8^c	
		Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	943.1 ^{cd}	820.3 ^e	666.0 ^f	743.2 ^b	242.3 ^c	210.8 ^e	174.3 ^g	192.6 ^b
	S ₂	1508.4 ^a	852.0 ^{de}	727.7 ^f	789.9 ^a	323.8 ^a	227.3 ^d	190.0 ^f	208.7 ^a
	S ₃	1078.7 ^b	901.5 ^{cd}	712.2 ^f	806.9 ^a	260.4 ^b	238.6^{cd}	187.1 ^{fg}	212.9 ^a
		Variety x Micro			M	Variety x Micro			M
V	M ₁	948.2 ^d	730.5 ^{gh}	559.7 ⁱ	645.1 ^c	233.3 ^d	192.4 ^f	151.5 ^g	172.0 ^d
	M ₂	1074.4 ^c	789.8 ^{fg}	681.1 ^h	735.5 ^b	262.8 ^c	208.5 ^e	178.0 ^f	193.3 ^c
	M ₃	1180.6 ^b	912.5 ^{de}	729.6 ^{gh}	821.1 ^b	288.4 ^b	238.9 ^d	190.2 ^f	214.6 ^b
	M ₄	1503.9 ^a	998.9 ^{cd}	837.3 ^{ef}	918.1 ^a	317.4 ^a	262.6 ^c	215.5 ^e	239.1 ^a
Comparison		S.Em±				S.Em±			
Variety (V)		15.0				3.4			
Seed (S)		11.3				2.5			
Micro (M)		19.3				3.1			
V x S		19.6				4.3			
V x M		33.4				5.4			
S x M		33.4				5.4			
V x S x M		57.9				9.4			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

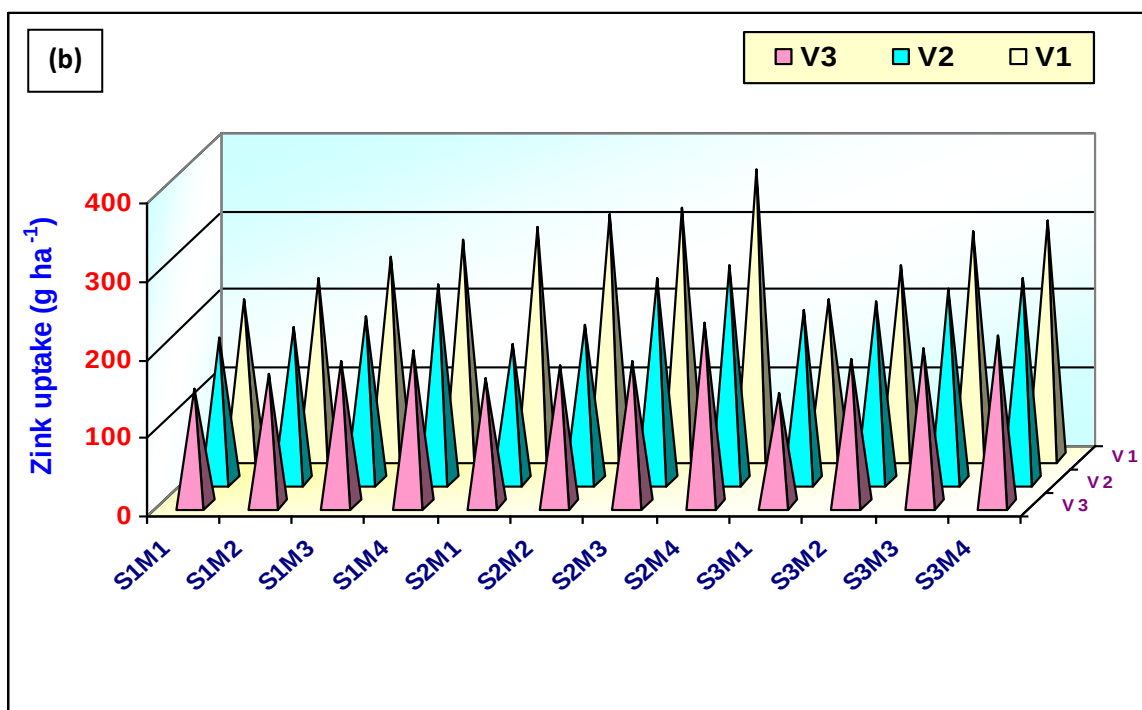
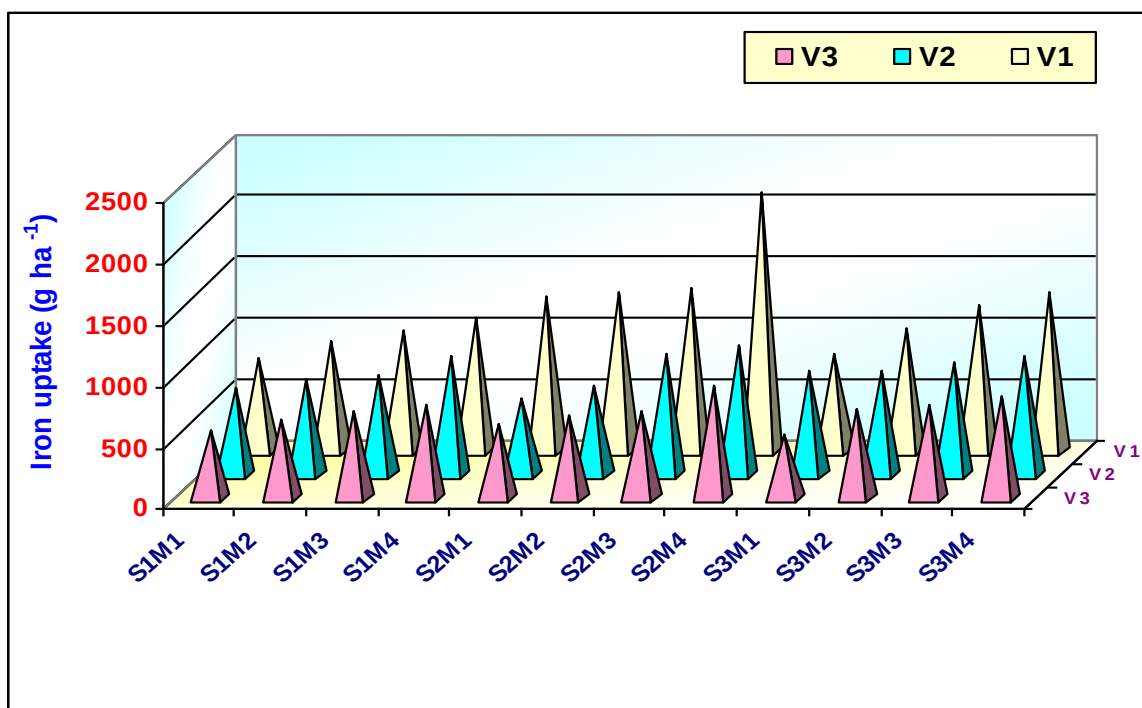
Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT



LEGEND

Varieties: V₁- GGV 0501, V₂- RNR 15048, V₃- BPT 5204;
 Seed Rate: S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
 Micronutrient: M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₄- FeSO₄ + ZnSO₄ (Each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

Fig. 20. Effect of genotypes, seed rates and micronutrients on (a) iron uptake (g ha^{-1}) and (b) zinc uptake (g ha^{-1}) under direct seeded condition during summer season

ZnSO₄ (V₁S₂M₄), while the lowest total zinc uptake (143.8) was recorded with cv. BPT 5204 sown using 35 kg ha⁻¹ seed rate and supplied with no micro nutrient (V₃S₃M₁).

4.1.2.4.6 Copper uptake (g ha⁻¹) (c.f. Table 106)

Copper (Cu) uptake presented significant variations due to cultivars and interactions while main effects due to seed rate (20.8 to 23.4) and micronutrient (18.9 to 26.7) and their interactions (19.9 to 36.0) were not significant during summer season.

Among the varieties, cv. GGV 0501 (V₁) recorded significantly higher (33.9) Cu uptake followed by cvs. RNR 15048 (V₂) and BPT 5204 (V₃) (25.6 and 19.8, respectively).

Interaction between variety and seed rate were significant, among all cv. GGV 0501 (V₁) at 30 kg ha⁻¹ seed rate (V₁S₂) recorded higher Cu uptake (41.4) which was on par with V₁S₁₋₃; while lower Cu uptake (17.6) was recorded with cv. BPT 5204 with lower seed rate of 25kg ha⁻¹ (V₃S₁). Variety X micronutrient again revealed significant variations, in that cv. GGV 0501 (V₁) with application of FeSO₄ + ZnSO₄ (V₁M₄) recorded higher Cu uptake (39.9) and in the absence of micronutrient application Cu uptake decreased particularly with cv. BPT 5204 (V₃M₁) (16.0).

Among the third order interactions significantly higher Cu uptake (49.9) was observed with cv. GGV 0501 (V₁) sown using medium seed rate of 30 kg and applied with both FeSO₄ and ZnSO₄ (V₁S₂M₄), while lower total copper uptake (14.3) was recorded with cv. BPT 5204 sown using 25 kg ha⁻¹ seed rate and supplied with no micro nutrient (V₃S₁ M₁).

4.1.2.4.7 Manganese uptake (g ha⁻¹) (c.f. Table 106)

Total manganese (Mn) uptake varied significantly due to cultivars, seed rates and interactions due to V x S, V x M and V x S x M during summer season.

Among the varieties, cv. GGV 0501 (V₁) recorded significantly higher (2934.3) Mn uptake followed by cvs. RNR 15048 (V₂) and BPT 5204 (V₃) (2528.3 and 2034.1, respectively). Seed rates (2173. 2 to 2390.9) and levels of micronutrients (1877.2 to 2709.4) did not reveal significant variations.

Interaction between variety and seed rate revealed higher total Mn uptake (3435.3) with cv. GGV 0501 (V₁) with 30 kg ha⁻¹ seed rate (V₁S₂) and was on par with

Table 106. Effect of genotypes, seed rates and micronutrients on uptake of copper and manganese under direct seeded condition during summer season

V x S x M		Copper (g ha ⁻¹)				Manganese (g ha ⁻¹)			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	24.6 ^{a-c}	20.8 ^{a-c}	14.3 ^c	19.9 ^a	2110.4 ^{a-c}	2150.1 ^{a-c}	1577.9 ^c	1946.1 ^a
	M ₂	27.2 ^{a-c}	22.5 ^{a-c}	16.8 ^{bc}	22.2 ^a	2399.1 ^{a-c}	2262.9 ^{a-c}	1824.9 ^{bc}	2162.3 ^a
	M ₃	30.5 ^{a-c}	24.4 ^{a-c}	18.4 ^{bc}	24.4 ^a	2613.7 ^{a-c}	2365.2 ^{a-c}	2093.2 ^{a-c}	2357.4 ^a
	M ₄	33.0 ^{a-c}	28.0 ^{a-c}	20.8 ^{bc}	27.3 ^a	2889.2 ^{a-c}	2848.0 ^{a-c}	2262.9 ^{a-c}	2666.7 ^a
S ₂	M ₁	34.7 ^{ab}	20.2 ^{a-c}	18.4 ^{bc}	24.4 ^a	3297.3 ^{ab}	1811.7 ^{a-c}	1705.6 ^{a-c}	2271.5 ^a
	M ₂	38.2 ^{ab}	23.4 ^{a-c}	20.6 ^{a-c}	27.4 ^a	3334.3 ^{ab}	2119.1 ^{a-c}	1942.7 ^{a-c}	2465.4 ^a
	M ₃	42.7 ^a	29.6 ^{a-c}	21.3 ^{a-c}	31.2 ^a	3390.9 ^{ab}	2900.7 ^{a-c}	2002.3 ^{a-c}	2764.6 ^a
	M ₄	49.9 ^a	31.8 ^{a-c}	26.3 ^{a-c}	36.0 ^a	3958.8 ^a	3060.1 ^{a-c}	2695.0 ^{a-c}	3238.0 ^a
S ₃	M ₁	24.3 ^{a-c}	24.3 ^{a-c}	15.2 ^{bc}	21.3 ^a	2097.5 ^{a-c}	2531.9 ^{a-c}	1485.6 ^{a-c}	2038.3 ^a
	M ₂	29.4 ^{a-c}	25.2 ^{a-c}	19.7 ^{a-c}	24.8 ^a	2635.1 ^{a-c}	2608.3 ^{a-c}	2111.6 ^{a-c}	2451.7 ^a
	M ₃	35.3 ^{ab}	27.4 ^{a-c}	22.1 ^{bc}	28.3 ^a	3147.1 ^{ab}	2754.0 ^{a-c}	2245.1 ^{a-c}	2715.4 ^a
	M ₄	36.9 ^{ab}	29.1 ^{a-c}	23.8 ^{bc}	29.9 ^a	3337.9 ^{a-c}	2927.7 ^{a-c}	2462.5 ^{a-c}	2909.4 ^a
Variety		33.9 ^a	25.6 ^b	19.8 ^c		2934.3 ^a	2528.3 ^b	2034.1 ^c	
		Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	28.8 ^{a-c}	23.9 ^{b-e}	17.6 ^e	20.8 ^a	2503.1 ^{a-c}	2406.6 ^{c-e}	1939.7 ^f	2173.2 ^a
	S ₂	41.4 ^v	26.2 ^{b-d}	21.6 ^{c-e}	23.9 ^a	3495.3 ^a	2472.9 ^{a-d}	2086.4 ^{c-e}	2279.7 ^a
	S ₃	31.5 ^{ab}	26.5 ^{b-d}	20.2 ^{de}	23.4 ^a	2804.4 ^{ab}	2705.5 ^{b-e}	2076.2 ^{de}	2390.9 ^a
		Variety x Micro			M	Variety x Micro			M
V	M ₁	27.9 ^{ab}	21.8 ^{ab}	16.0 ^b	18.9 ^a	2501.8 ^a	2164.6 ^{ab}	1589.7 ^b	1877.2 ^a
	M ₂	31.6 ^a	23.7 ^{ab}	19.0 ^b	21.4 ^a	2789.5 ^a	2330.1 ^{ab}	1959.7 ^b	2144.9 ^a
	M ₃	36.1 ^a	27.1 ^{ab}	20.6 ^b	23.9 ^a	3050.6 ^a	2673.3 ^{ab}	2113.5 ^b	2393.4 ^a
	M ₄	39.9 ^a	29.6 ^{ab}	23.7 ^{ab}	26.7 ^a	3395.3 ^a	2945.2 ^{ab}	2473.5 ^b	2709.4 ^a
Comparison		S.Em±				S.Em±			
Variety (V)		0.4				44.5			
Seed (S)		0.3				34.3			
Micro (M)		0.4				36.9			
V x S		0.5				59.3			
V x M		0.7				63.9			
S x M		0.7				63.9			
V x S x M		1.2				110.6			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

V₁S_{1&3}; while lower Mn uptake (1939.7) was recorded with cv. BPT 5204 with lower seed rate of 25 kg ha⁻¹ (V₃S₁). In variety X micronutrient cv. GGV 0501 (V₁) with combined application of FeSO₄ and ZnSO₄ (V₁M₄) recorded higher Mn uptake (3395.3) which was on par with V₂M₁₋₃ and V₂M₁₋₄. In the absence of micronutrient application Mn uptake decreased with lower uptake in cv. BPT 5204 (V₃M₁) (1589.7).

Of the three factor combinations, significantly higher total manganese uptake (3958.8) with cv. GGV 0501 (V₁) sown with 30 kg seed rate and applied with both FeSO₄ and ZnSO₄ (V₁S₂M₄), which was on par with V₁S₁₋₃M₁₋₄, V₂S₁₋₃M₁₋₄ and V₃S₁₋₃M₃₋₄, while the lower Mn uptake (1577.9) was recorded with BPT 5204 sown using 25 kg ha⁻¹ seed rate and supplied with no micro nutrient (V₃S₁ M₁) among all.

4.1.2.5 Post harvest soil chemical properties

4.1.2.5.1 Soil pH (c.f. Table 107)

pH in soil did not reveal significant differences due to main effects and third order interactions. Among others, in V x S, cv. GGV 0501 with 30 kg ha⁻¹ seed rate (V₁S₂) recorded significantly higher pH (8.01) while same cultivar with 25 kg ha⁻¹ seed rate (V₁S₁) had the pH of 7.83, and among seed rate X micronutrient combination, combined application of FeSO₄ and ZnSO₄ with medium seed rate (S_sM₄) recorded higher pH of 8.00; similar seed rate but supplied with ZnSO₄ alone was on par while lower pH of 7.85 occurred with supply of FeSO₄ and seed rate of 25 kg ha⁻¹ (S₁M₂). Three factors combinations had pH ranging from 7.68 to 8.01.

4.1.2.5.2 Soil EC (dS m⁻¹) (c.f. Table 107)

Soil EC revealed favourable range, none of the main effects was significant and so was second order interaction due to V x S, V x M and S x M. Among V x S x M, cv. GGV 0501 sown using 25 kg ha⁻¹ seed rate and supplied with FeSO₄ + ZnSO₄ (V₁S₁M₄) recorded higher EC (0.91) while lower soil EC (0.80) occurred with cv. RNR 15048 sown using 35 kg seed rate and supplied with ZnSO₄ only (V₂S₃M₃).

4.1.2.5.3 Soil organic carbon (%) (c.f. Table 107)

Soil organic carbon (OC) occurred within medium range, while none of the main effects was significant and so was interaction due to seed rate and micronutrient levels. Among V x S, cv. GGV 0501 with 35 kg seed rate (V₁S₃) had higher OC (0.61) while cv.

Table 107. Effect of genotypes, seed rates and micronutrients on soil pH, EC and OC after harvest under direct seeded condition after harvest during summer season

V x S x M		pH				EC (d Sm ⁻¹)				OC (%)			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	7.68 ^a	7.98 ^a	7.97 ^a	7.88^{ab}	0.83 ^{ab}	0.87 ^{ab}	0.87 ^{ab}	0.86^a	0.56 ^{a-e}	0.61 ^{a-d}	0.63 ^{a-c}	0.60^a
	M ₂	7.71 ^a	7.88 ^a	7.98 ^a	7.86^b	0.89 ^{ab}	0.86 ^{ab}	0.83 ^{ab}	0.86^a	0.59 ^{a-d}	0.60 ^{a-d}	0.58 ^{a-d}	0.59^a
	M ₃	7.96 ^a	7.97 ^a	7.96 ^a	7.96^{ab}	0.93 ^{ab}	0.80 ^{bc}	0.93 ^{ab}	0.89^a	0.66 ^{ab}	0.55 ^{a-e}	0.46 ^e	0.56^a
	M ₄	7.96 ^a	7.97 ^a	7.96 ^a	7.96^{ab}	0.98 ^a	0.88 ^{ab}	0.91 ^{ab}	0.92^a	0.54 ^{b-e}	0.60 ^{a-d}	0.50 ^{de}	0.55^a
S ₂	M ₁	8.00 ^a	7.93 ^a	8.01 ^a	7.98^{ab}	0.92 ^{ab}	0.97 ^{ab}	0.83 ^{ab}	0.91^a	0.57 ^{a-e}	0.62 ^{a-d}	0.53 ^{c-e}	0.57^a
	M ₂	8.01 ^a	8.03 ^a	7.95 ^a	8.00^a	0.81 ^{ab}	0.86 ^{ab}	0.88 ^{ab}	0.85^a	0.52 ^{c-e}	0.54 ^{b-e}	0.55 ^{a-e}	0.54^a
	M ₃	8.01 ^a	7.96 ^a	7.99 ^a	7.99^a	0.84 ^{ab}	0.83 ^{ab}	0.82 ^{ab}	0.83^a	0.59 ^{a-d}	0.58 ^{a-e}	0.53 ^{c-e}	0.57^a
	M ₄	8.01 ^a	8.01 ^a	7.97 ^a	8.00^a	0.91 ^{ab}	0.88 ^{ab}	0.91 ^{ab}	0.90^a	0.57 ^{a-e}	0.56 ^{a-e}	0.53 ^{c-e}	0.55^a
S ₃	M ₁	7.98 ^a	8.00 ^a	7.94 ^a	7.97^{ab}	0.88 ^{ab}	0.81 ^{ab}	0.89 ^{ab}	0.86^a	0.61 ^{a-d}	0.57 ^{a-e}	0.56 ^{a-e}	0.58^a
	M ₂	7.98 ^a	7.98 ^a	8.00 ^a	7.99^a	0.83 ^{ab}	0.80 ^c	0.85 ^{ab}	0.83^a	0.58 ^{a-e}	0.57 ^{a-e}	0.54 ^{b-e}	0.56^a
	M ₃	7.98 ^a	7.94 ^a	8.01 ^a	7.98^{ab}	0.85 ^{ab}	0.89 ^{ab}	0.90 ^{ab}	0.88^a	0.59 ^{a-d}	0.59 ^{a-d}	0.52 ^{c-e}	0.57^a
	M ₄	8.00 ^a	7.95 ^a	7.99 ^a	7.98^{ab}	0.91 ^{ab}	0.86 ^{ab}	0.83 ^{ab}	0.87^a	0.67 ^a	0.60 ^{a-d}	0.54 ^{b-e}	0.60^a
Variety		7.94^a	7.97^a	7.98^a		0.88^a	0.86^a	0.87^a		0.59^a	0.58^a	0.54^a	
Variety x Seed rate		S				S				S			
S	S ₁	7.83 ^b	7.95 ^{ab}	7.97 ^{ab}	7.92 ^a	0.91 ^a	0.85 ^a	0.88 ^a	0.88 ^a	0.59 ^{ab}	0.59 ^{ab}	0.54 ^{bc}	0.57 ^a
	S ₂	8.01 ^a	7.98 ^{ab}	7.98 ^{ab}	7.99 ^a	0.87 ^a	0.89 ^a	0.86 ^a	0.87 ^a	0.56 ^{a-c}	0.58 ^{a-c}	0.53 ^c	0.56 ^a
	S ₃	7.99 ^{ab}	7.97 ^{ab}	7.99 ^{ab}	7.98 ^a	0.87 ^a	0.84^a	0.87 ^a	0.86 ^a	0.61 ^a	0.58 ^{a-c}	0.54 ^{bc}	0.58 ^a
Variety x Micro		M				M				M			
M ₄	M ₁	7.89 ^a	7.97 ^a	7.97 ^a	7.94 ^a	0.88 ^a	0.89 ^a	0.87 ^a	0.88 ^a	0.58 ^{ab}	0.60 ^a	0.57 ^{ab}	0.58 ^a
	M ₂	7.90 ^a	7.96 ^a	7.98 ^a	7.95 ^a	0.84 ^a	0.84 ^a	0.85 ^a	0.84 ^a	0.57 ^{ab}	0.57 ^{ab}	0.55 ^{a-c}	0.56 ^a
	M ₃	7.98 ^a	7.96 ^a	7.99 ^a	7.98 ^a	0.87 ^a	0.84 ^a	0.88 ^a	0.86 ^a	0.61 ^a	0.57 ^{ab}	0.50 ^c	0.56 ^a
	M ₄	7.99 ^a	7.97 ^a	7.97 ^a	7.98 ^a	0.93 ^a	0.87 ^a	0.87 ^a	0.89 ^a	0.59 ^a	0.59 ^a	0.52 ^{bc}	0.57 ^a
Comparison		S.E.m±				S.E.m±				S.E.m±			
Variety (V)		0.04				0.04				0.04			
Seed (S)		0.03				0.02				0.01			
Micro (M)		0.02				0.02				0.01			
V x S		0.05				0.03				0.02			
V x M		0.04				0.03				0.02			
S x M		0.04				0.03				0.02			
V x S x M		0.07				0.05				0.03			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)
M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

BPT 5204 with medium seed rate (V_3S_2) had lower soil OC (0.53), among $V \times M$, cv. GGV 0501 with $ZnSO_4$ alone (V_1M_3) and $FeSO_4 + ZnSO_4$ (V_1S_4) had higher soil OC (0.61 and 0.59, respectively), while lower OC (0.50) was observed with cv. BPT 5204 supplied with $ZnSO_4$ alone (V_3M_3), and among $V \times S \times M$, cv. GGV 0501 sown using 35 $kg\ ha^{-1}$ seed rate and supplied with $FeSO_4 + ZnSO_4$ ($V_1S_3M_4$) while lower soil OC (0.50) occurred with cv. BPT 5204 sown using 25 kg seed rate and supplied with $ZnSO_4$ only ($V_3S_1M_3$).

4.1.2.5.4 Soil available nitrogen ($kg\ ha^{-1}$) (c.f. Table 108)

Available N varied significantly due to cultivars, seed rates and their interactions except main effects due to micronutrients and interaction due to seed rate and micronutrients during summer.

Significantly higher N (260.7) was recorded with the cv. BPT 5204 (V_3) which was on par with cv. RNR 15048 (V_2) while lower N was recorded in cv. GGV 0501 (V_1), and among the seed rates used, significantly higher N availability (256.6) was found at seed rate of 25 $kg\ ha^{-1}$ (V_1) and was on par with S_3 while lower available N (249.9) was recorded with seed rate of 30 $kg\ ha^{-1}$ (M_2).

Variety $\times$ seed rate revealed that cv. BPT 5204 seeds sown at 25 $kg\ ha^{-1}$ (V_3S_1) had significantly higher available N (264.1) which was on par with $V_3S_{2\&3}$ while lower soil available N (240.3) was recorded with cv. GGV 0501 at seed rate of 30 $kg\ ha^{-1}$ (V_1S_2), among variety $\times$ micronutrient cv. BPT 5204 irrespective of levels of micronutrients (V_3M_{1-4}) revealed higher N particularly in V_3M_1 (262.2), while lower N (244.0) was recorded with cv. GGV 0501 with application of $FeSO_4 + ZnSO_4$ (V_1M_4).

On the whole, Variety $\times$ seed rate $\times$ micronutrients interaction revealed higher soil available N (265.8) with cv. BPT 5204 sown with 25 kg seed rate and with no supply of micronutrient; in fact all combinations of cv. BPT 5204 were on par, while lower N (236.6) was recorded with cv. GGV 0501 sown using 30 $kg\ ha^{-1}$ seed rate and supplied with $FeSO_4 + ZnSO_4$ ($V_1S_2M_4$).

4.1.2.5.5 Soil available phosphorus ($kg\ ha^{-1}$) (c.f. Table 108)

Variations in available P revealed significant differences due to cultivars, seed rates and their interactions except main effects due to micronutrients

Significantly higher available P (41.8) was recorded with the cv. BPT 5204 (V_3) among cultivars; while lower P (27.6) was recorded in cv. GGV 0501 (V_1), among the seed rates used, significantly higher P (37.3) was found at seed rate of 25 kg ha⁻¹ (S_1); while lower P (32.3) was recorded at seed rate of 30 kg ha⁻¹ (S_2), and among micronutrients no application (M_1) recorded significantly higher P (36.1); while lower soil available P (33.7) was recorded with application of both the micronutrients (M_4).

Variety X seed rate interaction revealed significant difference in availability of P, in that cv. BPT 5204 seeds sown at 25 kg ha⁻¹ (V_3S_1) recorded significantly higher availability of P (45.0), while lower P was recorded with cv. GGV 0501 (V_1S_2) at seed rate of 30 kg ha⁻¹ (26.7). Interactions between Variety X micronutrient again revealed significant variations, in that cv. BPT 5204 with all micronutrient levels (V_3M_{1-4}) had higher P availability particularly in V_3M_1 (43.5); while lowest was recorded with cv. GGV 0501 at all micronutrient levels (V_1M_{1-4}) especially in V_1M_4 (26.5). Similarly, interactions due to micronutrients and seed rates were significant, wherein 25 kg seed rate with no application of micronutrients (S_1M_1) had higher available P (48.2) and it was at par with $S_{1-3}M_{1-3}$, while 30 kg ha⁻¹ seed rate with supplementation of both the micronutrients (S_2M_4) recorded lower phosphorus availability (31.6).

Overall, the three way interactions brought out significant difference in P availability in soil. Among all, cv. BPT 5204 sown with 25 kg seed rate without application of micronutrients ($V_3S_1M_1$) recorded significantly higher (48.2) availability of P and was on par with $V_3S_1M_{1-4}$. While the lowest availability of P was recorded with cv. GGV 0501 sown using 30 kg ha⁻¹ seed rate with application of $FeSO_4$ and $ZnSO_4$ individually and combined application of $FeSO_4 + ZnSO_4$ ($V_1S_2M_{2-4}$) particularly with $V_1S_2M_4$ (25.0) .

4.2.2.5.6 Soil available potassium (kg ha⁻¹) (c.f. Table 108)

Data on available K revealed significant variations due to cultivars, seed rates and their interactions except micronutrients.

Significantly higher available K (396.7) was recorded with the cv. BPT 5204 (V_3) which was on par with cv. RNR 15048 (V_2); while lower K (355.4) was recorded in cv. GGV 0501 (V_1), among the seed rates used, significantly higher K availability (382.7)

Table 108. Effect of genotypes, seed rates and micronutrients on soil available nitrogen, phosphorous and potassium after harvest under direct seeded condition after harvest during summer season

V x S x M		Nitrogen (kg ha ⁻¹)				Phosphorus (kg ha ⁻¹)				Potassium (kg ha ⁻¹)			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	251.0 ^{a-c}	256.3 ^{a-c}	265.8 ^a	257.7 ^a	31.8 ^{j-o}	38.1 ^{e-i}	48.2 ^a	39.4 ^a	362.5 ^{e-g}	386.5 ^{a-f}	413.8 ^a	387.6 ^a
	M ₂	250.3 ^{a-c}	255.9 ^{a-c}	264.4 ^a	256.9 ^a	29.8 ^{k-p}	37.9 ^{e-i}	44.2 ^{ab}	37.3 ^{ab}	361.6 ^{a-g}	376.6 ^{a-g}	410.2 ^{ab}	382.8 ^{ab}
	M ₃	250.2 ^{a-c}	255.2 ^{a-c}	263.4 ^a	256.3 ^a	29.4 ^{k-p}	36.3 ^{f-j}	43.9 ^{a-c}	36.5 ^{ab}	361.0 ^{e-g}	376.4 ^{a-g}	405.7 ^{a-c}	381.0 ^{ab}
	M ₄	249.0 ^{a-c}	254.8 ^{a-c}	262.6 ^{ab}	255.5 ^a	28.9 ^{l-p}	35.9 ^{g-j}	43.5 ^{a-d}	36.1 ^{bc}	359.8 ^{e-g}	374.7 ^{b-g}	403.9 ^{a-c}	379.5 ^{ab}
S ₂	M ₁	244.9 ^{a-c}	251.7 ^{a-c}	258.2 ^{a-c}	251.6 ^a	25.8 ^p	33.6 ^{h-m}	39.6 ^{b-g}	33.0 ^{e-e}	351.8 ^{fg}	368.6 ^{c-g}	388.4 ^{a-f}	369.6 ^{ab}
	M ₂	240.6 ^{bc}	251.4 ^{a-c}	258.1 ^{a-c}	250.0 ^a	25.5 ^p	33.3 ^{h-m}	38.8 ^{b-h}	32.5 ^{de}	348.3 ^g	365.8 ^{d-g}	388.2 ^{a-f}	367.4 ^{ab}
	M ₃	238.9 ^{bc}	251.4 ^{a-c}	257.7 ^{a-c}	249.3 ^a	25.0 ^p	33.0 ^{h-n}	38.5 ^{c-h}	32.2 ^{de}	348.0 ^g	364.7 ^{d-g}	387.3 ^{a-f}	366.7 ^{ab}
	M ₄	236.6 ^c	251.1 ^{a-c}	257.5 ^{a-c}	248.4 ^a	24.2 ^p	32.5 ⁱ⁻ⁿ	38.1 ^{d-i}	31.6 ^e	341.7 ^g	362.8 ^{e-g}	387.1 ^{a-f}	363.9 ^b
S ₃	M ₁	247.3 ^{a-c}	254.4 ^{a-c}	262.5 ^{ab}	254.7 ^a	28.9 ^{l-p}	35.9 ^{g-k}	42.6 ^{b-e}	35.8 ^{bc}	359.7 ^{e-g}	374.5 ^{b-g}	400.5 ^{a-d}	378.2 ^{ab}
	M ₂	246.5 ^{a-c}	253.6 ^{a-c}	260.5 ^{ab}	253.5 ^a	28.6 ^{m-p}	34.7 ^{g-k}	42.3 ^{b-e}	35.2 ^{b-d}	359.6 ^{e-g}	373.9 ^{b-g}	394.1 ^{a-e}	375.9 ^{ab}
	M ₃	246.5 ^{a-c}	253.4 ^{a-c}	258.6 ^{a-c}	252.8 ^a	27.4 ^{n-p}	33.8 ^{h-l}	41.7 ^{b-f}	34.3 ^{b-e}	358.4 ^{e-g}	373.3 ^{c-g}	392.2 ^{a-e}	374.6 ^{ab}
	M ₄	246.2 ^{a-c}	252.3 ^{a-c}	258.5 ^{a-c}	252.3 ^a	26.3 ^{op}	33.7 ^{h-m}	39.8 ^{b-g}	33.3 ^{c-e}	352.0 ^{f-g}	372.6 ^{c-g}	388.6 ^{a-f}	371.1 ^{ab}
Variety		245.7 ^b	253.5 ^{ab}	260.7 ^a		27.6 ^c	34.9 ^b	41.8 ^a		355.4 ^b	372.5 ^{ab}	396.7 ^a	
Variety x Seed rate		S				S				S			
S	S ₁	250.1 ^{cd}	255.6 ^{bc}	264.1 ^a	256.6 ^a	30.0	37.0 ^{bc}	45.0 ^a	37.3 ^a	361.2 ^{e-g}	378.6 ^{cd}	408.4 ^a	382.7 ^a
	S ₂	240.3 ^e	251.4 ^{cd}	257.9 ^{a-c}	249.9 ^b	25.1 ^f	33.1 ^d	38.8 ^b	32.3 ^c	347.5 ^g	365.5 ^{d-f}	387.7 ^{bc}	366.9 ^b
	S ₃	246.6 ^{de}	253.4 ^{bd}	260.0 ^{ab}	253.3 ^{ab}	27.8 ^e	34.5 ^{cd}	41.6 ^b	34.6 ^b	357.4 ^{fg}	373.6 ^{de}	393.8 ^b	374.9 ^a
Variety x Micro		M				M				M			
M ₄	M ₁	247.7 ^{bc}	254.1 ^{a-c}	262.2 ^a	254.7 ^a	28.8 ^c	35.9 ^b	43.5 ^a	36.1 ^a	358.0 ^{cd}	376.5 ^{bc}	400.9 ^a	378.5 ^a
	M ₂	245.8 ^c	253.6 ^{a-c}	261.0 ^a	253.5 ^a	28.0 ^c	35.3 ^b	41.8 ^a	35.0 ^{ab}	356.5 ^{cd}	372.1 ^c	397.5 ^e	375.4 ^d
	M ₃	245.2 ^c	253.3 ^{a-c}	259.9 ^{ab}	252.8 ^a	27.3 ^c	34.4 ^b	41.4 ^a	34.4 ^b	355.8 ^{cd}	371.5 ^{cd}	395.1 ^a	374.1 ^a
	M ₄	244.0 ^c	252.7 ^{a-c}	259.5 ^{ab}	252.1 ^a	26.5 ^c	34.0 ^b	40.5 ^a	33.7 ^d	351.2 ^d	370.0 ^{cd}	393.2 ^{ab}	371.5 ^a
Comparison		S.E.m±				S.E.m±				S.E.m±			
Variety (V)		2.1				1.2				7.9			
Seed (S)		1.4				0.5				2.5			
Micro (M)		2.2				0.6				3.6			
V x S		2.4				0.9				4.4			
V x M		3.8				1.0				6.3			
S x M		3.8				1.0				6.3			
V x S x M		6.5				1.7				10.9			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

was found at seed rate of 25 kg ha⁻¹ (S₁) which was on par with S₃, while lower K (374.9) was recorded at seed rate of 30 kg ha⁻¹ (S₂).

Among variety X seed rate cv. BPT 5204 seeds sown at 25 kg ha⁻¹ (V₃S₁) recorded significantly higher availability of K (408.4), while lower K status (357.4) was recorded with cv. GGV 0501 at seed rate of 30 kg ha⁻¹ (V₁S₂), among variety X micronutrient cv. BPT 5204 with no micronutrient application (V₃M₁) recorded higher K availability (400.9), while lower K (351.2) was recorded with cv. GGV 0501 with application of FeSO₄+ZnSO₄ (V₁M₄), and among seed rates and micronutrients 25 kg seed rate with no application of micronutrients (V₁M₁) recorded higher soil K (379.4), while 30 kg ha⁻¹ seed rate with supplementation of both the micronutrients (S₂M₄) recorded lower K availability (363.9).

Variety X seed rate X micronutrients revealed significantly higher K (413.8) in soil with cv. BPT 5204 sown using 25 kg seed rate and applied with no micronutrients (V₃S₁M₁), while lower availability of potassium (341.7) was recorded with cv. GGV 0501 sown using 30 kg ha⁻¹ seed rate and supplied with FeSO₄ + ZnSO₄ (V₁S₂M₄).

4.1.2.5.7 Soil available iron (mg kg⁻¹) (c.f. Table 109)

Available Fe varied significantly due to cultivars, seed rates and use of micronutrients and their interaction.

Significantly higher available Fe (15.23) was recorded with the cv. BPT 5204 (V₃) among all; while lower Fe (11.89) was recorded in cv. GGV 0501 (V₁), among seed rates, lower seed rate (S₁) recorded significantly higher soil Fe (14.13) availability of iron content in soil (S₁) and S₃ was at par; and lower Fe was recorded with S₂ (12.80), and among micronutrient levels significantly higher Fe (13.70) occurred with supply of both the micronutrients (M₄), while lower soil Fe (13.23) was recorded when no micronutrients applied.

In V x S, cv. BPT 5204 at all seed rates recorded significantly higher availability of Fe (16.60) particularly with 30 kg ha⁻¹ (V₃S₂), while lower soil Fe was recorded with cv. GGV 0501 at all seed rates especially with of 25 kg ha⁻¹ (V₂S₁) (10.80). among variety X micronutrient cv. BPT 5204 with combined application of micronutrient (iron and zinc) (V₃M₄) recorded higher available Fe (15.30) and it was on par with V₃M_{2&3}, while lower soil Fe was recorded with cv. GGV 0501 across micronutrient levels (V₂M₁).

4) especially in V_1M_1 (11.30), and among seed rate X micronutrient S_1M_4 recorded significantly higher availability of Fe, while lower Fe (12.47) was recorded with 30 kg seed rate without application of micronutrient (S_2M_1).

Of the third order interactions cv. BPT 5204 at all seed rates and micronutrient levels recorded significantly higher soil available Fe particularly with $V_3S_2M_4$ (15.80), while lower available Fe was recorded with cv. GGV 0501 sown using 30 kg ha⁻¹ seed rate without application of micronutrient ($V_1S_2M_1$) (10.00) .

4.1.2.5.8 Soil available zinc (mg kg⁻¹) (c.f. Table 109)

The data on available Zn revealed significant differences due to cultivars, seed rates and interactions except main effects due to micronutrients during summer.

BPT 5204 (V_3) among cultivars recorded higher soil available Zn (4.01); while lower Zn (2.60) was recorded with cv. GGV 0501 (V_1), and among the seed rates used, significantly higher available Zn (3.62) was found at the seed rate of 25 kg ha⁻¹ (S_1) while lower Zn (3.00) was recorded at seed rate of 30 kg ha⁻¹ (S_2).

Variety X seed rate revealed significantly higher available zinc (4.50) with cv. BPT 5204 seeds sown using 25 kg ha⁻¹ seed rate (V_3S_1); while significantly lower Zn (2.88) was recorded with cv. GGV 0501 at 30 kg ha⁻¹ (V_1S_2) (2.88), among variety X micronutrient cv. BPT 5204 with combined application of micronutrient (iron and zinc) (V_3M_4) recorded higher available Zn (4.22); while lower available Zn (2.52) was recorded with cv. GGV 0501 without micro nutrient application (V_1M_1), and among seed rate X micronutrient levels, S_1M_4 had higher available Zn (3.76); while lower available Zn (2.88) was recorded with medium seed rate and no supply of micronutrient (S_2M_2); other seed rates at same level of micronutrient were on par.

Overall, of the three way interaction cv. BPT 5204 at 25 kg ha⁻¹ seed rate and application of ZnSO₄ alone ($V_3S_1M_3$) recorded significantly higher available Zn (4.67); it was on par with $V_3S_1M_{1,2\&4}$, while lower available Zn (2.05) was recorded with cv. GGV 0501 sown using 30 kg ha⁻¹ seed rate but without application of micronutrient ($V_1S_2M_1$).

Table 109. Effect of genotypes, seed rates and micronutrients on soil available iron and zinc after harvest under direct seeded condition after harvest during summer season

V x S x M		Iron (mg kg ⁻¹)				Zinc (mg kg ⁻¹)			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	12.20 ^{b-j}	14.00 ^{a-h}	15.40 ^{b-i}	13.87^{ab}	2.86 ^{d-i}	3.42 ^{b-f}	4.27 ^{a-c}	3.52^{ab}
	M ₂	12.60 ^{g-j}	14.10 ^{a-g}	15.60 ^{a-h}	14.10^a	2.87 ^{d-i}	3.42 ^{d-i}	4.31 ^{ab}	3.53^{ab}
	M ₃	12.70 ^{f-j}	14.20 ^{a-g}	15.70 ^{ab}	14.20^a	2.88 ^{d-i}	3.42 ^{b-f}	4.67 ^a	3.66^a
	M ₄	12.90 ^{e-j}	14.40 ^{a-g}	15.80 ^{ab}	14.37^a	2.90 ^{d-i}	3.64 ^{a-f}	3.83 ^{a-f}	3.46^{ab}
S ₂	M ₁	10.00 ^k	12.90 ^{e-j}	14.50 ^a	12.47^c	2.05 ⁱ	2.91 ^{d-i}	3.69 ^{a-f}	2.88^b
	M ₂	11.10 ^{jk}	13.00 ^{d-j}	14.50 ^a	12.87^{bc}	2.13 ^{hi}	2.93 ^{d-i}	3.78 ^{a-f}	2.95^b
	M ₃	11.10 ^{jk}	13.00 ^{d-j}	14.70 ^{a-f}	12.93^{bc}	2.15 ^{g-i}	2.99 ^{d-i}	3.81 ^{a-f}	2.98^{ab}
	M ₄	12.90 ^{e-j}	14.40 ^{a-g}	15.80 ^a	14.37^a	2.63 ^{f-i}	3.05 ^{d-i}	3.83 ^{a-f}	3.17^{ab}
S ₃	M ₁	11.70 ^{i-k}	13.30 ^{c-i}	15.00 ^{a-d}	13.33^{a-c}	2.65 ^{f-i}	3.28 ^{b-i}	3.84 ^{a-f}	3.26^{ab}
	M ₂	11.80 ^{i-k}	13.30 ^{c-i}	15.20 ^{a-c}	13.43^{a-c}	2.65 ^{e-i}	3.34 ^{b-h}	4.00 ^{a-e}	3.33^{ab}
	M ₃	11.80 ^{i-k}	13.60 ^{b-i}	15.20 ^{a-c}	13.53^{a-c}	2.67 ^{f-i}	3.39 ^{b-g}	4.06 ^{a-e}	3.37^{ab}
	M ₄	11.90 ^{i-k}	14.00 ^{a-h}	15.30 ^{a-c}	13.73^{ab}	2.80 ^{e-i}	3.41 ^{b-f}	4.08 ^{a-d}	3.43^{ab}
Variety		11.89^c	13.68^b	15.23^a		2.60^c	3.27^b	4.01^a	
		Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	12.60 ^{ef}	14.20 ^{b-d}	15.60 ^a	14.13 ^a	2.88 ^e	3.48 ^{b-d}	4.50 ^a	3.62 ^a
	S ₂	10.80 ^g	13.00 ^{d-f}	14.60 ^a	12.80 ^b	2.24 ^g	2.97 ^{d-f}	3.78 ^{bc}	3.00 ^b
	S ₃	11.80 ^{fg}	13.60 ^{c-e}	15.20 ^a	13.53 ^a	2.69 ^{f-g}	3.36^{c-e}	3.99 ^{ab}	3.35 ^{ab}
		Variety x Micro			M	Variety x Micro			M
V	M ₁	11.30 ^c	13.40 ^b	15.00 ^b	13.23 ^b	2.52 ^e	3.20 ^{cd}	3.93 ^{ab}	3.22 ^a
	M ₂	11.80 ^c	13.50 ^b	15.10 ^a	13.47 ^{ab}	2.55 ^{de}	3.23 ^{cd}	4.03 ^a	3.27 ^a
	M ₃	11.90 ^c	13.60 ^b	15.20 ^a	13.57 ^{ab}	2.57 ^{de}	3.27 ^c	4.18 ^a	3.34 ^a
	M ₄	12.00 ^c	13.80 ^d	15.30 ^a	13.70 ^a	2.78 ^{c-e}	3.37 ^{bc}	4.22 ^a	3.46 ^a
Comparison		S.E.m±				S.E.m±			
Variety (V)		0.10				0.14			
Seed (S)		0.23				0.10			
Micro (M)		0.20				0.12			
V x S		0.40				0.17			
V x M		0.35				0.21			
S x M		0.35				0.21			
V x S x M		0.61				0.36			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

4.1.2.5.9 Soil available copper (mg kg^{-1}) (c.f. Table 110)

Available Cu varied significantly due to cultivars, seed rates, micronutrients and their interactions while main effects due to micronutrients and V x M were not significant during summer.

Among the cultivars, significantly higher available Cu (3.30) was recorded with the cv. BPT 5204 (V_3); while lower Cu (2.70) was recorded with cv. GGV 0501 (V_1), and among the seed rates used, significantly higher available Cu (3.52) was found with lower seed rate of 25 kg ha^{-1} (S_1), while lower available Cu (3.15) was recorded with medium seed rate of 30 kg ha^{-1} (S_2).

Variety X seed rate revealed significantly higher available Cu (3.52) with cv. BPT 5204 sown at 25 kg ha^{-1} seed rate (V_3S_1); while lower available Cu (2.53) was recorded with cv. GGV 0501 sown using higher seed rate (V_1S_3), and among seed rate and micronutrients higher available Cu (3.24) occurred with lower seed rate and supply of both the micronutrients (S_1M_4); while lower soil Cu status (2.85) occurred with medium seed rate and no supplementation of micronutrients (S_2M_1).

BPT 5204 with 25 kg ha^{-1} seed rate and combined application of both the micronutrient ($V_3S_1M_4$) recorded significantly higher available Cu (3.68); while lower available Cu was recorded with cv. GGV 0501 sown using 30 kg ha^{-1} seed rate and not supplied with micronutrient ($V_1S_2M_1$) (2.51) .

4.1.2.5.10 Soil available manganese (mg kg^{-1}) (c.f. Table 110)

Variations in available Mn revealed significant differences due to cultivars, seed rates and their interactions during summer.

Among the cultivars, significantly higher available Mn (11.34) was recorded with cv. BPT 5204 (V_3); while lower Mn (8.05) was recorded in cv. GGV 0501 (V_1), among the seed rates used, significantly higher available Mn (10.60) was found with lower seed rate of 25 kg ha^{-1} (S_1); while lower status (8.57) was recorded with medium seed rate of 30 kg ha^{-1} (S_2), and among levels of micronutrients significantly higher Mn (9.76) was recorded with combined application of both the micronutrients (M_4) which was on par with M_2 and M_3 ; while lower Mn occurred was recorded in M_1 (8.83)

Table 110. Effect of genotypes, seed rates and micronutrients on soil available copper and manganese after harvest under direct seeded condition after harvest during summer season

V x S x M		Copper (mg kg ⁻¹)				Manganese (mg kg ⁻¹)			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	2.71 ^{g-l}	3.08 ^{c-h}	3.39 ^{a-c}	3.06^{a-c}	8.28 ^{b-f}	8.94 ^{b-f}	10.55 ^b	9.26^b
	M ₂	2.73 ^{f-l}	3.11 ^{c-g}	3.41 ^{a-c}	3.08^{a-c}	8.34 ^{b-f}	9.08 ^{b-f}	15.27 ^a	10.90^a
	M ₃	2.80 ^{e-l}	3.12 ^{c-g}	3.62 ^{ab}	3.18^{ab}	8.34 ^{b-f}	9.20 ^{b-f}	15.36 ^a	10.97^a
	M ₄	2.90 ^{d-l}	3.14 ^{c-g}	3.68 ^a	3.24^a	8.35 ^{b-f}	9.34 ^{b-f}	16.10 ^a	11.26^b
S ₂	M ₁	2.51 ^l	2.91 ^{d-l}	3.14 ^{c-g}	2.85^c	7.23 ^f	8.35 ^{b-f}	9.38 ^{b-f}	8.32^b
	M ₂	2.52 ^l	2.95 ^{c-l}	3.14 ^{c-g}	2.87^c	7.61 ^f	8.40 ^{b-f}	9.47 ^{b-f}	8.49^b
	M ₃	2.54 ^l	2.96 ^{c-l}	3.14 ^{c-g}	2.88^c	7.85 ^{d-f}	8.42 ^{b-f}	8.52 ^{b-f}	8.26^b
	M ₄	2.55 ^{kl}	2.96 ^{c-l}	3.16 ^{c-g}	2.89^c	7.94 ^{d-f}	8.49 ^{b-f}	10.14 ^{b-e}	8.86^b
S ₃	M ₁	2.60 ^{j-l}	3.01 ^{c-k}	3.20 ^{b-f}	2.94^{bc}	8.05 ^{c-f}	8.49 ^{b-f}	10.25 ^{b-d}	8.93^b
	M ₂	2.61 ^{i-l}	3.04 ^{c-j}	3.25 ^{a-e}	2.97^{bc}	8.10 ^{c-f}	8.51 ^{b-f}	10.30 ^{bc}	8.97^b
	M ₃	2.65 ^{h-l}	3.04 ^{c-j}	3.28 ^{a-d}	2.99^{a-c}	8.28 ^{b-f}	8.59 ^{b-f}	10.32 ^{bc}	9.06^b
	M ₄	2.71 ^{g-l}	3.07 ^{c-i}	3.37 ^{a-d}	3.05^{a-c}	8.28 ^{b-f}	8.83 ^{b-f}	10.37 ^{bc}	9.16^b
Variety		2.70^c	3.00^b	3.30^a		8.05^c	8.72^b	11.34^a	
		Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	2.78 ^e	3.11 ^c	3.52 ^a	3.14 ^a	8.33 ^{de}	9.14 ^{cd}	14.32 ^a	10.60 ^a
	S ₂	2.53 ^f	2.95 ^d	3.15 ^c	2.88 ^c	7.66 ^e	8.42 ^{de}	9.63 ^{bc}	8.57 ^b
	S ₃	2.64 ^f	3.04 ^{cd}	3.28 ^b	2.99 ^b	8.18 ^{de}	8.61^{c-e}	10.31 ^b	9.03 ^b
		Variety x Micro			M	Variety x Micro			M
V	M ₁	2.61 ^a	3.00 ^a	3.24 ^a	2.95 ^a	7.85 ^c	8.59 ^c	10.06 ^b	8.83 ^b
	M ₂	2.62 ^a	3.04 ^a	3.26 ^a	2.97 ^a	8.02 ^c	8.66 ^c	11.68 ^a	9.45 ^{ab}
	M ₃	2.66 ^a	3.04 ^a	3.35 ^a	3.02 ^a	8.16 ^c	8.74 ^c	11.73 ^a	9.54 ^a
	M ₄	2.72 ^a	3.05 ^a	3.40 ^a	3.06 ^a	8.19 ^c	8.88 ^c	12.20 ^a	9.76 ^{ab}
Comparison		S.Em±				S.Em±			
Variety (V)		0.05				0.49			
Seed (S)		0.02				0.18			
Micro (M)		0.05				0.22			
V x S		0.04				0.32			
V x M		0.08				0.39			
S x M		0.08				0.39			
V x S x M		0.14				0.67			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Interaction due to variety X seed rate revealed significant differences in available manganese, in that cv. BPT 5204 sown at 25 kg ha⁻¹ seed rate (V₃S₂) recorded significantly higher available Mn (14.32), while lower Mn (7.66) was recorded with cv. GGV 0501 at seed rates of 30 kg ha⁻¹(V₁S₂), among variety X micronutrient cv. BPT 5204 with combined application of micronutrient (iron and zinc) (V₃M₄) recorded higher available Mn status (12.20); while lower Mn was recorded with cv. GGV 0501 at all micronutrient levels (V₁M₁₋₄) especially in V₁M₁ (7.85), among seed rate and micronutrient levels lower seed rate of 25 kg ha⁻¹ alongwith application of ferrous sulphate and zinc sulphate (S₁M₄) recorded higher available Mn (11.26);while lower Mn (8.32) was recorded with 30 kg ha⁻¹ without application of micronutrients (S₂M₁).

Among all, cv. BPT 5204 at 25 kg ha⁻¹seed rate with combined application of micronutrients recorded (V₃S₁M₄) significantly higher available Mn (16.10); and was on par V₃S₁M_{2&3}, while lower Zn (7.23) was recorded with cv. GGV 0501 sown using 30 kg ha⁻¹ seed rate without application of micronutrient (V₁S₂M₁).

4.1.2.6 Economics

4.1.2.6.1 Gross returns (₹ ha⁻¹) (c.f. Table 111)

Gross returns varied significantly due to cultivars, seed rates and use of micronutrients. All interactions were not significant except V X S interactions.

Among the varieties, cv. GGV 0501 (V₁) recorded significantly higher gross return (₹ 1,17,776/-) followed by cvs. RNR 15048 (V₂) and BPT 5204 (V₂) and both were at par (₹ 1,01,086/- and ₹ 1,00,060/- respectively); among seed rates higher gross return (₹ 1,11,710/-) was recorded with medium seed rate of 30 kg ha⁻¹ (S₂); gross returns decreased with lower and higher seed rates and both seed rates (S₁ and S₃) were at par, and among micronutrients combined application of FeSO₄ and ZnSO₄ (M₄) resulted in higher gross returns (₹ 1,15,930/-); while no application of micronutrient (M₁) recorded significantly lower gross return (₹ 98,857/-). Interactions due to variety and seed rates revealed significant difference in gross returns, in that cv. GGV 0501 with 30 kg ha⁻¹ seed rates were recorded significantly higher gross returns (₹ 1,27,022/-) and lower was recorded in cv. BPT 5204 at 35 kg ha⁻¹ seed rates (₹ 97371/-) Among the three treatment combinations gross returns varied from ₹ 81,686/- (V₂S₁M₁) to ₹ 1,35,745/- (V₁S₂M₄).

4.1.2.6.2 Net returns (₹ ha⁻¹) (c.f. Table 111 and Fig. 21a)

Net returns revealed almost identical variations as that of gross returns and variations were significant due to cultivars, seed rates and use of micronutrients. All interactions were not significant except V X S interactions. Among the varieties, cv. GGV 0501 (V₁) recorded significantly higher net returns (₹ 64,838/-) followed by cv. RNR 15048 (V₂) and both were at par; while lower net returns (₹ 47,121/-) were recorded with cv. BPT 5204 (V₃), among seed rates higher net returns (₹ 58,721/-) were recorded with medium seed rate of 30 kg ha⁻¹; net returns decreased with lower and higher seed rate and both were at par seed rate (S₁ and S₃), levels of micronutrients revealed significant variations, in that combined application (M₄) resulted in higher net returns (₹ 62,104/-); while no application of micronutrient (M₁) recorded significantly lower net returns (₹ 42,607/-). Among the three factor combinations, net returns varied from ₹ 29,525 /-(V₂S₁M₁) to ₹ 81,969/-(V₁S₂M₄).

4.1.2.6.3 B: C ratio (c.f. Table 111 and Fig. 21b)

B: C ratio varied significantly due to cultivars, seed rates and use of micronutrients and their interactions during summer.

Among the varieties, cv. GGV 0501 recorded significantly higher B: C ratio (2.22) followed by cvs. RNR 15,048 (V₂) and BPT 5204 (V₃) (1.90 and 1.89, respectively) and both were at par, among seed rates higher B: C ratio (2.11) was recorded with medium seed rate of 30 kg ha⁻¹ (S₂); B: C ratio decreased with lower (S₁) and higher (S₃) seed rates and both were at par. Similarly, use of micronutrients revealed significant variations individually and with combined application wherein the latter (M₄) i.e. combined application FeSO₄ and ZnSO₄ to soil and to the foliage resulted in higher B: C ratio (2.15) and was on par with M₃, while no application of micronutrient (M₁) recorded significantly lower B: C ratio (1.82).

Interactions between variety and seed rate were significant, among all cv. GGV 0501 at 30 kg ha⁻¹ seed rate (V₁S₂) recorded higher B: C ratio (2.40); while lower B: C ratio (1.83) was recorded with cv. BPT 5204 with higher seed rate of 35 kg ha⁻¹ (V₃S₃), among variety X micronutrient cv. GGV 0501 with application of FeSO₄ + ZnSO₄ (V₁M₄) and V₁M₃ recorded higher B: C ratio (2.40 and 2.38, respectively). In the absence of micronutrient application B: C ratio decreased irrespective of cultivars used and

Table 111. Effect of genotypes, seed rates and micronutrients on gross returns, net returns and B: C under direct seeded condition during summer season

V x S x M		Gross returns (₹ ha ⁻¹)				Net returns (₹ ha ⁻¹)				B : C ratio			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	99381 ^a	81686 ^a	96109 ^a	92392^a	47345 ^a	29525 ^a	44073 ^a	40314^a	1.91 ^{e-i}	1.57 ⁱ	1.85 ^{e-i}	1.77^f
	M ₂	103442 ^a	91594 ^a	101350 ^a	98795^a	50656 ^a	38683 ^a	48564 ^a	45968^a	1.96 ^{d-i}	1.73 ^{g-i}	1.92 ^{d-i}	1.87^{ef}
	M ₃	118954 ^a	103747 ^a	103079 ^a	108593^a	66293 ^a	50961 ^a	50418 ^a	55891^a	2.26 ^{a-e}	1.97 ^{d-h}	1.96 ^{d-i}	2.06^{b-e}
	M ₄	124387 ^a	112867 ^a	104179 ^a	113811^a	70776 ^a	59131 ^a	50568 ^a	60158^a	2.32 ^{a-d}	2.10 ^{b-g}	1.94 ^{f-i}	2.12^{a-c}
S ₂	M ₁	112363 ^a	92222 ^a	96242 ^a	100276^a	60162 ^a	39871 ^a	44041 ^a	48025^a	2.15 ^{a-f}	1.76 ^{f-i}	1.84 ^{f-i}	1.92^{c-f}
	M ₂	127707 ^a	100156 ^a	97730 ^a	108531^a	74756 ^a	47055 ^a	44779 ^a	55530^a	2.41 ^{ab}	1.89 ^{e-i}	1.85 ^{d-i}	2.05^{b-e}
	M ₃	132272 ^a	111046 ^a	101888 ^a	115069^a	79446 ^a	58070 ^a	49062 ^a	62193^a	2.50 ^a	2.10 ^{b-g}	1.93 ^{b-g}	2.18^{ab}
	M ₄	135745 ^a	122490 ^a	110659 ^a	122965^a	81969 ^a	68564 ^a	56883 ^a	69139^a	2.52 ^a	2.27 ^{a-e}	2.06 ^{b-g}	2.28^a
S ₃	M ₁	95135 ^a	85650 ^a	94934 ^a	91906^a	42769 ^a	33109 ^a	42568 ^a	39482^a	1.82 ^{f-i}	1.63 ^{hi}	1.81 ^{f-i}	1.75^f
	M ₂	110853 ^a	92755 ^a	99033 ^a	100881^a	57737 ^a	39464 ^a	45917 ^a	47706^a	2.09 ^{b-g}	1.74 ^{c-h}	1.86 ^{f-i}	1.90^{d-c}
	M ₃	125327 ^a	106669 ^a	102374 ^a	111457^a	72336 ^a	53503 ^a	49383 ^a	58407^a	2.37 ^{a-c}	2.01 ^{b-g}	1.94 ^{d-i}	2.10^{a-d}
	M ₄	127755 ^a	112148 ^a	93144 ^a	111016^a	73814 ^a	58032 ^a	39203 ^a	57016^a	2.37 ^{a-c}	2.07 ^{f-i}	1.73 ^{g-i}	2.06^{b-e}
Variety		117776^a	101086^b	100060^b		64838^a	47997^b	47121^b		2.22^a	1.90^b	1.89^b	
		Variety x Seed rate				Variety x Seed rate				Variety x Seed rate			
S	S ₁	111541 ^{bc}	97473 ^e	101179 ^{de}	103398^b	58768 ^{bc}	44575 ^e	48406 ^{de}	50583^b	2.11 ^{bc}	1.84 ^e	1.92 ^{de}	1.96^b
	S ₂	127022 ^a	106479 ^{cd}	101630 ^{de}	111710^a	74083 ^a	53390 ^{cd}	48691 ^{de}	58721^a	2.40 ^a	2.00 ^{cd}	1.92 ^{de}	2.11^a
	S ₃	114768 ^b	99306 ^{de}	97371 ^e	103814^b	61664 ^b	46027 ^{de}	44268 ^e	50653^b	2.16 ^b	1.86 ^{de}	1.83 ^e	1.95^b
		Variety x Micro				Variety x Micro				Variety x Micro			
M ₄	M ₁	102293 ^a	86519 ^a	95761 ^a	98857^d	50092 ^a	34168 ^a	43560 ^a	42607^d	1.96 ^{b-d}	1.65 ^e	1.83 ^{c-e}	1.82^c
	M ₂	114001 ^a	94835 ^a	99371 ^a	102736^c	61050 ^a	41734 ^a	46420 ^a	49735^c	2.15 ^b	1.79 ^{de}	1.88 ^{cd}	1.94^b
	M ₃	125518 ^a	107154 ^a	102447 ^a	111706^b	72692 ^a	54178 ^a	49621 ^a	58830^b	2.38 ^a	2.02 ^{bc}	1.94 ^{cd}	2.11^a
	M ₄	129295 ^a	115835 ^a	102660 ^a	115930^a	75519 ^a	61909 ^a	48884 ^a	62104^a	2.40 ^a	2.15 ^b	1.91 ^{cd}	2.15^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		2037				2037				0.04			
Seed (S)		1431				1431				0.03			
Micro (M)		2023				2023				0.04			
V x S		2478				2478				0.05			
V x M		3503				3503				0.07			
S x M		3503				3503				0.07			
V x S x M		6068				3068				0.11			

Varieties (V) : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

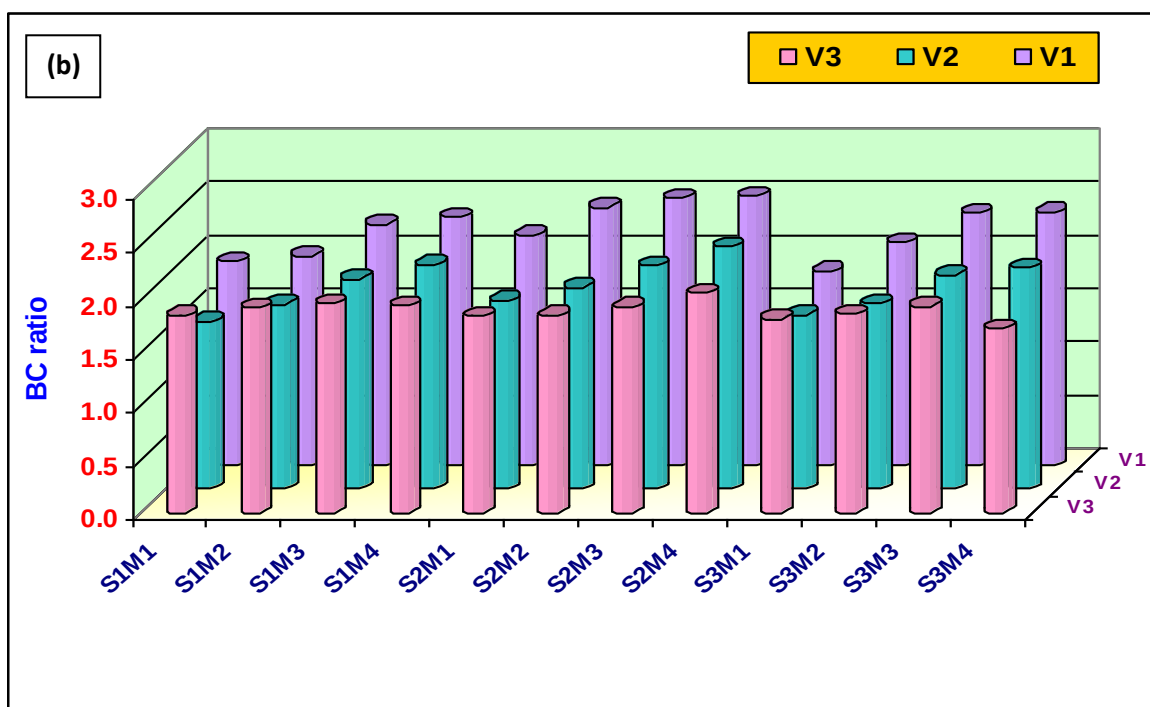
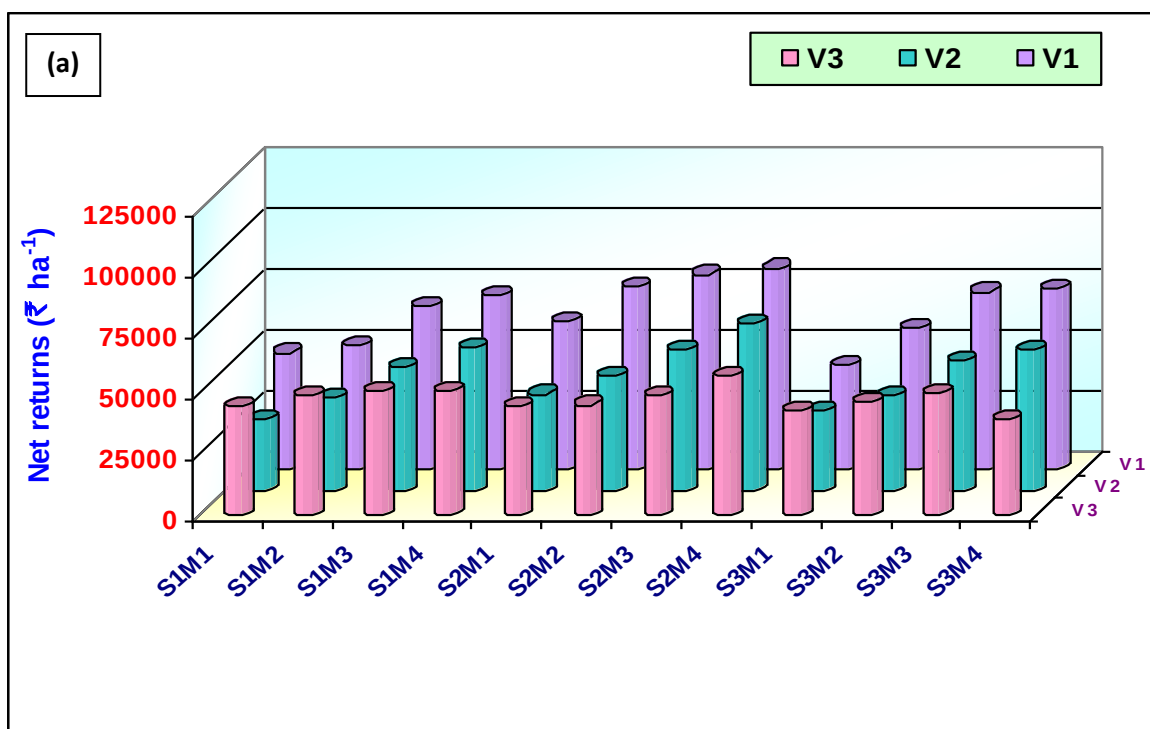
Seed Rate(S) : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient (M): M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT



LEGEND

Varieties: V₁- GGV 0501, V₂- RNR 15048, V₃- BPT 5204;
 Seed Rate: S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
 Micronutrient: M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS),
 M₄- FeSO₄ + ZnSO₄ (Each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

Fig. 21. Effect of genotypes, seed rates and micronutrients on (a) net returns (₹ ha⁻¹) and (b) B:C ratio under direct seeded condition during summer season

recorded lower B: C ratio with cv. RNR 15048 (V_2M_1) (1.65). Similarly, interaction due to micronutrients and seed rates were significant, wherein 30 kg seed rate with application of $FeSO_4 + ZnSO_4$ (S_2M_4) recorded higher B: C ratio (2.28) and was at par with S_2M_3 , while 25 and 35 kg ha⁻¹ seed rate without supplementation of micronutrient ($S_{1-3}M_1$) recorded lower B: C ratio and both were at par.

Overall, the three way interaction also revealed significant higher B: C ratio (2.52) with cv. GGV 0501 sown with 30 kg seed rate and applied with both $FeSO_4$ and $ZnSO_4$ or $ZnSO_4$ alone ($V_1S_2M_{3-4}$) (2.50 each), while the lower B: C ratio (1.57) was recorded with cv. RNR 15048 sown using 25 kg ha⁻¹ seed rate and supplied with no micro nutrient ($V_2S_1M_1$) among all.

4.1.7 Performance of factors over seasons (c.f. Table 112)

In general, yield levels during summer were a little lower (8.3%) compared to *khari* though same factors were studied. However, performance trends in cvs. GGV 0501 and BPT 5204 remained same across seasons, while those of cv. MTU 1010 and RNR 15048 significantly varied; MTU 1010 out yielded other cultivars during rainy season while RNR 15048 performed poorly in comparison to other fine rice cultivars during summer. Variations due to seed rate were not significant as the performance trend remained same during both the seasons. Similar was the performance of due to levels of micronutrients; consequent upon similar behaviour across seasons the variations were non-significant.

Table 112. Performance of production factors over seasons

Treatments	Yield (kg ha ⁻¹)		S.E.	‘t’ test
	<i>Kharif</i>	Summer		
Variety				
GGV 0501	5115	5524	233.71	1.75 ^{NS}
MTU 1010/RNR 15048	5920	4429	665.63	6.04 [*]
BPT 5204	4663	4270	175.45	2.24 ^{NS}
Seed rate				
25 kg ha ⁻¹	4956	4615	254.47	1.34 ^{NS}
30 kg ha ⁻¹	5680	5020	320.39	2.06 ^{NS}
35 kg ha ⁻¹	5060	4667	314.40	1.25 ^{NS}
Micronutrient levels				
Nil	4685	4234	283.64	1.59 ^{NS}
FeSO ₄	5052	4573	325.85	1.47 ^{NS}
ZnSO ₄	5410	4972	334.35	1.31 ^{NS}
FeSO ₄ + ZnSO ₄	5748	5185	335.12	1.68 ^{NS}
Seasonal Mean	5233	4741	247.24	1.99 ^{NS}

* Significant at 5%

NS - Not significant

4.2 Experiment II: Response of direct seeded rice to nutrient management for varied yield targets

4.2.1 Rainy season

4.2.1.1 Growth observations

4.2.1.1.1 Plant height (cm) (c.f. Table 113-116)

Plant height increased with the advancement of crop age reaching the highest at harvest and the variations were significant due to different treatments (Nutritional approaches-N, yield targets-T, and micronutrient and organic supplementation-M, and their combinations) at all the stages of observations (45, 67, 90 DAS and harvest) during both the years and on pooled basis except at 45 DAS. At 45 DAS, control (RDF) generally recorded lower height and the differences among treatments and control were significant during 2015-16 and on pooled basis wherein $N_2T_3M_2$ (37.7) differed significantly from control (33.7 on pooled basis).

At 67 DAS, all the factors (N-T-M) and their interactions varied significantly except the main effects due to nutrient approaches (N) and micronutrient supplementation (M). Variations in height due to yield targets were significant wherein the height increased with increase in targets vis-a-vis nutrition and taller (75.3) plants were observed with yield target of 8 t ha^{-1} (T_3) while, plants with 6 t ha^{-1} yield target (T_1) had lower height (67.9).

Two factor interactions were significant wherein among N x T higher yield target across micronutrients irrespective of nutritional approaches ($N_{1-2}T_3$) recorded taller plants (75.2–75.4) while NE with 6 t ha^{-1} (N_1T_1) recorded lower height (66.6), micronutrients across approaches in combinations with yield targets registered taller plants (76.7) with higher target coupled with supply of micronutrients (T_3M_2) while lower yield target and no micronutrient supply (T_1M_1) recorded dwarf plants (76.3), and among nutritional approaches and yield targets across micronutrient supply STCR approach and 8 t ha^{-1} (N_2T_3) recorded taller plants (74.5) while Nutrient Expert (NE) and lower yield target (N_1T_1) recorded lower plant height (70.7).

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + micronutrient supply ($N_2T_3M_2$) registered significantly taller plants (75.3) while the lower height (66.1)

Table 113. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on plant height (cm) at 45 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	37.5 ^a	40.5 ^a	43.0 ^a	40.3^a	28.0 ^{ab}	31.2 ^{ab}	32.4 ^{ab}	30.6^a	32.7 ^a	35.9 ^a	37.7 ^a	35.4^a
	M ₂	38.1 ^a	42.0 ^a	43.3 ^a	41.1^a	30.3 ^{ab}	32.2 ^{ab}	32.7 ^{ab}	31.8^a	34.2 ^a	37.1 ^a	38.0 ^a	36.4^a
N ₂	M ₁	39.0 ^a	39.0 ^a	41.9 ^a	40.0^a	30.7 ^{ab}	31.0 ^{ab}	31.6 ^{ab}	31.1^a	34.9 ^a	35.0 ^a	36.8 ^a	35.6^a
	M ₂	40.1 ^a	43.3 ^a	44.1 ^a	42.5^a	31.0 ^{ab}	33.1 ^{ab}	34.5 ^a	32.9^a	35.5 ^a	38.2 ^a	39.3 ^a	37.7^a
Target		38.7^b	41.2^a	43.1^a		30.0^b	31.9^{ab}	32.8^a		34.3^a	36.6^a	37.9^a	
Control		37.8				29.5				33.7			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		37.8 ^a	41.3 ^a	43.1 ^a	40.7^a	29.2 ^a	31.8 ^a	32.6 ^a	31.2^a	33.5 ^a	36.5 ^a	37.9 ^a	36.0^a
N ₂		39.5 ^a	41.1 ^a	43.0 ^a	41.2^a	30.9 ^a	32.1 ^a	33.1 ^a	32.0^a	35.2 ^a	36.6 ^a	38.0 ^a	36.6^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		38.2 ^a	39.8 ^a	42.5 ^a	40.2^a	29.4 ^b	31.1 ^{ab}	32.0 ^{ab}	36.8^a	33.8 ^a	35.5 ^a	37.3 ^a	35.5^a
M ₂		39.1 ^a	42.6 ^a	43.7 ^a	41.8^a	30.7 ^{ab}	32.7 ^{ab}	32.6 ^a	37.0^a	34.9 ^a	37.7 ^a	38.6 ^a	37.1^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		5.3				3.4				4.6			
T		6.5				4.2				5.6			
M		5.3				3.4				4.6			
N x T		9.2				6.0				8.0			
M x T		9.2				6.0				8.0			
N x M		7.5				4.9				6.5			
N x T x M		13.1				8.4				11.3			
Control Vs Rest		1.8		NS		1.1		3.1		1.10		3.2	

DAS - Days after sowing

NS – Not significant,

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 114. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on plant height (cm) at 67 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	69.2 ^g	73.2 ^{def}	75.7 ^{bcd}	72.7 ^{bc}	62.9 ^e	69.1 ^{cd}	74.0 ^{ab}	68.6 ^b	66.1 ^g	71.1 ^d	74.8 ^b	70.7 ^c
	M ₂	70.2 ^g	75.1 ^{bcd}	76.4 ^{bc}	73.9 ^b	64.3 ^e	75.3 ^a	74.5 ^{ab}	71.3 ^a	67.2 ^{fg}	75.2 ^b	75.5 ^b	72.6 ^b
N ₂	M ₁	71.1 ^{fg}	71.2 ^{fg}	74.1 ^{cde}	72.1 ^c	66.0 ^{de}	66.0 ^{de}	71.9 ^{bc}	67.9 ^b	68.5 ^{ef}	68.6 ^{ef}	73.0 ^c	70.0 ^c
	M ₂	71.7 ^{efg}	77.0 ^b	79.6 ^a	76.1 ^a	68.1 ^d	74.5 ^{ab}	76.1 ^a	72.9 ^a	69.9 ^{de}	75.8 ^b	77.9 ^a	74.5 ^a
Target		70.5 ^c	74.1 ^b	76.4 ^a		65.3 ^c	71.2 ^b	74.1 ^a		67.9 ^c	72.68 ^b	75.3 ^a	
Control		70.00				63.6				66.8			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		69.7 ^d	74.1 ^b	76.1 ^a	73.3 ^a	63.6 ^d	72.2 ^{ab}	74.3 ^a	70.0 ^a	66.6 ^d	73.2 ^b	75.2 ^a	71.7 ^a
N ₂		71.4 ^c	74.1 ^b	76.8 ^a	74.1 ^a	67.1 ^c	70.3 ^b	74.0 ^a	70.5 ^a	69.2 ^c	72.2 ^{ab}	75.4 ^a	72.3 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		70.1 ^d	72.2 ^c	74.9 ^b	72.4 ^a	64.5 ^d	67.5 ^c	72.9 ^b	68.3 ^a	67.3 ^e	69.9 ^d	73.9 ^c	70.4 ^a
M ₂		71.0 ^{cd}	76.1 ^b	78.0 ^a	75.0 ^a	66.2 ^{cd}	74.9 ^{ab}	75.3 ^a	72.1 ^a	68.6 ^f	75.5 ^b	76.7 ^a	73.6 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		1.51				1.99				1.04			
T		1.84				2.44				1.28			
M		1.51				1.99				1.04			
N x T		2.61				3.45				1.81			
M x T		2.61				3.45				1.81			
N x M		2.13				2.82				1.48			
N x T x M		3.69				4.88				2.56			
Control Vs Rest		1.71		4.99		2.73		7.98		1.51		4.43	

DAS - Days after sowing

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 115. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on plant height (cm) at 90 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	93.9 ^e	96.6 ^{cd}	100.1 ^{ab}	96.9 ^{bc}	90.0 ^f	93.0 ^{c-e}	95.1 ^c	92.7 ^c	92.0 ⁱ	94.8 ^{fg}	97.6 ^{cd}	94.8 ^c
	M ₂	94.1 ^e	98.7 ^{bc}	100.2 ^{ab}	97.7 ^b	91.5 ^{ef}	94.3 ^{cd}	97.9 ^b	94.5 ^b	92.1 ^{hi} a	96.5 ^{de}	99.1 ^{bc}	96.1 ^b
N ₂	M ₁	94.9 ^{de}	95.7 ^{de}	96.7 ^{cd}	95.8 ^c	91.8 ^{d-f}	91.9 ^{d-f}	94.1 ^{a-e}	92.6 ^c	93.4 ^{g-i}	93.8 ^{f-h}	95.4 ^{ef}	94.2 ^c
	M ₂	95.9 ^{de}	101.7 ^a	102.1 ^a	99.0 ^a	92.7 ^{de}	99.2 ^b	102.2 ^a	98.0 ^a	94.3 ^{f-h}	100.4 ^b	102.2 ^a	99.0 ^a
Target		94.7 ^c	98.2 ^b	99.8 ^a		91.5 ^c	94.6 ^b	97.3 ^a		93.1 ^c	96.4 ^b	98.6 ^a	
Control		94.1				91.4				92.7			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		94.0 ^c	97.7 ^a	100.2 ^a	97.3 ^a	90.8 ^d	93.7 ^c	96.5 ^{ab}	93.6 ^a	92.4 ^e	95.7 ^c	98.3 ^a	95.4 ^a
N ₂		95.4 ^c	98.7 ^{ab}	99.4 ^a	97.8 ^a	92.3 ^{cd}	95.6 ^b	98.1 ^a	95.3 ^a	93.8 ^d	97.1 ^b	98.8 ^a	96.5 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		94.4 ^d	96.2 ^c	98.4 ^b	96.3 ^a	90.9 ^d	92.5 ^d	94.6 ^c	92.6 ^a	92.7 ^e	94.3 ^d	96.5 ^c	94.5 ^a
M ₂		95.0 ^{cd}	100.2 ^a	101.2 ^a	98.8 ^a	92.1 ^d	96.7 ^b	100.1 ^a	96.3 ^a	93.6 ^{de}	98.5 ^b	100.6 ^a	97.5 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		1.3				1.5				1.0			
T		1.6				1.9				1.2			
M		1.3				1.5				1.0			
N x T		2.3				2.6				1.7			
M x T		2.3				2.6				1.7			
N x M		1.9				2.1				1.4			
N x T x M		3.2				3.7				2.5			
Control Vs Rest		2.4		NS		3.3		NS		2.1		6.2	

DAS - Days after sowing

NS – Not significant,

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 116. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on plant height (cm) at harvest under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	102.9 ^e	105.6 ^{cd}	109.1 ^{ab}	105.9 ^{bc}	99.7 ^g	101.3 ^{de}	102.3 ^{bc}	101.1 ^c	101.3 ^f	103.5 ^d	105.7 ^{bc}	103.5 ^c
	M ₂	103.1 ^e	107.7 ^{bc}	109.2 ^{ab}	106.7 ^b	100. ^{fg}	102.1 ^{cd}	102.6 ^{bc}	101.6 ^b	101.7 ^{ef}	104.9 ^c	105.9 ^{bc}	104.2 ^b
N ₂	M ₁	103.9 ^{de}	104.7 ^{de}	105.7 ^{cd}	104.8 ^c	100.2 ^{fg}	100.3 ^{fg}	101.3 ^{de}	100.6 ^d	102.1 ^{ef}	102.5 ^{d-f}	103.5 ^d	102.7 ^d
	M ₂	104.9 ^{de}	110.7 ^a	111.1 ^a	108.9 ^a	100.9 ^{ef}	103.0 ^b	104.0 ^a	102.6 ^a	102.9 ^{dc}	106.8 ^{ab}	107.6 ^a	105.8 ^a
Target		103.7 ^c	107.1 ^b	108.8 ^a		100.3 ^c	101.6 ^b	102.5 ^a		102.0 ^c	104.4 ^b	105.7 ^a	
Control		103.1				100.0				101.5			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		103.0 ^c	106.7 ^b	109.2 ^a	106.3 ^a	99.9 ^d	101.7 ^b	102.5 ^a	101.4 ^a	101.5 ^d	104.2 ^b	105.8 ^a	103.8 ^a
N ₂		104.4 ^c	107.7 ^{ab}	108.4 ^a	106.8 ^a	100.5 ^c	101.6 ^b	102.7 ^a	101.6 ^a	102.5 ^c	104.7 ^b	105.6 ^a	104.3 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		103.4 ^d	105.2 ^c	107.4 ^b	105.3 ^a	99.9 ^e	100.8 ^d	101.8 ^c	100.8 ^a	101.7 ^d	103.0 ^c	104.6 ^b	103.1 ^a
M ₂		104.0 ^{cd}	109.2 ^a	110.2 ^a	107.8 ^a	100.5 ^a	102.5 ^b	103.3 ^a	102.1 ^a	102.3 ^{cd}	105.9 ^a	106.7 ^a	105.0 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		1.4				0.5				0.7			
T		1.7				0.7				0.9			
M		1.4				0.5				0.8			
N x T		2.5				0.9				1.3			
M x T		2.5				0.9				1.3			
N x M		2.0				0.8				1.1			
N x T x M		3.5				1.3				1.9			
Control Vs Rest		2.6		NS		2.0		5.93		1.8		NS	

NS – Not significant,

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

was recorded with NE + 6 t ha⁻¹ yield target + no-micronutrient (N₁T₁M₁); other treatment combinations fared in between.

All combinations involving medium to higher yield target (T₂₋₃) and micronutrient supply + organics supply (M₂) under both approaches of nutrition (N₁₋₂) fared superior to control (66.8).

More or less similar trend prevailed at 90 DAS and at harvest. All the factors (N-T-M) and their interactions varied significantly except main effects due to nutritional approaches (N) and micronutrient supplementation (M). Variations in height due to yield targets were significant wherein the height increased with increase in targets vis-a-vis nutrition and taller (98.6 and 105.7, respectively) plants were observed with yield target of 8 t ha⁻¹ (T₃) while, plants with 6 t ha⁻¹ yield target (T₁) had lower height (93.1 and 102.0, respectively).

Two factor interactions were significant wherein higher yield target across micronutrients irrespective of nutritional approaches (N₁₋₂T₃) recorded taller plants (98.3-98.8 and 105.6 - 105.8, respectively) while NE with 6 t ha⁻¹ (N₁T₁) recorded lower height (92.4 and 101.5, respectively), micronutrients across approaches in combinations with yield targets registered taller plants (100.6 and 106.7, respectively) with higher target coupled with micronutrient application (T₃M₂) while lower yield target and no micronutrient supply (T₁M₁) recorded dwarf plants (92.7 and 101.7, respectively), and among approaches and yield targets across micronutrient supply STCR approach and 8 t ha⁻¹ yield target (N₁T₃) recorded taller plants (99.0 and 105.8, respectively) while NE and lower yield target of 6 t ha⁻¹ (N₁T₁) recorded lower plant height (92.6 and 100.6, respectively).

Among three factor combinations, taller plants (102.2 and 106.8, respectively) were observed with STCR + 8 t ha⁻¹ + micronutrient supply (N₂T₃M₂) while NE + 6 t ha⁻¹ + no micronutrient supply (N₁T₁M₁) resulted in dwarf plants (92.0 and 101.3, respectively at 90 DAS and at harvest). Other treatment combinations had intermediary heights.

In the comparison between control and rest of the treatments, N₁T₃M₂, N₂T₂₋₃M₂ fared superior to control (92.7 and 101.5, respectively) at 90 DAS and harvest.

4.2. 1.1. 2 Tiller count (no. m⁻¹ length) (c.f. Table 117-120)

Tiller count increased throughout crop growth recording the maximum at harvest and the variations were significant due to different factors and their interactions at all the stages of observations during both the years and on pooled basis .

At 45 DAS, variations in tiller count due to yield targets and supply of micro nutrients alongwith organics were significant wherein the tiller count increased with increase in yield targets corresponding with nutrition and more tillers (79.6) were observed with yield target of 8 t ha⁻¹ (T₃) while, plants with 6 t ha⁻¹ yield target (T₁) had lower tiller count (69.5), and micronutrient + organic supply (M₂) resulted in more tillers (77.5) over no supply (M₁–72.4 tillers); while nutritional approach did not induce significant variation.

Two factor interactions were significant wherein STCR approach coupled with higher yield target across micronutrients (N₂T₃) recorded more tiller count (79.0) while NE with 6 t ha⁻¹ (N₁T₁) recorded the lowest tiller count (67.7), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum tiller count (82.2) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂) while lower yield target and no micronutrient/organics (T₁M₁) recorded lower tiller count (68.2), and among nutritional approaches and yield targets across micronutrient supply STCR approach and 8 t ha⁻¹ (N₂T₃) recorded more tillers m⁻¹ length (79.8) while NE and lower yield target of 6 t ha⁻¹ (N₁T₁) recorded lower tiller count (72.8).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered significantly more number of tillers (83.8) followed by similar combination except medium yield target (N₂T₂M₂ – 83.3), while lower tiller count (66.2) was recorded with NE + 6 t ha⁻¹ yield target + no-micronutrient (N₁T₁M₁); other treatment combinations fared in between.

All combinations involving medium to higher yield target (T₂₋₃) and micronutrient supply (M₂) under both approaches of nutrition (N₁₋₂) and STCR + 7 t ha⁻¹ + micronutrient and organics (N₂T₂M₂) were superior to control (68.8).

More or less similar trend prevailed at 67 and 90 DAS and at harvest. All the factors (N-T-M) and their interactions varied significantly except main effects due to

Table 117. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on tiller count (no. m⁻¹ length) at 45 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	67.3 ^e	75.0 ^{cd}	81.0 ^a	74.4 ^c	65.0 ^f	70.7 ^{cd}	77.5 ^b	72.9 ^{abc}	66.2 ^h	72.8 ^{de}	79.3 ^b	72.8 ^c
	M ₂	71.7 ^d	79.3 ^{ab}	82.0 ^a	77.7 ^b	66.8 ^{ef}	72.5 ^c	79.0 ^{jb}	75.5 ^{jb}	69.3 ^g	75.9 ^c	80.5 ^b	75.2 ^b
N ₂	M ₁	72.0 ^d	73.3 ^d	77.3 ^{bc}	74.2 ^c	68.3 ^{d-f}	69.8 ^{bcde}	71.0 ^{j-d}	72.2 ^{jc}	70.2 ^{fg}	71.6 ^{e-g}	74.6 ^{cd}	72.1 ^c
	M ₂	74.3 ^{cd}	82.3 ^a	82.7 ^a	79.8 ^a	70.3 ^{c-e}	84.3 ^a	85.0 ^a	79.8 ^a	72.3 ^{d-f}	83.3 ^a	83.8 ^a	79.8 ^a
Target			77.5 ^b	80.8 ^a		67.6 ^c	74.3 ^b	78.1 ^a		69.5 ^c	75.9 ^b	79.5 ^a	
Control		71.33				66.3				68.8			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		69.5 ^e	77.2 ^c	81.5 ^a	76.1 ^a	65.9 ^c	71.6 ^b	78.3 ^a	71.9 ^a	67.7 ^e	74.4 ^c	79.9 ^a	74.0 ^a
N ₂		73.2 ^d	77.8 ^{bc}	80.0 ^{ab}	77.0 ^a	69.3 ^b	77.1 ^a	78.0 ^a	74.8 ^a	71.3 ^d	77.5 ^b	79.0 ^{ab}	75.9 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		69.7 ^d	74.2 ^c	79.2 ^b	74.4 ^a	66.7 ^e	70.3 ^d	74.3 ^c	70.4 ^a	68.2 ^e	72.2 ^d	76.7 ^c	72.4 ^b
M ₂		73.0 ^c	80.8 ^{ab}	82.3 ^a	78.7 ^a	68.6 ^{de}	78.4 ^b	82.0 ^a	76.3 ^{Ja}	70.8 ^d	79.6 ^b	82.2 ^a	77.5 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		2.0				2.3				1.4			
T		2.5				2.8				1.8			
M		2.0				2.3				1.4			
N x T		3.6				4.0				2.5			
M x T		3.6				4.0				2.5			
N x M		2.9				3.2				2.0			
N x T x M		5.0				5.6				3.5			
Control Vs Rest		3.3		9.6		3.7		10.9		2.3		6.7	

DAS - Days after sowing

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 118. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on tiller count (no. m⁻¹ length) at 67 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	110.7 ^h	129.3 ^{def}	131.3 ^{de}	123.0^c	107.0 ^g	125.7 ^{de}	134.7 ^c	123.2^{ac}	108.8 ⁱ	127.5 ^e	133.0 ^{cd}	123.2^c
	M ₂	118.7 ^g	134.3 ^{cd}	138.3 ^c	130.4^b	115.0 ^f	130.7 ^{cd}	134.7 ^c	128.8^b	116.8 ^h	132.5 ^{cd}	136.5 ^c	128.8^b
N ₂	M ₁	120.0 ^g	124.3 ^{fg}	131.3 ^{dc}	125.2^c	116.3 ^f	120.7 ^{ef}	128.7 ^{cd}	123.7^c	118.2 ^{gh}	122.5 ^{ef}	130.0 ^{de}	123.7^c
	M ₂	127.3 ^{eh}	145.7 ^b	157.7 ^a	143.5^a	123.7 ^{de}	142.7 ^b	154.0	142.1^a	125.5 ^{ef}	144.2 ^b	155.8 ^a	142.0^a
Target		119.2^c	133.4^b	139.6^a		115.5^c	129.9^b	138.0^a		117.3^c	131.6^b	138.8^a	
Control		113.6				110.0				111.8			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		114.7 ^d	131.8 ^b	134.8 ^b	127.1^a	111.0 ^e	128.2 ^c	134.7 ^b	126.0^a	112.8 ^e	130.0 ^c	134.8 ^b	125.9^a
N ₂		123.7 ^c	135.0 ^b	144.5 ^a	134.4^a	120.0 ^d	131.7 ^{bc}	141.3 ^a	132.9^a	121.8 ^c	133.3 ^b	142.9 ^a	132.8^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		115.3 ^f	126.8 ^d	131.3 ^c	124.0^b	111.7 ^e	123.2 ^d	131.7 ^c	123.5^a	113.5 ^f	125.0 ^d	131.5 ^c	123.3^b
M ₂		123.0 ^c	140.0 ^b	148.0 ^a	137.0^a	119.3 ^d	136.7 ^b	144.3 ^a	135.5^a	121.2 ^e	138.3 ^b	146.2 ^b	135.4^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		3.5				4.3				3.0			
T		4.3				5.3				3.6			
M		3.5				4.3				3.0			
N x T		6.0				7.5				5.1			
M x T		6.0				7.5				5.1			
N x M		4.9				6.1				4.1			
N x T x M		8.6				10.6				7.3			
Control Vs Rest		5.3		15.5		5.4		15.8		5.2		15.1	

DAS - Days after sowing

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 119. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on tiller count (no. m⁻¹ length) at 90 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	144.7 ^f	159.7 ^{de}	169.7 ^{bc}	158.0 ^c	135.7 ^f	157.7 ^{cd}	168.7 ^{ab}	154.0 ^c	140.2 ^b	158.7 ^d	169.2 ^{bc}	156.0 ^c
	M ₂	152.3 ^{ef}	171.7 ^{abc}	171.7 ^{abc}	165.2 ^b	147.3 ^e	165.0 ^{bc}	169.7 ^{ab}	160.7 ^b	149.8 ^e	168.3 ^{bc}	170.7 ^b	162.9 ^b
N ₂	M ₁	152.7 ^{ef}	153.3 ^{ef}	165.7 ^{cd}	157.2 ^c	151.0 ^{de}	152.7 ^{de}	163.0 ^{bc}	155.6 ^c	151.8 ^e	153.0 ^{de}	164.3 ^c	156.4 ^c
	M ₂	154.0 ^e	178.7 ^{ab}	179.7 ^a	170.8 ^a	152.7 ^a	175.7 ^a	175.3 ^a	167.9 ^a	153.3 ^{de}	177.0 ^a	177.5 ^a	169.3 ^a
Target		150.9 ^c	165.85 ^b	171.7 ^a		146.4 ^c	162.8 ^b	169.2 ^a		148.8 ^c	164.3 ^b	170.4 ^a	
Control		149.6				136.7				143.1			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		148.5 ^c	165.7 ^b	170.7 ^{ab}	161.6 ^a	141.5 ^d	161.3 ^b	169.2 ^a	157.3 ^a	145.0 ^d	163.5 ^b	169.9 ^a	159.5 ^a
N ₂		153.3 ^c	166.0 ^b	172.7 ^a	164.0 ^a	151.8 ^c	164.2 ^{ab}	169.2 ^a	161.7 ^a	152.6 ^c	165.0 ^b	170.9 ^a	162.8 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		148.7 ^d	156.5 ^c	167.7 ^b	157.6 ^a	143.3 ^d	155.2 ^c	165.8 ^b	154.8 ^a	146.0 ^e	155.8 ^c	166.8 ^b	156.2 ^a
M ₂		153.2 ^{cd}	175.2 ^a	175.7 ^a	168.0 ^a	150.0 ^c	170.3 ^{ab}	172.5 ^a	164.3 ^a	151.6 ^d	172.7 ^a	174.1 ^a	166.1 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		5.5				5.3				3.7			
T		6.7				6.5				4.4			
M		5.5				5.3				3.7			
N x T		9.5				9.2				6.3			
M x T		9.5				9.2				6.3			
N x M		7.7				7.5				5.2			
N x T x M		13.4				13.0				8.9			
Control Vs Rest		4.7		13.8		6.1		17.8		5.0		14.6	

DAS - Days after sowing

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 120. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on tiller count (no. m⁻¹ length) at harvest under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	166.5 ^g	179.2 ^{de}	197.5 ^{ab}	181.1 ^b	145.7 ^g	171.3 ^{cd}	180.3 ^{bc}	165.8 ^c	156.1 ^g	175.3 ^d	188.9 ^b	173.4 ^c
	M ₂	168.5 ^{fg}	189.9 ^{bc}	201.6 ^a	186.7 ^b	155.7 ^f	177.6 ^c	187.6 ^{ab}	173.6 ^b	162.1 ^f	183.7 ^c	194.6 ^a	180.1 ^b
N ₂	M ₁	176.8 ^{ef}	178.0 ^{ef}	188.9 ^{b-d}	181.2 ^b	161.3 ^{ef}	167.3 ^{de}	178.0 ^c	168.9 ^{bc}	169.1 ^e	172.7 ^{de}	183.5 ^c	175.1 ^c
	M ₂	181.5 ^{cde}	201.6 ^a	202.1 ^a	195.1 ^a	171.0 ^{cd}	189.7 ^a	193.3 ^a	184.7 ^a	176.2 ^d	195.6 ^a	197.7 ^a	189.8 ^a
Target		173.3 ^c	187.2 ^b	197.5 ^a		158.4 ^c	176.5 ^b	184.8 ^a		165.8 ^c	181.8 ^b	191.1 ^a	
Control		168.2				151.9				160.1			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		167.5 ^e	184.5 ^{cd}	199.5 ^a	183.8 ^a	150.7 ^e	174.5 ^c	184.0 ^{ab}	169.7 ^a	159.1 ^e	179.5 ^c	191.8 ^a	176.8 ^a
N ₂		179.1 ^d	189.8 ^{bc}	195.5 ^{ab}	188.1 ^a	166.2 ^d	178.5 ^{bc}	185.7 ^a	176.8 ^a	172.7 ^d	184.2 ^b	190.6 ^a	182.5 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		171.7 ^a	178.6 ^a	193.2 ^a	181.2 ^a	153.5 ^a	169.3 ^a	179.2 ^a	167.3 ^a	162.6 ^a	174.0 ^a	186.2 ^a	174.3 ^a
M ₂		175.0 ^a	195.7 ^a	201.9 ^a	190.9 ^a	163.3 ^a	183.6 ^a	190.5 ^a	179.1 ^a	169.2 ^a	189.7 ^a	196.2 ^a	185.0 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		6.4				5.8				3.3			
T		7.8				7.1				4.1			
M		6.4				5.8				3.3			
N x T		11.0				10.0				5.7			
M x T		11.0				10.0				5.7			
N x M		9.0				8.2				4.7			
N x T x M		15.6				14.2				8.1			
Control Vs Rest		3.6		10.6		9.1		26.6		4.0		11.6	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

nutrient approaches (N) and micronutrient supplementation (M) (except the latter at 67 DAS). Among the yield targets significantly more number of tillers (138.3, 170.4 and 191.1, respectively) occurred with higher yield target of 8 t ha⁻¹ (T₃) while, plants with 6 t ha⁻¹ yield target (T₁) had lower tiller count (117.3, 148.8 and 165.8, respectively).

Two factor interactions were significant wherein higher yield target across micronutrients with STCR approach (N₂T₃) recorded more number of tillers (142.9, 170.9 and 190.6, respectively) while SSNM with 6 t ha⁻¹ (N₁T₁) recorded lower tiller count (112.8, 145.0 and 159.1, respectively), micronutrients across approaches in combinations with yield targets registered more tiller count (146.2, 174.1 and 196.2, respectively) with higher target coupled with micronutrient and organics supply (T₃M₂) while lower yield target and no micronutrient supply (T₁M₁) recorded lower tiller count (113.5, 146.0 and 162.6, respectively), and among approaches and yield targets across micronutrient supply STCR approach and 8 t ha⁻¹ yield target (N₁T₃) registered higher tiller count (141.8, 169.3 and 189.9, respectively) while NE and lower yield target of 6 t ha⁻¹ (N₁T₁) recorded lower plant height (123.1, 156.0 and 173.4, respectively).

Among three factor combinations, significantly higher tiller count (155.8, 177.5 and 191.1, respectively) throughout were observed with STCR + 8 t ha⁻¹ + micronutrient supply (N₂T₃M₂) while NE + 6 t ha⁻¹ + no micronutrient supply (N₁T₁M₁) resulted in poor tiller count (108.8, 140.2 and 156.1, respectively at 67 and 90 DAS and at harvest) among all. Other treatment combinations had intermediary heights.

In between control and rest of the treatments, N₂T₂M₂ at 67 DAS, irrespective of approaches and micronutrient supply higher yield target of 8 t ha⁻¹ (N₁₋₂T₃M₁₋₂), N₂T₂M₂ and N₁T₂M₂ at 90 DAS, and all combinations except N₁₋₂T₁M₁₋₂ and N₂T₁M₁ at harvest differed significantly and fared superior to control (111.8, 143.1 and 160.1, respectively).

4.2.1.1.3 Leaf area (cm² plant⁻¹) (c.f. Table 121-124)

Leaf area (LA) increased till 90 DAS and decreased thereafter due to onset of senescence and the variations were significant due to different factors and their interactions at all the stages of observations during both the years and on pooled basis. Overall, the trend remained same throughout.

At 45 DAS, variations in LA due to main effects of yield targets were significant while those due to nutritional approaches (N) and those of micronutrients alongwith

organic (M) were not significant. LA increased with increase in yield targets corresponding with nutrition and higher LA (536.3) was observed with yield target of 8 t ha⁻¹ (T₃) closely followed by T₂ which was at par while, plants with 6 t ha⁻¹ yield target (T₁) had lower LA (478.0).

Two factor interactions were significant wherein STCR approach coupled higher yield target across micronutrients (N₂T₃) recorded higher LA (531.5) while NE with 6 t ha⁻¹ (N₁T₁) recorded the lowest LA (462.0), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum LA (550.5) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂) while lower yield target and no micronutrient/ organics (T₁M₁) recorded lower LA (470.5), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics (N₂M₂) recorded higher LA (536.0) while NE and no micronutrient + organics supply (N₁M₁) recorded lower LA (470.5).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered significantly higher LA (553.5) followed by similar combination with medium yield target (N₂T₂M₂ – 552.0), while lower LA (455.5) was recorded with NE + 6 t ha⁻¹ yield target + no-micronutrient (N₁T₁M₁); other treatment combinations fared in between.

All combinations involving medium to higher yield targets (N₁₋₂T₂₋₃M₁₋₂) and N₂T₁M₁₋₂ were significantly superior to control (46480) with regard to LA.

More or less similar trend prevailed at 67 and 90 DAS and at harvest. All the factors (N-T-M) and their interactions varied significantly except main effects due to nutrient approaches (N) and micronutrient supplementation (M). Among the yield targets significantly higher LA (862.3, 1389.3 and 795.9, respectively) occurred with higher yield target of 8 t ha⁻¹ (T₃) while, plants with 6 t ha⁻¹ yield target (T₁) had lower LA (792.3, 1389.3 and 714.8, respectively).

Two factor interactions were significant. Among N x T, higher yield target across micronutrients with STCR approach (N₂T₃) recorded higher LA (868.3, 1406.9 and 809.7, respectively at 67 and 90 DAS and at harvest) followed by N₁T₃ which was at par at 67 and 90 DAS while SSNM with 6 t ha⁻¹ (N₁T₁) recorded lower LA (774.2, 1199.3

Table 121. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on leaf area (cm² plant⁻¹) at 45 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	461.0 ^f	502.7 ^{cd}	531.7 ^b	498.4 ^c	450.0 ^g	509.3 ^{cd}	537.3 ^{ab}	498.9 ^c	455.5 ^h	506.0 ^d	534.5 ^d	498.7 ^c
	M ₂	467.0 ^f	521.0 ^b	548.0 ^a	512.0 ^b	470.0 ^f	521.0 ^{bc}	547.0 ^a	512.7 ^a	468.5 ^g	521.0 ^c	547.5 ^c	512.3 ^b
N ₂	M ₁	485.0 ^e	491.0 ^{de}	506.7 ^c	494.2 ^c	486.0 ^{ef}	494.0 ^{de}	512.3 ^{cd}	497.4 ^c	485.5 ^f	492.5 ^{ef}	509.5 ^{ef}	495.8 ^c
	M ₂	498.0 ^{c-e}	551.7 ^a	554.3 ^a	534.7 ^a	507.0 ^{cd}	552.3 ^a	552.7 ^a	537.3 ^a	502.5 ^{de}	552.0 ^a	553.5 ^a	536.0 ^a
Target		477.8 ^c	516.6 ^a	535.2 ^a		478.3 ^c	519.2 ^b	537.3 ^a		478.0 ^c	517.9 ^b	536.3 ^a	
Control		462.0				466.0				464.0			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		464.0 ^e	511.8 ^c	539.8 ^a	505.2 ^a	460.0 ^e	515.2 ^c	542.2 ^a	505.8 ^a	462.0 ^f	513.5 ^d	541.0 ^a	505.5 ^a
N ₂		491.5 ^d	521.3 ^b	530.5 ^b	514.4 ^a	496.5 ^d	523.2 ^{bc}	532.5 ^{ab}	517.4 ^a	494.0 ^e	522.3 ^c	531.5 ^b	515.9 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		473.0 ^f	496.8 ^d	519.2 ^c	496.3 ^a	468.0 ^e	501.7 ^c	524.8 ^b	498.2 ^a	470.5 ^f	499.3 ^d	522.0 ^c	497.3 ^a
M ₂		482.5 ^e	536.3 ^b	551.2 ^a	523.3 ^a	488.5 ^d	536.7 ^b	549.8 ^a	525.0 ^a	485.5 ^e	536.5 ^b	550.5 ^a	524.2 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		8.6				11.8				7.2			
T		10.5				14.5				8.9			
M		8.6				11.8				7.2			
N x T		14.8				20.5				12.6			
M x T		14.8				20.5				12.6			
N x M		12.1				16.7				10.2			
N x T x M		20.9				28.9				17.8			
Control Vs Rest		5.9		17.5		6.0		17.5		4.1		11.9	

DAS - Days after sowing

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 122. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on leaf area (cm² plant⁻¹) at 67 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	772.7 ^e	854.3 ^{bc}	862.0 ^{bc}	829.7 ^b	726.2 ^e	812.8 ^{b-d}	848.4 ^{a-c}	795.8 ^b	749.5 ^g	833.6 ^{b-e}	855.2 ^b	812.8 ^c
	M ₂	814.3 ^d	860.2 ^{bc}	863.7 ^{bc}	846.1 ^b	783.4 ^b	837.8 ^{b-d}	851.3 ^{ab}	824.1 ^{ab}	798.9 ^f	849.0 ^{bc}	857.5 ^b	835.1 ^b
N ₂	M ₁	819.5 ^d	831.3 ^{cd}	855.0 ^{bc}	835.3 ^b	785.0 ^d	787.5 ^{cd}	818.9 ^{b-b}	797.1 ^b	802.3 ^{ef}	809.4 ^{d-f}	836.9 ^{b-d}	816.2 ^c
	M ₂	838.3 ^{b-d}	870.0 ^{ab}	900.7 ^a	869.7 ^a	799.0 ^{b-d}	852.1 ^{ab}	898.8 ^a	850.0 ^a	818.7 ^{c-f}	861.1 ^b	899.8 ^a	859.8 ^a
Target		811.2 ^c	854.0 ^b	870.3 ^a		773.4 ^c	822.6 ^b	854.3 ^a		792.3 ^c	838.3 ^b	862.3 ^a	
Control		782.0				733.9				758.2			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		793.5 ^d	857.3 ^{ab}	862.8 ^{ab}	837.9 ^a	754.8 ^c	825.3 ^{ab}	849.8 ^a	810.0 ^a	774.2 ^d	841.3 ^b	856.3 ^{ab}	823.9 ^a
N ₂		828.9 ^c	850.7 ^b	877.8 ^a	852.a ^a	792.0 ^{bc}	819.8 ^{ab}	858.9 ^a	823.5 ^a	810.5 ^c	835.2 ^b	868.3 ^a	838.0 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		796.1 ^d	842.8 ^{bc}	858.5 ^b	832.5 ^a	755.6 ^e	800.2 ^{cd}	833.6 ^{bc}	796.5 ^a	775.9 ^d	821.5 ^c	846.1 ^b	814.5 ^a
M ₂		826.3 ^c	865.1 ^{ab}	882.2 ^a	857.9 ^a	791.2 ^{de}	845.0 ^{ab}	875.1 ^a	837.1 ^a	808.8 ^c	855.0 ^b	878.6 ^a	847.5 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		19.8				35.6				19.7			
T		24.2				43.6				24.2			
M		19.8				35.6				19.7			
N x T		34.3				61.7				34.2			
M x T		34.3				61.7				34.2			
N x M		28.0				50.4				27.9			
N x T x M		48.5				87.3				48.4			
Control Vs Rest		9.9		29.0		21.2		61.8		11.5		33.5	

DAS - Days after sowing

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 123. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on leaf area (cm² plant⁻¹) at 90 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	1160.1 ^e	1343.2 ^{bc}	1375.0 ^b	1292.8 ^b	1154.8 ^f	1333.4 ^{b-d}	1343.3 ^{b-d}	1277.2 ^b	1157.4 ^g	1338.3 ^{cd}	1359.2 ^{cd}	1285.0 ^c
	M ₂	1248.7 ^d	1355.3 ^{bc}	1414.1 ^{ab}	1339.4 ^b	1233.6 ^f	1341.8 ^{b-d}	1354.7 ^{bc}	1310.0 ^b	1241.2 ^f	1348.5 ^{cd}	1384.4 ^{bc}	1324.7 ^b
N ₂	M ₁	1262.8 ^{cd}	1272.3 ^{cd}	1348.5 ^{bc}	1294.5 ^b	1234.5 ^{ef}	1256.9 ^{de}	1333.8 ^{b-d}	1275.1 ^b	1248.6 ^f	1264.6 ^{ef}	1341.2 ^{cd}	1284.8 ^c
	M ₂	1334.2 ^{b-d} _d	1464.5 ^a	1478.1 ^a	1425.6 ^a	1281.1 ^{c-e}	1404.0 ^{ab}	1467.1 ^a	1384.1 ^a	1307.6 ^{de}	1434.2 ^{ab}	1472.6 ^a	1404.8 ^a
Target		1251.4 ^c	1358.8 ^b	1403.9 ^a		1226.0 ^b	1334.0 ^a	1374.7 ^a		1238.7 ^c	1346.4 ^b	1389.3 ^a	
Control		1230.2				1230.6				1230.5			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		1204.4 ^c	1349.2 ^a _b	1394.6 ^a	1316.1 ^a	1194.2 ^e	1337.6 ^a	1349.0 ^c	1293.6 ^a	1199.3 ^d	1343.4 ^b	1371.8 ^{ab}	1304.8 ^a
N ₂		1298.5 ^b	1368.4 ^a	1413.3 ^a	1360.1 ^a	1257.8 ^d	1330.4 ^c	1400.5 ^b	1329.6 ^a	1278.1 ^c	1349.4 ^b	1406.9 ^a	1344.8 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		1211.4 ^e	1307.7 ^{cd}	1361.8 ^b _c	1293.6 ^a	1194.6 ^e	1295.2 ^{cd}	1338.5 ^{bc}	1276.1 ^a	1203.0 ^d	1301.4 ^c	1350.2 ^b	1284.9 ^a
M ₂		1291.5 ^d	1409.9 ^{ab}	1446.1 ^a	1382.5 ^a	1257.3 ^d	1372.9 ^{ab}	1410.9 ^a	1347.0 ^a	1274.4 ^c	1391.4 ^a	1428.5 ^a	1364.8 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		55.4		121.2		43.4		112.0		36.3		73.07	
T		67.8				53.2				44.5			
M		55.4				43.4				36.3			
N x T		95.9				75.3				62.9			
M x T		95.9				75.3				62.9			
N x M		78.3				61.4				51.4			
N x T x M		135.6				106.4				89.0			
Control Vs Rest		41.5		121.2		38.4		112.0		25.0		73.07	

DAS - Days after sowing

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 124. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on leaf area (cm² plant⁻¹) at harvest under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	680.6 ^e	767.7 ^{cd}	781.3 ^{cd}	743.2 ^b	668.2 ^e	754.1 ^{b-d}	768.5 ^{bc}	730.3 ^b	674.4 ^f	760.9 ^{cd}	774.9 ^{bc}	736.8 ^c
	M ₂	726.0 _{de}	776.7 ^{cd}	792.9 ^{bc}	765.2 ^b	706.3 ^{de}	765.6 ^{bc}	785.4 ^b	752.4 ^b	716.2 ^e	771.2 ^{bc}	789.1 ^{bc}	758.8 ^b
N ₂	M ₁	724.6 ^{de}	730.3 ^{de}	774.6 ^{cd}	743.2 ^b	713.5 ^{c-e}	718.2 ^{c-e}	755.6 ^{b-d}	729.1 ^b	719.0 ^e	724.3 ^{de}	765.1 ^{bc}	736.1 ^c
	M ₂	755.6 ^{cd}	842.0 ^{ab}	860.0 ^a	819.2 ^a	743.8 ^{b-d}	768.8 ^{bc}	848.7 ^{bc}	787.1 ^a	749.7 _{c-e}	805.4 ^b	854.4 ^a	803.1 ^a
Target		721.7 ^c	779.2 ^b	802.2 ^a		708.0 ^c	751.7 ^b	789.5 ^a		714.8 ^c	765.4 ^b	795.9 ^b	
Control		696.8				681.4				689.1			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		703.3 ^d	772.2 ^{bc}	787.1 ^{ab}	754.2 ^a	687.3 ^d	759.9 ^{bc}	777.0 ^{ab}	741.4 ^a	695.3 ^e	766.0 ^c	782.0 ^b	747.8 ^a
N ₂		740.1 ^c	786.2 ^{ab}	817.3 ^a	781.2 ^a	728.6 ^c	743.5 ^{bc}	802.1 ^a	758.1 ^a	734.4 ^d	764.8 ^b	809.7 ^a	769.6 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		702.6 ^d	749.0 ^c	778.0 ^{bc}	743.2 ^a	690.9 ^d	736.2 ^{bc}	762.1 ^{bc}	729.7 ^a	696.7 ^d	742.6 ^c	770.0 ^b	736.4 ^a
M ₂		740.8 ^c	809.3 ^{ab}	826.5 ^a	792.2 ^a	725.1 ^{cd}	767.2 ^b	817.0 ^a	769.8 ^a	732.9 ^c	788.3 ^b	821.8 ^a	781.0 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		33.1				33.3				24.0			
T		40.6				40.8				29.4			
M		33.1				33.3				24.0			
N x T		57.4				57.7				41.6			
M x T		57.4				57.7				41.6			
N x M		46.9				47.0				34.0			
N x T x M		81.2				81.6				59.0			
Control Vs Rest		19.6		57.3		19.0		55.7		15.6		45.5	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

and 695.3, respectively), micronutrients across approaches in combinations with yield targets registered higher LA (878.6, 1428.5 and 821.8, respectively) with higher target coupled with micronutrient and organics supply (T_3M_2) while lower yield target and no micronutrient supply (T_1M_1) recorded lower LA (775.9, 1203.0 and 696.7, respectively), and among approaches and micronutrient + organics supply across yield targets STCR approach and micronutrient + organics supply (N_1M_2) registered higher LA (859.8, 1404.8 and 803.1, respectively) while NE and no micronutrient + organics supply (N_1M_1) recorded lower LA (812.8, 1285.0 and 736.8, respectively).

Among three factor combinations, significantly higher LA (899.8, 1472.6 and 854.4, respectively at 67 and 90 DAS and at harvest) throughout was observed with STCR + 8 t ha⁻¹ + micronutrient supply ($N_2T_3M_2$) while NE + 6 t ha⁻¹ + no micronutrient supply ($N_1T_1M_1$) resulted in poor LA (749.5, 1157.4 and 674.4, respectively). Other treatment combinations had intermediary LA.

In between control and rest of the treatments, all combinations except $N_1T_1M_1$ at 67 DAS, and combinations involving medium and high yield targets ($N_{1-2}T_{2-3}M_{1-2}$) and $N_2T_1M_1$ except $N_2T_2M_1$ at 90 DAS and at harvest fared superior to control (758.2, 1230.5 and 689.1, respectively).

4.2.1.1.4 Leaf area index (c.f. Table 125-128)

Leaf area index (LAI) followed trends in leaf area and increased till 90 DAS and decreased thereafter due to onset of senescence and the variations were significant due to different factors and their interactions at all the stages of observations during both the years and on pooled basis . Overall, the trend remained same throughout.

Variations in LAI due to main effects of yield targets and micronutrients alongwith organics (M) were significant while those due to nutritional approaches (N) were not significant. LAI increased with increase in yield targets corresponding with nutrition and higher LA (2.68, 4.41, 7.36 and 3.98, respectively at 45, 67 and 90 DAS at harvest) was observed with yield target of 8 t ha⁻¹ (T_3) closely followed by T_2 which was at par at times while, plants with 6 t ha⁻¹ yield target (T_1) had lower LAI (2.39, 3.96, 6.19 and 3.57, respectively).

Two factor interactions were significant. STCR approach coupled higher yield target across micronutrients (N_2T_3) recorded higher LAI (2.66, 4.24, 7.03 and 4.05,

Table 125. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on leaf area index at 45 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	2.31 ^e	2.51 ^c	2.66 ^b	2.49 ^c	2.25 ^g	2.55 ^{cd}	2.69 ^{ab}	2.49 ^c	2.28 ^h	2.53 ^d	2.67 ^b	2.49 ^c
	M ₂	2.34 ^e	2.61 ^b	2.74 ^a	2.56 ^b	2.35 ^f	2.61 ^{bc}	2.74 ^a	2.56 ^b	2.34 ^g	2.61 ^c	2.74 ^a	2.56 ^b
N ₂	M ₁	2.43 ^d	2.46 ^{cd}	2.53 ^c	2.47 ^c	2.43 ^{ef}	2.47 ^{de}	2.56 ^{cd}	2.49 ^c	2.43 ^f	2.46 ^{ef}	2.55 ^d	2.48 ^c
	M ₂	2.49 ^{cd}	2.76 ^a	2.77 ^a	2.67 ^a	2.54 ^{cd}	2.76 ^a	2.76 ^a	2.69 ^a	2.51 ^{de}	2.76 ^a	2.77 ^a	2.68 ^a
Target		2.39 ^c	2.58 ^b	2.68 ^a		2.39 ^c	2.60 ^b	2.69 ^a		2.39 ^c	2.59 ^b	2.68 ^a	
Control		2.31				2.33				2.32			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		2.32 ^e	2.56 ^c	2.70 ^a	2.53 ^a	2.30 ^e	2.58 ^c	2.71 ^a	2.53 ^a	2.31 ^f	2.57 ^d	2.71 ^a	2.53 ^a
N ₂		2.46 ^d	2.61 ^b	2.65 ^b	2.57 ^a	2.48 ^d	2.62 ^{bc}	2.66 ^{ab}	2.59 ^a	2.47 ^e	2.61 ^c	2.66 ^b	2.58 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		2.37 ^e	2.48 ^d	2.60 ^c	2.48 ^b	2.34 ^e	2.51 ^c	2.62 ^b	2.49 ^a	2.35 ^f	2.50 ^d	2.61 ^c	2.49 ^b
M ₂		2.41 ^e	2.68 ^b	2.76 ^a	2.62 ^a	2.44 ^d	2.68 ^b	2.75 ^a	2.63 ^a	2.43 ^a	2.68 ^b	2.75 ^a	2.62 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.04				0.06				0.04			
T		0.05				0.07				0.04			
M		0.04				0.06				0.04			
N x T		0.07				0.10				0.06			
M x T		0.07				0.10				0.06			
N x M		0.06				0.08				0.05			
N x T x M		0.10				0.14				0.09			
Control Vs Rest		0.03		0.08		0.03		0.87		0.02		0.06	

DAS - Days after sowing

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 126. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on leaf area index at 67 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	3.86 ^e	4.27 ^{bc}	4.31 ^{bc}	4.15 ^b	3.63 ^e	4.06 ^{b-d}	4.24 ^{a-c}	3.98 ^b	3.75 ^g	4.17 ^{b-e}	4.28 ^b	4.06 ^b
	M ₂	4.07 ^d	4.30 ^{bc}	4.32 ^{bc}	4.23 ^b	3.92 ^d	4.19 ^{b-d}	4.26 ^{a-c}	4.12 ^{ab}	3.99 ^f	4.24 ^{bc}	4.29 ^b	4.18 ^b
N ₂	M ₁	4.10 ^d	4.16 ^{cd}	4.28 ^{bc}	4.18 ^b	3.92 ^d	3.94 ^{cd}	4.09 ^{b-d}	3.99 ^b	4.01 ^{ef}	4.05 ^{d-f}	4.18 ^{b-d}	4.08 ^b
	M ₂	4.19 ^{b-d}	4.35 ^{ab}	4.50 ^a	4.35 ^a	3.99 ^{b-d}	4.26 ^{ab}	4.49 ^a	4.25 ^a	4.09 ^{c-f}	4.31 ^b	4.50 ^a	4.30 ^a
Target		4.06 ^c	4.27 ^b	4.35 ^a		3.87 ^c	4.11 ^b	4.27 ^a		3.96 ^c	4.19 ^b	4.31 ^b	
Control		3.91				3.67				3.79			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		3.97 ^d	4.29 ^{ab}	4.31 ^{ab}	4.19 ^a	3.77 ^c	4.13 ^{ab}	4.25 ^a	4.05 ^a	3.87 ^d	4.21 ^b	4.28 ^{ab}	4.12 ^a
N ₂		4.14 ^c	4.25 ^b	4.39 ^a	4.26 ^a	3.96 ^{bc}	4.10 ^{ab}	4.29 ^a	4.12 ^a	4.05 ^c	4.18 ^b	4.34 ^a	4.19 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		3.98 ^e	4.21 ^{cd}	4.29 ^{bc}	4.16 ^a	3.78 ^e	4.00 ^{cd}	4.17 ^{bc}	3.98 ^a	3.88 ^d	4.11 ^c	4.23 ^b	4.07 ^a
M ₂		4.13 ^d	4.33 ^{ab}	4.41 ^a	4.29 ^a	3.96 ^{de}	4.22 ^{ab}	4.38 ^a	4.19 ^a	4.04 ^c	4.28 ^b	4.39 ^a	4.24 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.10				0.18				0.10			
T		0.12				0.22				0.12			
M		0.10				0.18				0.10			
N x T		0.17				0.31				0.17			
M x T		0.17				0.31				0.17			
N x M		0.14				0.25				0.14			
N x T x M		0.24				0.44				0.24			
Control Vs Rest		0.05		0.14		0.10		0.30		0.05		0.16	

DAS - Days after sowing

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 127. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on leaf area index at 90DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	5.80 ^f	6.72 ^{cd}	6.88 ^{bc}	6.46 ^b	5.77 ^e	6.67 ^{bc}	6.72 ^{bc}	6.39 ^b	5.79 ^g	6.69 ^{cd}	6.80 ^{cd}	6.42 ^b
	M ₂	6.24 ^e	6.78 ^{cd}	7.07 ^{a-c}	6.70 ^b	6.17 ^d	6.71 ^{bc}	6.77 ^{bc}	6.55 ^b	6.21 ^f	6.74 ^{cd}	6.92 ^{bc}	6.62 ^b
N ₂	M ₁	6.31 ^{de}	6.36 ^{de}	6.74 ^{cd}	6.47 ^b	6.17 ^d	6.28 ^d	6.67 ^{bc}	6.38 ^b	6.24 ^f	6.32 ^{ef}	6.71 ^{cd}	6.42 ^b
	M ₂	6.67 ^{c-e}	7.32 ^{ab}	7.39 ^a	7.13 ^a	6.41 ^{cd}	7.02 ^{ab}	7.34 ^{bc}	6.92 ^a	6.54 ^{de}	7.17 ^{ab}	7.36 ^a	7.02 ^a
Target		6.25 ^c	6.79 ^b	7.02 ^b		6.13 ^c	6.67 ^b	6.87 ^a		6.19 ^c	6.73 ^b	6.95 ^a	
Control		6.15				6.13				6.14			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		6.02 ^c	6.75 ^{ab}	6.97 ^a	6.58 ^a	5.97 ^d	6.69 ^b	6.75 ^b	6.47 ^a	6.00 ^d	6.72 ^b	6.86 ^{ab}	6.52 ^a
N ₂		6.49 ^b	6.84 ^a	7.07 ^a	6.80 ^a	6.29 ^c	6.65 ^b	7.00 ^a	6.65 ^a	6.39 ^c	6.75 ^b	7.03 ^a	6.72 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		6.06 ^e	6.54 ^{cd}	6.81 ^{bc}	6.47 ^a	5.97 ^e	6.48 ^{cd}	6.69 ^{bc}	6.38 ^a	6.02 ^d	6.51 ^c	6.75 ^b	6.42 ^a
M ₂		6.46 ^d	7.05 ^{ab}	7.23 ^a	6.91 ^a	6.29 ^d	6.86 ^{ab}	7.05 ^a	6.74 ^a	6.37 ^c	6.96 ^a	7.14 ^a	6.82 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.28				0.22				0.18			
T		0.34				0.27				0.22			
M		0.28				0.22				0.18			
N x T		0.48				0.38				0.31			
M x T		0.48				0.38				0.31			
N x M		0.39				0.31				0.26			
N x T x M		0.68				0.53				0.45			
Control Vs Rest		0.20		0.60		0.19		0.56		0.12		0.36	

DAS - Days after sowing

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 128. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on leaf area index at harvest under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	3.40 ^e	3.84 ^{cd}	3.91 ^{cd}	3.72 ^b	3.34 ^e	3.77 ^{b-d}	3.84 ^{bc}	3.65 ^b	3.37 ^f	3.80 ^{cd}	3.87 ^{bc}	3.68 ^c
	M ₂	3.63 ^{de}	3.88 ^{cd}	3.96 ^{bc}	3.83 ^b	3.53 ^{de}	3.83 ^{bc}	3.93 ^b	3.76 ^b	3.58 ^e	3.86 ^{bc}	3.95 ^{bc}	3.79 ^b
N ₂	M ₁	3.62 ^{de}	3.65 ^{de}	3.87 ^{cd}	3.72 ^b	3.57 ^{c-e}	3.59 ^{c-e}	3.78 ^{b-d}	3.65 ^b	3.60 ^e	3.62 ^{de}	3.83 ^{bc}	3.68 ^c
	M ₂	3.78 ^{cd}	4.21 _{ab}	4.30 ^a	4.10 ^a	3.72 ^{b-d}	3.84 ^{bc}	4.24 ^a	3.94 ^a	3.75 ^{c-e}	4.03 ^b	4.27 ^a	4.02 ^a
Target		3.61 ^c	3.90 ^a	4.01 ^a		13.54 ^c	3.76 ^b	3.95 ^a		3.57 ^c	3.83 ^b	3.98 ^a	
Control		3.48				3.41				3.45			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		3.52 ^d	3.86 ^{bc}	3.94 _{ab}	3.77 ^a	3.44 ^d	3.80 ^{bc}	3.88 ^{ab}	3.71 ^a	3.48 ^d	3.83 ^b	3.91 ^b	3.74 ^a
N ₂		3.70 ^c	3.93 _{ab}	4.09 ^a	3.91 ^a	3.64 ^c	3.72 ^{bc}	4.01 ^a	3.79 ^a	3.67 ^c	3.82 ^b	4.05 ^a	3.85 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		3.51 ^e	3.75 ^{cd}	3.89 ^{bc}	3.72 ^a	3.45 ^e	3.68 ^a	3.81 ^{cd}	3.65 ^a	3.48 ^d	3.71 ^c	3.85 ^b	3.68 ^b
M ₂		3.70 ^d	4.05 _{ab}	4.13 ^a	3.96 ^a	3.63 ^{de}	3.84 ^c	4.09 ^b	3.85 ^a	3.66 ^c	3.94 ^b	4.11 ^a	3.90 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.17				0.17				0.12			
T		0.20				0.20				0.15			
M		0.17				0.17				0.12			
N x T		0.29				0.29				0.21			
M x T		0.29				0.29				0.21			
N x M		0.23				0.24				0.17			
N x T x M		0.41				0.41				0.29			
Control Vs Rest		0.09		0.28		0.09		0.27		0.07		0.22	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

respectively at 45, 67 and 90 DAS at harvest) while NE with 6 t ha⁻¹ (N₁T₁) recorded the lowest LAI (2.31, 3.87, 6.00 and 4.48 respectively), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum LAI (2.75, 4.29, 7.14 and 4.11, respectively) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂) while lower yield target and no micronutrients/organics (T₁M₁) recorded lower LAI (2.35, 3.88, 6.02 and 3.48, respectively), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics (N₂M₂) recorded higher LAI (2.68, 4.20, 7.02 and 4.02, respectively) while NE and no micronutrient + organics supply (N₁M₁) recorded lower LAI (2.49, 4.06, 6.42 and 3.71, respectively).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered significantly higher LAI (2.77, 4.50, 7.36 and 3.37, respectively at 45, 67 and 90 DAS and at harvest) at 90 DAS N₂T₂M₂ was on par, while lower LAI (2.28, 3.75, 5.79 and 4.27, respectively) was recorded with NE + 6 t ha⁻¹ yield target + no-micronutrient (N₁T₁M₁); other treatment combinations fared in between.

All combinations except N₁T₁M₁₋₂ at 45 DAS, N₁T₁M₁ at 67 DAS, and N₁T₁M₁₋₂, N₂T₁M₁ and N₂T₂M₁ at 90 DAS and harvest were significantly superior to control (2.32, 3.79, 6.14 and 3.45, respectively at 45, 67 and 90 DAS and at harvest) with regard to LAI.

4.2.1.1.5 Dry matter accumulation in leaves (g plant⁻¹)(c.f. Table 129-132 and Fig. 22a)

Dry matter (DM) in leaf increased throughout crop growth till harvest recording the maximum at harvest and the variations were significant due to different factors and their interactions at all the stages of observations during both the years and on pooled basis.

At 45 DAS, variations in DM only due to yield targets were significant wherein the DM increased with increase in yield targets corresponding with nutrition and higher DM (0.85) occurred with yield target of 8 t ha⁻¹ (T₃) while, plants with 6 t ha⁻¹ yield target (T₁) had lower DM (0.55). Differences due to nutritional approaches (N) and micronutrient + organic supply (M) were not significant.

Two factor interactions were significant wherein STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher DM (0.75) while NE with 6 t ha^{-1} (N_1T_1) recorded the lowest DM (0.69), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum DM (0.92) with higher target (8 t ha^{-1}) coupled with micronutrients and organics (T_3M_2) while lower yield target and no micronutrient/organics (T_1M_1) recorded lower DM (0.50), and among nutritional approaches and yield targets across micronutrient supply STCR approach and 8 t ha^{-1} yield target (N_2T_3) recorded higher DM (0.85) while NE and lower yield target of 6 t ha^{-1} (N_1T_1) recorded lower DM (0.65) in leaves.

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + micronutrient supply ($N_2T_3M_2$) registered the maximum DM (0.95) followed by similar combination but with medium yield target ($N_2T_2M_2$ – 0.92), while lower DM (0.45) was recorded with NE + 6 t ha^{-1} yield target + no-micronutrient/organics ($N_1T_1M_1$) among all; other treatment combinations fared in between.

All combinations involving medium to higher yield target (T_{2-3}) irrespective of nutritional approach (N_{1-2}) and micronutrient supply (M_{1-2}) and $N_2T_1M_1$ fared better than control with recommended practices (0.49).

More or less similar trend prevailed at 67 and 90 DAS and at harvest. Among the main effects variations in DM due to yield targets were significant. DM increased with increase in yield targets corresponding with increase in nutrition and higher DM (2.44, 11.18 and 16.72, respectively) occurred with yield target of 8 t ha^{-1} (T_3) while, plants with 6 t ha^{-1} yield target (T_1) had lower DM (1.77, 8.96 and 14.86, respectively). Differences due to nutritional approaches (N) and micronutrient + organic supply (M) were not significant except with latter treatment at harvest wherein with micronutrient DM in leaves was significantly higher (16.37) against without micronutrient + organics supplementation (15.47).

Combination of two factors also resulted in significant variation in leaf DM. DM was higher and at parity (2.43-2.46, 11.08-11.28 and 16.57-16.87, respectively at 67 and 90 DAS and at harvest) with both the approaches with yield target of 8 t ha^{-1} ($N_{1-2}T_3$) while NE with 6 t ha^{-1} (N_1T_1) recorded the lowest DM (1.55, 8.46 and 14.27, respectively), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum DM (2.62, 11.47 and 17.19, respectively) with

Table 129. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on dry matter accumulation in leaves (g plant⁻¹) at 45 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	0.47 ^e	0.70 ^{cd}	0.83 ^{bc}	0.67^c	0.44 ^f	0.67 ^e	0.80 ^c	0.64^c	0.45 ^h	0.69 ^e	0.82 ^c	0.65^c
	M ₂	0.53 ^{ef}	0.77 ^{cd}	0.90 ^{ab}	0.73^b	0.50 ^{ef}	0.74 ^c	0.87 ^b	0.70^b	0.52 ^g	0.75 ^d	0.89 ^b	0.72^b
N ₂	M ₁	0.57 ^e	0.67 ^d	0.77 ^{ce}	0.67^c	0.54 ^e	0.64 ^d	0.74 ^c	0.64^c	0.55 ^g	0.65 ^f	0.75 ^d	0.65^c
	M ₂	0.70 ^d	0.93 ^a	0.97 ^a	0.87^a	0.67 ^d	0.90 ^{ab}	0.94 ^a	0.84^a	0.69 ^e	0.92 ^{ab}	0.95 ^a	0.85^a
Target		0.57^c	0.77^b	0.87^a		0.54^c	0.74^b	0.84^a		0.55^c	0.75^b	0.85^a	
Control		0.50				0.47				0.49			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		0.50 ^e	0.73 ^c	0.87 ^a	0.70^a	0.47 ^e	0.70 ^e	0.84 ^a	0.67^a	0.49 ^e	0.72 ^c	0.85 ^a	0.69^a
N ₂		0.63 ^d	0.80 ^b	0.87 ^a	0.77^a	0.60 ^d	0.77 ^b	0.84 ^a	0.74^a	0.62 ^d	0.79 ^b	0.85 ^a	0.75^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		0.52 ^d	0.68 ^c	0.80 ^b	0.67^a	0.49 ^e	0.65 ^c	0.77 ^b	0.64^a	0.50 ^f	0.67 ^d	0.79 ^c	0.65^a
M ₂		0.62 ^c	0.85 ^b	0.93 ^a	0.80^a	0.59 ^d	0.82 ^b	0.90 ^a	0.77^a	0.60 ^e	0.84 ^b	0.92 ^a	0.79^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.06				0.05				0.02			
T		0.07				0.06				0.02			
M		0.06				0.05				0.02			
N x T		0.10				0.09				0.03			
M x T		0.10				0.09				0.03			
N x M		0.08				0.07				0.03			
N x T x M		0.15				0.12				0.05			
Control Vs Rest		0.06		0.18		0.05		0.15		0.05		0.16	

DAS - Days after sowing

Nutrient approach (N)

Yield Targets (T)

Micronutrient & Organics (M)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 130. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on dry matter accumulation in leaves (g plant⁻¹) at 67 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	1.39 ^f	2.33 ^{cd}	2.69 ^{a-c}	2.14^b	1.30 ^h	1.90 ^{d-f}	2.10 ^{cd}	1.77^c	1.35 ^h	2.11 ^{ef}	2.40 ^{cd}	1.95^c
	M ₂	1.86 ^e	2.39 ^{b-d}	2.76 ^{ab}	2.34^b	1.63 ^g	2.03 ^{c-e}	2.17 ^{bc}	1.94^b	1.75 ^g	2.21 ^{de}	2.46 ^{bc}	2.14^b
N ₂	M ₁	2.09 ^{de}	2.26 ^d	2.36 ^{cd}	2.24^b	1.73 ^{fg}	1.77 ^{fg}	1.90 ^{d-f}	1.80^c	1.91 ^{fg}	2.01 ^{ef}	2.13 ^e	2.02^c
	M ₂	2.2 ^d	2.86 ^a	2.93 ^a	2.68^a	1.83 ^{e-g}	2.40 ^{ab}	2.63 ^a	2.29^a	2.05 ^{ef}	2.63 ^{ab}	2.78 ^a	2.49^a
Target		1.90^c	2.46^b	2.69^a		1.62^c	2.03^b	2.20^a		1.77^c	2.24^b	2.44^a	
Control		1.83				1.60				1.71			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		1.63 ^d	2.36 ^{bc}	2.73 ^a	2.24^a	1.47 ^d	1.97 ^b	2.13 ^{ab}	1.86^a	1.55 ^d	2.16 ^b	2.43 ^a	2.05^a
N ₂		2.18 ^c	2.56 ^{ab}	2.64 ^a	2.46^a	1.78 ^c	2.08 ^b	2.27 ^a	2.04^a	1.98 ^c	2.32 ^a	2.46 ^a	2.25^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		1.74 ^e	2.29 ^{cd}	2.53 ^{bc}	2.19^a	1.52 ^e	1.83 ^d	2.00 ^c	1.78^a	1.63 ^f	2.06 ^d	2.26 ^c	1.98^a
M ₂		2.06 ^d	2.63 ^{ab}	2.84 ^a	2.51^a	1.73 ^d	2.22 ^b	2.40 ^a	2.12^a	1.90 ^e	2.42 ^b	2.62 ^a	2.31^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.18				0.15				0.13			
T		0.22				0.19				0.16			
M		0.18				0.15				0.13			
N x T		0.32				0.26				0.22			
M x T		0.32				0.26				0.22			
N x M		0.26				0.21				0.18			
N x T x M		0.45				0.37				0.32			
Control Vs Rest		0.17		0.50		0.10		0.30		0.11		0.33	

DAS - Days after sowing

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 131. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on dry matter accumulation in leaves (g plant⁻¹) at 90 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	8.47	10.43 ^{c-f}	11.10 ^{a-c}	9.99 ^c	7.03 ^d	10.57 ^{ab}	11.03 ^a	9.54 ^c	7.75 ^d	10.50 ^b	11.05 ^{ab}	9.77 ^c
	M ₂	9.73 ^f	10.93 ^{b-d}	10.77 ^{a-c}	10.59 ^b	8.60 ^c	10.77 ^a	11.13 ^a	10.17 ^b	9.17 ^c	10.985 ^{ab}	11.12 ^{ab}	10.38 ^b
N ₂	M ₁	9.93 ^f	10.10 ^{ef}	10.80 ^{b-e}	10.27 ^{bc}	8.67 ^c	8.90 ^c	10.70 ^{ab}	9.42 ^c	9.30 ^c	9.50 ^c	10.73 ^b	9.84 ^c
	M ₂	10.2 ^{d-f}	11.07 ^{ab}	11.80 ^a	11.17 ^a	9.07 ^{bc}	11.17 ^a	11.83 ^a	10.72 ^a	9.63 ^c	11.33 ^{ab}	11.82 ^a	10.93 ^a
Target		9.60 ^c	10.74 ^b	11.28 ^a		8.40 ^b	10.40 ^a	11.20 ^a		8.96 ^c	10.55 ^b	11.18 ^a	
Control		9.10				8.47				8.80			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		9.10 ^d	10.68 ^b	11.08 ^{ab}	10.13 ^a	7.82 ^d	10.67 ^{ab}	11.08 ^{ab}	9.86 ^a	8.46 ^c	10.68 ^{ab}	11.08 ^a	10.07 ^a
N ₂		10.07 ^c	10.80 ^b	11.28 ^a	10.70 ^a	8.87 ^c	10.03 ^b	11.27 ^a	10.06 ^a	9.47 ^c	10.42 ^b	11.28 ^a	10.39 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		9.20 ^d	10.27 ^c	10.92 ^b	10.10 ^a	7.9 ^c	9.7 ^b	10.90 ^a	9.45 ^a	8.53 ^c	10.0 ^b	10.89 ^a	9.81 ^a
M ₂		10.00 ^c	11.22 ^{ab}	11.45 ^a	10.9 ^a	8.8 ^{bc}	11.0 ^a	11.50 ^a	10.43 ^a	9.4 ^b	11.0 ^a	11.47 ^a	10.65 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.45				1.00				0.60			
T		0.55				1.23				0.70			
M		0.45				1.00				0.60			
N x T		0.77				1.74				1.00			
M x T		0.77				1.74				1.00			
N x M		0.63				1.42				0.80			
N x T x M		1.09				2.46				1.40			
Control Vs Rest		0.65		NS		0.95		2.76		0.55		1.61	

DAS - Days after sowing

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 132. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on dry matter accumulation in leaves (g plant⁻¹) at harvest under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	14.29 ^f	16.69 ^{cd}	17.35 ^{bcd}	16.11 ^{bc}	13.55 ^e	15.05 ^{cd}	15.68 ^b	14.76 ^c	13.92 ^g	15.87 ^{de}	16.51 ^c	15.44 ^c
	M ₂	15.11 ^{ef}	16.81 ^{bcd}	17.52 ^{bc}	16.48 ^b	14.51 ^d	15.95 ^b	15.71 ^b	15.39 ^b	14.81 ^f	16.38 ^{cd}	16.62 ^{bc}	15.93 ^b
N ₂	M ₁	15.47 ^e	15.59 ^e	16.79 ^{bcd}	15.95 ^c	14.57 ^d	14.67 ^{cd}	15.17 ^{bc}	14.80 ^c	15.02 ^f	15.13 ^f	15.98 ^{de}	15.37 ^c
	M ₂	16.53 ^d	17.71 ^b	19.17 ^a	17.80 ^a	14.84 ^{cd}	16.27 ^a	16.34 ^a	15.82 ^a	15.87 ^e	16.99 ^b	17.76 ^a	16.81 ^a
Target		15.40 ^c	16.70 ^b	17.70 ^a		14.30 ^c	15.40 ^b	15.70 ^a		14.86 ^c	16.09 ^b	16.72 ^a	
Control		14.40				13.9				14.15			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		14.70 ^e	16.75 ^{bc}	17.43 ^{ab}	16.30 ^a	14.03 ^d	15.30 ^b	15.70 ^a	15.07 ^a	14.37 ^d	16.03 ^b	16.37 ^a	15.69 ^a
N ₂		16.00 ^d	16.65 ^{cd}	17.98 ^a	16.88 ^a	14.71 ^c	15.47 ^{ab}	15.75 ^a	15.31 ^a	15.35 ^c	16.06 ^b	16.87 ^a	16.09 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		14.88 ^d	16.14 ^c	17.07 ^b	16.03 ^a	14.06 ^d	14.86 ^c	15.42 ^b	14.78 ^a	14.47 ^e	15.50 ^d	16.28 ^c	15.41 ^b
M ₂		15.82 ^c	17.26 ^b	18.35 ^a	17.14 ^a	14.67 ^c	16.11 ^a	16.03 ^a	15.60 ^a	15.25 ^d	16.68 ^b	17.19 ^a	16.37 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.57				0.32				0.29			
T		0.69				0.39				0.36			
M		0.57				0.32				0.29			
N x T		0.98				0.55				0.51			
M x T		0.98				0.55				0.51			
N x M		0.80				0.45				0.41			
N x T x M		1.39				0.78				0.72			
Control Vs Rest		0.91		2.71		0.53		1.57		0.60		1.77	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

higher target (8 t ha^{-1}) coupled with micronutrients/ and organics (T_3M_2) while lower yield target and no micronutrient/organics (T_1M_1) recorded lower DM (1.63, 8.5 and 14.4, respectively), and among nutritional approaches and yield targets across micronutrient supply STCR approach and 8 t ha^{-1} yield target (N_2T_3) recorded higher DM (2.49, 10.9 and 16.8, respectively) while NE and lower yield target of 6 t ha^{-1} (N_1T_1) recorded lower DM (1.9, 9.8 and 15.4, respectively) in leaves.

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + micronutrient supply ($N_2T_3M_2$) registered the maximum DM (2.78, 11.82 and 17.76, respectively), while lower DM (1.35, 7.75 and 13.92, respectively at 67 and 90 DAS and at harvest) was recorded with NE + 6 t ha^{-1} yield target + no-micronutrient or organics ($N_1T_1M_1$) among all; other treatment combinations fared in between.

All (three factor) combinations involving medium and higher yield target (T_{2-3}) irrespective of nutritional approach (N_{1-2}) and micronutrient supply (M_{1-2}) at 67 DAS, same combinations except $N_2T_2M_1$ at 90 DAS and similar combinations except $N_1T_2M_1$ at harvest were superior to control with recommended practices (1.71, 8.80 and 14.21, respectively at 67 and 90 DAS and at harvest).

4.2.1.1.6 Dry matter accumulation in stem (g plant^{-1}) (c.f. Table 133-136 and Fig. 22b)

DM in stem increased throughout crop growth till harvest recording the maximum at harvest and the variations were significant due to all the factors and their interactions at all the stages of observations during both the years and on pooled basis. At 45 DAS, variations in DM only due to yield targets were significant wherein the DM increased with increase in yield targets corresponding with higher fertilization and higher DM (1.42) occurred with yield target of 8 t ha^{-1} (T_3) while, plants with 6 t ha^{-1} yield target (T_1) had lower DM (1.13). Differences due to nutritional approaches (N) and micronutrient + organic supply (M) were not significant.

Two factor interactions were significant wherein STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher DM (1.45) while NE with 6 t ha^{-1} (N_1T_1) recorded the lowest DM (1.10), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum DM (1.52) with higher target (8 t ha^{-1}) coupled with micronutrients and organics (T_3M_2) while lower yield target and no micronutrient/organics (T_1M_1) recorded lower DM

(1.12), and among nutritional approaches and yield targets across micronutrient supply STCR approach and 8 t ha⁻¹ yield target (N₂T₃) recorded higher DM (1.45) while NE and lower yield target of 6 t ha⁻¹(N₁T₁) recorded lower DM (1.27) in leaves.

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered the maximum DM (1.55) followed by similar combination but with medium yield target (N₂T₂M₂ – 1.52), while lower DM (1.08) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁) among all; other treatment combinations fared in between.

All combinations involving medium to higher yield target (T₂₋₃) irrespective of nutritional approach (N₁₋₂) and micronutrient supply (M₁₋₂) except N₂T₂M₁ fared better than control with recommended practices (1.09).

More or less similar trend prevailed at 67 and 90 DAS and at harvest. Among the main effects variations in DM due to yield targets were significant. DM increased with increase in yield targets corresponding with increase in nutrition and higher DM (2.57, 17.4 and 28.12, respectively) occurred with yield target of 8 t ha⁻¹ (T₃) while, plants with 6 t ha⁻¹ yield target (T₁) had lower DM (1.89, 12.50 and 25.50, respectively). Differences due to nutritional approaches (N) and micronutrient + organic supply (M) were not significant except at 90 DAS wherein N₂ and M₂ fared better than N₁ and M₁, respectively.

Combination of two factors also resulted in significant variation in stem DM. DM was always higher (2.62, 17.06 and 28.43, respectively at 67 and 90 DAS and at harvest) with STCR approach with yield target of 8 t ha⁻¹ (N₂T₃) and N₁T₃ at times at parity with the former treatment, while NE with 6 t ha⁻¹ (N₁T₁) recorded the lowest DM (1.63, 12.03 and 24.55, respectively), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum DM (2.71, 19.18 and 28.97, respectively) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂) while lower yield target and no micronutrients and organics (T₁M₁) recorded lower DM (1.72, 12.09 and 24.60, respectively), and among nutritional approaches and yield targets across micronutrient supply STCR approach and 8 t ha⁻¹ yield target (N₂T₃) recorded higher DM (2.66, 17.38 and 28.36, respectively) while NE and lower yield target of 6 t ha⁻¹(N₁T₁) recorded lower DM (2.07, 14.14 and 25.97, respectively) in leaves.

Table 133. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on dry matter accumulation in stem (g plant⁻¹) at 45 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	1.11 ^f	1.35 ^{de}	1.45 ^{bc}	1.30^{bc}	1.05 ^g	1.29 ^{de}	1.39 ^c	1.24^c	1.08 ^f	1.32 ^d	1.42 ^b	1.27^c
	M ₂	1.15 ^f	1.39 ^{cd}	1.50 ^{ab}	1.35^b	1.09 ^{fg}	1.32 ^d	1.45 ^{bc}	1.29^b	1.12 ^{ef}	1.35 ^d	1.49 ^a	1.32^b
N ₂	M ₁	1.19 ^f	1.29 ^e	1.39 ^{cd}	1.29^c	1.12 ^f	1.22 ^b	1.32 ^d	1.22^c	1.15 ^e	1.25 ^d	1.35 ^c	1.25^c
	M ₂	1.32 ^{de}	1.55 ^a	1.59 ^a	1.49^a	1.25 ^e	1.49 ^{ab}	1.52 ^a	1.42^a	1.29 ^{cd}	1.52 ^a	1.55 ^a	1.45^a
Target		1.19^c	1.40^b	1.49^a		1.13^c	1.33^b	1.42^a		1.13^c	1.33^b	1.42^a	
Control		1.12				1.05				1.09			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		1.13 ^d	1.37 ^b	1.49 ^a	1.33^a	1.07 ^e	1.30 ^c	1.42 ^a	1.26^a	1.10 ^e	1.34 ^c	1.45 ^a	1.30^a
N ₂		1.25 ^c	1.42 ^b	1.49 ^a	1.39^a	1.19 ^d	1.35 ^b	1.42 ^a	1.32^a	1.22 ^d	1.39 ^b	1.45 ^a	1.35^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		1.15 ^e	1.32 ^c	1.42 ^b	1.30^a	1.08 ^f	1.25 ^d	1.35 ^c	1.23^a	1.12 ^f	1.29 ^d	1.39 ^c	1.27^a
M ₂		1.24 ^d	1.47 ^b	1.55 ^a	1.42^a	1.17 ^e	1.40 ^b	1.49 ^a	1.35^a	1.20 ^e	1.44 ^b	1.52 ^a	1.39^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.06				0.04				0.04			
T		0.07				0.05				0.05			
M		0.06				0.04				0.04			
N x T		0.10				0.07				0.07			
M x T		0.10				0.07				0.07			
N x M		0.08				0.06				0.06			
N x T x M		0.14				0.10				0.10			
Control Vs Rest		0.11		NS		0.04		0.11		0.07		0.21	

DAS - Days after sowing

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 134. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on dry matter accumulation in stem (g plant⁻¹) at 67 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	1.47 ^h	2.40 ^{def}	2.60 ^{cd}	2.16 ^d	1.23 ^e	2.17 ^{bc}	2.53 ^a	1.98 ^b	1.38 ^g	2.28 ^{cd}	2.57 ^b	2.07
	M ₂	2.13 ^g	2.53 ^{cde}	2.67 ^c	2.44 ^b	1.70 ^d	2.27 ^b	2.27 ^b	2.08 ^b	1.92 ^f	2.40 ^{bc}	2.47 ^b	2.26
N ₂	M ₁	2.23 ^{fg}	2.27 ^{fg}	2.40 ^{def}	2.30 ^c	1.93 ^{cd}	2.10 ^{bc}	2.17 ^{bc}	2.07 ^b	2.08 ^{ef}	2.18 ^{de}	2.28 ^{cd}	2.18
	M ₂	2.33 ^{efg}	2.90 ^b	3.13 ^a	2.79 ^a	2.10 ^{bc}	2.70 ^{ja}	2.77 ^a	2.52 ^a	2.22 ^{de}	2.80 ^a	2.95 ^a	2.66
Target		2.04 ^c	2.53 ^b	2.70 ^a		1.74 ^c	2.31 ^b	2.44 ^a		1.89 ^c	2.42 ^b	2.57 ^a	
Control		2.10				1.67				1.88			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		1.80 ^d	2.47 ^b	2.63 ^{ab}	2.30 ^a	1.47 ^d	2.22 ^b	2.40 ^{ab}	2.18 ^a	1.63 ^e	2.34 ^c	2.52 ^{ab}	2.16
N ₂		2.28 ^c	2.58 ^b	2.77 ^a	2.54 ^a	2.02 ^c	2.40 ^{ab}	2.47 ^a	2.44 ^a	2.15 ^d	2.49 ^b	2.62 ^a	2.42
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		1.85 ^e	2.33 ^d	2.50 ^c	2.23 ^a	1.58 ^d	2.13 ^b	2.3a	2.14 ^a	1.72 ^e	2.23 ^c	2.43 ^b	2.13
M ₂		2.23 ^d	2.72 ^b	2.90 ^a	2.62 ^a	1.90 ^c	2.48 ^a	2.5a ^j	2.48 ^a	2.07 ^d	2.60 ^a	2.71 ^a	2.46
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.14				0.16				0.11			
T		0.18				0.20				0.13			
M		0.14				0.16				0.11			
N x T		0.25				0.28				0.19			
M x T		0.25				0.28				0.19			
N x M		0.20				0.23				0.15			
N x T x M		0.35				0.39				0.26			
Control Vs Rest		0.11		0.33		0.10		0.30		0.08		0.25	

DAS - Days after sowing

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 135. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on dry matter accumulation in stem (g plant⁻¹) at 90 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
4N ₁	M ₁	11.53 ^f	15.20 ^{cd}	17.57 ^{ab}	14.77 ^c	11.23 ^f	12.93 ^{de}	16.40 ^c	13.52 ^c	11.38 ^f	14.07 ^d	16.98 ^c	14.14 ^c
	M ₂	13.10 ^e	16.07 ^c	19.67 ^a	16.28 ^b	12.23 ^{ef}	13.43 ^d	17.33 ^{bc}	14.33 ^{ba}	12.67 ^e	14.75 ^d	18.00 ^b	15.31 ^b
14N ₂	M ₁	13.17e ^a	14.07e ^a	14.07 ^d	13.80 ^d	12.43 ^{de}	12.60 ^{de}	13.27 ^{de}	12.77 ^d	12.80 ^e	13.33 ^e	14.27 ^d	13.31 ^d
	M ₂	13.57 ^e	20.00 ^a	20.57 ^a	18.04 ^a	12.70 ^{de}	18.33 ^{ab}	19.13 ^a	16.72 ^a	13.13 ^e	19.17 ^{ab}	19.85 ^a	17.38 ^a
Target		12.60 ^c	16.20 ^b	18.20 ^a		12.10 ^c	14.30 ^b	16.50 ^a		12.50 ^c	15.30 ^b	17.40 ^a	
Control		12.90				11.63				12.30			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		12.32 ^e	15.63 ^d	18.62 ^a	15.52 ^a	11.73 ^d	13.18 ^c	16.87 ^a	13.93 ^a	12.03 ^f	14.41 ^d	17.74 ^a	14.73 ^b
N ₂		13.37 ^f	17.03 ^c	17.82 ^b	16.11 ^a	12.57 ^c	15.47 ^b	16.20 ^{ab}	14.74 ^a	12.97 ^e	16.25 ^c	17.06 ^b	15.43
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		12.35 ^f	14.63 ^d	16.42 ^c	14.47 ^a	11.83 ^e	12.77 ^d	14.83 ^c	13.14 ^a	12.09 ^f	13.70 ^d	15.63 ^c	13.81 _b
M ₂		13.33 ^e	18.03 ^b	20.12 ^a	17.16 ^a	12.47 ^{de}	15.88 ^b	18.23 ^a	15.55 ^a	12.90 ^e	16.96 ^b	19.18 ^a	16.34 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.73				0.68				0.47			
T		0.90				0.83				0.58			
M		0.73				0.68				0.47			
N x T		1.27				1.17				0.82			
M x T		1.27				1.17				0.82			
N x M		1.04				0.96				0.67			
N x T x M		1.80				1.66				1.16			
Control Vs Rest		1.33		3.91		0.67		1.95		1.00		2.92	

DAS - Days after sowing

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 136. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on dry matter accumulation in stem (g plant⁻¹) at harvest under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	25.29 ^g	27.63 ^{cdef}	28.29 ^{bc}	27.07 ^c	22.83 ^f	24.87 ^{de}	26.91 ^{bc}	24.87 ^c	24.06 ⁱ	26.25 ^{ef}	27.60 ^{cd}	25.97 ^c
	M ₂	26.85 ^{ef}	28.12 ^{bcd}	28.79 ^b	27.93 ^b	23.20 ^f	26.83 ^{bc}	27.23 ^{bc}	25.76 ^b	25.03 ^h	27.48 ^{cd}	28.02 ^c	26.84 ^b
N ₂	M ₁	27.08 ^{ef}	27.44 ^{def}	28.29 ^{bcd}	27.49 ^{bc}	23.21 ^f	24.16 ^{ef}	25.93 ^{cd}	24.43 ^c	25.14 ^{gh}	25.80 ^{fg}	26.94 ^{de}	25.96 ^c
	M ₂	27.84 ^{cde}	29.79 ^a	30.00 ^a	29.21 ^a	24.81 ^{de}	27.88 ^b	29.83 ^a	27.51 ^a	26.33 ^{ef}	28.83 ^b	29.92 ^a	28.36 ^a
Target		26.77 ^c	28.24 ^b	28.77 ^a		23.51 ^c	25.94 ^b	27.48 ^a		25.14 ^c	27.09 ^b	28.12 ^a	
Control		25.80				23.10				24.50			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		26.07 ^c	27.87 ^b	28.55 ^a	27.50 ^a	23.02 ^c	25.85 ^b	27.07 ^a	25.31 ^a	24.55 ^c	26.86 ^c	27.81 ^b	26.41 ^a
N ₂		27.46 ^b	28.61 ^a	28.98 ^a	28.35 ^a	24.01 ^c	26.02 ^b	27.88 ^a	26.97 ^a	25.74 ^d	27.32 ^{bc}	28.43 ^a	27.16 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		26.19 ^d	27.53 ^c	28.13 ^b	27.28 ^a	23.02 ^d	24.52 ^c	26.42 ^b	24.65 ^a	24.60 ^e	26.03 ^d	27.27 ^c	25.97 ^a
M ₂		27.35 ^b	28.95 ^a	29.41 ^a	28.57 ^a	24.01 ^{cd}	27.36 ^b	28.53 ^a	26.63 ^a	25.68 ^d	28.16 ^b	28.97 ^a	27.60 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.50				0.96				0.50			
T		0.61				1.18				0.61			
M		0.50				0.96				0.50			
N x T		0.86				1.67				0.86			
M x T		0.86				1.67				0.86			
N x M		0.70				1.36				0.70			
N x T x M		1.22				2.36				1.21			
Control Vs Rest		1.05		NS		1.48		NS		0.87		2.55	

NS – Not significant,

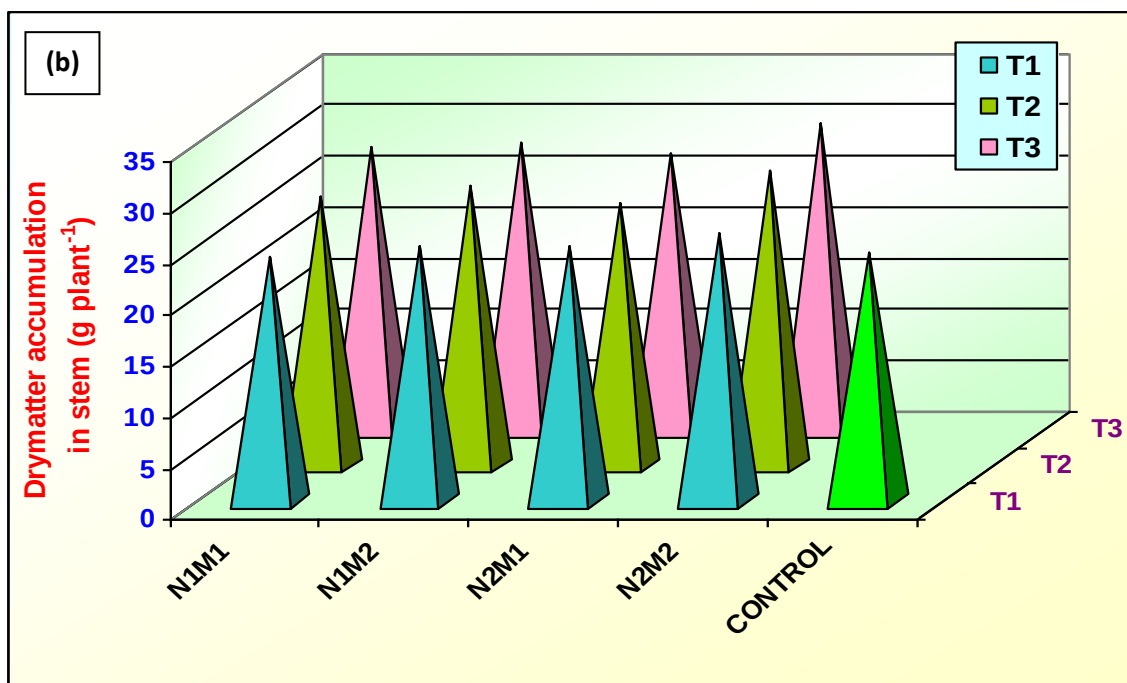
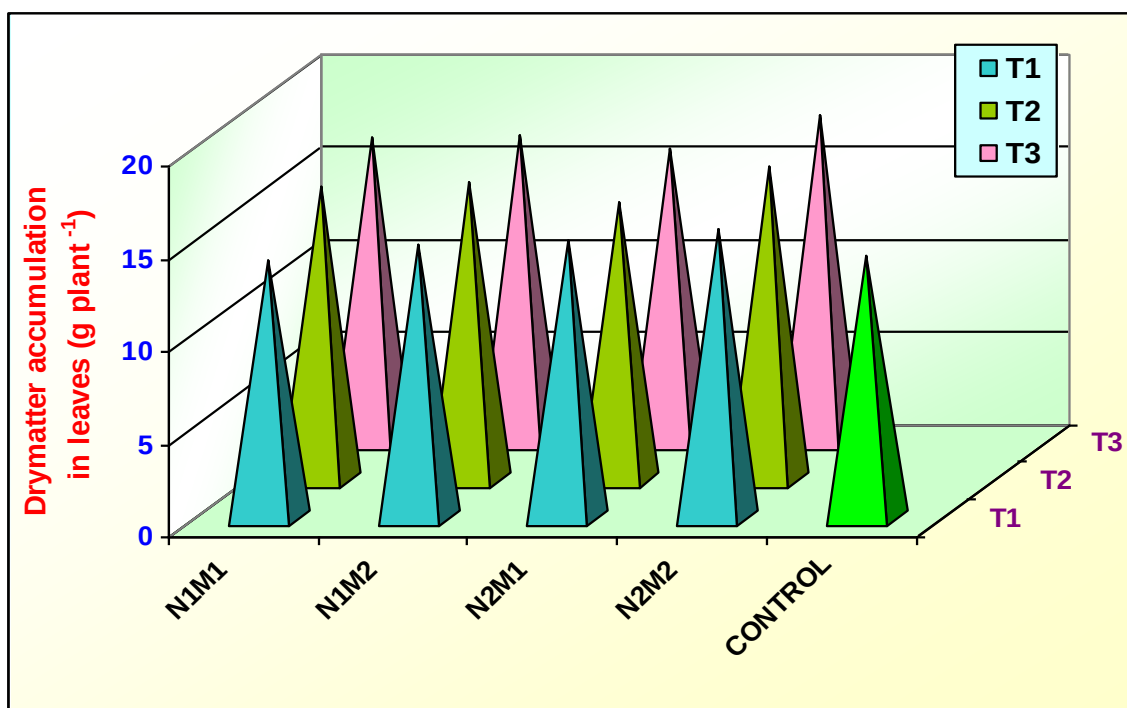
Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT



LEGEND

Nutritional approaches (N): N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
 Yield Targets (T): T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
 Micronutrient & Organics (M): M₁ - Without FeSO₄+ZnSO₄ + Organics, M₂ - With FeSO₄+ZnSO₄ + Organics

Fig. 22. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on dry matter accumulation in (a) leaves (g plant^{-1}) and (b) stem (g plant^{-1}) at harvest under direct seeded condition during rainy season

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered the maximum DM (2.95, 19.85 and 29.92, respectively), while lower DM (1.38, 11.38 and 24.06, respectively at 67 and 90 DAS and at harvest) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient or organics (N₁T₁M₁) among all; other treatment combinations fared in between.

Among the three factor combinations, all the medium and higher yield targets (T₂₋₃) irrespective of nutritional approaches (N₁₋₂) and micronutrient supply (M₁₋₂) at 67 DAS including N₂T₁M₂, all higher yield targets (T₂₋₃) irrespective of nutritional approaches (N₁₋₂) and micronutrient supply (M₁₋₂) at 90 DAS including N₂T₂M₂ except N₂T₃M₁, and all the higher yield targets (T₂₋₃) irrespective of nutritional approaches and micronutrient supply except N₂T₃M₁ but including and N₁₋₂T₂M₂ at harvest were superior to control with recommended practices (1.88, 12.30 and 24.50, respectively at 67 and 90 DAS and at harvest).

4.2.1.1.7 Dry matter accumulation in panicles (g plant⁻¹) (c.f. Table 137 and Fig. 23a)

DM in reproductive parts was measured only at harvest. Data revealed significant variations due to factors under study and their combinations. Main effects due to yield targets (T) and use of micronutrients and organics (M) revealed significant variations in DM in panicle while different methods of nutrition (N) failed to induce significant differences though STCR (N₂ - 31.42) fared better between the two. Among the yield targets, DM in panicles increased with increase in yield targets corresponding with higher fertilization and higher DM (34.51) occurred with yield target of 8 t ha⁻¹ (T₃) while, plants with 6 t ha⁻¹ yield target (T₁) had lower DM (24.77). Similarly, supply of micronutrients and organics (M₂) registered significantly higher DM content (32.20) over no supplementation (M₁).

All the two factor interactions were significant, in that nutritional approach x yield target revealed significantly higher DM (34.44 and 34.57) with higher yield target irrespective of the approaches (N₁₋₂T₃) used, while lower DM (21.81) among these combinations occurred with NE approach and lower yield target (N₁T₁). In T x M, T₃M₂ had significantly higher DM in panicles (36.5) while T₁M₁ recorded lower DM (23.07), and in case of N x M, N₂M₂ recorded significantly higher DM in panicles (34.42) while N₁M₁ recorded lower DM (28.00).

Table 137. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on dry matter accumulation in panicle (g plant⁻¹) at harvest under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	20.36 ^f	29.89 ^c	32.77 ^b	27.68 ^c	19.48 ^h	30.64 ^{de}	34.86 ^c	28.33 ^c	19.92 ⁱ	30.27 ^{de}	33.82 ^c	28.00 ^c
	M ₂	24.83 ^e	31.12 ^c	33.28 ^b	29.74 ^b	22.57 ^h	31.28 ^d	36.85 ^{bc}	30.24 ^b	23.70 ^h	31.27 ^d	35.04 ^{bc}	29.99 ^b
N ₂	M ₁	26.73 ^d	29.57 ^c	30.33 ^b	28.88 ^b	25.72 ^g	26.17 ^{fg}	32.05 ^d	27.98 ^c	26.22 ^g	27.87 ^f	31.19 ^d	28.43 ^c
	M ₂	29.83 ^c	33.61 ^b	36.03 ^c	33.16 ^a	28.62 ^{ef}	38.53 ^{ab}	39.87 ^a	35.67 ^a	29.23 ^{ef}	36.07 ^b	37.95 ^a	34.42 ^a
Target		25.4 ^c	31.0 ^b	33.1 ^a		24.1 ^c	31.65 ^b	35.9 ^a		24.8 ^c	31.4 ^b	34.5 ^a	
Control		24.80				21.00				22.90			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		22.59 ^d	30.51 ^b	33.03 ^a	28.71 ^a	21.03 ^d	30.96 ^b	35.86 ^a	29.28 ^a	21.81 ^e	30.73 ^c	34.44 ^a	28.99 ^a
N ₂		28.28 ^c	31.59 ^b	33.18 ^a	31.02 ^a	27.17 ^c	32.35 ^b	36.96 ^a	31.83 ^a	27.73 ^d	31.97 ^b	34.57 ^a	31.42 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		23.54 ^e	29.73 ^c	31.55 ^b	28.28 ^a	22.60 ^e	28.40 ^c	33.46 ^c	28.15 ^a	23.07 ^e	29.07 ^d	32.51 ^c	28.21 ^b
M ₂		27.33 ^d	32.37 ^b	34.66 ^a	31.45 ^a	25.60 ^d	34.91 ^a	38.36 ^b	32.95 ^a	26.46 ^f	33.64 ^b	36.51 ^a	32.20 ^c
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		1.06				1.67				0.88			
T		1.29				2.05				1.08			
M		1.06				1.67				0.88			
N x T		1.83				2.89				1.53			
M x T		1.83				2.89				1.53			
N x M		1.49				2.36				1.25			
N x T x M		2.59				4.09				2.16			
Control Vs Rest		1.19		3.49		2.70		7.89		1.41		4.11	

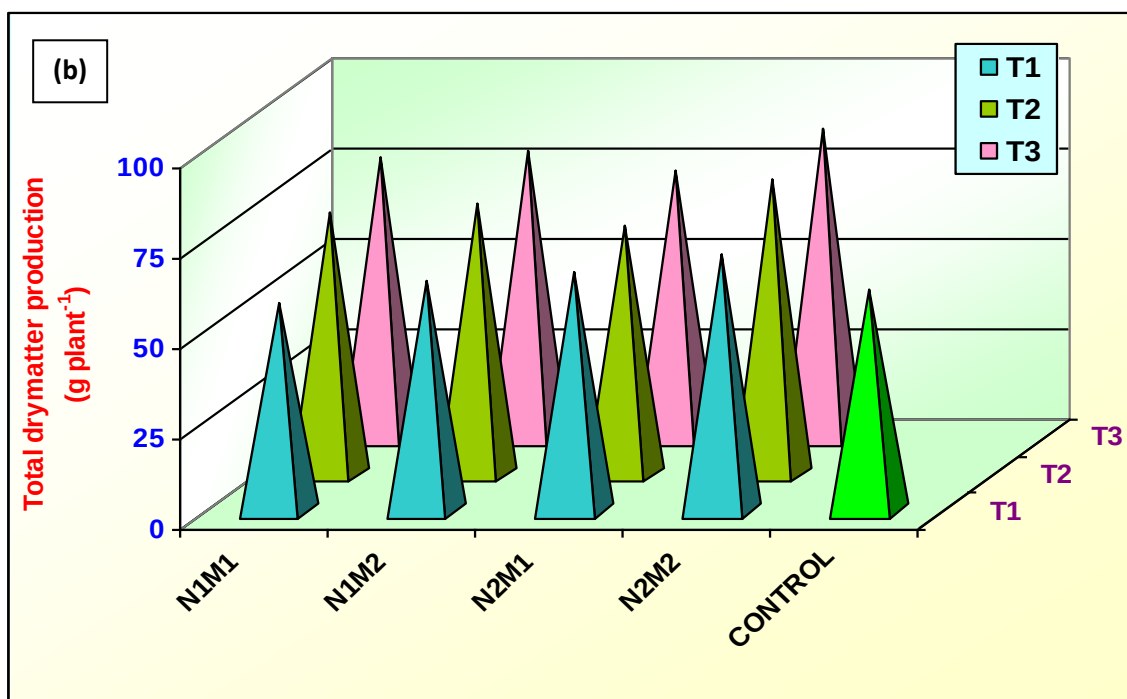
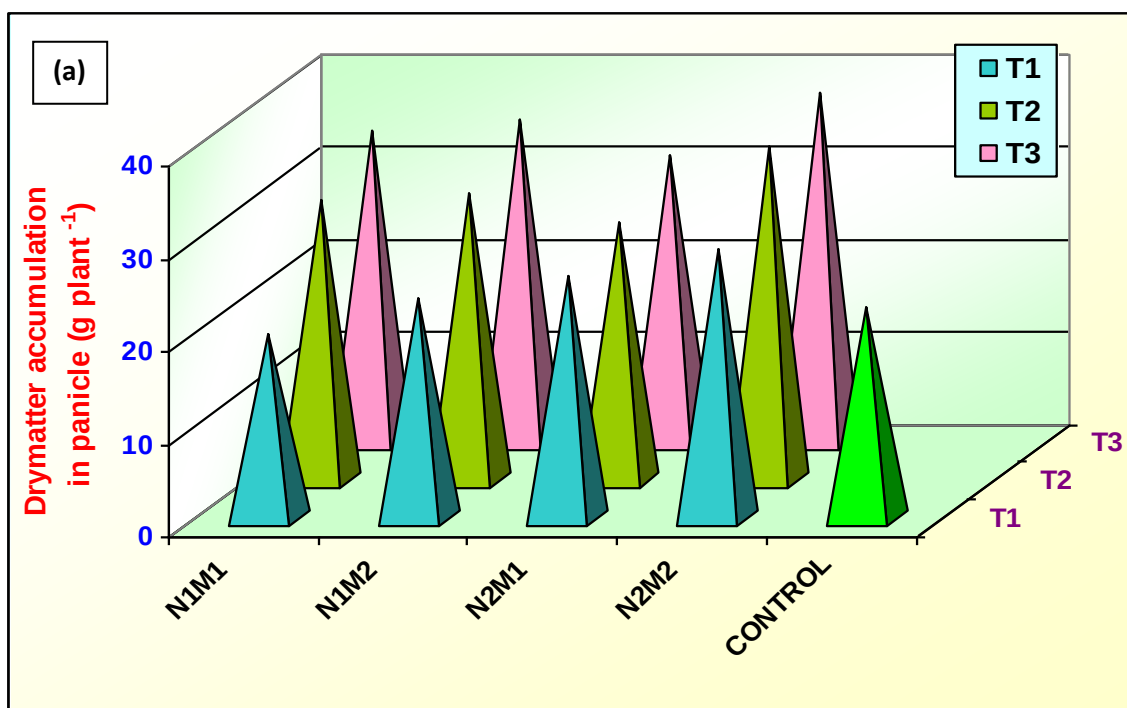
Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT



LEGEND

Nutritional approaches (N): N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
 Yield Targets (T): T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
 Micronutrient & Organics (M): M₁ - Without FeSO₄+ZnSO₄ + Organics, M₂ - With FeSO₄+ZnSO₄ + Organics

Fig. 23. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on (a) dry matter accumulation in panicles (g plant^{-1}) and (b) total dry matter production (g plant^{-1}) at harvest under direct seeded condition during rainy season

Among the three factors (N x T x M) interactions, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered the maximum DM content in panicles (38.0), while lower DM (19.9) was recorded with NE + 6 t ha⁻¹ yield target + no-micronutrient (N₁T₁M₁) among all; other treatment combinations fared in between.

All combinations involving medium to higher yield targets (T₂₋₃) irrespective of nutrition approach (N₁₋₂) and micronutrient supply (M₁₋₂) and N₂T₂M₂ fared better than control with recommended practices (22.90).

4.2.1.1.8 Total dry matter production (g plant⁻¹) (c.f. Table 138-141 and Fig. 23b)

Total dry matter (TDM) in stem increased throughout crop growth till harvest recording the maximum at harvest and the variations were significant due to all the factors studied and their interactions at all the stages of observations during both the years and on pooled basis.

At 45 DAS, the means due to NE and STCR (N₁₋₂) were at par (1.99 and 2.11, respectively), as par yield targets were concerned TDM revealed significant variations wherein higher yield target of 8 t ha⁻¹(T₃) recorded higher TDM (2.31) while lower target (T₁ – 6 t ha⁻¹) recorded lower TDM (1.71), and among the micronutrient and organics, supplementation of FeSO₄ + ZnSO₄ and organics (M₂) recorded significantly higher TDM (2.17) over no supplementation (M₁ – 1.92).

All the two factor interactions were significant due to N x T wherein STCR approach coupled with higher yield target across micronutrients (N₂T₃) recorded higher TDM (2.31) followed by NE with similar yield target (N₁T₃ – 2.31) which was on par while NE with 6 t ha⁻¹ (N₁T₁) recorded the lowest TDM (1.59), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum TDM (2.44) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂) while lower yield target and no micronutrient + organics (T₁M₁) recorded lower TDM (1.62), and among nutritional approaches and micronutrient supply across yield targets higher TDM (2.31) was observed with STCR + micronutrient supply (N₂M₂) while lower TDM (1.93) was recorded with NE + no micronutrient /organics supply (N₁M₁).

Among the three factors (N x T x M) interactions, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered the maximum TDM (2.51) followed by similar combination but with medium target (N₂T₂M₂) which was on par, while lower TDM (1.53) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁) among all; other treatment combinations fared in between.

All combinations involving medium to higher yield target (T₂₋₃) irrespective of nutrition approach (N₁₋₂) and micronutrient supply (M₁₋₂) and N₂T₁M₂ fared better than control with recommended practices (1.57).

Similar trend prevailed at 67 and 90 DAS and at harvest. The means due to nutritional approaches (NE/STCR - N₁₋₂) were at par (4.21, 24.8 and 71.0, and 4.67, 25.7 and 74.7, respectively), as par yield targets were concerned TDM revealed significant variations wherein higher yield target of 8 t ha⁻¹(T₃) recorded higher TDM (5.01, 28.5 and 79.33, respectively) while lower target (T₁ – 6 t ha⁻¹) recorded lower TDM (3.66, 21.5 and 64.75, respectively), and among the micronutrient and organics, supplementation of FeSO₄ + ZnSO₄ and organics (M₂) recorded significantly higher TDM (4.77, 27.0 and 76.2, respectively) over no supplementation (M₁ – 4.11, 23.5 and 69.6, respectively).

All the two factor interactions were significant. Among N x T, STCR approach coupled with higher yield target across micronutrients (N₂T₃) recorded higher TDM (5.07, 28.30 and 79.90, respectively at 67 and 90 DAS and at harvest) followed by NE with similar yield target (N₁T₃ – 4.95, 28.8 and 78.8, respectively) which was on par while NE with 6 t ha⁻¹ (N₁T₁) recorded the lowest TDM (3.18, 20.50 and 60.70, respectively), micronutrients + organics across nutritional approaches in combination with yield targets registered the maximum TDM (5.33, 30.6 and 82.7, respectively) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂) while lower yield target and no micronutrient + organics (T₁M₁) recorded lower TDM (3.35, 20.6 and 62.1, respectively), and among nutritional approaches and micronutrient supply across yield targets, higher TDM (5.14, 28.3 and 79.6, respectively) was observed with STCR + micronutrient supply (N₂M₂) while NE + no micronutrient /organics supply (N₁M₁) recorded lower TDM (4.02, 23.9 and 69.4, respectively).

Among the three factors (N x T x M) interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered the maximum TDM (5.73, 31.7 and 85.6,

Table 138. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on total dry matter production (g plant⁻¹) at 45 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	1.58 ^f	2.05 ^{de}	2.29 ^c	1.97^c	1.48 ^g	1.96 ^{de}	2.19 ^c	1.88 ^c	1.53 ^g	2.01 ^e	2.24 ^c	1.93 ^c
	M ₂	1.69 ^{fg}	2.15 ^d	2.42 ^b	2.09^b	1.59 ^f	2.06 ^d	2.32 ^b	1.99 ^a	1.64 ^h	2.11 ^d	2.37 ^b	2.04 ^b
N ₂	M ₁	1.75 ^f	1.95 ^e	2.15 ^d	1.95^c	1.66 ^f	1.86 ^e	2.06 ^d	1.86 ^c	1.71 ^h	1.91 ^f	2.11 ^d	1.91 ^c
	M ₂	2.02 ^e	2.49 ^{ab}	2.55 ^a	2.35^a	1.92 ^e	2.39 ^{ab}	2.46 ^a	2.26 ^b	1.97 ^{ef}	2.44 ^{ab}	2.51 ^a	2.31 ^a
Target		1.76^c	2.16^b	2.35^a		1.66^c	2.07^b	2.26^a		1.71^c	2.12^b	2.31^a	
Control		1.62				1.52				1.57			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		1.63 ^e	2.10 ^c	2.35 ^a	2.03 ^a	1.54 ^e	2.01 ^c	2.26 ^a	1.94 ^a	1.59 ^e	2.0c	2.31 ^a	1.99 ^a
N ₂		1.89 ^d	2.22 ^b	2.35 ^a	2.15 ^a	1.79 ^d	2.12 ^b	2.26 ^a	2.06 ^a	1.84 ^d	2.17 ^b	2.31 ^a	2.11 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		1.67 ^f	2.00 ^d	2.22 ^c	1.96 ^b	1.57 ^f	1.91 ^d	2.12 ^c	1.87 ^b	1.62 ^f	1.96 ^d	2.17 ^c	1.92 ^b
M ₂		1.85 ^e	2.32 ^b	2.49 ^a	2.22 ^a	1.76 ^e	2.22 ^b	2.39 ^a	2.12 ^a	1.81 ^e	2.27 ^b	2.44 ^a	2.17 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.08				0.07				0.05			
T		0.09				0.09				0.06			
M		0.08				0.07				0.05			
N x T		0.13				0.12				0.09			
M x T		0.13				0.12				0.09			
N x M		0.11				0.10				0.07			
N x T x M		0.19				0.17				0.12			
Control Vs Rest		0.15		0.45		0.08		0.24		0.11		0.33	

DAS - Days after sowing

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 139. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on total dry matter production (g plant⁻¹) at 67 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	2.86 ^g	4.73 ^{de}	5.29 ^c	4.29^d	2.53 ^g	4.07 ^{cde}	4.63 ^b	3.74^c	2.70 ^h	4.40 ^{de}	4.96 ^c	4.02^d
	M ₂	3.99 ^b	4.93 ^d	5.43 ^{bc}	4.78^b	3.33 ^f	4.30 ^{bcd}	4.43 ^{bc}	4.02^b	3.66 ^g	4.61 ^d	4.93 ^c	4.40^b
N ₂	M ₁	4.33 ^f	4.53 ^{ef}	4.76 ^{de}	4.54^c	3.67 ^{ef}	3.87 ^e	4.07 ^{cde}	3.87^{bc}	4.00 ^f	4.20 ^{ef}	4.41 ^{de}	4.20^c
	M ₂	4.59 ^{def}	5.76 ^{ab}	6.06 ^a	5.47^a	3.93 ^{de}	5.10 ^a	5.40 ^a	4.81^a	4.26 ^{ef}	5.43 ^b	5.73 ^a	5.14^a
Target		3.94^c	4.99^b	5.39^c		3.37^c	4.34^b	4.6^a		3.66^c	4.66^b	5.01^a	
Control		3.93				3.27				3.60			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		3.43 ^e	4.83 ^c	5.36 ^{ab}	4.54^a	2.93 ^d	4.18 ^b	4.53 ^a	3.88^a	3.18 ^e	4.51 ^c	4.95 ^{ab}	4.21^a
N ₂		4.46 ^d	5.14 ^b	5.41 ^a	5.00^a	3.80 ^c	4.48 ^a	4.73 ^a	4.34^a	4.13 ^d	4.81 ^b	5.07 ^a	4.67^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		3.59 ^f	4.63 ^d	5.03 ^c	4.42^a	3.10 ^e	3.97 ^e	4.35 ^c	3.81^b	3.35 ^f	4.30 ^d	4.69 ^c	4.11^a
M ₂		4.29 ^d	5.34 ^b	5.74 ^a	5.12^a	3.63 ^d	4.70 ^d	4.92 ^a	4.42^a	3.96 ^d	5.02 ^b	5.33 ^a	4.77^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.23				0.24				0.18			
T		0.29				0.29				0.22			
M		0.23				0.24				0.18			
N x T		0.40				0.41				0.31			
M x T		0.40				0.41				0.31			
N x M		0.33				0.34				0.26			
N x T x M		0.57				0.58				0.45			
Control Vs Rest		0.19		0.57		0.49		2.18		0.15		0.45	

DAS - Days after sowing

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 140. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on total dry matter production (g plant⁻¹) at 90 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	20.00 ^g	25.63 ^e	28.63 ^c	24.76 ^c	18.27 ^f	23.50 ^{cd}	27.43 ^b	23.06 ^c	19.13 ^f	24.57 ^d	28.03 ^c	23.91 ^c
	M ₂	22.83 ^f	27.00 ^d	30.77 ^b	26.87 ^b	20.83 ^e	24.20 ^c	28.47 ^b	24.50 ^b	21.83 ^e	25.60 ^d	29.62 ^b	25.68 ^b
N ₂	M ₁	23.10 ^f	23.17 ^f	26.03 ^e	24.43 ^d	21.10 ^e	21.50 ^e	23.97 ^c	22.19 ^c	22.10 ^e	22.83 ^e	25.00 ^d	23.11 ^d
	M ₂	23.77 ^f	31.50 ^b	32.37 ^a	29.21 ^d	21.77 ^{de}	29.50 ^{ab}	30.97 ^a	27.41 ^a	22.77 ^e	30.50 ^b	31.67 ^a	28.31 ^a
Target		22.43 ^c	26.08 ^b	29.45 ^a		20.49 ^c	24.68 ^b	27.71 ^a		21.46 ^c	25.88 ^b	28.58 ^a	
Control		22.10				20.10				21.10			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		21.42 ^e	26.32 ^c	29.70 ^a	25.81 ^a	19.55 ^e	23.85 ^e	27.95 ^a	23.76 ^a	20.48 ^e	25.08 ^c	28.83 ^a	24.80 ^a
N ₂		23.43 ^d	27.83 ^b	292.0 ^a	26.80 ^a	21.43 ^d	25.50 ^d	27.47 ^a	24.80 ^a	22.43 ^d	26.67 ^b	28.33 ^a	25.81 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		21.65 ^f	24.90 ^d	27.33 ^c	24.59 ^b	19.68 ^d	22.50 ^c	25.50 ^b	22.63 ^a	20.62 ^f	23.7 ^d	26.52 ^c	23.61 ^b
M ₂		23.30 ^c	29.25 ^h	31.67 ^a	28.04 ^a	21.30 ^c	26.85 ^b	29.72 ^a	25.96 ^a	22.30 ^e	28.05 ^b	30.64 ^a	27.00 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.78				2.043				0.76			
T		0.95				2.502				0.93			
M		0.78				2.043				0.76			
N x T		1.34				3.538				1.31			
M x T		1.34				3.538				1.31			
N x M		1.10				2.889				1.07			
N x T x M		1.90				5.004				1.85			
Control Vs Rest		1.56		4.57		1.64		4.80		1.36		4.07	

DAS - Days after sowing

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table141. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on total dry matter production (g plant⁻¹) at harvest under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	59.95 ^h	74.21 ^{de}	78.41 ^c	70.86 ^d	55.86 ⁱ	70.56 ^{de}	77.45 ^c	67.96 ^c	57.91 ^k	72.39 ^{fg}	77.93 ^d	69.41 ^c
	M ₂	66.79 ^g	76.05 ^d	79.61 ^{bc}	74.15 ^b	60.28 ^h	74.06 ^d	79.80 ^{bc}	71.38 ^b	63.53 ^j	74.90 ^e	79.71 ^c	72.77 ^b
N ₂	M ₁	69.27 ^f	72.60 ^e	75.08 ^d	72.32 ^c	63.50 ^{gh}	64.99 ^{fg}	73.15 ^d	67.21 ^c	66.79 ⁱ	68.79 ^h	74.11 ^{ef}	69.76 ^c
	M ₂	74.21 ^{de}	81.11 ^b	85.21 ^z	80.17 ^a	68.27 ^{ef}	82.68 ^{ab}	86.04 ^a	79.00 ^a	71.24 ^g	81.89 ^b	85.62 ^a	79.59 ^a
Target		67.55 ^c	75.99 ^b	79.58 ^a		61.98 ^c	73.07 ^b	79.11 ^a		64.75 ^c	74.53 ^b	79.34 ^a	
Control		65.10				58.10				61.60			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		63.07 ^e	75.13 ^c	79.01 ^a	72.50 ^a	58.07 ^d	72.31 ^b	78.63 ^a	69.67 ^a	60.72 ^e	73.72 ^c	78.82 ^a	71.09 ^a
N ₂		71.74 ^d	76.85 ^b	80.14 ^a	76.25 ^a	65.89 ^c	73.83 ^b	79.59 ^a	73.10 ^a	68.81 ^d	75.34 ^b	79.87 ^a	74.68 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		64.61 ^f	73.41 ^d	76.75 ^c	71.59 ^a	59.68 ^f	67.77 ^d	75.30 ^c	67.59 ^a	62.15 ^f	70.59 ^d	76.02 ^c	69.59 ^b
M ₂		70.50 ^e	78.58 ^b	82.41 ^a	77.16 ^a	64.28 ^e	78.37 ^b	82.92 ^a	75.19 ^a	67.39 ^e	78.48 ^b	82.67 ^a	76.18 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		1.31				2.18				1.15			
T		1.61				2.67				1.40			
M		1.31				2.18				1.15			
N x T		2.27				3.78				1.98			
M x T		2.27				3.78				1.98			
N x M		1.85				3.09				1.62			
N x T x M		3.21				5.35				2.81			
Control Vs Rest		2.17		6.33		3.95		11.54		2.18		6.34	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

respectively at 67 and 90 DAS and at harvest), while lower TDM (2.70, 19.1 and 57.9, respectively) was recorded with NE + 6 t ha⁻¹ yield target + no-micronutrient (N₁T₁M₁) among all; other treatment combinations fared in between.

All combinations involving medium to higher yield target (T₂₋₃) irrespective of nutrition approach (N₁₋₂) and micronutrient supply (M₁₋₂) and N₂T₁M₂ at 67 DAS and at harvest, and N₁T₃M₁, N₁₋₂T₃M₁₋₂ and N₂T₂₋₃M₁ at 90 DAS fared better than control with recommended practices (3.60, 21.10 and 61.60, respectively).

4.2.1.1.9 Spectral indices

4.2.1.1.9.1 SPAD values (leaf chlorophyll) (c.f. Table 142-144)

SPAD chlorophyll values were higher initially and remained almost same throughout growth and the variations were significant due to different nutritional approaches, yield targets and micronutrient + organic supply and due to their combinations at all the stages of observations (45, 67 and 90 DAS and harvest) during both the years and on pooled basis. At 45 DAS, differences in main effects due to nutrient approaches (32.4–33.1), and micronutrient supply (31.8 - 33.7) were not significant whereas those due to yield targets were significant wherein higher yield target of 8 t ha⁻¹ (T₃) recorded higher value (34.4) while lower target of 6 t ha⁻¹ (T₁) recorded lower value (30.6).

Two factor interactions were significant wherein higher yield target across micronutrients irrespective of nutritional approaches (M₁₋₂T₃) recorded higher value (34.4 and 34.2) while NE with 6 t ha⁻¹ (N₁T₁) recorded lower value (29.4), micronutrients across approaches in combinations with yield targets registered higher SPAD value (35.0) with higher target coupled with micronutrients and organics (T₃M₂) followed by T₂M₂ (34.6) which was at par while lower yield target and no micronutrient/organics (T₁M₁) recorded lower value (29.7), and among nutritional approaches and micronutrient supply across yield targets N₂M₂ recorded higher SPAD value (34.2) while N₁M₁ recorded lower value (31.7).

Among the three factors interaction (N x T x M), STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered significantly higher SPAD chlorophyll (35.4) while the lower value (28.1) was recorded with NE + 6 t ha⁻¹ yield target + no-micronutrient (N₁T₁M₁); other treatment combinations fared in between.

All combinations involving medium to higher yield target (T_{2-3}) and micronutrient + organics supply (M_2) under both approaches of nutrition (N_{1-2}) and $N_1T_1M_2$ except $N_2T_2M_1$ were superior to control (29.5).

More or less similar trend prevailed at 67 and 90 DAS. All the factors (N-T-M) and their interactions varied significantly except main effects due to nutrient approaches (N) and micronutrient supplementation (M). Variations in SPAD meter values due to yield targets were significant wherein values increased with increase in targets vis-a-vis nutrition and highest readings (33.0 and 32.3, respectively) occurred with yield target of 8 t ha^{-1} (T_3) while, 6 t ha^{-1} yield target (T_1) had lower SPAD values (29.6 and 32.3, respectively).

Two factor interactions were significant wherein STCR coupled with higher yield target across micronutrients (N_2T_3) recorded higher values (34.4 and 32.3, respectively at 67 and 90 DAS) and $N_{1-2}T_3$ were at par at 90 DAS while SSNM with 6 t ha^{-1} (N_1T_1) recorded lower values (28.5 and 30.6, respectively), micronutrients across approaches in combinations with yield targets registered higher SPAD readings (33.8 and 32.8, respectively) with higher target coupled with micronutrient + organics (T_3M_2) while lower yield target and no micronutrient supply (T_1M_1) recorded lower readings (28.7 and 30.6, respectively), and among approaches and yield targets across micronutrient supply STCR approach and 8 t ha^{-1} yield target (N_1T_3) recorded the maximum value (33.6 and 32.3, respectively) while NE and lower yield target of 6 t ha^{-1} (N_1T_1) recorded lower value (30.6 and 31.2, respectively).

Among three factor combinations, higher SPAD readings (35.1 and 33.0, respectively) were observed with STCR + 8 t ha^{-1} + micronutrient supply ($N_2T_3M_2$) followed by similar treatment combinations but with medium yield target ($N_2T_2M_2$) which was at par while NE + 6 t ha^{-1} + no micronutrient supply ($N_1T_1M_1$) resulted lower values (27.4 and 30.1, respectively at 90 DAS and at harvest). Other treatment combinations had intermediary values.

In the comparison between control and rest of the treatments, irrespective of nutritional approach and micronutrients + organic levels all the medium and higher yield targets including $N_2T_1M_2$ were superior to control (28.99) at 67 DAS, while at 90 DAS only $N_1T_1M_1$ had significantly lower SPAD value than control (32.3) while all other combinations were at par.

Table 142. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on SPAD values at 45 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	28.8 ^d	34.2 ^b	35.0 ^{ab}	32.7 ^c	27.4 ^f	31.3 ^{cd}	33.3 ^{ab}	30.7 ^c	28.1 ^h	32.8 ^{de}	34.2 ^{bc}	31.7 ^c
	M ₂	32.4 ^c	34.4 ^b	35.2 ^{ab}	34.0 ^b	29.1 ^e	33.1 ^{ab}	34.0 ^a	32.1 ^b	30.8 ^g	33.8 ^{bcd}	34.6 ^{ab}	33.1 ^b
N ₂	M ₁	32.6 ^c	32.7 ^c	34.2 ^b	33.2 ^c	29.9 ^{de}	30.1 ^{de}	32.1 ^{bc}	30.7 ^c	31.3 ^{fg}	31.4 ^{fg}	33.2 ^{cd}	32.0 ^c
	M ₂	33.8 ^{bc}	35.9 ^a	36.3 ^a	35.3 ^a	30.3 ^{de}	34.8 ^a	34.5 ^a	33.2 ^a	32.1 ^{ef}	35.4 ^a	35.4 ^a	34.3 ^a
Target		31.9 ^c	34.3 ^b	35.2 ^a		29.2 ^c	32.3 ^b	33.5 ^a		30.6 ^c	33.4 ^b	34.4 ^a	
Control		31.4				27.7				29.5			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		30.6 ^c	34.3 ^a	35.1 ^a	33.3 ^a	28.2 ^d	32.2 ^b	33.7 ^a	31.4 ^a	29.4 ^d	33.3 ^b	34.4 ^a	32.4 ^a
N ₂		33.2 ^b	34.3 ^a	35.3 ^a	34.3 ^a	30.1 ^c	32.5 ^b	33.3 ^{ab}	32.0 ^a	31.7 ^c	33.4 ^b	34.3 ^a	33.1 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		30.7 ^d	33.5 ^c	34.6 ^b	32.9 ^a	28.6 ^d	30.7 ^c	32.7 ^b	30.7 ^a	29.7 ^d	32.1 ^c	33.7 ^b	31.8 ^a
M ₂		33.1 ^c	35.2 ^{ab}	35.8 ^a	34.7 ^a	29.7 ^{cd}	34.0 ^a	34.3 ^a	32.7 ^a	31.4 ^c	34.6 ^a	35.0 ^a	33.7 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.9				1.0				0.7			
T		1.1				1.3				0.8			
M		0.9				1.0				0.7			
N x T		1.6				1.8				1.1			
M x T		1.6				1.8				1.1			
N x M		1.3				1.4				1.0			
N x T x M		2.2				2.5				1.6			
Control Vs Rest		1.4		NS		1.3		3.7		0.9		2.6	

DAS - Days after sowing

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 143. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on SPAD values at 67 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	29.1 ^f	31.9 ^{de}	33.3 ^{bc}	31.4 ^b	25.8 ^f	31.3 ^{bc}	32.1 ^b	29.73 ^c	27.4 ^h	31.6 ^{de}	32.7 ^b	30.6 ^c
	M ₂	29.9 ^{fg}	32.1 ^{cde}	33.0 ^{b-d}	31.7 ^b	29.2 ^e	32.0 ^{bc}	32.1 ^b	31.10 ^b	29.6 ^g	32.1 ^{b-d}	32.6 ^{bc}	31.4 ^b
N ₂	M ₁	30.2 ^{fg}	31.0 ^{ef}	32.0 ^{c-e}	31.1 ^b	29.7 ^{de}	30.6 ^{cd}	31.4 ^{bc}	30.57 ^b	30.0 ^{fg}	30.8 ^{ef}	31.7 ^{c-e}	30.8 ^c
	M ₂	31.7 ^{ade}	33.9 ^{ab}	34.6 ^a	33.4 ^a	30.8 ^{b-d}	34.8 ^a	35.7 ^a	33.77 ^a	31.2 ^{de}	34.3 ^a	35.1 ^a	33.6 ^a
Target		30.2 ^c	32.2 ^{ab}	33.2 ^a		28.9 ^c	32.2 ^b	32.8 ^a		29.6 ^c	32.2 ^b	33.0 ^a	
Control		29.2				28.7				28.9			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		29.5 ^d	32.0 ^b	33.1 ^a	31.3 ^a	27.5 ^e	31.6 ^c	32.1 ^{bc}	30.4 ^a	28.5 ^e	31.8 ^c	32.6 ^b	31.0 ^a
N ₂		30.9 ^c	32.4 ^{ab}	33.3 ^a	32.2 ^a	30.3 ^d	32.7 ^{ab}	33.6 ^a	32.2 ^a	30.6 ^d	32.6 ^b	33.4 ^a	32.2 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		29.6 ^d	31.4 ^c	32.7 ^b	31.3 ^a	27.8 ^d	31.0 ^b	31.8 ^b	30.2 ^a	28.7 ^e	31.2 ^c	32.2 ^b	30.8 ^a
M ₂		30.8 ^c	33.0 ^{ab}	33.8 ^a	32.3 ^a	30.0 ^c	33.4 ^a	33.9 ^a	32.4 ^a	30.4 ^d	33.2 ^a	33.8 ^a	32.5 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.8				0.9				0.6			
T		1.0				1.0				0.7			
M		0.8				0.9				0.6			
N x T		1.4				1.5				0.6			
M x T		1.4				1.5				1.0			
N x M		1.1				1.2				0.9			
N x T x M		2.0				2.0				1.5			
Control Vs Rest		1.2		NS		1.0		2.80		0.7		2.0	

DAS - Days after sowing,

Nutrient approach (N)

Yield Targets (T)

Micronutrient & Organics (M)

NS – Not significant

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 144. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on SPAD values at 90 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	30.4 ^e	31.8 ^{cd}	32.5 ^{bc}	31.6 ^{bc}	29.9 ^b	31.3 ^a	31.5 ^a	30.9 ^b	30.1 ^f	31.5 ^{cde}	32.0 ^{bc}	31.2 ^c
	M ₂	31.0 ^{de}	32.4 ^{bc}	33.3 ^{ab}	32.2 ^b	30.9 ^a	31.4 ^a	31.7 ^a	31.3 ^a	31.0 ^e	31.9 ^{b-d}	32.5 ^{ab}	31.8 ^b
N ₂	M ₁	31.1 ^{de}	31.5 ^{cde}	31.9 ^{cd}	31.5 ^c	31.0 ^a	31.1 ^a	31.4 ^a	31.2 ^{ab}	31.1 ^{de}	31.3 ^{c-e}	31.7 ^{a-d}	31.4 ^{bc}
	M ₂	31.6 ^{cde}	33.2 ^{ab}	34.3 ^a	33.0 ^a	31.3 ^a	31.5 ^a	31.7 ^a	31.5 ^a	31.5 ^{cde}	32.4 ^{ab}	33.0 ^a	32.3 ^a
Target		31.0 ^c	32.2 ^a	33.0 ^a		30.8 ^a	31.3 ^a	31.6 ^a		30.9 ^c	31.8 ^a	32.3 ^a	
Control		30.70				30.51				32.30			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		30.7 ^d	32.1 ^{bc}	32.9 ^{ab}	31.9 ^a	30.4 ^b	31.4 ^a	31.6 ^a	31.1 ^a	30.6 ^d	31.7 ^{bc}	32.3 ^a	31.5 ^a
N ₂		31.4 ^{cd}	32.4 ^{ab}	33.1 ^a	32.3 ^a	31.1 ^a	31.3 ^a	31.6 ^a	31.3 ^a	31.3 ^c	31.9 ^{ab}	32.3 ^a	31.8 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		30.8 ^e	31.7 ^{cd}	32.2 ^{bc}	31.6 ^a	30.4 ^b	31.2 ^a	31.5 ^a	31.0 ^a	30.6 ^e	31.4 ^{cd}	31.8 ^{bc}	31.3 ^a
M ₂		31.3 ^{de}	32.8 ^b	33.8 ^a	32.6 ^a	31.1 ^a	31.5 ^a	31.7 ^a	31.4 ^a	31.2 ^d	32.0 ^b	32.8 ^a	32.0 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.75				NS				0.47			
T		0.92				NS				0.58			
M		0.75				NS				0.47			
N x T		1.31				0.89				0.82			
M x T		1.31				0.89				0.82			
N x M		1.07				0.73				0.67			
N x T x M		1.85				1.26				1.16			
Control Vs Rest		0.60		1.70		0.69		NS		0.49		1.45	

DAS - Days after sowing

Nutrient approach (N)

Yield Targets (T)

Micronutrient & Organics (M)

NS – Not significant,

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂- With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

4.2.1.1.9.2 NDVI (Green seeker) readings (c.f. Table 145-147)

NDVI values increased with advancement in age of crop and the variations were significant due to different nutritional approaches, yield targets and micronutrient + organic supply and due to their combinations at all the stages of observations (45, 67, 90 DAS and harvest) during both the years and on pooled basis .

At 45 DAS, differences in main effects due to nutritional approaches (32.4 – 33.1), and micronutrient supply (31.8 - 33.7) were not significant whereas those due to yield targets were significant wherein higher yield target of 8 t ha⁻¹ (T₃) recorded higher value (0.47) while lower target of 6 t ha⁻¹ (T₁) recorded lower index (0.43).

Two factor interactions were significant wherein STCR coupled with higher yield target (N₂T₃) across micronutrients recorded higher value (0.48) while NE with 6 t ha⁻¹ (N₁T₁) recorded lower index (0.41), micronutrients in combinations with yield targets across nutritional approaches registered higher index (0.49) with higher target coupled with micronutrients and organics (T₃M₂) while lower yield target and no micronutrient/organics (T₁M₁) recorded lower index (0.42), and among nutritional approaches and micronutrient supply across yield targets N₂M₂ recorded higher NDVI (0.48) while N₁M₁ recorded lower index (0.42).

Among the three factors interaction (N x T x M), STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered significantly higher index (0.50) while the lower NDVI value (0.40) was recorded with NE + 6 t ha⁻¹ yield target + no-micronutrient (N₁T₁M₁); other treatment combinations fared in between.

All combinations involving N₂T₁₋₃M₁ and higher yield target (T₃) irrespective of nutritional approaches and micronutrient and organics levels supply except N₁T₃M₂ fared superior to control (0.39).

More or less identical trend prevailed at 67 and 90 DAS. All the factors (N-T-M) and their interactions varied significantly except main effects due to nutritional approaches (N) and micronutrient supplementation (M). Variations in NDVI meter values due to yield targets were significant wherein values increased with increase in targets vis-a-vis fertilization and the NDVI readings (0.48 and 0.69, respectively at 67 and 90 DAS) occurred with yield target of 8 t ha⁻¹ (T₃) while, 6 t ha⁻¹ yield target (T₁) had lower NDVI values (0.44 and 0.64, respectively).

Table 145. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on NDVI (green seeker reading) at 45 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	0.40 ^c	0.44 ^{bc}	0.50 ^{abc}	0.45^b	0.38 ^g	0.42 ^{cde}	0.44 ^{bc}	0.41^c	0.40 ^f	0.43 ^{de}	0.42 ^{ef}	0.42^j
	M ₂	0.41 ^{bc}	0.46 ^{a-c}	0.50 ^{abc}	0.46^b	0.39 ^{fg}	0.44 ^{bc}	0.46 ^b	0.43^b	0.42 ^{ef}	0.43 ^{de}	0.49 ^{ab}	0.45^j
N ₂	M ₁	0.42 ^{bc}	0.42 ^{bc}	0.45 ^{bc}	0.43^b	0.40 ^{e-g}	0.41 ^{def}	0.43 ^{cd}	0.41^c	0.43 ^{de}	0.42 ^{ef}	0.47 ^{bc}	0.44^j
	M ₂	0.43 ^{bc}	0.51 ^{ab}	0.55 ^a	0.50^a	0.41 ^{def}	0.49 ^a	0.49 ^a	0.46^a	0.48 ^{ab}	0.45 ^{cd}	0.50 ^a	0.48^j
Target		0.42^b	0.46^{ab}	0.50^a		0.40^c	0.44^b	0.46^a		0.43^a	0.43^b	0.47^a	
Control		0.40				0.39				0.39			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		0.41 ^b	0.45 ^{ab}	0.50 ^a	0.45^a	0.38 ^d	0.43 ^b	0.45 ^a	0.42^a	0.41 ^d	0.43 ^c	0.45 ^b	0.43^a
N ₂		0.42 ^b	0.47 ^{ab}	0.50 ^a	0.46^a	0.40 ^c	0.45 ^a	0.46 ^a	0.44^a	0.45 ^b	0.43 ^c	0.48 ^a	0.45^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		0.41 ^c	0.43 ^{bc}	0.48 ^{ab}	0.44^a	0.39 ^e	0.41 ^d	0.44 ^c	0.41a	0.42 ^c	0.42 ^c	0.44 ^b	0.43^a
M ₂		0.42 ^{bc}	0.48 ^{ab}	0.53 ^a	0.48^a	0.40 ^{de}	0.46 ^b	0.48 ^a	0.45^a	0.45 ^b	0.44 ^b	0.49 ^a	0.46^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.02				0.02				0.01			
T		0.02				0.01							
M		0.02				0.01							
N x T		0.03				0.02							
M x T		0.03				0.02							
N x M		0.03				0.02							
N x T x M		0.04				0.03							
Control Vs Rest		0.015		0.04		0.03		NS		0.01		0.05	

DAS - Days after sowing

Nutrient approach (N)

Yield Targets (T)

Micronutrient & Organics (M)

NS – Not significant,

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 146. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on NDVI (green seeker reading) at 67 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	0.42 ^b	0.46 ^{ab}	0.48 ^a	0.45^b	0.39 ^d	0.45 ^{abc}	0.46 ^{abc}	0.43^b	0.41 ^e	0.46 ^{bcd}	0.47 ^{abc}	0.44^a
	M ₂	0.46 ^{ab}	0.48 ^a	0.49 ^a	0.48^a	0.43 ^{cd}	0.45 ^{abc}	0.49 ^a	0.46^{ab}	0.44 ^d	0.46 ^{bcd}	0.49 ^a	0.47^a
N ₂	M ₁	0.46 ^{ab}	0.46 ^{ab}	0.47 ^a	0.46^{ab}	0.42 ^{cd}	0.43 ^{bc}	0.44 ^{bc}	0.43^{ab}	0.44 ^d	0.45 ^{cd}	0.46 ^{bcd}	0.45^a
	M ₂	0.47 ^a	0.49 ^a	0.49 ^a	0.48^a	0.43 ^{cd}	0.46 ^{abc}	0.48 ^{ab}	0.46^a	0.45 ^{cd}	0.48 ^{ab}	0.49 ^a	0.47^a
Target		0.45 ^b	0.47 ^a	0.48 ^a		0.42 ^b	0.45 ^a	0.47 ^a		0.44 ^c	0.46 ^b	0.48 ^a	
Control		0.45				0.42				0.44			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		0.44 ^c	0.47 ^{ab}	0.49 ^a	0.47^a	0.41 ^c	0.45 ^{ab}	0.47 ^a	0.46^a	0.42 ^d	0.46 ^{bc}	0.48 ^a	0.46
N ₂		0.46 ^{bc}	0.47 ^{ab}	0.48 ^{ab}	0.47^a	0.43 ^{bc}	0.45 ^{ab}	0.46 ^{ab}	0.46^a	0.45 ^c	0.46 ^{bc}	0.47 ^{ab}	0.46
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		0.44 ^c	0.46 ^{ab}	0.48 ^{ab}	0.46^a	0.41 ^c	0.44 ^{bc}	0.45 ^b	0.45^a	0.43 ^d	0.45 ^c	0.46 ^{bc}	0.45^a
M ₂		0.46 ^{bc}	0.48 ^{bc}	0.49 ^a	0.48^a	0.43 ^{bc}	0.46 ^b	0.49 ^a	0.47^a	0.45 ^c	0.47 ^b	0.49 ^a	0.47^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.02				0.03				0.02			
T		0.03				0.03							
M		0.02				0.03							
N x T		0.04				0.05							
M x T		0.04				0.05							
N x M		0.04				0.04							
N x T x M		0.06				0.07							
Control Vs Rest		0.02		NS		0.02		0.05		0.01		NS	

DAS - Days after sowing

NS – Not significant,

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 147. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on NDVI (green seeker reading) at 90 DAS under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	0.65 ^d	0.69 ^{b-d}	0.72 ^{a-c}	0.69 ^b	0.60 ^a	0.64 ^a	0.64 ^a	0.63 ^a	0.62 ^d	0.66 ^{a-d}	0.68 ^{a-c}	0.65 ⁿ
	M ₂	0.67 ^{cd}	0.72 ^{a-c}	0.73 ^{ab}	0.71 ^{ab}	0.61 ^a	0.64 ^a	0.65 ^a	0.63 ^a	0.64 ^{cd}	0.68 ^{a-c}	0.69 ^{a-c}	0.67 ^{ab}
N ₂	M ₁	0.68 ^{b-d}	0.68 ^{b-d}	0.72 ^{a-c}	0.69 ^b	0.62 ^a	0.66 ^a	0.64 ^a	0.64 ^a	0.65 ^{a-d}	0.67 ^{a-d}	0.68 ^{a-c}	0.67 ^{ab}
	M ₂	0.68 ^{b-d}	0.75 ^a	0.75 ^a	0.73 ^a	0.63 ^a	0.65 ^a	0.67 ^a	0.65 ^a	0.66 ^{a-d}	0.70 ^{ab}	0.71 ^a	0.69 ^a
Target		0.67 ^b	0.71 ^a	0.70 ^a		0.62 ^a	0.65 ^a	0.65 ^a		0.64 ^b	0.68 ^a	0.69 ^a	
Control		0.67				0.61				0.64			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		0.66 ^d	0.70 ^{bc}	0.73 ^{ab}	0.70 ^a	0.60 ^b	0.64 ^{ab}	0.65 ^{ab}	0.63 ^a	0.63 ^c	0.67 ^{ab}	0.69 ^a	0.66 ^a
N ₂		0.68 ^{cd}	0.72 ^{ab}	0.74 ^{ab}	0.71 ^a	0.63 ^{ab}	0.66 ^a	0.66 ^a	0.65 ^a	0.65 ^{bc}	0.69 ^a	0.70 ^a	0.68 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		0.66 ^c	0.69 ^{bc}	0.72 ^{ab}	0.69 ^a	0.61 ^a	0.65 ^a	0.64 ^a	0.63 ^a	0.63 ^c	0.67 ^{ab}	0.68 ^{ab}	0.66 ^{ab}
M ₂		0.68 ^c	0.73 ^a	0.74 ^a	0.72 ^a	0.62 ^a	0.65 ^a	0.66 ^a	0.64 ^a	0.65 ^{bc}	0.69 ^a	0.70 ^a	0.68 ^a
Comparison	S.Em±	LSD 0.05				S.Em±	LSD 0.05			S.Em±	LSD 0.05		
N	0.03					0.04				0.03			
T	0.04					0.05				0.04			
M	0.03					0.04				0.03			
N x T	0.06					0.07				0.05			
M x T	0.06					0.07				0.05			
N x M	0.05					0.06				0.04			
N x T x M	0.08					0.11				0.07			
Control Vs Rest	0.01	0.05				0.02	NS			0.01	0.04		

DAS - Days after sowing

NS – Not significant,

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Two factor interactions were significant wherein STCR coupled with higher yield target across micronutrients (N_2T_3) recorded higher values (0.47 and 0.70, respectively at 67 and 90 DAS) and N_1T_3 was at par while SSNM with 6 t ha⁻¹ (N_1T_1) recorded lower index (0.42 and 0.63, respectively), micronutrients across approaches in combinations with yield targets registered higher NDVI readings (0.49 and 0.70, respectively) at 67 DAS with higher target coupled with micronutrient + organics (T_3M_2); other combinations were at par at 90 DAS while lower yield target and no micronutrient supply (T_1M_1) recorded lower readings (0.43 and 0.63, respectively at 67 and 90 DAS), and among approaches across yield targets coupled with micronutrient levels N_2M_2 recorded higher value (0.47 and 0.44, respectively at 67 and 90 DAS) while NE and no micronutrient and organics (N_1M_1) consistently registered lower NDVI value (0.44 and 0.66, respectively).

Among three factor combinations, higher NDVI values (0.49 and 0.71, respectively at 67 and 90 DAS) were observed with STCR + 8 t ha⁻¹ + micronutrient and organics supply ($N_2T_3M_2$) followed by similar treatment combinations but with medium yield target ($N_2T_2M_2$) at 67 DAS while all combinations were at par except $N_1T_1M_{1-2}$ at 90 DAS.

When control and rest of the treatments were compared, at 67 DAS there occurred no significant differences among all, while at 90 DAS combinations involving higher yield target irrespective of nutritional approach and micronutrient levels ($N_{1-2}T_3M_{1-2}$) and $N_{1-2}T_2M_{1-2}$ fared superior to control (0.44 and 0.64, respectively at 67 and 90 DAS).

4.2.1.1.10 Days to 50% flowering (c.f. Table 148)

Data pertaining days to 50% flowering revealed significant variation due to nutritional approaches, yield targets and micronutrient + organics application and their interactions during both the years and on pooled basis.

Main effects due to nutritional approaches and micronutrient + organics supply were not significant while influences due to yield target varied significantly wherein higher yield target of 8 t ha⁻¹ (T_3) took more days (99.1) to 50%; T_2 with medium target was next in the order and was on par with T_3 , while T_1 with lower yield target was early (94.99) in flowering.

Table 148. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on days to 50 per cent flowering (days) under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	94.67 ^c	96.67 ^{bc}	98.33 ^{bc}	96.56 ^b	92.47 ^b	94.42 ^b	96.05 ^b	94.31 ^b	93.57 ^c	95.54 ^{bc}	97.19 ^{bc}	95.43 ^b
	M ₂	96.00 ^{bc}	98.00 ^{bc}	99.33 ^{bc}	97.78 ^b	94.10 ^b	95.7 ^b	97.00 ^b	95.61 ^{ab}	95.05 ^{bc}	96.86 ^{bc}	98.17 ^{bc}	96.69 ^b
N ₂	M ₁	96.67 ^{bc}	96.33 ^{bc}	97.33 ^{bc}	96.78 ^b	94.09 ^b	94.09 ^b	95.07 ^b	94.42 ^b	95.38 ^{bc}	95.21 ^{bc}	96.20 ^{bc}	95.60 ^b
	M ₂	96.67 ^{bc}	102.00 ^b	109.67 ^a	102.78 ^a	94.42 ^b	99.63 ^{ab}	104.90 ^a	99.65 ^a	95.54 ^{bc}	100.81 ^b	107.28 ^a	101.21 ^a
Target		96.00 ^b	98.25 ^b	101.17 ^a		93.77 ^b	95.97 ^{ab}	98.25 ^a		94.88 ^b	97.11 ^{ab}	99.71 ^a	
Control		95.6				93.4				94.5			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		95.33 ^b	97.33 ^b	98.83 ^b	97.17 ^a	93.28 ^a	95.07 ^a	96.52 ^a	94.96 ^a	94.31 ^b	96.20 ^b	97.68 ^b	96.06 ^a
N ₂		96.67 ^b	99.17 ^b	103.50 ^a	99.78 ^a	94.26 ^a	96.86 ^a	99.98 ^a	97.03 ^a	95.46 ^b	98.01 ^b	101.74 ^a	98.41 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		95.67 ^b	96.50 ^b	97.83 ^b	96.67 ^a	93.28 ^b	94.26 ^{ab}	95.56 ^{ab}	94.36 ^a	94.47 ^c	95.38 ^{b_c}	96.70 ^{b_c}	95.52 ^a
M ₂		96.33 ^b	100.00 ^b	104.50 ^a	100.28 ^a	94.26 ^{ab}	97.67 ^{ab}	100.95 ^a	97.63 ^a	95.30 ^{b_c}	98.84 ^b	102.73 ^a	98.95 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		3.6				4.3				3.5			
T		4.5				5.3				4.2			
M		3.6				4.3				3.5			
N x T		6.3				7.5				6.0			
M x T		6.3				7.5				6.0			
N x M		5.1				6.1				4.9			
N x T x M		8.9				10.6				8.5			
Control Vs Rest		2.1		6.3		2.3		NS		2.0		5.9	

NS – Not significant,

Nutrient approach (N)

Yield Targets (T)

Micronutrient & Organics (M)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Two factor interactions were significant. STCR approach coupled higher yield target across micronutrients (N_2T_3) recorded more days (101.74) to 50% flowering, while NE with 6 t ha^{-1} (N_1T_1) flowered early (94.21), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum days (102.73) to 50% flowering, with higher target (8 t ha^{-1}) coupled with micronutrients and organics (T_3M_2) while lower yield target and no micronutrient/organics (T_1M_1) flowered early (94.47), and among nutritional approaches and micronutrient + organics supply across yield targets, STCR approach and micronutrients + organics (N_2M_2) took more days (101.21) for 50% flowering, while NE and no micronutrient + organics supply (N_1M_1) came to flowering early (95.43).

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + micronutrient supply ($N_2T_3M_2$) registered the maximum days (107.28) to 50% flowering, while early flowering (93.57) occurred with NE + 6 t ha^{-1} yield target + no-micronutrient ($N_1T_1M_1$) and all combinations except $N_2T_{2-3}M_{1-2}$ were on par.

Among all combinations, STCR + 8 t ha^{-1} yield target + micronutrient supply ($N_2T_3M_2$) and similar combinations but with 7 t ha^{-1} ($N_2T_2M_2$) took more days to flowering than control (94.55).

4.2.1.2 Yield components and yield

4.2.1.2.1 Unproductive tiller (no. m^{-2}) (c.f. Table 149)

Number of unproductive tillers at harvest varied significantly due to main effects and interaction of nutritional approaches, yield targets and micronutrient + organic levels during both the years and on pooled basis. Main effects due to nutritional approaches (N) and micronutrient + organics supply (M) were not significant while effects due to yield targets were significant wherein the unproductive tiller count decreased with increase in yield targets and the lowest unproductive tillers (51.43) occurred with T_3 (8 t ha^{-1} yield target) while the maximum count (72.8) occurred with T_1 with 6 t ha^{-1} yield target.

Two factor interactions were significant wherein both NE and STCR approaches coupled with higher yield target across micronutrients ($N_{1-2}T_3$) recorded lower unproductive tillers (50.9 – 51.9) while NE with 6 t ha^{-1} (N_1T_1) recorded the highest count (82.0), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the minimum unproductive tiller count (46.0) with higher

Table 149. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on unproductive tillers (m⁻²) at harvest under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	73.0 ^a	54.0 ^{cd}	44.7 ^{ef}	57.2 ^a	99.0 ^a	74.0 ^d	63.3 ^e	78.8 ^a	86.0 ^a	64.0 ^e	54.0 ^g	68.4 ^a
	M ₂	63.3 ^b	45.7 ^{ef}	44.3 ^f	51.1 ^b	92.7 ^{ab}	68.3 ^{de}	55.3 ^f	72.1 ^b	78.0 ^b	57.0 ^{fg}	49.8 ^h	64.5 ^b
N ₂	M ₁	63.0 ^b	58.3 ^{bc}	50.3 ^{de}	57.2 ^a	86.3 ^{bc}	85.7 ^{bc}	69.0 ^{de}	80.3 ^a	74.7 ^{bc}	72.0 ^{cd}	59.7 ^f	69.6 ^a
	M ₂	57.7 ^{bc}	44.0 ^f	43.3 ^f	48.3 ^b	81.7 ^c	46.3 ^g	41.0 ^g	56.3 ^c	69.7 ^d	45.2 ⁱ	42.2 ⁱ	52.7 ^c
Target		64.3 ^a	50.5 ^b	45.7 ^c		89.9 ^a	68.6 ^b	57.2 ^c		72.8 ^a	58.6 ^b	60.b ^a	
Control		44.7				92.5				68.6			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		68.2 ^a	49.8 ^{cd}	44.5 ^e	54.2 ^a	95.8 ^a	71.2 ^c	59.3 ^d	75.4 ^a	82.0 ^a	60.5 ^c	51.9 ^d	66.4 ^a
N ₂		60.3 ^b	51.2 ^c	46.8 ^{de}	52.8 ^a	84.0 ^b	66.0 ^c	55.0 ^d	68.3 ^a	72.2 ^b	58.6 ^c	50.9 ^d	61.2 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		68.0 ^a	56.2 ^c	47.5 ^d	57.2 ^a	92.7 ^a	79.8 ^c	66.2 ^d	79.6 ^a	80.3 ^a	68.0 ^c	56.8 ^d	69.0 ^a
M ₂		60.5 ^b	44.8 ^d	43.8 ^a	49.7 ^a	87.2 ^b	57.3 ^e	48.2 ^f	64.2 ^a	73.8 ^b	51.1 ^e	46.0 ^f	58.6 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		3.7				5.0				2.2			
T		4.5				6.1				2.7			
M		3.7				5.0				2.2			
N x T		6.3				8.7				3.8			
M x T		6.3				8.7				3.8			
N x M		5.1				7.0				3.1			
N x T x M		8.9				12.2				5.4			
Control Vs Rest		4.1		13.1		6.3		18.6		3.9		11.3	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

target (8 t ha^{-1}) coupled with micronutrients and organics (T_3M_2) while lower yield target and no micro-nutrition (T_1M_1) recorded higher count (80.3), and among nutritional approaches and micronutrient and organics supply across yield targets, STCR + micronutrient/organics supply (N_2M_2) recorded least number of unproductive tillers (52.3) while NE whether micronutrient supplied or not recorded higher unproductive tiller count (68.0 and 68.8 with N_1M_1 and N_1M_2 , respectively).

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + micronutrient supply ($N_2T_3M_2$) registered significantly less number of unproductive tillers (42.2), while the maximum tiller count (86.0) was observed with NE + 6 t ha^{-1} yield target + no-micronutrient ($N_1T_1M_1$); other treatment combinations fared in between.

Of all the combinations, $N_1T_1M_1$ recorded significantly higher unproductive tiller count while medium and high higher yield targets receiving micronutrient and organics with both the approaches ($N_{1-2}T_{2-3}M_1$) recorded lower number of unproductive tillers (68.6) than control receiving recommended dose of fertilizers.

4.2.1.2.2 Productive tillers at harvest (no. m^{-2}) (c.f. Table 150 and Fig. 24a)

Tiller count varied significantly due to nutrition approach used, pre-set yield targets and micronutrient + organics supply and their interactions at harvest during both the years and on pooled basis. Among the main effects, both the nutritional approaches and micronutrient levels did not induce significant variations, however, STCR approach and nutrient supply (M_2) were numerically superior (379.4 and 388.0, respectively), while the count increased with increase in yield targets corresponding with increased nutrition and more tillers (401.7) occurred with higher yield target of 8 t ha^{-1} (T_3) while 6 t ha^{-1} yield target (T_1) had lower tiller count (384.4).

Two factor interactions were significant wherein STCR approach coupled higher yield target across micronutrients (N_2T_3) recorded more tiller count (405.8) while NE with 6 t ha^{-1} (N_1T_1) recorded the lowest tiller count (306.3), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum tiller count (421.2) with higher target (8 t ha^{-1}) coupled with micronutrients and organics (T_3M_2) while lower yield target and no micronutrients + organics (T_1M_1) recorded lower tiller count (312.6), and among nutritional approaches and micronutrient supply across yield targets, STCR approach and 8 t ha^{-1} with micronutrient and organic supply (N_2M_2)

Table 150. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on productive tillers (m⁻²) at harvest under direct seeded condition during rainy season

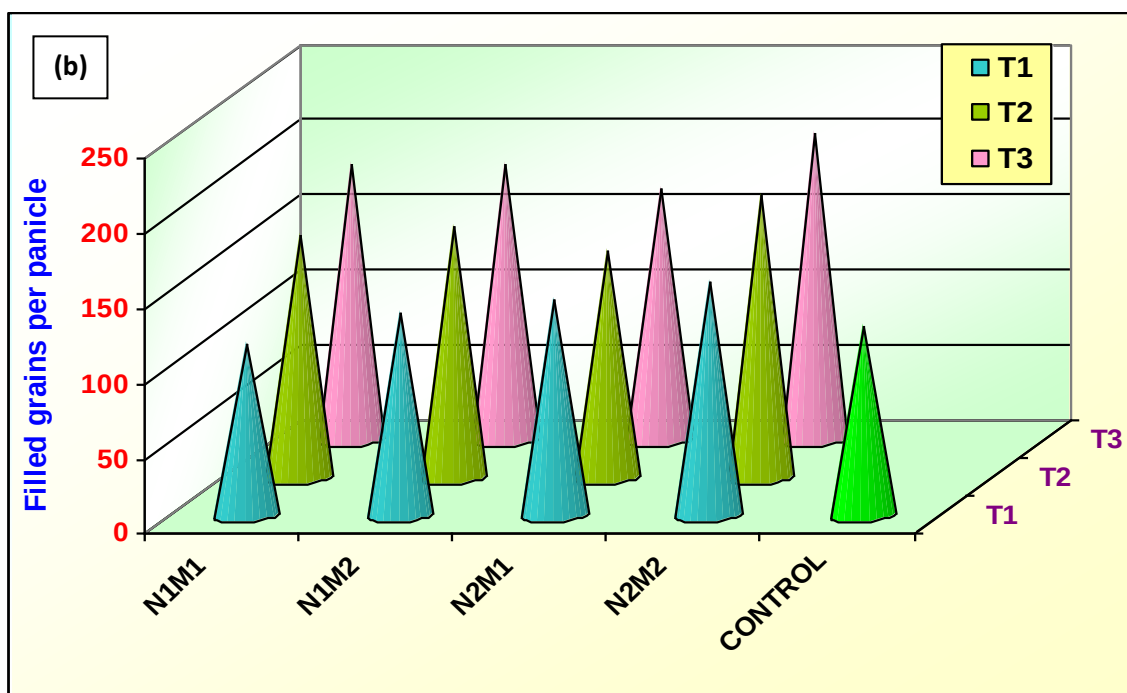
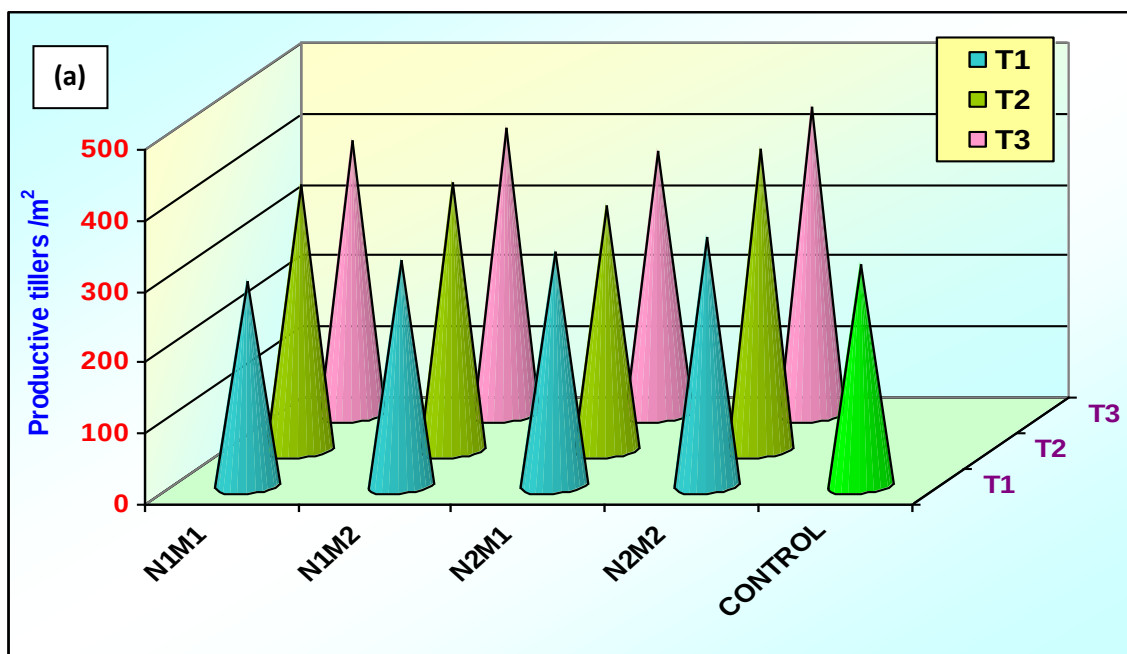
N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	358.0 ^g	403.7 ^{cde}	422.3 ^{bc}	394.7 ^c	225.0 ^h	354.7 ^g	355.3 ^c	311.7 ^c	291.5 ^f	379.2 ^c	388.8 ^c	353.2 ^c
	M ₂	378.0 ^f	420.7 ^{bc}	431.0 ^b	409.9 ^b	264.3 ^{fg}	343.7 ^c	381.7 ^b	329.9 ^b	321.2 ^c	382.2 ^c	406.3 ^b	369.9 ^b
N ₂	M ₁	382.3 ^{ef}	394.7 ^{de}	409.0 ^{cd}	395.3 ^c	285.0 ^{ef}	304.0 ^{de}	342.3 ^c	310.4 ^c	333.7 ^d	349.3 ^d	375.7 ^c	352.9 ^c
	M ₂	396.0 ^{def}	458.3 ^a	461.3 ^a	438.5 ^a	314.0 ^d	395.7 ^{ab}	410.7 ^a	373.5 ^a	355.0 ^a	427.0 ^a	436.0 ^a	406.0 ^a
Target		378.6 ^c	419.3 ^b	430.9 ^a		272.1 ^c	349.5 ^b	372.5 ^a		325.3 ^b	384.4 ^b	401.7 ^a	
Control		376.0				255.3				315.7			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		368.0 ^d	412.2 ^b	426.7 ^{ab}	402.3 ^a	244.7 ^d	349.2	368.5a	320.8 ^a	306.3 ^e	380.7 ^c	397.6 ^{ab}	361.5 ^a
N ₂		389.2 ^c	426.5 ^{ab}	435.2 ^a	417.0 ^a	299.5 ^c	349.8 ^b	376.5 ^a	341.9 ^a	344.3 ^d	388.2 ^{bc}	405.8 ^a	379.4 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		370.2 ^d	399.2 ^b	415.7 ^b	395.0 ^a	255.0 ^f	329.3 ^d	348.8 ^c	311.0 ^a	312.6 ^f	364.3 ^d	382.3 ^c	353.1 ^a
M ₂		387.0 ^c	439.5 ^{ab}	446.2 ^a	424.2 ^a	289.2 ^e	369.7 ^b	396.2 ^a	351.7 ^a	338.1 ^e	404.6 ^b	421.2 ^a	388.0 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		13.0				15.1				10.0			
T		15.9				18.5				12.2			
M		13.0				15.1				10.0			
N x T		22.5				26.1				17.3			
M x T		22.5				26.1				17.3			
N x M		18.4				21.4				14.1			
N x T x M		31.9				37.00				24.5			
Control Vs Rest		8.3		24.3		26.4		77.1		13.9		40.5	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT



LEGEND

Nutritional approaches (N):	N ₁ - Nutrient Expert,	N ₂ - Soil Test Crop Response approach
Yield Targets (T):	T ₁ - 6 t ha ⁻¹ ,	T ₂ - 7 t ha ⁻¹ , T ₃ - 8 t ha ⁻¹
Micronutrient & Organics (M):	M ₁ - Without FeSO ₄ +ZnSO ₄ + Organics,	M ₂ - With FeSO ₄ +ZnSO ₄ + Organics

Fig. 24. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on (a) productive tillers m⁻² and (b) filled grains panicle⁻¹ at harvest under direct seeded condition during rainy season

recorded more tillers m^{-2} (421.2) while NE and no micronutrient + organics (N_1M_1) recorded lower tiller count (312.6).

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + micronutrient supply ($\text{N}_2\text{T}_3\text{M}_2$) registered significantly more number of tillers (436.0) followed by similar combination but with medium yield target ($\text{N}_1\text{T}_2\text{M}_2$ – 427.0), while lower tiller count (291.5) was recorded with NE + 6 t ha^{-1} yield target + no micronutrient/organics ($\text{N}_1\text{T}_1\text{M}_1$) among all; other treatment combinations fared in between.

All combinations involving medium and high yield target except $\text{N}_2\text{T}_2\text{M}_1$ were significantly superior to recommended control (384.2).

4.2.1.2.3 Total tiller count at harvest (no. m^{-2}) (c.f. Table 151)

Tiller count increased throughout crop growth recording the maximum at harvest and the variations were significant due to different factors and their interactions during both the years and on pooled basis. In the main effects variations in tiller count due to yield targets were significant wherein the tiller count increased with increase in fertilization for higher yield targets and highest tiller count (461.7) occurred with 8 t ha^{-1} yield target (T_3) while lower tiller count (397.7) occurred with 6 t ha^{-1} . Nutrient approaches and supply of micro nutrients alongwith organics did not induce significant effects individually.

Two factor interactions were significant wherein STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded more tiller count (460.2) while NE with 6 t ha^{-1} (N_1T_1) recorded the lowest tiller count (379.7), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum tiller count (474.5) with higher target (8 t ha^{-1}) coupled with micronutrients and organics (T_3M_2) while lower yield target and no micro-nutrition (T_1M_1) recorded lower tiller count (388.4), and among nutritional approaches and micronutrient supply across yield targets, STCR approach and micronutrient supply 8 t ha^{-1} (N_2M_2) recorded more tillers m^{-2} (458.7) while NE and no micronutrient supply (N_1M_1) recorded lower tiller count (421.6).

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + micronutrient supply ($\text{N}_2\text{T}_3\text{M}_2$) registered significantly more number of tillers (461.7) followed by similar combination but with medium yield target and NE + higher target +

Table 151. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on total number of tillers (m⁻²) at harvest under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	416.3 ^f	448.0 ^d	493.7 ^{ab}	452.7 ^c	324.0 ^h	428.7 ^{abc}	418.7 ^{bcd}	390.5 ^b	370.2 ^g	438.3 ^{cd}	456.2 ^{bc}	421.6 ^c
	M ₂	421.3 ^{ef}	474.7 ^{bc}	504.0 ^a	466.7 ^b	357.0 ^g	412.0 ^{c-e}	437.0 ^{abc}	402.0 ^b	389.2 ^f	443.3 ^{cd}	470.5 ^{ab}	434.3 ^b
N ₂	M ₁	442.0 ^{de}	445.0 ^d	472.3 ^{bc}	453.1 ^c	371.3 ^{fg}	389.7 ^{ef}	411.3 ^{cde}	390.8 ^b	406.7 ^{ef}	417.3 ^e	441.8 ^{cd}	421.9 ^c
	M ₂	453.7 ^{cd}	504.0 ^a	505.3 ^a	487.7 ^a	395.7 ^{def}	442.0 ^{ab}	451.7 ^a	429.8 ^a	424.7 ^{de}	473.0 ^{ab}	478.5 ^a	458.7 ^a
Target		433.3 ^c	467.9 ^b	493.8 ^a		362.0 ^b	418.1 ^a	429.6 ^a		397.7 ^c	442.9 ^a	461.7 ^a	
Control		420.6				347.8				384.25			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		418.8 ^e	461.3 ^{cd}	498.8 ^a	459.6 ^a	340.5 ^c	420.3 ^a	427.8 ^a	396.2 ^a	379.7 ^d	440.8 ^b	463.3 ^a	427.9 ^a
N ₂		447.8 ^d	474.5 ^b	488.8 ^{ab}	470.4 ^a	383.5 ^b	415.8 ^a	431.5 ^a	410.3 ^a	415.7 ^c	445.2 ^b	460.2 ^a	440.4 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		429.2 ^d	446.5 ^c	483.0 ^b	452.9 ^a	347.7 ^d	409.2 ^b	415.0 ^b	390.6 ^a	388.4 ^e	427.8 ^c	449.0 ^b	421.7 ^a
M ₂		437.5 ^{cd}	489.3 ^{ab}	504.7 ^a	477.2 ^a	376.3 ^c	427.0 ^{ab}	444.3 ^a	415.9 ^a	406.9 ^d	458.2 ^b	474.5 ^a	446.5 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		14.4				17.1				12.4			
T		17.7				21.0				15.2			
M		14.4				17.1				12.4			
N x T		25.0				29.7				21.4			
M x T		25.0				30.0				21.4			
N x M		20.4				24.2				17.5			
N x T x M		35.4				42.0				30.3			
Control Vs Rest		21.7		63.4		22.0		64.5		10.5		30.6	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

micronutrient & organics supply ($N_1T_3M_2$) (474.0 and 470.5, respectively) which were at par, while lower tiller count (370.2) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient ($N_1T_1M_1$) among all; other treatment combinations fared in between.

All combinations except those involving 6 t ha⁻¹ irrespective of approaches and micronutrient levels ($N_{1-2}T_1M_{1-2}$) excluding the one involving STCR + 6 t ha⁻¹ + micronutrient supply ($N_2T_1M_2$) recorded higher tiller count and were significantly superior to the recommended control (384.2).

4.2.1.2.4 Panicle length (cm) (c.f. Table 152)

Panicle length varied significantly due to nutritional approaches, yield targets and micronutrient supply and their interactions. Among the main effects both nutritional approaches and micronutrient levels did not induce significant changes in panicle length while effects due to varied fertilization for different yield targets revealed significant variations in that higher yield target (T_3) recorded longer panicle (27.4) whereas lower yield target (T_1) recorded shorter panicle (25.7).

Two factor interactions were significant wherein STCR approaches coupled higher yield target across micronutrients (N_2T_3) recorded longer panicle (27.7) while NE with 6 t ha⁻¹ (N_1T_1) recorded the shorter panicle (25.2), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum panicle length (27.8) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T_3M_2) while lower panicle length (25.5) was observed with lower target coupled with and no micronutrient/organics (T_1M_1), and among nutritional approaches and micronutrient supply across yield targets, STCR approach and micronutrient supply (N_2M_2) recorded longer panicle (27.4) while NE and no micronutrient supply (N_1M_1) recorded shorter panicle length (26.3).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply ($N_2T_3M_2$) registered significantly longer panicle (28.3), while shorter panicle (24.9) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient ($N_1T_1M_1$) among all; other treatment combinations fared in between.

All the medium and high yield targets irrespective of nutritional approaches and micronutrient levels ($N_{1-2}T_{2-3}M_{1-2}$) except $N_2T_2M_1$ were significantly superior to the recommended control (25.4) with regard to panicle length.

Table 152. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on panicle length (cm) at harvest under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	26.7 ^e	28.1 ^{cd}	28.7 ^{bc}	27.8 ^b	23.9 ^e	25.4 ^{bc}	25.7 ^b	25.0 ^b	24.9 ^g	26.8 ^{cd}	27.2 ^{bc}	26.3 ^c
	M ₂	26.7 ^e	28.3 ^{bcd}	28.7 ^{bc}	27.9 ^b	24.3 ^{de}	25.7 ^b	25.7 ^b	25.2 ^b	25.5 ^f	27.1 ^{bc}	27.2 ^{bc}	26.6 ^b
N ₂	M ₁	27.7 ^d	27.9 ^d	28.6 ^{bc}	28.1 ^b	24.5 ^{de}	24.8 ^{cd}	25.6 ^b	25.0 ^b	26.1 ^e	26.4 ^{de}	27.1 ^{bc}	26.5 ^{bc}
	M ₂	28.2 ^{bcd}	28.8 ^{ab}	29.3 ^a	28.8 ^a	24.9 ^{cd}	25.9 ^b	27.2 ^a	26.0 ^a	26.5 ^{de}	27.4 ^b	28.3 ^a	27.4 ^a
Target		27.3 ^c	28.3 ^b	28.8 ^a		24.4 ^c	25.5 ^b	26.0 ^a		25.7 ^c	26.9 ^b	27.4 ^a	
Control		26.67				24.23				25.4			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		26.7 ^d	28.2 ^c	28.7 ^{ab}	27.9 ^a	24.1 ^d	25.6 ^b	25.7 ^b	25.1 ^a	25.2 ^e	26.9 ^c	27.2 ^b	26.4 ^a
N ₂		28.0 ^c	28.4 ^{bc}	29.0 ^a	28.5 ^a	24.7 ^c	25.4 ^b	26.4 ^a	25.5 ^a	26.3 ^d	26.9 ^c	27.7 ^a	27.0 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		27.2 ^d	28.0 ^c	28.6 ^b	27.9 ^a	24.2 ^d	25.1 ^c	25.7 ^b	25.0 ^a	25.5 ^e	26.6 ^c	27.2 ^b	26.4 ^a
M ₂		27.5 ^d	28.6 ^b	29.0 ^a	28.4 ^a	24.6 ^c	25.8 ^b	26.5 ^a	25.6 ^a	26.0 ^d	27.2 ^b	27.8 ^a	27.0 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.36				0.39				0.25			
T		0.44				0.48				0.31			
M		0.36				0.39				0.25			
N x T		0.62				0.68				0.43			
M x T		0.62				0.68				0.43			
N x M		0.50				0.55				0.35			
N x T x M		0.87				0.96				0.61			
Control Vs Rest		0.56		1.65		0.65		NS		0.47		1.38	

NS – Not significant,

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

4.2.1.2.5 Unfilled grains per panicle (no.) (c.f. Table 153)

Data on unfilled grains per panicle revealed significant variations due to nutritional approaches, yield targets and micronutrient supply and their interactions during both the years on pooled basis. Among the main effects nutritional approach did not induce significant changes in number of filled grains while the effects due to varied fertilization and micronutrient + organic supply resulted in significant variations. 6 t ha⁻¹ yield target (T₁) recorded more unfilled grains (26.2) while 8 t ha⁻¹ (T₃) recorded lower number of unfilled grains (16.7), and among micronutrient levels, no micronutrient/organics supply (M₁) recorded more unfilled grains (23.2) while micronutrient + organic supply (M₂) recorded lower unfilled grains per panicle (23.2).

Two factor interactions were significant wherein both NE and STCR approaches coupled with higher yield target across micronutrients (N₁₋₂T₃) recorded lower unfilled grains per panicle (16.9 and 16.4, respectively) while NE with 6 t ha⁻¹ (N₁T₁) recorded the maximum unfilled grains (29.0), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum unfilled grains panicle⁻¹ (29.5) with lower target (6 t ha⁻¹) with no micronutrients and organics (T₁M₂₁) while lower unfilled grains (15.5) was observed higher target coupled with micronutrient + organics supply (T₃M₂), and among nutritional approaches and micronutrient supply across yield targets, STCR approach and micronutrient supply (N₂M₂) recorded less number of unfilled grains (27.4) while NE with or without micronutrient and organics supply (N₁M₁₋₂) recorded higher unfilled grains per panicle (23.4 and 22.9).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered significantly lower unfilled grains (13.0), while maximum unfilled grains panicle⁻¹ (32.9) was recorded with NE + 6 t ha⁻¹ yield target + no-micronutrient (N₁T₁M₁) among all; other treatment combinations fared in between.

All the medium and high yield targets irrespective of nutritional approaches and micronutrient levels (N₁₋₂T₂₋₃M₁₋₂) including N₂T₁M₂ had significantly lower unfilled grains than control (27.5) while N₁T₁M₁ had significantly higher unfilled grains (32.9) among all.

Table 153. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on unfilled grains panicle⁻¹ at harvest under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	20.7 ^a	16.3 ^c	13.5 ^{ef}	16.8 ^a	45.0 ^a	26.7 ^{de}	18.0 ^f	29.9 ^a	32.9 ^a	21.5 ^{cd}	15.8 ^g	23.4 ^a
	M ₂	19.1 ^b	14.6 ^{de}	13.0 ^f	15.6 ^b	31.0 ^{bc}	24.3 ^d	23.0 ^e	26.1 ^b	25.1 ^b	19.5 ^{ef}	18.0 ^f	20.9 ^b
N ₂	M ₁	18.1 ^b	16.7 ^c	15.4 ^{cd}	16.7 ^a	34.0 ^b	29.0 ^{cd}	24.3 ^e	29.1 ^a	26.1 ^b	22.8 ^c	19.9 ^{de}	22.9 ^a
	M ₂	16.6 ^c	12.3 ^f	10.9 ^g	13.3 ^c	25.0 ^c	17.0 ^f	15.0 ^f	19.0 ^c	20.8 ^{de}	14.7 ^g	13.0 ^h	16.2 ^c
Target		18.6 ^a	14.9 ^b	13.2 ^c		33.7 ^a	24.3 ^b	20.0 ^c		26.2 ^a	19.6 ^b	16.7 ^c	
Control		19.7				35.3				27.5			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		19.9 ^a	15.4 ^c	13.3 ^d	16.2 ^a	38.0 ^a	25.5 ^c	20.5 ^e	28.0 ^a	29.0 ^a	20.5 ^c	16.9 ^e	22.1 ^a
N ₂		17.4 ^b	14.5 ^c	13.2 ^d	15.0 ^a	29.5 ^b	23.0 ^d	19.7 ^e	24.1 ^a	23.4 ^b	18.8 ^d	16.4 ^e	19.5 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		19.4 ^a	16.5 ^c	14.5 ^d	16.8 ^a	39.5 ^a	27.8 ^b	21.2 ^c	29.5 ^a	29.5 ^a	22.2 ^b	17.8 ^c	23.2 ^a
M ₂		17.9 ^b	13.5 ^e	12.0 ^f	14.5 ^a	28.0 ^b	20.7 ^c	19.0 ^c	22.6 ^a	22.9 ^b	17.1 ^c	15.5 ^d	18.5 ^b
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.9				2.2				1.1			
T		1.0				2.7				1.3			
M		0.9				2.2				1.1			
N x T		1.5				3.9				1.9			
M x T		1.5				3.9				1.9			
N x M		1.2				3.1				1.6			
N x T x M		2.1				5.5				2.7			
Control Vs Rest		0.4		1.3		1.5		4.4		0.7		2.1	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

4.2.1.2.6 Filled grains per panicle (no.) (c.f. Table 154 and Fig. 24b)

Data on filled grains per panicle revealed significant variations due to nutritional approaches, yield targets and micronutrient supply and their interactions during both the years and on pooled basis. Among the main effects nutritional approach did not induce significant changes in number of filled grains while the effects due to varied fertilization and micronutrient + organic supply produced significant variations. 8 t ha⁻¹ yield target (T₃) recorded more filled grains (185.1) while 6 t ha⁻¹ (T₁) recorded lower number of filled grains (137.9), and among micronutrient levels, micronutrient + organics supply (M₂) recorded more filled grains (172.7) while no micronutrient/organic supply (M₁) recorded less filled grains per panicle (154.2).

Two factor interactions were significant wherein STCR approach coupled higher yield target across micronutrients (N₂T₃) recorded more grains per panicle (189.2), so was N₁T₂ (184.2) which was on par while NE with 6 t ha⁻¹ (N₁T₁) recorded less grains per panicle (125.4), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum filled grains (194.1) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂) while less number of filled grains (129.6) was observed lower target coupled with and no micro nutrients/organics (T₁M₁), and among nutritional approaches and micronutrient supply across yield targets, STCR approach and micronutrient supply (N₂M₂) recorded more filled grains (183.0) while NE and no micronutrient supply (N₁M₁) recorded less filled grains (153.4).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered significantly more filled grains (204.2), while less filled grains (114.6) were recorded with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁) among all; other treatment combinations fared in between.

All the medium and high yield targets irrespective of nutritional approaches and micronutrient levels (N₁₋₂T₂₋₃M₁₋₂) and N₂T₁M₁₋₂ were significantly superior to the recommended control (126.5) with regard to filled grains per panicle.

4.2.1.2.7 Total grains per panicle (no.) (c.f. Table 155)

Total grains per panicle varied significantly due to nutritional approaches, yield targets and micronutrient supply and their interactions during both the years and on

Table 154. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on filled grains panicle⁻¹ at harvest under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	133.8 ^g	185.3 ^{cde}	206.9 ^{ab}	175.3 ^c	95.3 ^g	137.3 ^{cd}	162.0 ^b	131.5 ^c	114.6 ^h	161.3 ^{cd}	184.5 ^b	153.5 ^c
	M ₂	153.4 ^f	192.9 ^{bcd}	210.7 ^a	185.7 ^b	119.0 ^{ef}	142.0 ^c	157.1 ^b	139.4 ^b	136.2 ^g	167.4 ^c	183.9 ^b	162.5 ^b
N ₂	M ₁	172.2 ^e	178.4 ^{de}	194.7 ^{bc}	181.8 ^{bc}	117.0 ^f	125.9 ^{d-f}	141.3 ^c	128.1 ^c	144.6 ^f	152.2 ^e	168.0 ^c	154.9 ^c
	M ₂	180.9 ^{cde}	210.9 ^a	217.7 ^a	203.2 ^a	132.0 ^{che}	165.3 ^b	191.0 ^a	162.8 ^a	156.5 ^{de}	188.1 ^b	204.3 ^a	183.0 ^a
Target		160.0 ^c	191.8 ^a	207.5 ^a		115.8 ^c	142.6b ^z	162.8 ^z		137.9 ^c	167.3 ^b	185.1 ^a	
Control		147.0				106.1				126.5			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		143.6 ^d	189.1 ^b	208.8 ^a	180.5 ^a	107.2 ^d	139.7 ^b	159.5 ^a	135.5 ^a	125.4 ^e	164.4 ^c	184.2 ^a	158.0 ^a
N ₂		176.6 ^c	194.7 ^b	206.2 ^a	192.5 ^a	124.5 ^c	145.6 ^b	166.2 ^a	145.4 ^a	150.5 ^d	170.1 ^b	186.2 ^a	168.9 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		153.0 ^e	181.8 ^c	200.8 ^b	178.5 ^a	106.2 ^d	131.6 ^c	151.7 ^b	129.8 ^a	129.6 ^e	156.7 ^c	176.3 ^b	154.2 ^b
M ₂		167.2 ^d	201.9 ^a	214.2 ^a	194.4 ^a	125.5 ^c	153.7 ^b	174.0 ^a	151.1 ^a	146.3 ^d	177.8 ^b	194.1 ^a	172.7 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		9.3				8.5				4.8			
T		11.4				10.4				5.8			
M		9.3				8.5				4.8			
N x T		16.2				14.7				8.2			
M x T		16.2				14.7				8.2			
N x M		13.2				12.0				6.7			
N x T x M		22.9				20.8				11.7			
Control Vs Rest		5.0		14.8		10.7		31.3		5.7		16.6	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 155. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on total grains panicle⁻¹ at harvest under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	154.5 ^g	201.5 ^{de}	220.5 ^{a-c}	192.2 ^c	140.3 ^e	164.0 ^{cd}	180.0 ^b	161.4 ^{bc}	147.4 ^g	182.8 ^{cd}	200.2 ^b	176.8 ^c
	M ₂	172.5 ^f	207.5 ^{cd}	223.7 ^{ab}	201.2 ^b	150.0 ^{de}	166.3 ^c	180.1 ^b	165.5 ^b	161.3 ^f	186.9 ^d	201.9 ^b	183.4 ^b
N ₂	M ₁	190.3 ^e	195.1 ^{de}	210.1 ^{b-d}	198.5 ^{bc}	151.0 ^{de}	154.9 ^{cd}	165.7 ^c	157.2 ^c	170.7 ^e	175.0 ^e	187.9 ^c	177.9 ^c
	M ₂	197.5 ^{de}	223.2 ^{ab}	228.6 ^a	216.4 ^a	157.0 ^{cd}	182.3 ^b	206.0 ^a	181.8 ^a	177.3 ^{de}	202.8 ^b	217.3 ^a	199.1 ^a
Target		178.7 ^c	206.8 ^b	220.7 ^a		149.6 ^c	166.9 ^b	182.9 ^a		164.2 ^c	186.8 ^b	201.8 ^a	
Control		166.6				141.33				154.0			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		163.5 ^e	204.5 ^c	222.1 ^a	196.7 ^a	145.2 ^c	165.2 ^b	180.0 ^a	163.5 ^a	154.4 ^d	184.8 ^b	201.1 ^a	180.1 ^a
N ₂		193.9 ^d	209.2 ^{bc}	219.4 ^{ab}	207.5 ^a	154.0 ^c	168.6 ^b	185.8 ^a	169.5 ^a	174.0 ^c	188.9 ^b	202.6 ^a	188.5 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		172.4 ^e	198.3 ^c	215.3 ^b	195.3 ^a	145.7 ^d	159.5 ^c	172.8 ^b	159.3 ^a	159.1 ^e	178.9 ^c	194.1 ^b	177.4 ^b
M ₂		185.0 ^d	215.4 ^b	226.1 ^a	208.8 ^a	153.5 ^{cd}	174.3 ^b	193.0 ^a	173.6 ^a	169.3 ^d	194.8 ^b	209.6 ^a	191.2 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		9.4				8.4				4.8			
T		11.6				10.2				5.9			
M		9.4				8.4				4.8			
N x T		16.3				14.5				8.4			
M x T		16.3				14.5				8.4			
N x M		13.3				11.8				6.8			
N x T x M		23.1				20.5				11.8			
Control Vs Rest		5.1		15.0		10.0		29.45		5.4		15.7	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

pooled basis. Among the main effects nutritional approach did not induce significant changes in number grains while the effects due to varied fertilization and micronutrient +

organics supply resulted in significant variations. 8 t ha⁻¹ yield target (T₃) recorded more grains (201.8) while 6 t ha⁻¹ (T₁) recorded lower total number of grains (164.2), and among micronutrient levels, micronutrient/organics supply (M₂) recorded more total grain number (191.2) while no micronutrient + organic supply (M₁) recorded lower total number of grains (177.4) per panicle.

Two factor interactions were significant wherein both NE and STCR approaches coupled with higher yield target across micronutrients (N₁₋₂T₃) recorded higher total number of grains per panicle (202.6 and 201.1, respectively) while NE with 6 t ha⁻¹ (N₁T₁) recorded the minimum total grains (154.4), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum grains panicle⁻¹ (209.6) with higher target (8 t ha⁻¹) with micronutrients and organics (T₃M₂) while lower number of grains (159.1) was observed lower target and without micronutrient + organics supply (T₁M₁), and among nutritional approaches and micronutrient supply across yield targets, STCR approach and micronutrient supply (N₂M₂) recorded more number of grains (199.1) while NE with or without micronutrient and organics supply (N₁M₁₋₂) recorded lower grains per panicle (176.8 and 177.9, respectively).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered significantly more number of grains (217.3), while minimum grains panicle⁻¹ (147.4) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁) among all; other treatment combinations fared in between.

The entire N x T x M combinations except N₁T₂M₁₋₂ were superior to recommended control (154.0).

4.2.1.2.8 Sterility percentage (c.f. Table 156 and Fig. 25a)

Sterility per cent varied significantly due to nutritional approaches, yield targets and micronutrient supply and their interactions. Among the main effects, nutritional approaches and levels of micronutrient + organics did not induce significant changes in sterility percent while the effects due to varied fertilization for different yield targets resulted in significant variations and among them, 8 t ha⁻¹ yield target (T₃) recorded lower sterility per cent (8.6) while 6 t ha⁻¹ (T₁) recorded higher sterility per cent (16.7).

Table 156. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on sterility percentage under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	13.4 ^a	8.1 ^{de}	6.1 ^g	9.2 ^a	32.3 ^a	16.3 ^{de}	10.0 ^g	19.5 ^a	22.8 ^a	12.2 ^{ad}	8.1 ^{ef}	14.4 ^a
	M ₂	11.2 ^b	7.0 ^f	5.8 ^g	8.0 ^b	20.8 ^{bc}	14.7 ^{ef}	12.8 ^g	16.1 ^b	16.0 ^b	10.9 ^d	9.3 ^e	12.0 ^a
N ₂	M ₁	9.5 ^c	8.5 ^d	7.3 ^{ef}	8.4 ^b	22.5 ^b	18.7 ^{cd}	14.7 ^{ef}	18.6 ^a	16.0 ^b	13.6 ^c	11.0 ^d	13.5 ^a
	M ₂	8.4 ^d	5.5 ^{gh}	4.8 ^h	6.2 ^a	15.9 ^{de}	9.3 ^{cd}	7.3 ^g	10.8 ^c	12.2 ^d	7.4 ^f	6.0 ^g	8.5 ^a
Target		42.5 ^a	29.1 ^b	24 ^c		22.9 ^a	14.8 ^b	11.2 ^c		16.75 ^a	11.03 ^b	8.6 ^c	
Control		11.9				28.9				20.4			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		12.3 ^a	7.6 ^c	6.0 ^d	8.63 ^a	26.5 ^a	15.5 ^c	11.4 ^d	17.8 ^a	19.4 ^a	11.5 ^c	8.7 ^e	13.2
N ₂		9.0 ^b	7.0 ^c	6.1 ^d	7.4 ^a	19.2 ^b	14.0 ^c	11.0 ^c	14.73 ^a	14.1 ^b	10.5 ^d	8.5 ^e	11.0
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		11.5 ^a	8.3 ^c	6.7 ^d	8.8 ^a	27.4 ^a	17.5 ^b	12.3 ^c	19.06 ^a	19.4 ^a	12.9 ^c	9.5 ^d	13.2 ^a
M ₂		9.8 ^b	6.3 ^d	5.3 ^e	7.1 ^a	18.4 ^b	12.0 ^c	10.0 ^d	13.4 ^a	14.1 ^b	9.1 ^d	7.7 ^e	10.3 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.7				2.2				1.0			
T		0.6				1.8				0.8			
M		0.6				1.8				0.8			
N x T		1.0				3.1				1.4			
M x T		1.0				3.1				1.4			
N x M		0.8				2.6				1.1			
N x T x M		1.4				4.4				2.0			
Control Vs Rest		0.3		0.9		1.6		4.7		1.4		4.1	

NS – Not significant,

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Two factor interactions were significant wherein both NE and STCR approaches coupled with higher yield target across micronutrients ($N_{1-2}T_3$) recorded lower sterility per cent (8.5 and 8.7, respectively) while NE with 6 t ha^{-1} (N_1T_1) recorded the maximum sterility per cent (19.4), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum sterility per cent (19.4) with lower target (6 t ha^{-1}) + no micronutrients and organics (T_1M_1) while lower sterility percent (7.7) was observed higher yield target and micronutrient + organics supply (T_3M_2), and among nutritional approaches and micronutrient supply across yield targets, STCR approach and micronutrient supply (N_2M_2) recorded significantly lower sterility per cent (8.5) while others were at par.

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + micronutrient supply ($N_2T_3M_2$) registered significantly lower sterility per cent (6.0), while the maximum sterility per cent (22.8) was recorded with NE + 6 t ha^{-1} yield target + no-micronutrient ($N_1T_1M_1$) among all; other treatment combinations fared in between.

The entire $N \times T \times M$ combinations except $N_1T_1M_1$ were superior to recommended control (20.41) with lower sterility percent.

4.2.1.2.9 1000-grain weight (g) (c.f. Table 157)

Data on 1000-grain weight/test weight revealed that neither main effects nor the interactions due to nutritional approaches, yield targets and micronutrient supply during both the years and on pooled basis were significant. The main effects ranged between 23.7-23.8, 23.4-24.1 and 23.1- 24.2, respectively due to nutritional approaches, yield targets and levels of micronutrient + organics supply.

4.2.1.2.10 Grain weight (g plant⁻¹) (c.f. Table 158)

Nutritional approaches, yield targets and micronutrient supply and their interactions produced significant variations in grain weight during both the years and on pooled basis except main effects due to nutritional approaches (35.2 – 36.7, respectively with N_1 and N_2) .

Effects due to yield targets revealed higher grain weight (38.3) with 8 t ha^{-1} yield target (T_3) while 6 t ha^{-1} (T_1) recorded lower grain weight (32.8), and among micronutrient levels, micronutrient + organics supply (M_2) recorded higher grain weight (37.4) while no micronutrient/organic supply (M_1) recorded lower weight (34.6).

Table 157. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on 1000- grain weight (g) at harvest under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	23.0 ^a	24.8 ^a	25.7 ^a	24.50 ^a	22.6 ^a	23.1 ^a	23.2 ^a	22.97 ^a	22.8 ^a	24.0 ^a	24.5 ^a	23.7 ^a
	M ₂	22.8 ^a	25.6 ^a	25.7 ^a	24.70 ^a	22.8 ^a	23.2 ^a	23.2 ^a	23.07 ^a	22.8 ^a	24.4 ^a	24.5 ^a	23.9 ^a
N ₂	M ₁	22.6 ^a	24.5 ^a	23.1 ^a	23.40 ^a	22.8 ^a	22.9 ^a	23.1 ^a	22.93 ^a	23.0 ^a	23.7 ^a	23.1 ^a	23.2 ^a
	M ₂	24.5 ^a	25.7 ^a	25.9 ^a	25.37 ^a	22.9 ^a	23.2 ^a	23.4 ^a	23.17 ^a	23.7 ^a	24.5 ^a	24.6 ^a	24.2 ^a
Target		23.2 ^a	25.2 ^a	25.1 ^a		22.7 ^a	23.1 ^a	23.2 ^a		23.1 ^a	24.2 ^a	24.2 ^a	
Control		22.3				22.7				22.5			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		22.9 ^a	25.2 ^a	25.7 ^a	24.6 ^a	22.7 ^a	23.1 ^a	23.2 ^a	23.0 ^a	22.3 ^a	24.2 ^a	24.5 ^a	23.7 ^a
N ₂		23.6 ^a	25.1 ^a	24.5 ^a	24.4 ^a	22.9 ^a	23.0 ^a	23.3 ^a	23.1 ^a	23.4 ^a	24.1 ^a	23.9 ^a	23.8 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		22.8 ^a	24.7 ^a	24.4 ^a	24.0 ^a	22.7 ^a	23.0 ^a	23.2 ^a	23.0 ^a	22.4 ^a	23.9 ^a	23.8 ^a	23.4 ^a
M ₂		23.7 ^a	25.6 ^a	25.8 ^a	25.0 ^a	22.8 ^a	23.2 ^a	23.3 ^a	23.1 ^a	23.3 ^a	24.4 ^a	24.6 ^a	24.1 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		3.1				2.8				2.1			
T		3.9				3.5				2.6			
M		3.2				2.8				2.1			
N x T		5.5				4.9				3.6			
M x T		5.5				4.9				3.6			
N x M		4.5				4.0				3.0			
N x T x M		7.8				6.9				5.1			
Control Vs Rest		1.0		NS		1.6		NS		0.9		NS	

NS – Not significant,

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 158. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on grain yield (g plant⁻¹) under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	31.3 ^f	38.8 ^{bc}	39.5 ^{bc}	36.5 ^{bc}	29.7 ^c	33.9 ^{a-c}	34.8 ^{ab}	32.8 ^b	30.5 ^g	36.4 ^{cd}	37.2 ^{bc}	34.7 ^c
	M ₂	33.7 ^{ef}	39.0 ^{bc}	41.5 ^{ab}	38.1 ^b	30.3 ^c	34.7 ^{ab}	35.5 ^{ab}	33.5 ^b	32.0 ^{lg}	36.9 ^{b-d}	38.5 ^{a-c}	35.8 ^b
N ₂	M ₁	33.7 ^{ef}	35.0 ^{de}	38.9 ^{bc}	35.9 ^c	32.6 ^{bc}	32.8 ^{bc}	33.9 ^{a-c}	33.1 ^b	33.1 ^{e-g}	33.9 ^{d-f}	36.4 ^{cd}	34.5 ^c
	M ₂	37.9 ^{cd}	41.9 ^{ab}	44.2 ^a	41.4 ^a	33.4 ^{bc}	37.9 ^a	38.2 ^a	36.5 ^a	35.6 ^{c-e}	39.9 ^{ab}	41.2 ^a	38.9 ^a
Target		34.2 ^c	38.7 ^b	41.0 ^a		31.5 ^b	34.8 ^a	35.6 ^a		32.8 ^c	36.8 ^b	38.3 ^a	
Control		31.5				30.1				30.7			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		32.5 ^d	38.9 ^b	40.5 ^{ab}	37.3 ^a	30.0 ^c	34.3 ^{ab}	35.2 ^{ab}	33.2 ^a	31.3 ^c	36.6 ^a	37.8 ^a	35.2 ^a
N ₂		35.8 ^c	38.5 ^b	41.6 ^a	38.6 ^a	33.0 ^b	35.4 ^{ab}	36.1 ^a	34.8 ^a	34.4 ^b	36.9 ^a	38.8 ^a	36.7 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		32.5 ^d	36.9 ^c	39.2 ^b	36.2 ^a	31.1 ^c	33.3 ^{bc}	34.4 ^{ab}	33.0 ^a	31.8 ^e	35.1 ^{cd}	36.8 ^{bc}	34.6 ^b
M ₂		35.8 ^c	40.5 ^b	42.9 ^a	39.7 ^a	31.8 ^{bc}	36.3 ^a	36.9 ^a	35.0 ^a	33.8 ^d	38.4 ^{ab}	39.9 ^a	37.4 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		2.0				2.5				1.8			
T		2.5				3.1				2.2			
M		2.0				2.5				1.8			
N x T		3.5				4.3				3.2			
M x T		3.5				4.3				3.2			
N x M		2.8				3.5				2.6			
N x T x M		4.9				6.1				4.5			
Control Vs Rest		1.2		3.8		1.6		4.8		1.2		3.5	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Among two factor combinations, STCR approach coupled higher yield target across micronutrients (N_2T_3) recorded higher yield (38.8) while NE with 6 t ha^{-1} (N_1T_1) recorded the lower yield (31.3), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum yield (39.92) with higher target (8 t ha^{-1}) coupled with micronutrients and organics (T_3M_2) while lower yield (31.8) was observed with lower target coupled with and no micro nutrients/organics (T_1M_1), and among nutritional approaches and micronutrient supply across yield targets, STCR approach and micronutrient supply (N_2M_2) recorded higher grain weight (38.9) while STCR and NE and no micronutrient supply ($N_{1\&2}M_1$) recorded lower grain weight (34.5 and 34.7, respectively).

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + micronutrient supply ($N_2T_3M_2$) registered significantly higher grain weight (41.2) followed by STCR + 7 t ha^{-1} yield target + micronutrient supply ($N_2T_2M_2$ – 39.9) which was on par, while lower weight (30.5) was recorded with NE + 6 t ha^{-1} yield target + no micronutrient ($N_1T_1M_1$) and $N_1T_1M_1$ and $N_2T_1M_1$ were on par whereas all other treatment combinations fared in between.

All the medium and high grain weight targets irrespective of nutritional approaches and micronutrient levels ($N_{1-2}T_{2-3}M_{1-2}$) including $N_2T_1M_2$ were significantly superior to the recommended control (30.7) with regard to grain weight.

4.2.1.2.10 Grain yield (kg ha^{-1}) (c.f. Table 159 and Fig. 25b)

Grain yield varied significantly due to nutritional approaches, yield targets and micronutrient supply and their interactions during both the years and on pooled basis. Among the main effects nutritional approaches did not induce significant changes (6793 – 6988, respectively with N_1 and N_2) while the effects due to varied fertilization and micronutrient + organic supply resulted in significant variations. In the yield targets, 8 t ha^{-1} yield target (T_3) recorded the maximum grain yield (7299) while 6 t ha^{-1} (T_1) recorded lower yield (6298), and among micronutrient levels, micronutrient + organics supply (M_2) recorded higher yield (7098) while in the absence of micronutrient/organics supply (M_1) yield was lower (6683).

Two factor interactions were significant wherein STCR approach coupled higher yield target across micronutrients (N_2T_3) recorded higher yield (7303) while NE with

Table 159. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on grain yield (kg ha⁻¹) under direct seeded condition during rainy season

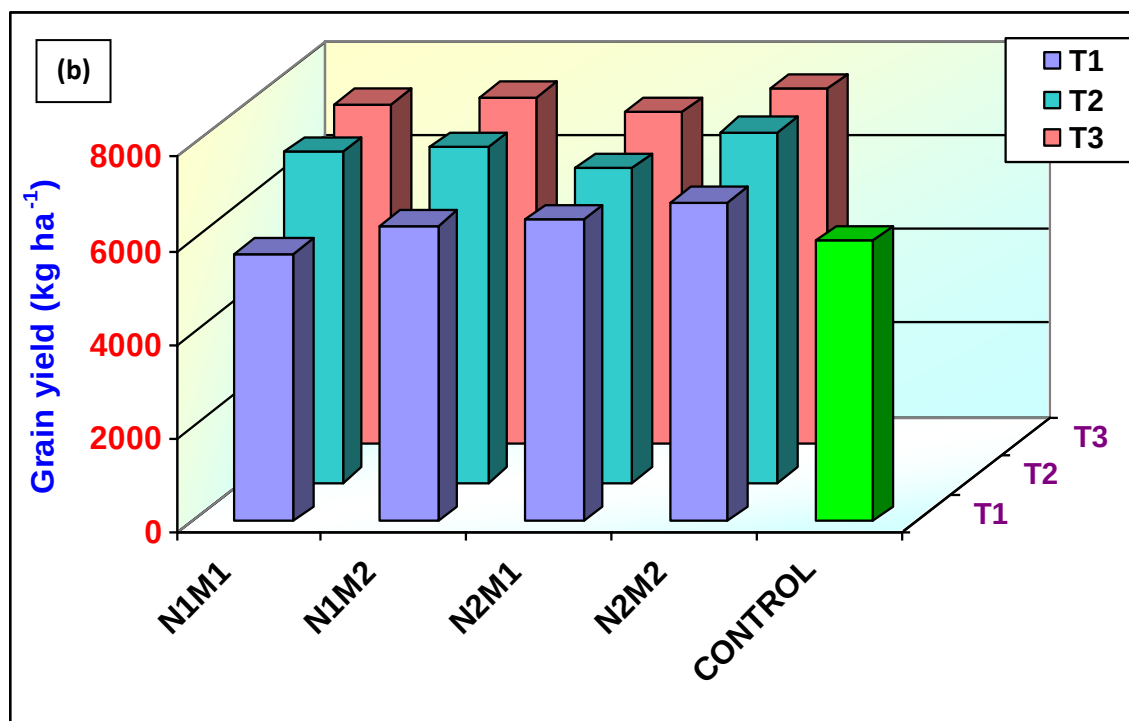
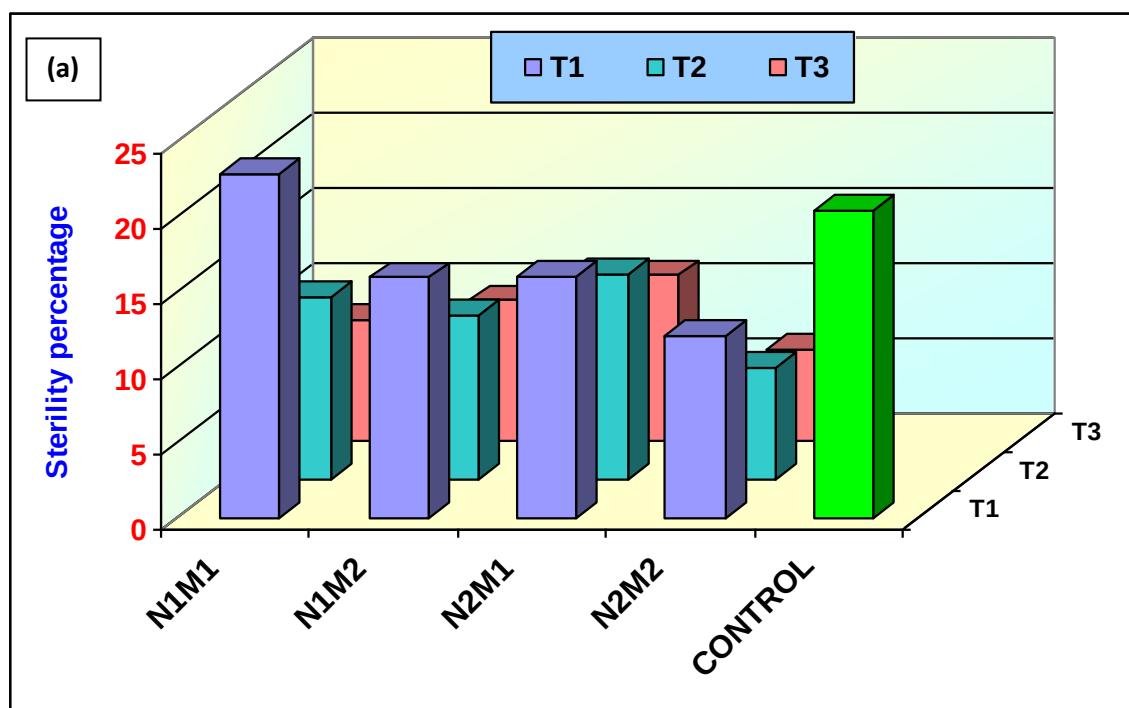
N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	5532 ^f	7241 ^c	7403 ^{ab}	6725 ^c	5878 ^f	6835 ^{cde}	7044 ^{bc}	6586 ^c	5705 ^h	7038 ^e	7223 ^{cd}	6655 ^b
	M ₂	6029 ^e	7305 ^d	7649 ^c	6994 ^b	6550 ^e	6964 ^{bcd}	7087 ^{bc}	6867 ^b	6290 ^h	7135 ^{de}	7368 ^{bc}	6931 ^a
N ₂	M ₁	6099 ^e	6633 ^{ab}	7252 ^a	6661 ^c	6706 ^{de}	6723 ^{de}	6848 ^{cde}	6759 ^b	6403 ^h	6678 ^f	7050 ^e	6710 ^b
	M ₂	6855 ^c	7650 ^{bc}	7708 ^a	7404 ^a	6739 ^{de}	7238 ^{ab}	7403 ^a	7127 ^a	6797 ^f	7444 ^{ab}	7556 ^a	7266 ^c
Target		6128 ^c	7207 ^b	7503 ^a		6468 ^c	6940 ^b	7095 ^a		6298 ^c	7073 ^b	7299 ^a	
Control		6021				5921				5971			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		5781 ^d	7273 ^b	7526 ^a	6860 ^a	6214 ^d	6900 ^{bc}	7065 ^{ab}	6726 ^a	5997 ^d	7086 ^b	7296 ^a	6793 ^a
N ₂		6477 ^c	7142 ^b	7480 ^a	7033 ^a	6723 ^c	6981 ^{ab}	7126 ^a	6943 ^a	6600 ^c	7061 ^b	7303 ^a	6988 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		5816 ^e	6937 ^c	7328 ^b	6694 ^a	6292 ^e	6779 ^{cd}	6946 ^{bc}	6672 ^a	6054 ^f	6858 ^d	7137 ^c	6683 ^b
M ₂		6442 ^d	7477 ^b	7679 ^a	7199 ^a	6645 ^d	7101 ^{ab}	7245 ^a	6997 ^a	6543 ^e	7289 ^b	7462 ^a	7098 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		178				179				103			
T		218				219				126			
M		178				179				103			
N x T		308				309				179			
M x T		308				309				179			
N x M		251				253				146			
N x T x M		435				438				253			
Control Vs Rest		233		682		278		812		159		466	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT



LEGEND

Nutritional approaches (N): N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
 Yield Targets (T): T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
 Micronutrient & Organics (M): M₁ - Without FeSO₄+ZnSO₄ + Organics, M₂ - With FeSO₄+ZnSO₄ + Organics

Fig. 25. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on (a) sterility percentage and (b) grain yield (kg ha⁻¹) under direct seeded condition during rainy season

6 t ha⁻¹ (N₁T₁) recorded the lower yield (5997), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum yield (7462) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂) while lower yield (6054) was observed lower target coupled with and no micro nutrients/organics (T₁M₁), and among nutritional approaches and micronutrient supply across yield targets, STCR approach and micronutrient supply (N₂M₂) recorded higher grain yield (7266) while NE and no micronutrient supply (N₁M₁) recorded lower grain yield (6655).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered significantly higher yield (7556) followed by STCR + 7 t ha⁻¹ yield target + micronutrient supply (N₂T₂M₂ - 7444) which was on par, while lower yield (5705) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient/organics (N₁T₁M₁) and N₁T₁M₁ and N₂T₁M₁ were on par whereas all other treatment combinations fared in between.

All the medium and high yield targets irrespective of nutritional approaches and micronutrient levels (N₁₋₂T₂₋₃M₁₋₂) including except N₂T₁M₂ were significantly superior to the recommended control (5971) with regard to grain yield.

4.2.1.2.11 Straw yield (kg ha⁻¹) (c.f. Table 160 and Fig. 26a)

Similar to grain yield, straw yield varied significantly due to nutritional approaches, yield targets and micronutrient supply and their interactions during both the years and on pooled basis. Among the main effects only yield targets produced significant variations wherein, 8 t ha⁻¹ yield target (T₃) recorded the maximum straw yield (8739) while 6 t ha⁻¹ (T₁) recorded lower yield (7192).

Two factor interactions were significant wherein among N x T, both NE and STCR approaches coupled with higher yield target across micronutrients (N₁₋₂T₃) recorded higher yield (8485-8446) while NE with 6 t ha⁻¹ (N₁T₁) recorded the lower yield (6992), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum yield (8144) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂) while lower yield (6993) was observed lower target coupled with and no micro-nutrition (T₁M₁), and among nutritional approaches and micronutrient supply across yield targets, STCR approach and

Table 160. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on straw yield (kg ha⁻¹) under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	6722 ^f	7791 ^d	8391 ^{bc}	7635 ^a	6788 ^f	7907 ^{cd}	8403 ^{ab}	7699 ^c	6755 ^h	7849 ^d	8397 ^{bc}	7667 ^c
	M ₂	7238 ^e	8084 ^{cd}	8497 ^{ab}	7940 ^b	7099 ^{ef}	8305 ^{ab}	8649 ^{ab}	8018 ^b	7169 ^g	8195 ^c	8573 ^{ab}	7979 ^b
N ₂	M ₁	7264 ^e	7368 ^e	8055 ^{cd}	7562 ^c	7198 ^e	7633 ^b	8252 ^{bc}	7694 ^c	7231 ^{fg}	7501 ^{ef}	8154 ^c	7629 ^c
	M ₂	7373 ^e	8505 ^{ab}	8770 ^a	8216 ^a	7855 ^d	8650 ^{ab}	8708 ^a	8404 ^a	7614 ^{de}	8577 ^{ab}	8739 ^a	8310 ^a
Target		7149 ^c	7937 ^b	8428 ^a		7235 ^b	8123 ^b	8503 ^a		7192 ^c	8030 ^b	8465 ^a	
Control		7087				6850				6968			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		6980 ^d	7938 ^b	8444	7787 ^a	6944 ^d	8106 ^b	8526 ^a	7859 ^a	6962 ^d	8022 ^b	8485 ^a	7823 ^a
N ₂		7318 ^c	7937 ^b	8412 ^a	7889 ^a	7527 ^c	8142 ^a	8480 ^a	8050 ^a	7423 ^c	8039 ^b	8446 ^a	7969 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		6993 ^e	7580 ^c	8223 ^b	7599 ^a	6993 ^e	7770 ^c	8328 ^b	7697 ^a	6993 ^e	7675 ^c	8275 ^b	7648 ^a
M ₂		7306 ^d	8295 ^b	8634 ^a	8078 ^a	7477 ^d	8477 ^{ab}	8679 ^a	8211 ^a	7391 ^d	8386 ^b	8656 ^a	8144 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		274				295				226			
T		224				241				185			
M		224				241				185			
N x T		387				417				320			
M x T		387				417				320			
N x M		316				341				261			
N x T x M		548				590				452			
Control Vs Rest		258		753		259		758		205		600	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

micronutrient supply (N_2M_2) recorded higher straw yield (8310) while NE and no micronutrient supply (N_1M_1) recorded lower straw yield (7667) and N_1M_2 was on par.

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply ($N_2T_3M_2$) registered significantly higher yield (8739) followed by STCR + 7 t ha⁻¹ yield target + micronutrient supply ($N_2T_2M_2$ - 78577) and NE + 8 t ha⁻¹ yield target + micronutrient supply ($N_2T_2M_2$ - 8573) which were on par, while lower yield (6755) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient ($N_1T_1M_1$).

All the medium and high yield targets irrespective of nutritional approaches and micronutrient levels ($N_{1-2}T_{2-3}M_{1-2}$) including $N_2T_2M_2$ and $N_1T_2M_2$ were significantly superior to the recommended control (6968) with regard to straw yield.

4.2.1.2.12 Harvest index (c.f. Table 161)

None of the main effects and interactions due to nutritional approaches, yield targets or micronutrient + organic levels were significant with regard to harvest index. The indices due to hovered around 0.46 and 0.47 in all.

4.2.1.4 Grain composition

4.2.1.3.1 Grain nitrogen (%) (c.f. Table 162)

Data pertaining grain N content revealed significant variation due to main effects due to yield targets and levels of micronutrients and organics, and interaction among nutritional approaches, yield targets and micronutrient + organics application during both the years and on pooled basis.

In main effects, nutritional approaches did not differ significantly, higher yield target (T_3) had significantly higher grain N (1.22) and it decreased with decrease in yield targets recording the lowest (1.10) with lower yield target (T_1), between levels of micronutrients and organics, their supply (M_2) registered significantly higher grain N content (1.19) over no supply micronutrients and organics (M_1 - 1.14).

Two factor interactions were also significant. In that, STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher N content (1.22); NE with similar target was on par, while NE with 6 t ha⁻¹ (N_1T_1) had lower N content (1.08), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum grain N (1.24) with higher target (8 t ha⁻¹) applied with

Table 161. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on harvest index under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	0.45 ^a	0.48 ^a	0.47 ^a	0.47 ^a	0.46 ^a	0.46 ^a	0.46 ^a	0.46 ^a	0.46 ^a	0.47 ^a	0.46 ^a	0.46 ^a
	M ₂	0.46 ^a	0.47 ^a	0.47 ^a	0.47 ^a	0.48 ^a	0.46 ^a	0.45 ^a	0.46 ^a	0.47 ^a	0.47 ^a	0.46 ^a	0.47 ^a
N ₂	M ₁	0.46 ^a	0.47 ^a	0.47 ^a	0.47 ^a	0.48 ^a	0.47 ^a	0.45 ^a	0.47 ^a	0.47 ^a	0.47 ^a	0.46 ^a	0.47 ^a
	M ₂	0.48 ^a	0.47 ^a	0.47 ^a	0.47 ^a	0.46 ^a	0.46 ^a	0.46 ^a	0.46 ^a	0.47 ^a	0.46 ^a	0.46 ^a	0.46 ^a
Target		0.46 ^a	0.47 ^a	0.47 ^a		0.47 ^a	0.46 ^a	0.46 ^a		0.46 ^a	0.46 ^a	0.46 ^a	
Control		0.46				0.46				0.46			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		0.45 ^a	0.48 ^a	0.47 ^a	0.47 ^a	0.47 ^a	0.46 ^a	0.45 ^a	0.46 ^a	0.46 ^a	0.47 ^a	0.46 ^a	0.46 ^a
N ₂		0.47 ^a	0.47 ^a	0.47 ^a	0.47 ^a	0.47 ^a	0.46 ^a	0.46 ^a	0.46 ^a	0.47 ^a	0.47 ^a	0.46 ^a	0.47 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		0.45 ^a	0.48 ^a	0.47 ^a	0.48 ^a	0.47 ^a	0.47 ^a	0.45 ^a	0.46 ^a	0.46 ^a	0.47 ^a	0.46 ^a	0.46 ^a
M ₂		0.47 ^a	0.47 ^a	0.47 ^a	0.47 ^a	0.47 ^a	0.46 ^a	0.46 ^a	0.46 ^a	0.47 ^a	0.47 ^a	0.46 ^a	0.47 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.03				0.04				0.03			
T		0.04				0.04				0.04			
M		0.03				0.04				0.03			
N x T		0.06				0.06				0.06			
M x T		0.06				0.06				0.06			
N x M		0.05				0.05				0.05			
N x T x M		0.08				0.09				0.08			
Control Vs Rest		0.01		NS		0.01		NS		0.01		NS	

NS – Not significant,

Nutrient approach (N)

Yield Targets (T)

Micronutrient & Organics (M)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 162. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on grain nitrogen (%) under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	1.12 ^d	1.15 ^{b-d}	1.18 ^{bc}	1.15 ^b	0.99 ^h	1.18 ^c	1.24 ^b	1.14 ^c	1.06 ^f	1.17 ^{de}	1.21 ^{bc}	1.14 ^c
	M ₂	1.13 ^{cd}	1.18 ^{bc}	1.19 ^b	1.17 ^b	1.07 ^g	1.24 ^b	1.24 ^b	1.18 ^b	1.10 ^h	1.21 ^{bc}	1.22 ^b	1.17 ^b
N ₂	M ₁	1.13 ^{cd}	1.14 ^{b-d}	1.17 ^{b-d}	1.15 ^b	1.09 ^f	1.12 ^e	1.22 ^b	1.14 ^c	1.11 ^{gh}	1.13 ^{fg}	1.19 ^{cd}	1.14 ^c
	M ₂	1.15 ^{b-d}	1.10 ^b	1.26 ^a	1.20 ^a	1.15 ^d	1.24 ^b	1.26 ^a	1.22 ^a	1.15 ^{ef}	1.22 ^b	1.26 ^a	1.21 ^a
Target		1.13 ^c	1.17 ^b	1.20 ^a		1.08 ^c	1.20 ^b	1.24 ^a		1.10 ^c	1.18 ^b	1.22 ^a	
Control		1.13				0.99				1.06			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		1.12 ^d	1.17 ^{bc}	1.19 ^{ab}	1.16 ^a	1.03 ^d	1.21 ^{ab}	1.24 ^a	1.16 ^a	1.08 ^e	1.19 ^b	1.21 ^a	1.16 ^a
N ₂		1.14 ^{cd}	1.17 ^{bc}	1.21 ^a	1.17 ^a	1.12 ^c	1.18 ^b	1.24 ^a	1.18 ^a	1.13 ^d	1.17 ^c	1.22 ^a	1.18 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		1.13 ^c	1.14 ^c	1.18 ^b	1.15 ^a	1.04 ^d	1.15 ^b	1.23 ^{ab}	1.14 ^b	1.08 ^e	1.15 ^c	1.20 ^b	1.14 ^b
M ₂		1.14 ^c	1.19 ^{ab}	1.22 ^a	1.18 ^a	1.11 ^c	1.24 ^a	1.25 ^a	1.20 ^a	1.12 ^d	1.21 ^b	1.24 ^a	1.19 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.03				0.01				0.02			
T		0.04				0.02				0.02			
M		0.03				0.01				0.02			
N x T		0.06				0.02				0.03			
M x T		0.06				0.02				0.03			
N x M		0.05				0.02				0.02			
N x T x M		0.08				0.03				0.04			
Control Vs Rest		0.02		0.06		0.03		0.11		0.16		0.46	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

micronutrients and organics (T_3M_1) while lower yield target but without micronutrients/ organics (T_1M_1) had lower grain N (1.08), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics supply (N_2M_2) recorded the maximum grain N (1.21), while NE without or with micronutrient + organics supply (N_1M_{1-2}) had the lowest N content (1.4 each).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + with micronutrient and organic supply ($N_2T_3M_2$) registered the maximum grain N (1.26), while lower grain N (1.06) was observed with NE + 6 t ha⁻¹ yield target + no micronutrient and organics ($N_1T_1M_1$); other combinations fared in between.

All N-T-M combinations were comparable with recommended control (1.06).

4.2.1.3.1 Grain phosphorus (%) (c.f. Table 163)

Grain P content revealed significant variation due to main effects due to yield targets and interactions due to nutritional approaches, yield targets and micronutrient + organics application during both the years and on pooled basis.

In main effects nutritional approaches and levels of micronutrients and organics did not differ significantly, higher yield target (T_3) had significantly higher grain N (0.25) and it decreased with decrease in yield targets recording the lowest (0.22) with lower yield target (T_1).

Two factor interactions were also significant. In that, STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher P content (0.26); NE with similar target was on par, while NE with 6 t ha⁻¹ (N_1T_1) had lower P content (0.22), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum grain P (0.27) with higher target (8 t ha⁻¹) applied with micronutrients and organics (T_3M_1) while lower yield target but without micronutrients/ organics (T_1M_1) had lower grain P (0.22), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics supply (N_2M_2) recorded the maximum grain P (0.26), while NE without or with micronutrient + organics supply (N_1M_{1-2}) had the lowest P content (0.23 each).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + with micronutrient and organic supply ($N_2T_3M_2$) registered the maximum grain P (0.28)

Table 163. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on grain phosphorus (%) under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	0.20 ^b	0.22 ^b	0.22 ^b	0.21 ^a	0.23 ^c	0.25 ^{bc}	0.27 ^{ab}	0.25 ^b	0.21 ^e	0.23 ^{c-e}	0.25 ^{a-d}	0.23 ^b
	M ₂	0.21 ^b	0.22 ^b	0.23 ^b	0.22 ^a	0.23 ^c	0.26 ^{bc}	0.28 ^{ab}	0.26 ^b	0.22 ^{de}	0.24 ^{b-e}	0.26 ^{a-c}	0.24 ^b
N ₂	M ₁	0.21 ^b	0.21 ^b	0.22 ^b	0.21 ^a	0.23 ^c	0.25 ^{bc}	0.26 ^{bc}	0.25 ^b	0.22 ^{de}	0.23 ^{c-e}	0.24 ^{b-e}	0.23
	M ₂	0.22 ^b	0.23 ^b	0.24 ^a	0.23 ^a	0.25 ^{bc}	0.30 ^a	0.32 ^a	0.29 ^a	0.23 ^{c-e}	0.27 ^{ab}	0.28 ^a	0.26 ^a
Target		0.21 ^a	0.22 ^a	0.23 ^a		0.24 ^b	0.27 ^a	0.28 ^a		0.22 ^b	0.24 ^a	0.25 ^a	
Control		0.20				0.23				0.21			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		0.20 ^a	0.22 ^a	0.22 ^a	0.21 ^a	0.23 ^d	0.26 ^{bc}	0.28 ^{ab}	0.25 ^a	0.22 ^c	0.24 ^{a-c}	0.25 ^{ab}	0.23 ^a
N ₂		0.21 ^a	0.22 ^a	0.23 ^a	0.22 ^a	0.24 ^{cd}	0.27 ^{ab}	0.29 ^a	0.27 ^a	0.23 ^{bc}	0.25 ^{a-b}	0.26 ^a	0.24 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		0.20 ^a	0.21 ^a	0.22 ^a	0.21 ^a	0.23 ^d	0.25 ^{cd}	0.27 ^{bc}	0.25 ^a	0.22 ^c	0.23 ^{bc}	0.24 ^{bc}	0.23 ^a
M ₂		0.21 ^a	0.23 ^a	0.23 ^a	0.22 ^a	0.24 ^d	0.28 ^{ab}	0.30 ^a	0.27 ^a	0.23 ^{bc}	0.25 ^{ab}	0.27 ^a	0.25 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.04				0.01				0.02			
T		0.05				0.01				0.03			
M		0.04				0.01				0.02			
N x T		0.08				0.01				0.04			
M x T		0.08				0.01				0.04			
N x M		0.06				0.01				0.03			
N x T x M		0.11				0.02				0.05			
Control Vs Rest		0.02		0.07		0.002		0.05		0.01		0.03	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

followed by $N_2T_2M_2$ which was on par, while lower grain P (0.21) was observed with NE + 6 t ha⁻¹ yield target + no micronutrient and organics ($N_1T_1M_1$); other combinations fared in between.

All N-T-M combinations except combinations involving higher yield target ($N_{1-2}T_3M_{1-2}$), $N_1T_2M_2$ and $N_2T_2M_2$ were comparable with recommended control (0.21) in grain P.

4.2.1.3.1 Grain potassium (%) (c.f. Table 164)

Grain K content revealed significant variation due to main effects due to yield targets and interactions due to nutritional approaches, yield targets and micronutrient + organics application during both the years and on pooled basis.

In main effects nutritional approaches and levels of micronutrients and organics did not differ significantly, higher yield target (T_3) had significantly higher grain K (0.40) and it decreased with decrease in yield targets recording the lowest (0.36) with lower yield target (T_1).

Two factor interactions were also significant. In that, STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher K content (0.41), while NE with 6 t ha⁻¹ (N_1T_1) had lower K content (0.35), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum grain K (0.42) with higher target (8 t ha⁻¹) applied with micronutrients and organics supply (T_3M_1) while lower yield target but without micronutrient/organics (T_1M_1) had lower grain K (0.36), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics supply (N_2M_2) recorded the maximum grain K (0.41), while NE without or with micronutrient + organics supply (N_1M_{1-2}) had lower K content (0.37 and 0.38, respectively).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + with micronutrient and organic supply ($N_2T_3M_2$) registered the maximum grain K (0.44) followed by $N_2T_2M_2$ which was on par, while lower grain K (0.34) was observed with NE + 6 t ha⁻¹ yield target + no micronutrient and organics ($N_1T_1M_1$); other combinations fared in between.

Among N-T-M combinations except $N_1T_1M_1$ all other combinations had numerically higher grain K than recommended control (0.35).

Table 164. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on grain potassium (%) under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	0.37 ^d	0.41 ^{a-d}	0.42 ^{a-d}	0.40 ^b	0.32 ^b	0.35 ^b	0.36 ^{ab}	0.34 ^b	0.34 ^f	0.38 ^{c-e}	0.39 ^{cd}	0.37 ^b
	M ₂	0.38 ^{cd}	0.41 ^{a-d}	0.43 ^{a-c}	0.41 ^b	0.34 ^b	0.36 ^{ab}	0.36 ^a	0.36 ^b	0.36 ^{ef}	0.39 ^{cd}	0.40 ^{bc}	0.38 ^b
N ₂	M ₁	0.39 ^{b-d}	0.41 ^{a-d}	0.41 ^{a-d}	0.40 ^b	0.34 ^b	0.35 ^b	0.35 ^b	0.35 ^b	0.37 ^{de}	0.38 ^{c-e}	0.38 ^{c-e}	0.38 ^b
	M ₂	0.41 ^{a-d}	0.44 ^{ab}	0.46 ^a	0.44 ^a	0.35 ^b	0.40 ^a	0.41 ^a	0.39 ^a	0.38 ^{c-e}	0.42 ^{ab}	0.44 ^a	0.41 ^a
Target		0.39 ^b	0.42 ^a	0.43 ^a		0.34 ^b	0.36 ^{ab} ^b	0.37 ^a		0.36 ^c	0.39 ^b	0.40 ^a	
Control		0.38				0.33				0.35			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		0.38 ^c	0.41 ^{a-c}	0.43 ^{ab}	0.40 ^a	0.33 ^c	0.35 ^{a-c}	0.36 ^{a-c}	0.35 ^a	0.35 ^e	0.38 ^{cd}	0.39 ^{bc}	0.38 ^a
N ₂		0.40 ^{bc}	0.42 ^{ab}	0.44 ^a	0.42 ^a	0.34 ^{bc}	0.37 ^{ab}	0.38 ^a	0.37 ^a	0.37 ^d	0.40 ^{ab}	0.41 ^a	0.39 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		0.38 ^c	0.41 ^{bc}	0.41 ^{bc}	0.40 ^a	0.33 ^c	0.35 ^{bc}	0.36 ^{a-c} _c	0.34 ^a	0.36 ^e	0.38 ^{cd}	0.39 ^{bc}	0.37 ^a
M ₂		0.40 ^{bc}	0.43 ^{ab}	0.45 ^a	0.42 ^a	0.34 ^c	0.38 ^{ab}	0.39 ^a	0.37 ^a	0.37 ^{de}	0.40 ^b	0.42 ^a	0.40 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.03				0.03				0.02			
T		0.04				0.04				0.02			
M		0.03				0.03				0.02			
N x T		0.06				0.06				0.03			
M x T		0.06				0.06				0.03			
N x M		0.05				0.05				0.02			
N x T x M		0.08				0.08				0.04			
Control Vs Rest		0.02				0.03				0.04			

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

4.2.1.3.1 Grain iron (mg kg^{-1}) (c.f. Table 165)

Grain Fe content revealed significant variation due to main effects and interactions due to nutritional approaches, yield targets and micronutrient + organics application during both the years and on pooled basis.

In main effects due to nutritional approaches, STCR had significantly higher grain Fe (N_2 - 37.1) over NE (N_1 - 34.9). Among yield targets, higher yield target (T_3) had significantly higher grain Fe (39.2) and it decreased with decrease in yield targets recording the lowest (32.3) with lower yield target (T_1). Similarly, supply of micronutrients and organics (M_2) registered higher grain Fe (M_2 - 40.1) over no supply (M_1 - 34.2)

Two factor interactions were also significant. In that, STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher Fe content (40.1), while NE with 6 t ha^{-1} (N_1T_1) had lower Fe content (31.0), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum grain Fe (41.8) with higher target (8 t ha^{-1}) applied with micronutrients and organics supply (T_3M_1) while lower yield target but without micronutrient/organics (T_1M_1) had lower grain Fe (31.6), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics supply (N_2M_2) recorded the maximum grain Fe (40.1), while NE without or with micronutrient + organics supply (N_1M_{1-2}) had lower Fe content (34.4 and 34.0, respectively).

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + with micronutrient and organic supply ($N_2T_3M_2$) registered the maximum grain K (0.44) followed by $N_2T_2M_2$ which was on par, while lower grain Fe (0.34) was observed with NE + 6 t ha^{-1} yield target + no micronutrient and organics ($N_1T_1M_1$); other combinations fared in between.

Among N-T-M, all combinations involving medium and higher yield targets ($N_{1,2}T_2M_{1-2}$) and $N_2T_1M_2$ were superior to recommended control (31.2).

4.2.1.3.1 Grain zinc (mg kg^{-1}) (c.f. Table 166)

Data on grain Zn content revealed significant variations due to main effects of yield targets and interactions due to nutritional approaches, yield targets and micronutrient + organics application during both the years and on pooled basis.

Table 165. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on grain iron (mg kg⁻¹) under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	32.2 ^h	36.6 ^{e-g}	42.2 ^{cd}	37.0 ^{bc}	28.6 ^f	33.3 ^{b-d}	33.6 ^{bc}	31.8 ^c	30.4 ^h	35.0 ^e	37.9 ^{cd}	34.4 ^{bc}
	M ₂	32.7 ^{gh}	38.4 ^{dc}	43.7 ^c	38.3 ^b	30.3 ^e	33.5 ^{bc}	33.8 ^{bc}	32.5 ^b	31.5 ^{gh}	36.0 ^{dc}	38.8 ^c	35.4 ^b
N ₂	M ₁	33.2 ^{f-h}	35.1 ^{e-g}	37.2 ^{ef}	35.2 ^c	32.4 ^d	32.9 ^{cd}	33.3 ^{b-d}	32.9 ^b	32.8 ^{fg}	34.0 ^{ef}	35.3 ^e	34.0 ^c
	M ₂	35.4 ^{e-h}	48.b	54.7 ^a	46.1 ^a	33.1 ^{cd}	34.3 ^{ab}	35.0 ^a	34.2 ^a	34.3 ^{ef}	41.2 ^b	44.9 ^a	40.1 ^a
Target		33.4 ^c	39.6 ^b	44.5 ^a		31.1 ^b	33.5 ^a	33.9 ^a		32.3 ^c	36.5 ^b	39.2 ^a	
Control		32.5				29.9				31.2			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		32.4 ^d	37.5 ^c	42.9 ^b	37.6 ^a	29.5 ^d	33.4 ^{bc}	33.7 ^{ab}	32.2 ^a	31.0 ^e	35.5 ^c	38.3 ^b	34.9 ^b
N ₂		34.3 ^d	41.6 ^b	46.0 ^a	40.6 ^a	32.8 ^c	33.6 ^{ab}	34.2 ^a	33.5 ^a	33.6 ^d	37.6 ^b	40.1 ^a	37.1 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		32.7 ^e	35.8 ^d	39.7 ^c	36.1 ^a	30.5 ^e	33.1 ^c	33.5 ^{bc}	32.4 ^a	31.6 ^e	34.5 ^d	36.6 ^c	34.2 ^a
M ₂		34.0 ^{de}	43.3 ^b	49.2 ^a	42.2 ^a	31.7 ^d	33.9 ^{ab}	34.4 ^a	33.3 ^a	32.9 ^e	38.6 ^b	41.8 ^a	37.8 ^{a,b}
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		2.6				0.6				1.3			
T		3.1				0.8				1.6			
M		2.6				0.6				1.3			
N x T		4.4				1.1				2.2			
M x T		4.4				1.1				2.2			
N x M		3.6				0.9				1.8			
N x T x M		6.3				1.6				3.1			
Control Vs Rest		1.2		3.73		0.77		2.24		0.64		1.87	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 166. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on grain zinc (mg kg⁻¹) under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	15.3 ^e	16.3 ^{bc}	16.5 ^b	16.0 ^c	10.6 ^e	14.2 ^{ab}	14.5 ^{ab}	13.1 ^b	13.0 ⁱ	15.2 ^{de}	15.5 ^c	14.6 ^b
	M ₂	15.6 ^{de}	16.4 ^b	17.3 ^a	16.4 ^b	11.9 ^d	14.4 ^{ab}	14.7 ^{ab}	13.7 ^b	13.8 ^h	15.4 ^{cd}	16.0 ^b	15.1 ^d
N ₂	M ₁	15.8 ^{c-e}	15.8 ^{c-e}	16.3 ^{bc}	16.0 ^c	12.8 ^{cd}	13.7 ^{bc}	14.2 ^{ab}	13.6 ^b	14.3 ^g	14.8 ^f	15.3 ^{cd}	14.8 ^c
	M ₂	16.0 ^{b-d}	17.3 ^v	17.4 ^a	16.9 ^a	14.1 ^{bc}	14.9 ^{ab}	15.6 ^a	14.9 ^a	15.0 ^{ef}	16.1 ^b	16.5 ^a	15.9 ^a
Target		15.7 ^c	16.5 ^b	16.9 ^a		12.4 ^b	14.3 ^a	14. ^a		14.0 ^c	15.4 ^b	15.8 ^a	
Control		15.3				11.3				13.3			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		15.5 ^d	16.3 ^b	16.9 ^a	16.2 ^a	11.3 ^c	14.3 ^{ab}	14.6 ^a	13.4 ^a	13.4 ^e	15.3 ^c	15.7 ^b	14.8 ^a
N ₂		15.9 ^c	16.6 ^{ab}	16.8 ^a	16.4 ^a	13.5 ^b	14.3 ^{ab}	14.9 ^a	14.2 ^a	14.7 ^d	15.4 ^c	15.9 ^a	15.3 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		15.6 ^e	16.1 ^{cd}	16.4 ^c	16.0 ^a	11.7 ^d	13.9 ^b	14.4 ^{ab}	13.3 ^a	13.7 ^f	15.0 ^c	15.4 ^b	14.7 ^a
M ₂		15.8 ^{de}	16.8 ^b	17.3 ^a	16.7 ^a	13.0 ^c	14.7 ^{ab}	15.1 ^a	14.3 ^a	14.4 ^e	15.7 ^b	16.2 ^a	15.5 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.3				0.8				0.1			
T		0.4				1.0				0.2			
M		0.3				0.8				0.1			
N x T		0.6				1.4				0.3			
M x T		0.6				1.4				0.3			
N x M		0.5				1.1				0.2			
N x T x M		0.8				2.0				0.4			
Control Vs Rest		0.1		0.3		0.4		1.1		0.2		0.5	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

In main effects among yield targets, higher yield target (T_3) had significantly higher grain Zn (15.8) and it decreased with decrease in yield targets recording the lowest (14.0) with lower yield target (T_1). Similarly, STCR approach (N_2) and supply of micronutrients and organics (M_2) registered numerically higher grain Zn.

Two factor interactions were also significant. In that, STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher Zn content (15.9), while NE with 6 t ha⁻¹ (N_1T_1) had lower Zn content (13.4), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum grain Zn (16.2) with higher target (8 t ha⁻¹) applied with micronutrients and organics supply (T_3M_1) while lower yield target but without micronutrient/organics (T_1M_1) had lower grain Fe (13.7), and among nutritional approaches and micronutrient + organics supply across yield targets, STCR approach and micronutrients + organics supply (N_2M_2) recorded the maximum grain Zn (15.9), while NE without micronutrient + organics supply (N_1M_1) had the lowest Zn content (14.6).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + with micronutrient and organic supply ($N_2T_3M_2$) registered the maximum grain Zn (16.5) followed by $N_2T_2M_2$ which was on par, while lower grain Zn (13.0) was observed with NE + 6 t ha⁻¹ yield target + no micronutrient and organics ($N_1T_1M_1$); other combinations fared in between.

Among N-T-M, all combinations involving medium and higher yield targets ($N_{1,2}T_2M_{1,2}$) and $N_2T_1M_2$ were superior to recommended control (13.3).

4.2.1.3.1 Grain copper (mg kg⁻¹) (c.f. Table 167)

Data on grain Cu content revealed significant variations due to main effects of yield targets and interactions due to nutritional approaches, yield targets and micronutrient + organics application during both the years and on pooled basis.

In main effects among yield targets, higher yield target (T_3) had significantly higher grain Cu (2.11) and it decreased with decrease in yield targets recording the lowest (1.39) with lower yield target (T_1). Similarly, STCR approach (N_2) and supply of micronutrients and organics (M_2) registered numerically higher grain Cu.

Two factor interactions were also significant. In that, NE approach coupled with higher yield target across micronutrients (N_1T_3) recorded higher Cu content (2.12), while

Table 167. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on grain copper (mg kg⁻¹) under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	1.30 ^f	2.10 ^d	2.40 ^c	1.93 ^c	1.01 ⁱ	1.31 _{de}	1.48 ^c	1.26 ^c	1.15 ^k	1.70 ^f	1.94 ^d	1.60 ^c
	M ₂	1.61 ^e	2.10 ^d	2.93 ^b	2.21 ^b	1.10 ^h	1.44 ^c	1.67 ^b	1.40 ^b	1.35 ^j	1.77 ^e	2.30 ^c	1.81 ^b
N ₂	M ₁	1.61 ^e	2.03 ^d	2.10 ^d	1.91 ^d	1.15 ^g	1.21 ^f	1.34 ^d	1.23 ^d	1.38 ⁱ	1.62 ^h	1.72 ^f	1.57 ^d
	M ₂	2.03 ^d	3.17 ^a	3.22 ^a	2.81 ^a	1.28 ^e	1.70 ^b	1.75 ^a	1.57 ^a	1.66 ^g	2.43 ^b	2.48 ^a	2.19 ^a
Target		1.64 ^c	2.35 ^b	2.66 ^a		1.13 ^c	1.41 ^b	1.56 ^a		1.39 ^c	1.88 ^b	2.11 ^a	
Control		1.41				1.05				1.23			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		1.45 ^d	2.10 ^b	2.67 ^a	2.07 ^a	1.05 ^e	1.37 ^c	1.57 ^a	1.33 ^a	1.25 ^f	1.73 ^d	2.12 ^a	1.70 ^a
N ₂		1.82 ^c	2.60 ^a	2.66 ^a	2.36 ^a	1.21 ^d	1.45 ^b	1.54 ^a	1.40 ^a	1.52 ^e	2.03 ^c	2.10 ^b	1.88 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		1.45 ^f	2.06 ^d	2.25 ^c	1.92 ^b	1.08 ^f	1.26 ^d	1.41 ^c	1.25 ^b	1.27 ^f	1.66 ^d	1.83 ^c	1.59 ^a
M ₂		1.82 ^e	2.64 ^b	3.08 ^a	2.51 ^a	1.19 ^e	1.57 ^b	1.71 ^a	1.49 ^a	1.51 ^e	2.10 ^b	2.39 ^a	2.00 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.06				0.03				0.02			
T		0.08				0.04				0.02			
M		0.06				0.03				0.02			
N x T		0.11				0.06				0.03			
M x T		0.11				0.06				0.03			
N x M		0.09				0.05				0.02			
N x T x M		0.16				0.08				0.02			
Control Vs Rest		0.05		0.14		0.02		0.05		0.16		0.47	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

NE with 6 t ha⁻¹ (N₁T₁) had lower Cu content (1.25), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum grain Cu (2.39) with higher target (8 t ha⁻¹) applied with micronutrients and organics (T₃M₂) while lower yield target but without micronutrient/organics (T₁M₁) had lower grain Cu (1.27), and among nutritional approaches and micronutrient + organics supply across yield targets, STCR approach and micronutrients + organics supply (N₂M₂) recorded the maximum grain Cu (2.19), while NE without micronutrient + organics supply (N₁M₁) had the lowest Cu content (1.27).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient and organic supply (N₂T₃M₂) registered the maximum grain Cu (2.48) followed by N₂T₂M₂ (2.43) which was next best, while lower grain Cu (1.15) was observed with NE + 6 t ha⁻¹ yield target + no micronutrient and organics (N₁T₁M₁); other combinations fared in between.

Among N-T-M, all combinations involving medium and higher yield targets (N_{1,2}T₂M_{1,2}) were superior to recommended control (1.23) with regard to grain Cu.

4.2.1.3.1 Grain manganese (mg kg⁻¹) (c.f. Table 168)

Grain Mn content revealed significant variations due to main effects of yield targets and interactions due to nutritional approaches, yield targets and micronutrient + organics application during both the years and on pooled basis.

In main effects among yield targets, higher yield target (T₃) had significantly higher grain Mn (33.54) and it decreased with decrease in yield targets recording the lowest (30.73) with lower yield target (T₁). Similarly, STCR approach (N₂) and supply of micronutrients and organics (M₂) registered numerically higher grain Mn.

Two factor interactions were also significant. In that, NE approach coupled with higher yield target across micronutrients (N₁T₃) recorded higher Mn content (33.73) and NE with higher yield target and both approaches with medium target were at par, while NE with 6 t ha⁻¹ (N₁T₁) had lower Mn content (1.25), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum grain Mn (33.81) with higher target (8 t ha⁻¹) applied with micronutrients and organics supply (T₃M₁) while lower yield target but without micronutrient/organics (T₁M₁) had lower grain Mn (30.00), and among nutritional approaches and micronutrient + organics supply

Table 168. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on grain manganese (mg kg⁻¹) under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	28.62 ^f	33.29 ^{b-d}	33.60 ^{bc}	31.84 ^c	28.62 ^e	33.49 ^{a-c}	32.86 ^{bc}	31.66 ^c	28.62 ^g	33.39 ^{cd}	33.23 ^{cd}	31.75 ^c
	M ₂	30.34 ^e	33.49 ^{b-d}	33.79 ^{bc}	32.54 ^b	29.91 ^d	33.60 ^{ab}	33.15 ^{bc}	32.22 ^{bc}	30.13 ^f	33.54 ^{bc}	33.47 ^{b-d}	32.38 ^b
N ₂	M ₁	32.43 ^d	32.86 ^{cd}	33.32 ^{b-d}	32.87 ^b	30.34 ^d	33.79 ^{ab}	33.29 ^{a-c}	32.47 ^b	31.39 ^e	33.32 ^{cd}	33.31 ^{cd}	32.67 ^b
	M ₂	33.15 ^{cd}	34.32 ^{ab}	34.99 ^a	34.15 ^a	32.43 ^c	34.32 ^a	33.32 ^{a-c}	33.36 ^a	32.79 ^d	34.32 ^a	34.15 ^{ad}	33.75 ^a
Target		31.14 ^b	33.49 ^a	33.92 ^a		30.33 ^c	33.80 ^a	33.16 ^b		30.73 ^b	33.64 ^a	33.54 ^a	
Control		29.91				34.99				32.45			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		29.48 ^d	33.39 ^{bc}	33.69 ^{ab}	32.19 ^a	29.27 ^d	33.54 ^{ab}	33.01 ^b	31.94 ^a	29.38 ^c	33.47 ^a	33.35 ^a	32.06 ^a
N ₂		32.79 ^c	33.59 ^{ab}	34.15 ^a	33.51 ^a	31.39 ^c	34.05 ^a	33.31 ^b	32.91 ^a	32.09 ^b	33.82 ^a	33.73 ^a	33.21 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		30.53 ^e	33.08 ^c	33.46 ^{bc}	32.35 ^a	29.48 ^d	33.64 ^{ab}	33.08 ^b	32.07 ^a	30.00 ^e	33.36 ^{bc}	33.27 ^c	32.21 ^a
M ₂		31.74 ^d	33.90 ^{ab}	34.39 ^a	33.34 ^a	31.17 ^c	33.96 ^a	33.24 ^{ab}	32.79 ^a	31.46 ^d	33.93 ^a	33.81 ^{ab}	33.07 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.64				0.64				0.43			
T		0.78				0.78				0.52			
M		0.64				0.64				0.43			
N x T		1.11				1.11				0.74			
M x T		1.11				1.11				0.74			
N x M		0.90				0.90				0.60			
N x T x M		1.56				1.57				1.04			
Control Vs Rest		0.32		0.94		0.47		1.39		0.68		1.99	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

across yield targets STCR approach and micronutrients + organics supply (N_2M_2) recorded the maximum grain Mn (33.75), while NE without micronutrient + organics supply (N_1M_1) had the lowest Mn content (31.75).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + with micronutrient and organic supply ($N_2T_3M_2$) registered the maximum grain Mn (34.15) followed by $N_2T_2M_2$ (34.22) which was next best, while lower grain Mn (28.68) was observed with NE + 6 t ha⁻¹ yield target + no micronutrient and organics ($N_1T_1M_1$); other combinations fared in between.

Recommended control (32.45) was comparable to all N-T-M combinations except $N_1T_1M_{1-2}$ and $N_2T_1M_1$.

4.2.1.4 Grain protein (%) (c.f. Table 169 and Fig. 26b)

Data on grain crude protein content followed trends in grain N content and revealed significant variations due to main effects of yield targets and interactions due to nutritional approaches, yield targets and micronutrient + organics application during both the years and on pooled basis.

In the main effects nutritional approaches did not differ significantly, higher yield target (T_3) had significantly higher grain protein (7.25) and it decreased with decrease in yield targets recording the lowest (6.57). Among the nutritional approaches and micronutrient/organics, numerically higher crude protein was observed with STCR approach (N_2 – 7.00) and supply of micronutrients and organics (M_2 – 7.02).

Two factor interactions were also significant. In that, STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher grain protein content (7.29); NE with similar target was on par (7.22), while NE with 6 t ha⁻¹ (N_1T_1) had lower protein content (6.41), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum grain protein (7.36) with higher target (8 t ha⁻¹) applied with micronutrients and organics (T_3M_2) while lower yield target but without micronutrient/organics (T_1M_1) had lower grain protein (6.45), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics supply (N_2M_2) recorded the maximum grain protein (7.19), while NE/STCR without micronutrient + organics supply ($N_{1-2}M_1$) had the lower grain protein contents (6.81 each).

Table 169. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on grain protein content (%) under direct seeded condition during rainy season

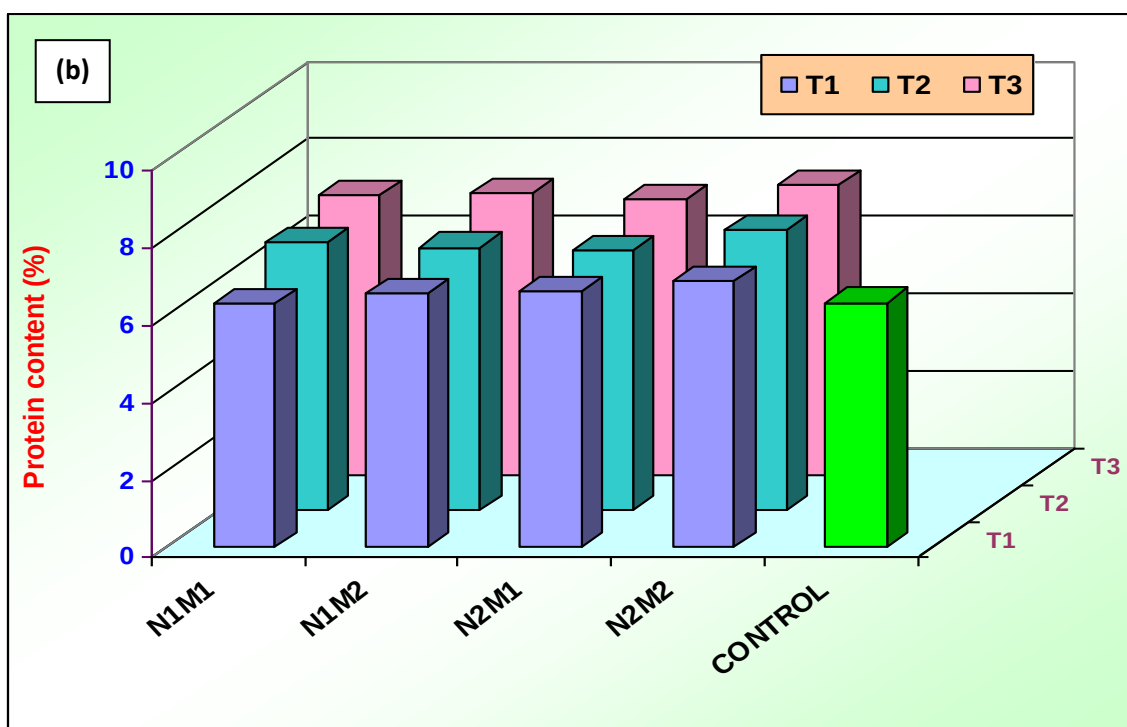
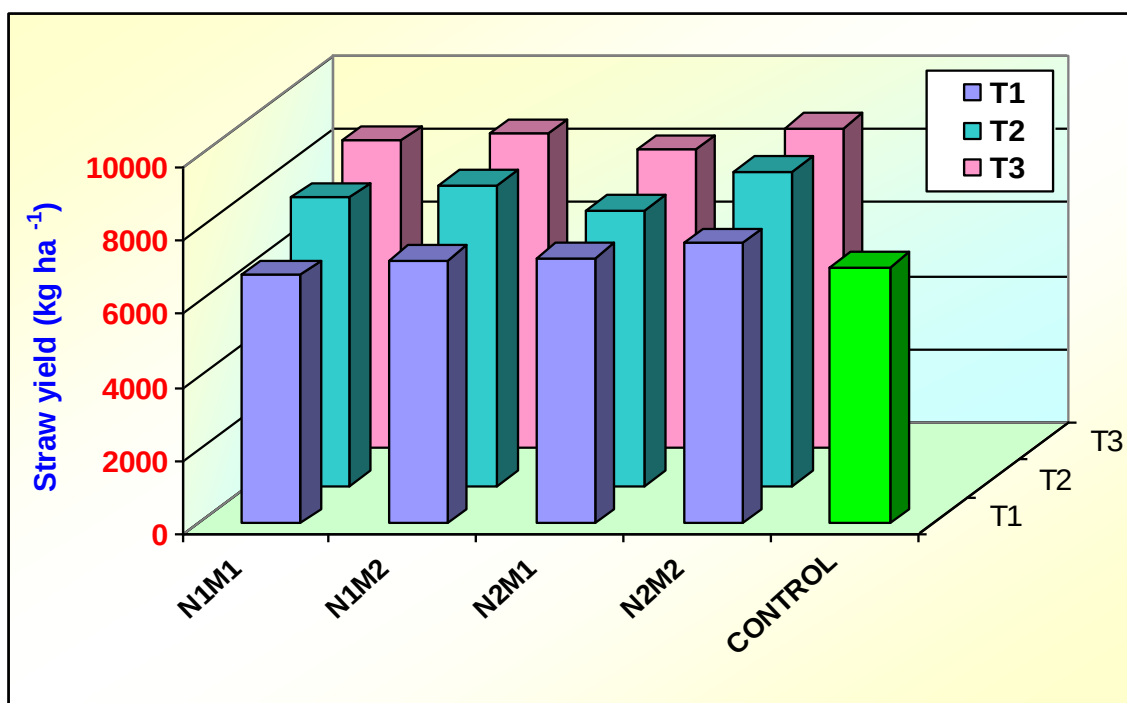
N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	6.67 ^e	6.8 ^{b-e}	7.04 ^{bc}	6.85 ^b	5.91 ^e	7.03 ^{a-d}	7.36 ^{ab}	6.77 ^b	6.29 ^f	6.93 ^{b-e}	7.20 ^{a-c}	6.81 ^b
	M ₂	6.70 ^{de}	7.02 ^{b-d}	7.08 ^b	6.93 ^b	6.35 ^{de}	6.56 ^{c-e}	7.39 ^{ab}	6.76 ^b	6.52 ^{ef}	6.79 ^{c-e}	7.23 ^{ab}	6.85 ^b
N ₂	M ₁	6.74 ^{c-e}	6.78 ^{b-e}	6.94 ^{b-e}	6.82 ^b	6.48 ^{c-e}	6.67 ^{b-e}	7.23 ^{a-c}	6.80 ^b	6.61 ^{ef}	6.73 ^{de}	7.09 ^{a-d}	6.81 ^b
	M ₂	6.83 ^{b-e}	7.09 ^b	7.50 ^a	7.14 ^a	6.85 ^{a-d}	7.41 ^{ab}	7.47 ^a	7.25 ^a	6.84 ^{b-e}	7.25 ^{ab}	7.49 ^a	7.19 ^a
Target		6.73 ^b	6.93 ^a	7.14 ^a		6.40 ^c	6.92 ^b	7.36 ^a		6.57 ^c	6.93 ^b	7.25 ^a	
Control		6.70				5.92				6.31			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		6.68 ^d	6.93 ^{bc}	7.06 ^{ab}	6.89 ^a	6.13 ^c	6.79 ^b	7.37 ^a	6.77 ^a	6.41 ^d	6.86 ^e	7.22 ^{ab}	6.83 ^a
N ₂		6.79 ^{cd}	6.93 ^{bc}	7.22 ^a	6.98 ^a	6.67 ^b	7.04 ^{ab}	7.35 ^a	7.02 ^a	6.73 ^c	6.99 ^{bc}	7.29 ^a	7.00 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		6.70 ^d	6.81 ^{cd}	6.99 ^{bc}	6.83 ^a	6.20 ^d	6.85 ^{bc}	7.30 ^{ab}	6.78 ^a	6.45 ^{ab}	6.83 ^c	7.14 ^{ab}	6.81 ^a
M ₂		6.77 ^d	7.06 ^b	7.29 ^a	7.04 ^a	6.60 ^{cd}	6.98 ^{a-c}	7.43 ^a	7.00 ^a	6.68 ^a	7.02 ^{bc}	7.36 ^a	7.02 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.19				0.45				0.25			
T		0.23				0.55				0.31			
M		0.19				0.45				0.25			
N x T		0.33				0.78				0.43			
M x T		0.33				0.78				0.43			
N x M		0.27				0.64				0.35			
N x T x M		0.47				1.10				0.61			
Control Vs Rest		0.09		0.27		0.23		0.65		0.13		0.36	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT



LEGEND

Nutritional approaches (N): N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T): T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M): M₁ - Without FeSO₄+ZnSO₄ + Organics, M₂ - With FeSO₄+ZnSO₄ + Organics

Fig. 26. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on (a) straw yield (kg ha⁻¹) and (b) grain protein content (%) under direct seeded condition during rainy season

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + with micronutrient and organic supply (N₂T₃M₂) registered the maximum grain protein (7.49), while lower grain protein (6.29) was observed with NE + 6 t ha⁻¹ yield target + no micronutrient and organics (N₁T₁M₁); other combinations fared in between.

All N-T-M combinations involving medium and high yield targets (N₁₋₂T₁₋₂M₁₋₂) and N₂T₁M₂ were superior to recommended control (6.31).

4.2.1.3 Nutrient uptake

4.2.1.3.1 Nitrogen uptake (kg ha⁻¹) (c.f. Table 170 and Fig. 27a)

Data pertaining N uptake revealed significant variations due to nutritional approaches, yield targets and micronutrient + organics application and their interactions during both the years and on pooled basis.

Main effects due to all the factors viz., nutritional approaches, yield targets and micronutrient + organics supply were significant. STCR (N₁ - 131.3), higher yield target (T₃ - 143.7) and micronutrients + organics supply (M₂ - 135.95) recorded higher N uptake over other levels.

Two factor interactions were also significant. In that, STCR approach coupled with higher yield target across micronutrients (N₂T₃) recorded higher N uptake (144.19), while NE with 6 t ha⁻¹ (N₁T₁) had lower uptake of N (100.3), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum uptake (150.95) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂) while lower yield target and no micronutrient/organics (T₁M₁) had lower N uptake (102.8), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics (N₂M₂) recorded the maximum uptake (141.8), while NE and no micronutrient + organics supply (N₁M₁) had the lowest N uptake (102.8).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered the maximum uptake of N (156.5), while lower uptake (93.71) occurred with NE + 6 t ha⁻¹ yield target + no-micronutrient (N₁T₁M₁); other combinations fared in between.

All N-T-M combinations except N₁T₁M₁ were significantly superior to the recommended control (98.2) with regard to N uptake.

Table 170. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on nitrogen uptake (kg ha⁻¹) under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	106.9 ^g	137.0 ^d	149.7 ^c	131.2 ^c	80.5 ^j	117.9 ^e	131.9 ^c	110.1 ^d	93.71 ^k	127.4 ^f	140.8 ^c	120.6 ^c
	M ₂	116.6 ^f	145.8 ^c	154.8 ^b	139.1 ^b	97.3 ⁱ	129.8 ^c	135.8 ^b	121.0 ^b	106.9 ^j	137.8 ^d	145.3 ^b	130.0 ^b
N ₂	M ₁	119.2 ^f	126.4 ^e	140.3 ^d	128.6 ^d	104.8 ^b	109.9 ^g	123.3 ^d	112.7 ^c	111.9 ⁱ	118.1 ^h	131.8 ^e	120.6 ^c
	M ₂	129.6 ^e	156.6 ^b	166.4 ^a	150.9 ^a	113.7 ^f	138.2 ^b	146.8 ^a	132.9 ^a	121.6 ^g	147.4 ^b	156.5 ^a	141.8 ^a
Target		126.6 ^c	141.5 ^b	152.8 ^a		99.0 ^c	123.9 ^b	134.5 ^a		108.6 ^c	132.7 ^b	143.7 ^a	
Control		115.9				81.2				98.2			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		111.8 ^d	141.4 ^b	152.2 ^a	135.1 ^a	88.9 ^d	123.8 ^b	133.8 ^a	115.5 ^a	100.3 ^d	132.6 ^b	143. ^a	125.3 ^b
N ₂		124.4 ^c	141.5 ^b	153.3 ^a	139.7 ^a	109.2 ^c	124.0 ^b	135.0 ^a	122.8 ^a	116.8 ^c	132.7 ^b	144. ^a	131. ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		113.1 ^f	131.7 ^d	145.0 ^c	129.9 ^b	92.6 ^f	113.9 ^d	127.6 ^c	111.4 ^a	102.8 ^f	122.8 ^d	136.3 ^c	120.6 ^b
M ₂		123.1 ^e	151.2 ^b	160.6 ^a	145.0 ^a	105.5 ^e	133.9 ^b	141.3 ^a	126.9 ^a	114.3 ^e	142.6 ^b	150.9 ^a	135.9 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		2.9				2.3				2.0			
T		3.6				2.8				2.4			
M		2.9				2.3				2.0			
N x T		5.0				3.9				3.4			
M x T		5.0				3.9				3.4			
N x M		4.1				3.2				2.8			
N x T x M		7.1				5.5				4.8			
Control Vs Rest		2.0		6.0		1.2		3.6		1.3		3.9	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

4.2.1.3.2 Phosphorus uptake (kg ha^{-1}) (c.f. Table 171 and Fig. 27b)

P uptake varied significantly due to nutritional approaches, yield targets and micronutrient + organics application and their interactions during both the years and on pooled basis.

Similar to N uptake, main effects due to all the factors viz., nutritional approaches, yield targets and micronutrient + organics supply were significant. STCR based nutrient supply (N_1 – 23.6), higher yield target (T_3 – 25.9) and micronutrients + organics supply (M_2 – 24.6) registered higher P uptake over other levels.

Two factor interactions were also significant. In that, STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher P uptake (20.0), while NE with 6 t ha^{-1} (N_1T_1) had lower uptake of N (17.3), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum uptake (28.2) with higher target (8 t ha^{-1}) coupled with micronutrients and organics (T_3M_2) while lower yield target and no micronutrient/organics (T_1M_1) had lower P uptake (17.6), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics (N_2M_2) recorded the maximum uptake (26.6), while NE and no micronutrient + organics supply (N_1M_1) had the lowest P uptake (20.8).

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + micronutrient supply ($N_2T_3M_2$) registered the maximum uptake of P (30.5), while lower uptake (16.2) occurred with NE + 6 t ha^{-1} yield target + no-micronutrient ($N_1T_1M_1$); other combinations fared in between.

All N-T-M combinations except $N_1T_1M_1$ were significantly superior to the recommended control (16.2) with regard to P uptake.

4.2.1.3.3 Potassium uptake (kg ha^{-1}) (c.f. Table 172 and Fig. 28a)

Trends in K uptake were similar to N and P while the values were at same level as that of N. Variations in uptake were also significant due to nutritional approaches, yield targets and micronutrient + organics application and their interactions during both the years and on pooled basis.

Table 171. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on phosphorus uptake (kg ha⁻¹) under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	15.9 ⁱ	22.6 ^e	24.3 ^c	20.9 ^c	16.4 ^j	21.2 ^g	24.5 ^d	20.7 ^c	16.2 ^j	21.9 ^f	24.4 ^d	20.8 ^c
	M ₂	18.1 ^h	23.5 ^d	25.5 ^b	22.3 ^b	18.8 ⁱ	23.0 ^e	26.3 ^c	22.7 ^b	18.5 ⁱ	23.2 ^e	25.9 ^c	22.5 ^b
N ₂	M ₁	18.7 ^h	20.1 ^g	23.1 ^{de}	20.6 ^c	19.3 ⁱ	20.4 ^h	22.2 ^f	20.7 ^c	19.0 ⁱ	20.3 ^h	22.7 ^e	20.7 ^c
	M ₂	21.5 ^f	26.1 ^{ab}	26.8 ^a	24.7 ^a	20.7 ^{gh}	30.7 ^b	34.1 ^a	28.5 ^a	21.0 ^g	28.4 ^b	30.5 ^a	26.6 ^a
Target		18.5 ^c	23.0 ^b	24.9 ^a		18.8 ^c	23.9 ^b	26.8 ^a		18.7 ^c	23.5 ^b	25.9 ^a	
Control		17.8				16.7				17.3			
Approach-N-(NE/STCR) x Target (T)					N	N x T		N		N x T		N	
N ₁		17.0 ^d	23.0 ^b	24.9 ^a	21.6 ^a	17.6 ^e	22.1 ^c	25.4 ^b	21.7 ^b	17.3 ^d	22.6 ^b	17.3 ^d	21.7 ^b
N ₂		20.0 ^c	23.1 ^b	25.1 ^a	22.7 ^a	20.0 ^d	25.6 ^b	28.2 ^a	24.6 ^a	20.0 ^c	24.3 ^a	20.0 ^c	23.6 ^a
Micronutrient/organics (M) x Target (T)					M	M x T		M		M x T		M	
M ₁		17.3 ^f	21.3 ^d	23.7 ^c	20.7 ^b	17.9 ^f	20.8 ^d	23.3 ^c	20.7 ^b	17.6 ^f	21.1 ^d	23.5 ^c	20.7 ^b
M ₂		19.7 ^e	24.7 ^b	26.2 ^a	23.5 ^a	19.8 ^e	26.9 ^b	30.2 ^a	25.6 ^a	19.8 ^e	25.8 ^b	28.2 ^a	24.6 ^a
Comparison	S.Em±	LSD 0.05				S.Em±	LSD 0.05			S.Em±	LSD 0.05		
N	0.5					0.5				0.3			
T	0.6					0.6				0.4			
M	0.5					0.5				0.3			
N x T	0.8					0.8				0.6			
M x T	0.8					0.8				0.6			
N x M	0.7					0.7				0.5			
N x T x M	1.1					1.1				0.8			
Control Vs Rest	0.3	1.0				0.3	0.8			0.2	0.7		

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 172. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on potassium uptake (kg ha⁻¹) under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	88.6 ^h	125.2 ^d	135.7 ^c	116.5 ^c	94.5 ^j	131.0 ^f	152.9 ^c	126.2 ^c	91.6 ^k	128.1 ^f	144.3 ^c	121.3 ^c
	M ₂	101.7 ^g	129.6 ^d	142.0 ^b	124.4 ^b	105.4 ⁱ	147.4 ^d	171.0 ^b	141.3 ^b	103.6 ^j	138.5 ^d	156.5 ^b	132.9 ^b
N ₂	M ₁	103.2 ^g	108.7 ^f	129.0 ^d	113.7 ^d	117.8 ^h	124.1 ^g	136.8 ^e	126.2 ^c	110.5 ⁱ	116.4 ^h	132.9 ^e	120.0 ^c
	M ₂	115.9 ^e	145.1 ^b	155.7 ^a	138.9 ^a	128.2 ^{fg}	174.7 ^b	190.6 ^a	164.5 ^a	122.1 ^g	159.9 ^b	173.2 ^a	151.7 ^a
Target		102.3 ^c	127.1 ^b	140.6 ^a		111.5 ^c	144.3 ^b	162.9 ^a		106.9 ^c	135.7 ^b	151.7 ^a	
Control		94.9				99.6				97.2			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		95.1 ^e	127.4 ^c	138.9 ^b	120.4 ^a	100.0 ^e	139.2 ^c	162.0 ^a	133.7 ^b	97.6 ^e	133.3 ^c	150.4 ^a	127.1 ^b
N ₂		109.6 ^d	126.9 ^c	142.4 ^a	126.3 ^a	123.0 ^d	149.4 ^b	163.7 ^a	145.3 ^a	116.3 ^d	138.2 ^b	153.1 ^a	135.8 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		95.9 ^f	116.9 ^d	132.4 ^c	115.1 ^b	106.20 ^f	127.6 ^d	144.8 ^c	126.2 ^b	101.0 ^f	122.3 ^d	138.6 ^c	120.6 ^b
M ₂		108.8 ^e	137.3 ^b	148.9 ^a	131.7 ^a	116.84 ^e	161.0 ^b	180.8 ^a	152.9 ^a	112.8 ^e	149.2 ^b	164.9 ^a	142.3 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		3.0				3.4				2.6			
T		3.6				4.1				3.1			
M		3.0				3.4				2.6			
N x T		5.1				5.8				4.4			
M x T		5.1				5.8				4.4			
N x M		4.2				4.7				3.6			
N x T x M		7.2				8.2				6.3			
Control Vs Rest		1.9		5.6		1.8		5.3		1.6		4.6	

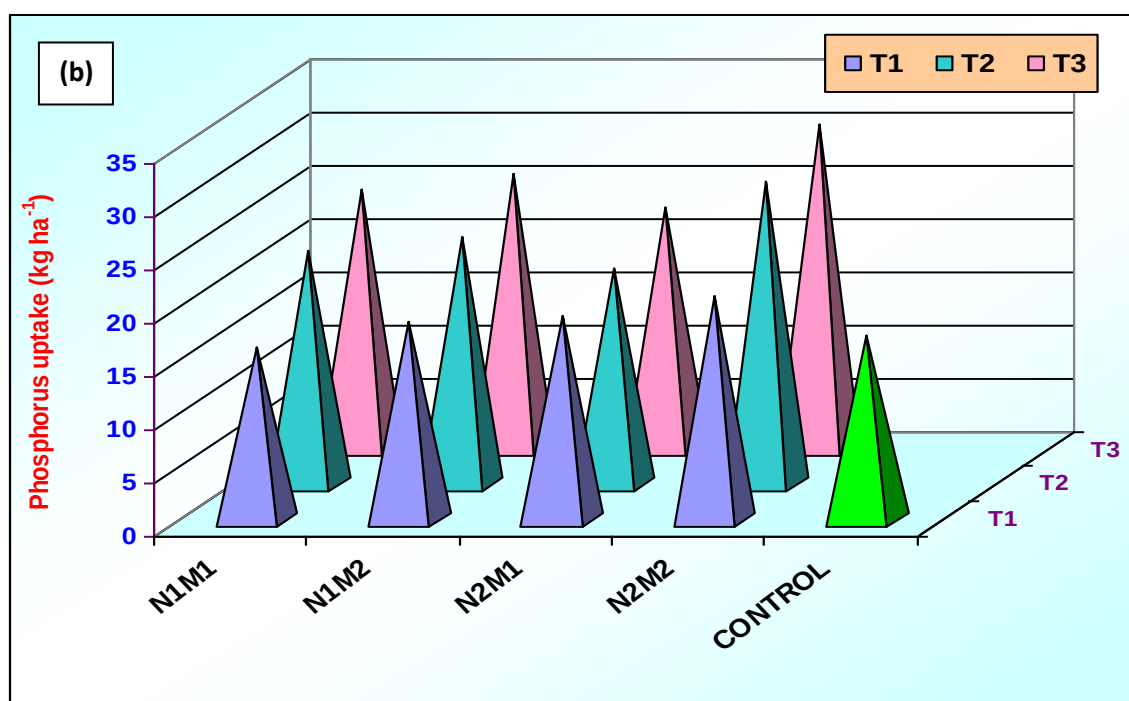
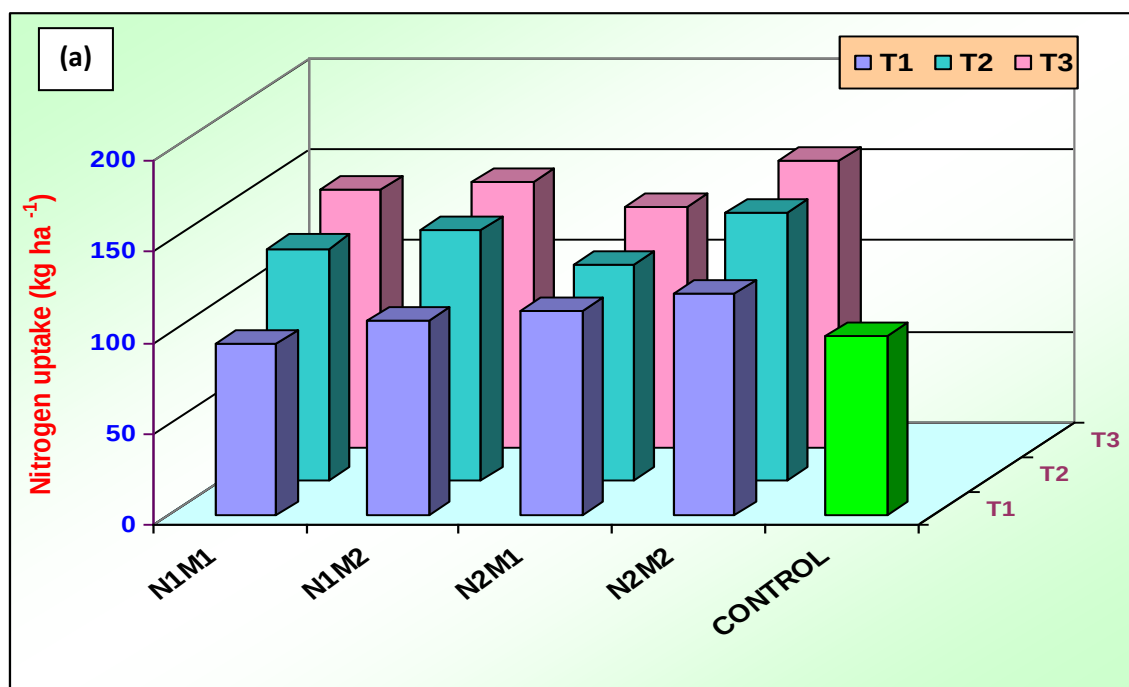
Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT



LEGEND

Nutritional approaches (N): N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
 Yield Targets (T): T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
 Micronutrient & Organics (M): M₁ - Without FeSO₄+ZnSO₄ + Organics, M₂ - With FeSO₄+ZnSO₄ + Organics

Fig. 27. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on (a) nitrogen uptake (kg ha^{-1}) and (b) phosphorus uptake (kg ha^{-1}) under direct seeded condition during rainy season

All the main effects were significant wherein STCR (N_1 - 135 .8) over NE, 8 t ha⁻¹ (T_3 – 151.7) over other levels (7 and 6 t ha⁻¹) and supply of micronutrient + organics (M_2 – 142.3) over no application were superior in K uptake.

Two factor interactions were also significant. In that, STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher K uptake (153.1), while NE with 6 t ha⁻¹ (N_1T_1) had lower uptake of N (97.6), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum uptake (164.9) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T_3M_2) while lower yield target and no micronutrient/organics (T_1M_1) had lower K uptake (101.0), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics (N_2M_2) recorded the maximum uptake (151.7), while NE and no micronutrient + organics supply (N_1M_1) had the lowest K uptake (121.3).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply ($N_2T_3M_2$) registered the maximum uptake of K (173.2), while lower uptake (91.6) occurred with NE + 6 t ha⁻¹ yield target + no-micronutrient ($N_1T_1M_1$); other combinations fared in between.

All N-T-M combinations except $N_1T_1M_1$ were significantly superior to the recommended control (97.2) with regard to K uptake.

4.2.1.3.4 Iron uptake (g ha⁻¹) (c.f. Table 173 and Fig. 28b)

Trends in Fe uptake were similar to major nutrients and the variations in uptake were also significant due to nutritional approaches, yield targets and micronutrient + organics application and their interactions during both the years and on pooled basis.

All the main effects except nutritional approaches were significant. Among yield targets, higher target of 8 t ha⁻¹ (T_3) registered higher Fe uptake (1825.0) and the uptake decreased with decreasing yield targets wherein lower yield target of 6 t ha⁻¹ (T_1) recorded lower Fe uptake (1353.2). In micronutrients + organics levels, the treatments receiving both the components (M_2) registered higher Fe uptake (1724.2) while in the absence of them (M_1) the uptake was the lowest (1506.0).

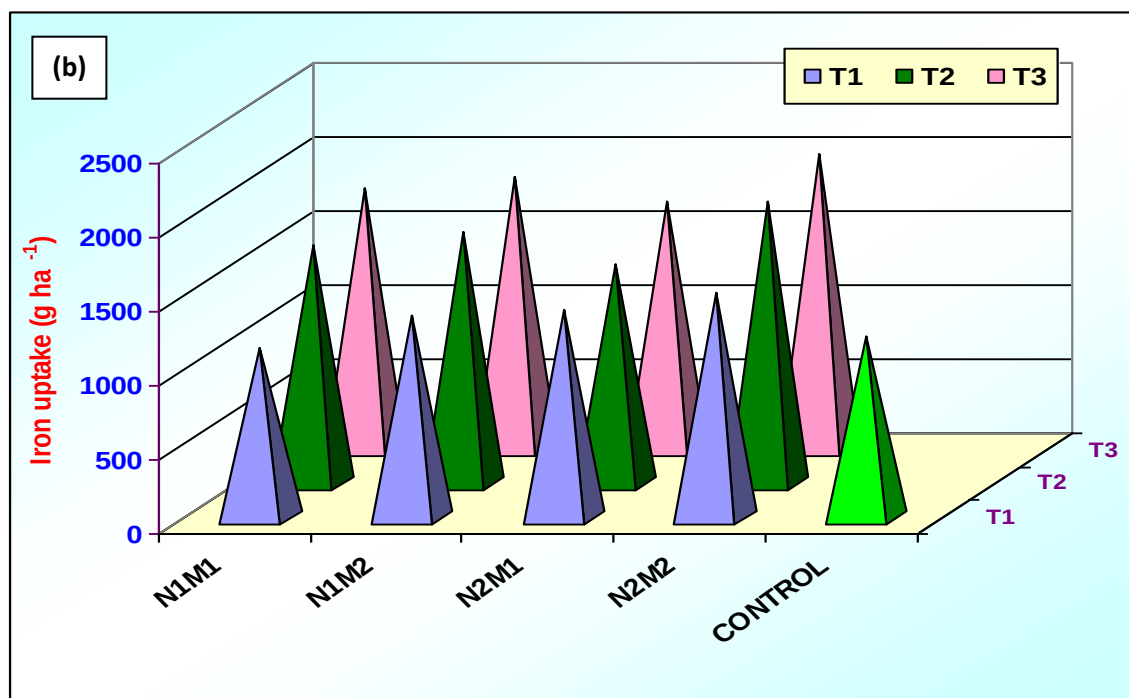
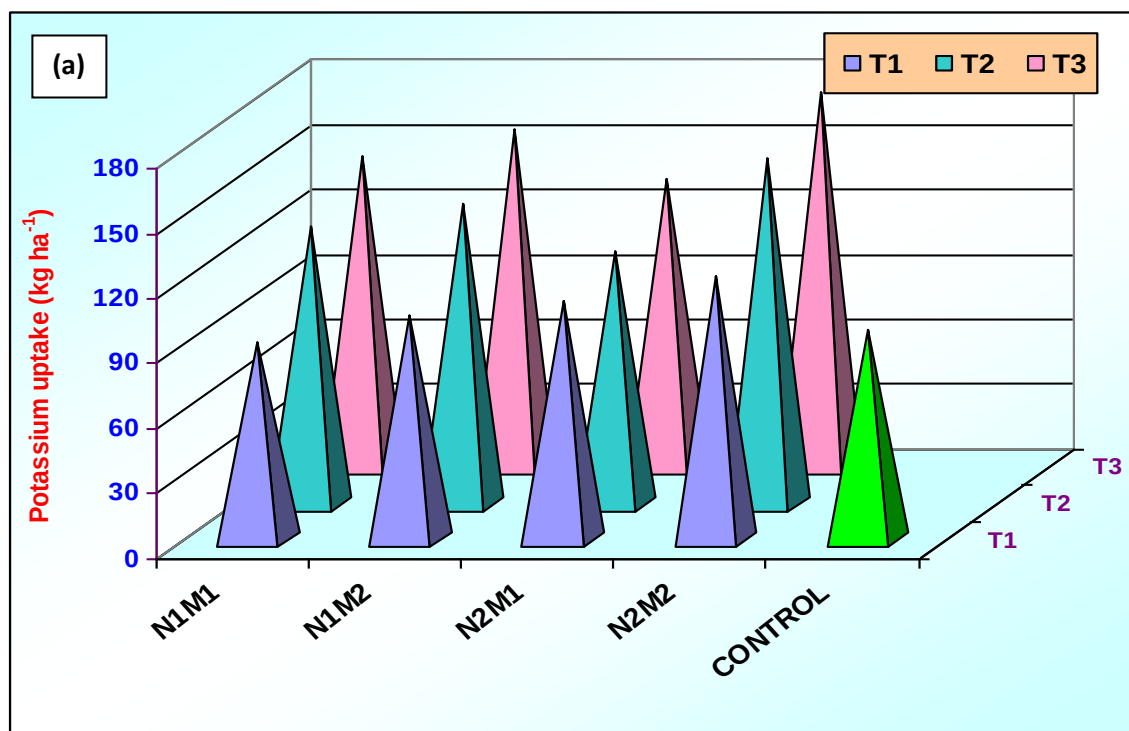
Two factor interactions were significant. In that, STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher Fe uptake (1842.0),

Table 173. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on iron uptake (g ha⁻¹) under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	1419.5 ^g	1823.5 ^d	2053.3 ^b	1765.4 ^c	853.4 ⁱ	1397.6 ^e	1488.7 ^d	1246.6 ^d	1136.5 ⁱ	1610.5 ^f	1771.0 ^d	1506.0 ^c
	M ₂	1605.2 ^f	1936.6 ^c	2130.6 ^a	1890.8 ^b	1120.9 ^h	1465.9 ^d	1559.5 ^c	1382.1 ^b	1363.1 ^h	1701.2 ^e	1845.0 ^c	1636.5 ^b
N ₂	M ₁	1617.2 ^{ef}	1669.1 ^{ef}	1910.5 ^c	1732.3 ^c	1181.8 ^g	1287.9 ^f	1450.3 ^d	1306.7 ^c	1399.5 ^h	1478.5 ^g	1680.4 ^e	1519.5 ^c
	M ₂	1690.1 ^e	2177.7 ^a	2337.8 ^a	2068.5 ^a	1337.3 ^f	1623.1 ^a	1669.2 ^b	1543.2 ^a	1513.7 ^g	1900.4 ^b	2003.5 ^a	1805.9 ^a
Target		1583.0 ^c	1901.7 ^b	2108.1 ^a		1123.4 ^c	1443.6 ^b	1541.9 ^a		1353.2 ^c	1672.7 ^b	1825.0 ^a	
Control		1532.2				915.2				1223.7			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		1512.4 ^d	1880.0 ^b	2092.0 ^a	1828.1 ^a	987.2 ^d	1431.8 ^b	1524.1 ^a	1314.3 ^b	1249.8 ^d	1655.9 ^b	1808.0 ^a	1571.2 ^a
N ₂		1653.6 ^c	1923.4 ^b	2124.1 ^a	1900.4 ^a	1259.5 ^c	1455.5 ^b	1559.8 ^a	1425.0 ^a	1456.6 ^c	1689.5 ^b	1842.0 ^a	1662.7 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		1518.4 ^f	1746.3 ^d	1981.9 ^c	1748.9 ^b	1017.6 ^f	1342.8 ^d	1469.5 ^c	1276.6 ^b	1268.0 ^f	1544.5 ^d	1725.7 ^c	1512.7 ^b
M ₂		1647.6 ^e	2057.2 ^b	2234.2 ^a	1979.7 ^a	1229.1 ^e	1544.5 ^b	1614.3 ^a	1462.7 ^a	1438.4 ^e	1800.8 ^b	1924.3 ^a	1721.2 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		46.8				34.4				32.9			
T		57.3				42.1				40.3			
M		46.8				34.4				32.9			
N x T		81.0				59.6				57.0			
M x T		81.0				59.6				57.0			
N x M		66.1				48.7				46.6			
N x T x M		114.6				84.3				80.7			
Control Vs Rest		30.5		89.1		18.4		53.8		21.0		61.3	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT



LEGEND

Nutritional approaches (N): N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
 Yield Targets (T): T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
 Micronutrient & Organics (M): M₁ - Without FeSO₄+ZnSO₄ + Organics, M₂ - With FeSO₄+ZnSO₄ + Organics

Fig. 28. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on (a) potassium uptake (kg ha⁻¹) and (b) iron uptake (g ha⁻¹) under direct seeded condition during rainy season

while NE with 6 t ha⁻¹ (N₁T₁) had lower uptake of Fe (1249.8), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum uptake (1924.2) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂) while lower yield target and no micronutrient/organics (T₁M₁) had lower Fe uptake (1249.8), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics (N₂M₂) recorded the maximum uptake (1805.0), while NE and no micronutrient + organics supply (N₁M₁) had the lowest Fe uptake (1506.0).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered the maximum uptake of Fe (2003.5), while lower uptake (1136.5) was occurred with NE + 6 t ha⁻¹ yield target + no micronutrient/organics (N₁T₁M₁); other combinations fared in between.

All N-T-M combinations except N₁T₁M₁ were significantly superior to the recommended control (1223.7) with regard to Fe uptake.

4.2.1.3.5 Zinc uptake (g ha⁻¹) (c.f. Table 174 and Fig. 29)

Trends in Zn uptake were similar to iron but the uptake was of lower order and the variations in uptake were also significant due to nutritional approaches, yield targets and micronutrient + organics application and their interactions during both the years and on pooled basis.

All the main effects except nutritional approaches were significant. Among yield targets, higher target of 8 t ha⁻¹ (T₃) registered higher Zn uptake (616.2) and the uptake decreased with decreasing yield targets wherein lower yield target of 6 t ha⁻¹ (T₁) recorded lower Fe uptake (438.9). In micronutrients + organics levels, the treatments receiving both the components (M₂) registered higher Zn uptake (581.7) while in the absence of them (M₁) the uptake was the lowest (502.0).

Two factor interactions were significant. In that, STCR approach coupled with higher yield target across micronutrients (N₂T₃) recorded higher Zn uptake (609.2), while NE with 6 t ha⁻¹ (N₁T₁) had lower uptake of Zn (402.3), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum uptake (655.5) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂)

Table 174. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on zinc uptake (g ha⁻¹) under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	560.4 ^h	754.0 ^e	833.9 ^c	716.1 ^c	162.7 ⁱ	362.0 ^e	392.6 ^d	305.8 ^c	361.6 ^j	558.0 ^f	613.3 ^d	510.9 ^c
	M ₂	648.4 ^g	799.1 ^d	855.5 ^{bc}	767.7 ^b	237.6 ^h	386.7 ^d	411.1 ^c	345.2 ^b	443.0 ⁱ	592.9 ^e	633.3 ^c	556.4 ^d
N ₂	M ₁	657.8 ^{fg}	675.8 ^{fg}	778.7 ^{de}	704.1 ^c	258.6 ^g	284.5 ^{gh}	302.6 ^f	281.9 ^d	458.2 ⁱ	480.2 ^h	540.7 ^g	493.0 ^b
	M ₂	683.2 ^f	867.7 ^b	907.4 ^a	819.4 ^a	302.5 ^f	433.0 ^b	448.1 ^a	394.5 ^a	492.8 ^h	650.3 ^b	677.7 ^a	607.0 ^a
Target		637.5 ^c	774.1 ^b	843.9 ^a		240.4 ^c	266.5 ^b	388.6 ^a		438.9 ^c	570.3 ^b	616.2 ^a	
Control		601.9				216.3				409.1			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		604.4 ^d	776.5 ^b	844.7 ^a	741.9 ^a	200.2 ^e	374.3 ^b	401.9 ^a	325.5 ^a	402.3 ^e	575.4 ^c	623.3 ^a	533.7 ^a
N ₂		670.5 ^c	771.8 ^b	843.1 ^a	761.8 ^a	280.6 ^d	358.7 ^c	375.3 ^b	338.2 ^a	475.5 ^d	565.3 ^c	609.2 ^b	550.0 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		609.1 ^f	714.9 ^d	806.3 ^c	710.1 ^b	210.7 ^f	323.2 ^d	347.6 ^c	293.8 ^b	409.9 ^f	519.1 ^d	577.0 ^c	502.0 ^b
M ₂		665.8 ^e	833.4 ^b	881.4 ^a	793.5 ^a	270.1 ^e	409.9 ^b	429.6 ^a	369.8 ^a	467.9 ^e	621.6 ^b	655.5 ^a	581.7 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		18.8				7.3				10.9			
T		23.0				8.9				13.3			
M		18.9				7.3				10.9			
N x T		32.7				12.6				18.9			
M x T		32.7				12.6				18.9			
N x M		26.7				10.3				15.4			
N x T x M		46.1				17.8				26.7			
Control Vs Rest		12.1		35.5		3.9		11.3		7.05		20.6	

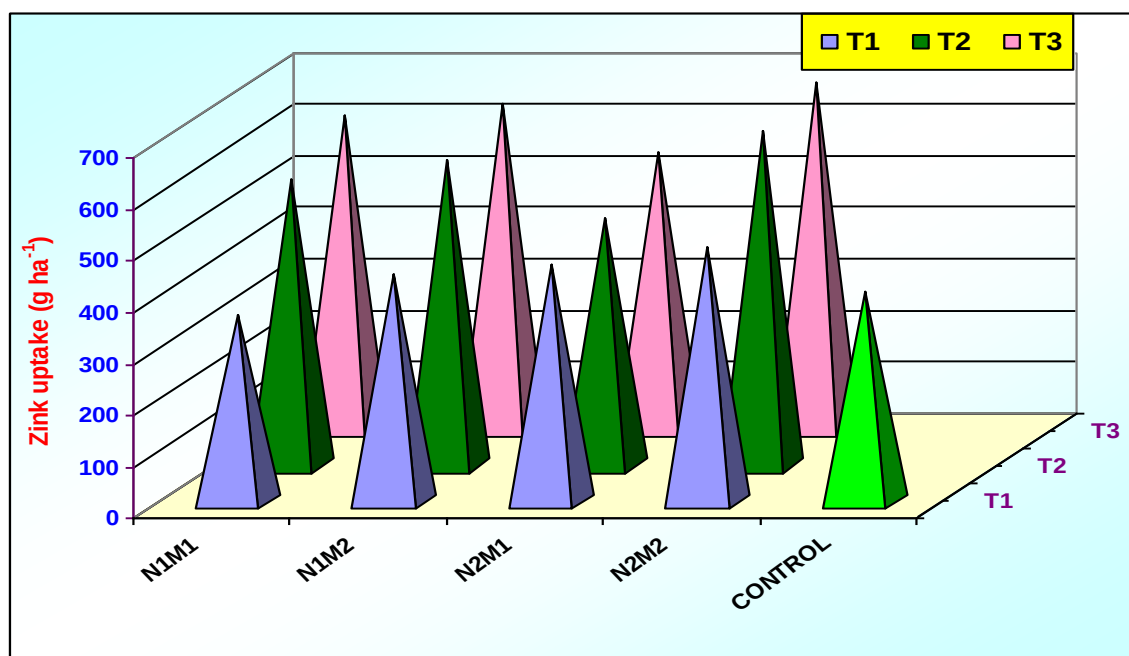
Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT



LEGEND		
Nutritional approaches (N):	N ₁ - Nutrient Expert,	N ₂ - Soil Test Crop Response approach
Yield Targets (T):	T ₁ - 6 t ha ⁻¹ ,	T ₂ - 7 t ha ⁻¹ , T ₃ - 8 t ha ⁻¹
Micronutrient & Organics (M):	M ₁ - Without FeSO ₄ +ZnSO ₄ + Organics,	M ₂ - With FeSO ₄ +ZnSO ₄ + Organics

Fig. 29. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on zinc uptake (g ha^{-1}) under direct seeded condition during rainy season

while lower yield target and no micronutrient/organics (T_1M_1) had lower Zn uptake (409.0), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics (N_2M_2) recorded the maximum uptake (607.0), while NE and no micronutrient + organics supply (N_1M_1) had the lowest Zn uptake (510.9).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply ($N_2T_3M_2$) registered the maximum uptake of Zn (677.7), while lower uptake (361.6) was occurred with NE + 6 t ha⁻¹ yield target + no micronutrient ($N_1T_1M_1$); other combinations fared in between.

All N-T-M combinations except $N_1T_1M_1$ were significantly superior to the recommended control (409.1) with regard to Zn uptake.

4.2.1.3.6 Copper uptake (g ha⁻¹) (c.f. Table 175)

Data on copper (Cu) uptake revealed significant variations due to nutritional approaches, yield targets and micronutrient + organics application and their interactions during both the years and on pooled basis, however, the uptake was of lower order among micronutrients.

All the main effects due to nutritional approaches, yield targets and micronutrient + organics application were significant. Of nutritional approaches STCR (N_2 –34.2) fared superior to NE (N_1 –31.7). Among yield targets, higher target of 8 t ha⁻¹ (T_3) registered higher Cu uptake (39.2) and the uptake decreased with decreasing yield targets wherein lower yield target of 6 t ha⁻¹ (T_1) recorded lower Cu uptake (25.2). In micronutrients + organics levels, the treatments receiving both the components (M_2) registered higher Cu uptake (39.3) while in the absence of them (M_1) the uptake was the lowest (30.0).

Two factor interactions were significant. In that, STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher Cu uptake (39.1), while NE with 6 t ha⁻¹ (N_1T_1) had lower uptake of Cu (22.7), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum uptake (43.0) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T_3M_2) while lower yield target and no micronutrient/organics (T_1M_1) had lower Cu uptake (23.1), and among nutritional approaches and micronutrient + organics supply across

Table 175. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on copper uptake (g ha⁻¹) under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	22.9 ⁱ	35.6 ^e	40.1 ^d	32.9 ^c	18.8 ^j	28.4 ^f	34.3 ^c	27.1 ^b	20.8 ^k	32.0 ^g	37.2 ^d	30.0 ^c
	M ₂	26.8 ^h	36.7 ^e	45.3 ^c	36.2 ^d	22.2 ⁱ	32.3 ^d	37.0 ^b	30.5 ^c	24.5 ^j	34.5 ^e	41.2 ^c	33.4 ^b
N ₂	M ₁	27.0 ^h	31.7 ^g	36.5 ^e	31.7 ^b	23.6 ^h	25.2 ^g	30.2 ^e	26.4 ^d	25.3 ^j	28.5 ⁱ	33.4 ^f	29.0 ^d
	M ₂	32.7 ^f	47.6 ^b	50.7 ^a	43.7 ^a	27.8 ^f	37.8 ^b	39.1 ^a	34.9 ^a	30.2 ^h	42.7 ^b	44.9 ^a	39.3 ^a
Target		27.3 ^c	37.9 ^b	43.2 ^a		23.1 ^c	30.9 ^b	35.1 ^a		25.2 ^c	34.4 ^b	39.2 ^a	
Control		25.1				20.2				22.64			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		24.9 ^f	36.2 ^d	42.7 ^b	34.6 ^b	20.5 ^f	30.4 ^d	35.6 ^a	28.8 ^a	22.7 ^e	33.3 ^c	39.2 ^a	31.7 ^b
N ₂		29.8 ^e	39.7 ^c	43.6 ^a	37.7 ^a	25.7 ^e	31.5 ^c	34.7 ^b	30.6 ^a	27.8 ^d	35.6 ^b	39.1 ^a	34.2 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		24.9 ^f	33.7 ^d	38.3 ^c	32.3 ^b	21.2 ^f	26.8 ^d	32.2 ^c	26.7 ^b	23.1 ^f	30.2 ^d	35.3 ^c	29.5 ^b
M ₂		29.8 ^e	42.1 ^b	48.0 ^a	40.0 ^a	25.0 ^e	35.1 ^b	38.0 ^a	32.7 ^a	27.4 ^e	38.6 ^b	43.0 ^a	36.3 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.8				0.6				0.6			
T		1.0				0.8				0.7			
M		0.8				0.6				0.6			
N x T		1.4				1.0				1.0			
M x T		1.4				1.0				1.0			
N x M		1.1				0.9				0.8			
N x T x M		1.9				1.5				1.5			
Control Vs Rest		0.5		1.5		0.3		0.9		0.4		1.0	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

yield targets STCR approach and micronutrients + organics (N_2M_2) recorded the maximum uptake (39.3), while NE and no micronutrient + organics supply (N_1M_1) had the lowest Cu uptake (30.0).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply ($N_2T_3M_2$) registered the maximum uptake of Cu (677.7), while lower uptake (20.8) occurred with NE + 6 t ha⁻¹ yield target + no micronutrient ($N_1T_1M_1$); other combinations fared in between.

All N-T-M combinations except $N_1T_1M_1$ were significantly superior to the recommended control (22.64) with regard to Cu uptake.

4.2.1.3.7 Manganese uptake (g ha⁻¹) (c.f. Table 176)

Similar to other essential nutrients uptake, data on manganese (Mn) uptake revealed significant variations due to nutritional approaches, yield targets and micronutrient + organics application and their interactions during both the years and on pooled basis, however, the uptake was of higher order among micronutrients.

The main effects due to factors viz., yield targets and micronutrient + organics application were significant while those due to nutritional approaches were not significant (STCR - 4229.6 was numerically superior to NE – 4016.5). Among yield targets, higher target of 8 t ha⁻¹ (T_3) registered higher Mn uptake (4769.0) and the uptake decreased with decreasing yield targets wherein lower yield target of 6 t ha⁻¹ (T_1) recorded lower Mn uptake (3301.3). In micronutrients + organics levels, the treatments receiving both the components (M_2) registered higher Mn uptake (4426.9) while in the absence of them (M_1) the uptake was the lowest (3075.9).

Two factor interactions were significant. In that, STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher Mn uptake (4801.7), while NE with 6 t ha⁻¹ (N_1T_1) had lower uptake of Mn (3043.3), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum uptake (5050.3) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T_3M_2) while lower yield target and no micronutrient/organics (T_1M_1) had lower Mn uptake (3075.9), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics

Table 176. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on manganese uptake (g ha⁻¹) under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	3368.2 ^h	4953.3 ^e	5405.8 ^c	4575.8 ^c	2297.5 ^h	3317.2 ^e	3779.4 ^c	3131.4 ^c	2832.8 ^h	4135.2 ^e	4592.6 ^c	3853.6 ^d
	M ₂	3840.6 ^g	5198.4 ^d	5668.1 ^b	4902.4 ^b	2666.8 ^g	3643.0 ^{cd}	4059.7 ^b	3456.5 ^b	3253.7 ^g	4420.7 ^d	4863.9 ^b	4179.4 ^b
N ₂	M ₁	3899.1 ^g	4351.2 ^f	5122.2 ^{de}	4457.5 ^d	2739.0 ^g	2986.3 ^f	3611.2 ^d	3112.2 ^c	3319.0 ^g	3668.7 ^f	4366.7 ^d	3784.8 ^c
	M ₂	4474.5 ^f	5690.0 ^b	6115.5 ^a	5426.6 ^a	3124.6 ^f	4284.1 ^a	4357.9 ^a	3922.2 ^a	3799.5 ^f	4987.1 ^b	5236.7 ^a	4674.4 ^a
Target		3895.6 ^c	5048.2 ^b	5577.9 ^a		2707.0 ^c	3557.7 ^b	3952.1 ^a		3301.3 ^c	4302.9 ^b	4769.0 ^b	
Control		3728.4				2449.3				3088.8			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		3604.4 ^d	5075.8 ^b	5537.0 ^a	4739.1 ^a	2482.1 ^e	3480.1 ^c	3919.6 ^a	3293.9 ^a	3043.3 ^d	4278.0 ^b	4728.3 ^a	4016.5 ^a
N ₂		4186.8 ^c	5020.6 ^b	5618.8 ^a	4942.1 ^a	2931.8 ^d	3635.2 ^b	3984.6 ^c	3517.2 ^a	3559.3 ^c	4327.9 ^b	4801.7 ^a	4229.6 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		3633.7 ^f	4652.2 ^d	5264.0 ^c	4516.6 ^b	2518.2 ^f	3151.8 ^d	3695.3 ^c	3121.8 ^b	3075.9 ^f	3902.0 ^d	4479.7 ^c	3819.2 ^b
M ₂		4157.5 ^e	5444.2 ^b	5891.8 ^a	5164.5 ^a	2895.7 ^e	3963.5 ^b	4208.8 ^a	3689.4 ^a	3526.6 ^e	4703.9 ^b	5050.3 ^a	4426.9 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		130.2				92.6				88.2			
T		159.4				113.4				108.0			
M		130.2				92.6				88.2			
N x T		225.4				160.4				152.7			
M x T		225.4				160.4				152.7			
N x M		184.0				131.0				124.7			
N x T x M		318.8				226.9				216.0			
Control Vs Rest		80.8		235.8		49.8		145.34		54.9		160.4	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

N₂M₂) recorded the maximum uptake (4674.4), while NE and no micronutrient + organics supply (N₁M₁) had the lowest Mn uptake (3853.6).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered the maximum uptake of Mn (5236.7), while lower uptake (2832.8) occurred with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁); other combinations fared in between.

All N-T-M combinations except N₁T₁M₁ were significantly superior to the recommended control (3088.8) with regard to Mn uptake.

4.2.1.4 Post harvest chemical properties of soil

4.2.1.3.1 Soil pH (c.f. Table 177)

Soil pH of the experimental site 2014-15 (8.13 – 8.33) were higher compared to those during 2015-16 (7.76 - 7.99) and revealed significant variations during individual years due to main effects of yield targets and interactions except N x M during 2014-15 while on pooled basis these variations were masked and became non-significant as the trend was almost in opposite directions for instance during 2014-15 of the main effects due to yield targets significantly higher pH was observed with higher yield target (T₃ – 8.30) while during 2015-16 higher pH occurred with lower yield target (T₁- 7.94) and similar was the case with N x T x M interactions. The pH with control was 8.21, 7.98 and 8.09 during 2014-15, 2015-16 and on pooled basis.

4.2.1.3.1 Soil EC (dS m⁻¹) (c.f. Table 178)

Overall, EC values were within safe range for crop and the values were lower during 2014-15 (0.60 – 0.83) compared to those of 2015-16 (0.61 – 1.05), and unlike soil pH, variations in soil EC revealed significant differences due to main effects of yield targets and interactions .

Only main effects due to yield targets revealed significant variations wherein lower yield target of 6 t ha⁻¹(M₁) had higher EC value (0.76) while higher yield target (M₃) had lower EC (0.70); moderate target had values in between. Two factor interactions were significant. In that, NE approach coupled lower yield target across micronutrients (N₁T₁) recorded higher EC (0.80), while NE with 8 t ha⁻¹ (N₁T₃) had lower EC value (0.65); other combinations had intermediary values, micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum EC (0.80) with lower target (6 t ha⁻¹) without micronutrients and organics (T₁M₁) while medium and higher yield targets coupled with micronutrients + organics

Table 177. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on soil pH under direct seeded condition after harvest during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	8.13 ^b	8.25 ^{ab}	8.30 ^{ab}	8.23^a	7.99 ^a	7.88 ^{b-d}	7.83 ^{de}	7.90^a	8.06 ^a	8.07 ^a	8.06 ^a	8.06^a
	M ₂	8.22 ^{ab}	8.27 ^{ab}	8.31 ^{ab}	8.27^a	7.95 ^{ab}	7.83 ^{c-e}	7.82 ^{c-e}	7.87^a	8.09 ^a	8.05 ^a	8.07 ^a	8.07^a
N ₂	M ₁	8.23 ^{ab}	8.23 ^{ab}	8.25 ^{ab}	8.24^a	7.93 ^{ab}	7.90 ^{bc}	7.84 ^{c-e}	7.89^a	8.08 ^a	8.07 ^a	8.05 ^a	8.06^a
	M ₂	8.24 ^{ab}	8.31 ^{ab}	8.33 ^a	8.29	7.90 ^{bc}	7.79 ^e	7.76 ^e	7.82^b	8.07 ^a	8.05 ^a	8.05 ^a	8.06^a
Target		8.21^b	8.2^b	8.30^a		7.94^a	7.85^b	7.81^c		8.07^a	8.06^a	8.05^a	
Control		8.21				7.98				8.09			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		8.18 ^a	8.26 ^a	8.30 ^a	8.25^a	7.97 ^a	7.86 ^b	7.83 ^{bc}	7.88^a	8.07 ^a	8.06 ^a	8.06 ^a	8.06^a
N ₂		8.24 ^a	8.27 ^a	8.29 ^a	8.27^a	7.92 ^a	7.85 ^{bc}	7.80 ^c	7.85^a	8.08 ^a	8.06 ^a	8.05 ^a	8.06^a
M (M) x Target (T)					M	M x T			M	M x T			M
M ₁		8.18 ^b	8.24 ^{ab}	8.27 ^{ab}	8.23a	7.96 ^a	7.89 ^b	7.83 ^c	7.90^a	8.07 ^a	8.07 ^a	8.05 ^a	8.06^a
M ₂		8.23 ^{ab}	8.29 ^{ab}	8.32 ^a	8.28a	7.93 ^{ab}	7.81 ^c	7.79 ^c	7.84^a	8.08 ^a	8.05 ^a	8.06 ^a	8.06^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.11				0.05				0.05			
T		0.13				0.06				0.07			
M		0.11				0.05				0.05			
N x T		0.19				0.08				0.09			
M x T		0.19				0.08				0.09			
N x M		0.15				0.07				0.08			
N x T x M		0.27				0.12				0.13			
Control Vs Rest		0.06		0.17		0.03		0.07		0.03		0.08	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 178. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on soil EC (d Sm⁻¹) under direct seeded condition after harvest during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	0.65 ^{a-c}	0.60 ^{bc}	0.62 ^{bc}	0.62^b	1.05 ^a	0.75 ^{bc}	0.69 ^{bc}	0.83^a	0.85 ^a	0.67 ^b	0.65 ^b	0.73^a
	M ₂	0.62 ^{bc}	0.59 ^c	0.61 ^{bc}	0.61^b	0.87 ^{ab}	0.73 ^{bc}	0.69 ^{bc}	0.76^{ab}	0.75 ^{ab}	0.66 ^b	0.65 ^b	0.69^a
N ₂	M ₁	0.68 ^{a-c}	0.74 ^{a-c}	0.83 ^a	0.75^a	0.82 ^{bc}	0.76 ^{bc}	0.73 ^{bc}	0.77^{ab}	0.75 ^{ab}	0.75 ^{ab}	0.78 ^{ab}	0.76^a
	M ₂	0.65 ^{a-c}	0.72 ^{a-c}	0.78 ^{ab}	0.72^a	0.75 ^{bc}	0.63 ^c	0.61 ^c	0.66^b	0.70 ^b	0.67 ^d	0.69 ^b	0.69^a
Target		0.65^a	0.66^a	0.71^a		0.87^a	0.72^b	0.68^b		0.76^a	0.69^b	0.70^{ab}	
Control		0.71				0.88				0.79			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		0.64 ^{bc}	0.59 ^c	0.61 ^{bc}	0.62^a	0.96 ^a	0.74 ^b	0.69 ^b	0.80^a	0.80 ^a	0.67 ^b	0.65 ^b	0.71^a
N ₂		0.67 ^{bc}	0.73 ^{ab}	0.81 ^a	0.73^a	0.78 ^b	0.69 ^b	0.67 ^b	0.72^a	0.72 ^{ab}	0.71 ^{ab}	0.74 ^{ab}	0.72^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		0.66 ^a	0.67 ^a	0.72 ^a	0.69^a	0.93 ^a	0.75 ^{bc}	0.71 ^{bc}	0.80^a	0.80 ^a	0.71 ^{ab}	0.72 ^{ab}	0.74^a
M ₂		0.64 ^a	0.65 ^a	0.70 ^a	0.66^a	0.81 ^{ab}	0.68 ^{bc}	0.65 ^c	0.71^a	0.73 ^{ab}	0.67 ^b	0.67 ^b	0.69^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.11				0.12				0.08			
T		0.13				0.15				0.10			
M		0.11				0.12				0.08			
N x T		0.18				0.21				0.15			
M x T		0.18				0.21				0.15			
N x M		0.15				0.17				0.12			
N x T x M		0.26				0.29				0.21			
Control Vs Rest		0.05		0.15		0.07		0.22		0.05		0.14	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

(T₂₋₃M₂) had lower EC (0.67 each), and among nutritional approaches and micronutrient + organics supply across yield targets variations on pooled basis were non-significant due to differential behaviour during individual years.

Among the three factors interaction, NE + 6 t ha⁻¹ yield target + no micronutrient supply (N₁T₁M₁) registered the maximum EC (0.85), while lower EC values (0.65 each) occurred with NE + 8 t ha⁻¹ yield target + with or without micronutrient (N₁T₃M₁₋₂); other combinations fared in between.

Among N-T-M combinations and recommended control only NE + 8 t ha⁻¹ yield target + with or without micronutrient (N₁T₃M₁₋₂) fared superior to control (0.79) with lower EC values.

4.2.1.3.1 Organic carbon (%) (c.f. Table 179)

Overall, OC values were lower during 2014-15 (0.44 – 0.57) with medium to low ratings compared to those of 2015-16 (0.65 – 0.90) which revealed medium to high ratings, and variations due to only interactions were significant.

Two factor interactions were significant. In that, STCR approach coupled with higher yield target across micronutrients (N₂T₃) recorded higher OC (0.70), while NE with 7 t ha⁻¹ (N₁T₂) had lower OC value (0.55); N₁₋₂T₁ were on par with the latter treatment. Micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum OC (0.66) with higher target (8 t ha⁻¹) without micronutrients and organics (T₃M₁) while moderate yield target coupled with micronutrients + organics (T₂M₂) had lower OC (0.59), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach with or without micronutrients and organics (N₂M₁₋₂) recorded significantly higher soil OC (0.64 and 0.67, respectively) while NE with or without micronutrients or organics (N₁M₁₋₂) had lower soil OC (0.57 and 0.58, respectively).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + no micronutrient supply (N₂T₃M₁) registered the maximum OC (0.74), while lower OC (0.54 each) was recorded with NE + 7 t ha⁻¹ yield target + micronutrient and organics (N₁T₂M₂); other combinations fared in between.

Table 179. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on soil organic carbon (%) under direct seeded condition after harvest during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	0.47 ^{ab}	0.45 ^b	0.46 ^b	0.46^a	0.73 ^{bc}	0.66 ^c	0.72 ^{bc}	0.70^b	0.60 ^{b-d}	0.56 ^{cd}	0.59 ^{b-d}	0.58^b
	M ₂	0.47 ^{ab}	0.44 ^b	0.46 ^b	0.46^a	0.73 ^{bc}	0.65 ^c	0.67 ^c	0.68^b	0.60 ^{b-d}	0.54 ^d	0.56 ^{cd}	0.57^b
N ₂	M ₁	0.48 ^{ab}	0.49 ^{ab}	0.57 ^a	0.51^a	0.75 ^{a-c}	0.81 ^{a-c}	0.90 ^a	0.82^a	0.62 ^{b-d}	0.65 ^{bc}	0.74 ^a	0.67^a
	M ₂	0.48 ^{ab}	0.49 ^{ab}	0.50 ^{ab}	0.49^a	0.74 ^{a-c}	0.79 ^{a-c}	0.85 ^{ab}	0.79^a	0.61 ^{b-d}	0.64 ^{bc}	0.67 ^{ab}	0.64^a
Target		0.47^a	0.47^a	0.50^a		0.74^a	0.73^a	0.78^a		0.61^a	0.60^a	0.64^a	
Control		0.49				0.78				0.63			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		0.47 ^{ab}	0.45 ^b	0.46 ^{ab}	0.46^a	0.73 ^{bc}	0.65 ^c	0.69 ^{bc}	0.69^a	0.60 ^{bc}	0.55 ^c	0.58 ^{bc}	0.58^a
N ₂		0.48 ^{ab}	0.49 ^{ab}	0.53 ^a	0.50^a	0.75 ^{bc}	0.80 ^{ab}	0.87 ^a	0.81^a	0.61 ^{bc}	0.64 ^b	0.70 ^a	0.65^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		0.47 ^a	0.47 ^b	0.52 ^a	0.49^a	0.74 ^a	0.73 ^a	0.81 ^a	0.76^a	0.61 ^{ab}	0.60 ^{ab}	0.66 ^a	0.63^a
M ₂		0.47 ^a	0.47 ^a	0.48 ^a	0.47^a	0.73 ^a	0.72 ^a	0.76 ^a	0.74^a	0.60 ^{ab}	0.59 ^b	0.62 ^{ab}	0.60^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.06				0.10				0.05			
T		0.07				0.12				0.07			
M		0.06				0.10				0.05			
N x T		0.10				0.17				0.09			
M x T		0.10				0.17				0.09			
N x M		0.08				0.14				0.08			
N x T x M		0.14				0.24				0.13			
Control Vs Rest		0.03		0.08		0.05		0.14		0.03		0.08	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Control with recommended fertilization had moderate OC content (0.63) and was comparable to all other N-T-M combinations except STCR + 8 t ha⁻¹ yield target + no micronutrient supply (N₂T₃M₁).

4.2.1.3 Soil available nutrient status

4.2.1.3.1 Available nitrogen (kg ha⁻¹) (c.f. Table 180)

Data pertaining N uptake revealed significant variation due to main effects due to yield targets and interaction among nutritional approaches, yield targets and micronutrient + organics application during both the years and on pooled basis.

In main effects higher yield target (M₃) had relatively higher soil available N (256.0) and it differed significantly from medium yield target (M₂ – 248.8).

Two factor interactions were also significant. In that, STCR approach coupled with higher yield target across micronutrients (N₂T₃) recorded higher N status (267.3), while NE with 7 t ha⁻¹ (N₁T₂) had lower soil available N (235.5) followed by N₁T₃ which was on par, micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum N (257.5) with higher target (8 t ha⁻¹) but with no micronutrients and organics (T₃M₁) while moderate yield target coupled with micronutrient/organics (T₂M₂) had lower N (247.5), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics (N₂M₂) recorded the maximum uptake (141.8), while NE and no micronutrient + organics supply (N₁M₁) had the lowest N uptake (102.8).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + without or with micronutrient supply (N₂T₃M₁₋₂) registered the maximum soil available N (268.0 and 266.7, respectively), while lower N (234.6) was observed with NE + 7 t ha⁻¹ yield target + micronutrient and organics (N₁T₂M₂) followed by N₁T₂M₁ which was on par; other combinations fared in between.

All N-T-M combinations except N₁T₂M₁₋₂ and N₁T₃M₂ were on par with the recommended control (259) with regard to soil available N while former treatments had significantly lower soil N at harvest.

Table 180. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on soil available nitrogen (kg ha⁻¹) under direct seeded condition after harvest during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	258.8 ^{a-c}	241.0 ^c	250.5 ^{a-c}	250.1 ^b	244.3 ^{ab}	231.7 ^b	243.7 ^{ab}	239.9 ^b	251.6 ^{b-d}	236.4 ^e	247.1 ^{c-e}	245.0 ^b
	M ₂	257.0 ^{a-c}	240.0 ^c	247.7 ^{bc}	248.2 ^b	244.1 ^{ab}	229.3 ^b	236.6 ^{ab}	236.7 ^b	250.6 ^{b-d}	234.6 ^e	242.2 ^{de}	242.5 ^b
N ₂	M ₁	264.0 ^{a-c}	269.2 ^{ab}	276.3 ^a	269.9 ^a	251.4 ^{ab}	258.0 ^a	259.6 ^a	256.4 ^a	257.7 ^{a-c}	263.6 ^{ab}	268.0 ^a	263.1 ^a
	M ₂	263.6 ^{a-c}	267.5 ^{ad}	273.9 ^a	268.3 ^a	248.5 ^{ab}	253.4 ^{ab}	259.4 ^a	253.7 ^a	256.0 ^{a-d}	260.4 ^{a-c}	266.7 ^a	261.0 ^a
Target		260.9 ^a	254.4 ^a	262.1 ^a		247.1 ^a	243.1 ^a	249.8 ^a		254.0 ^{ab}	248.8 ^b	256.0 ^a	
Control		266.5				251.6				259.1			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		257.9 ^{ab}	240.5 ^c	249.1 ^{bc}	249.2 ^a	244.2 ^{ac}	230.5 ^c	240.2 ^{bc}	238.3 ^a	251.1 ^{cd}	235.5 ^e	244.6 ^{de}	243.7 ^a
N ₂		263.8 ^{ab}	268.3 ^c	275.1 ^{bc}	269.1 ^a	250.0 ^{ab}	255.7 ^{ab}	259.5 ^a	255.1 ^a	256.9 ^{bc}	262.0 ^{ab}	267.3 ^a	262.1 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		261.4 ^a	255.1 ^a	263.4 ^a	260.0 ^a	247.9 ^a	244.9 ^a	251.6 ^a	248.1 ^a	254.6 ^{ab}	250.0 ^{ab}	257.5 ^a	254.1 ^a
M ₂		260.3 ^a	253.7 ^a	260.8 ^a	258.3 ^a	246.3 ^a	241.3 ^a	248.0 ^a	245.2 ^a	253.3 ^{ab}	247.5 ^b	254.4 ^{ab}	251.7 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		18.0				13.6				8.4			
T		14.7				16.6				10.3			
M		14.7				13.6				8.4			
N x T		25.4				23.5				14.5			
M x T		25.4				23.5				14.5			
N x M		20.8				19.2				11.9			
N x T x M		35.9				33.2				20.6			
Control Vs Rest		7.8		22.7		7.1		20.8		4.2		14.1	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

4.2.1.3.2 Soil available phosphorus (kg ha^{-1}) (c.f. Table 181)

Data on soil available P uptake revealed significant variations due to main effects of yield targets and interactions effects of nutritional approaches, yield targets and micronutrient + organics application during both the years and on pooled basis. In the main effects, higher yield target (T_3) recorded higher soil available P (35.8) while other two targets were at par and had lower soil P at harvest (30.4-31.6).

Two factor interactions were also significant. In that, STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher P status (40.9), while NE with 6 t ha^{-1} (N_1T_1) had lower soil available P (28.8), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum P (38.3) with higher target (8 t ha^{-1}) coupled with no micronutrients and organics (T_3M_1) while lower yield target whether supplied with micronutrient/organics or not (T_1M_{1-2}) had lower P status (30.1 and 30.6, respectively), and among nutritional approaches and micronutrient + organics supply across yield targets, STCR approach and no micronutrients + organics (N_2M_1) recorded the maximum P (37.3), while NE and no micronutrient + organics supply (N_1M_1) had the lowest P status (29.5).

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + no micronutrient supply ($N_2T_3M_1$) registered the maximum available P (45.8), while available P (28.6) occurred with NE + 6 t ha^{-1} yield target + micronutrient/organics ($N_1T_1M_2$); other combinations fared in between.

All N-T-M combinations except $N_2T_3M_{1-2}$ were comparable with the recommended control (31.3) while the former treatment combinations had significantly higher soil available P.

4.2.1.3.3 Soil available potassium (kg ha^{-1}) (c.f. Table 182)

Trends in available K uptake were similar to N and P and variation in values were also significant due to main effects of yield targets and interactions among nutritional approaches, yield targets and micronutrient + organics application during both the years and on pooled basis. Among the yield levels higher yield target of 8 t ha^{-1} (M_3) recorded higher soil available K (376.3) followed by moderate target of 7 t ha^{-1} which was on par while lower yield target (M_1) had lower soil available K (355.2).

Table 181. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on soil available phosphorus (kg ha⁻¹) under direct seeded condition after harvest during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	34.7 ^b	36.1 ^b	37.1 ^b	36.0 ^{bc}	23.5 ^{ef}	24.1 ^{d-f}	24.5 ^{d-f}	24.0 ^b	29.1 ^e	30.1 ^{c-e}	30.8 ^{c-e}	30.0 ^c
	M ₂	34.2 ^b	34.9 ^b	36.8 ^b	35.3 ^c	23.0 ^f	23.6 ^{ef}	24.3 ^{d-f}	23.6 ^b	28.6 ^e	29.3 ^{de}	30.6 ^{c-e}	29.5 ^c
N ₂	M ₁	38.5 ^b	40.4 ^b	59.0 ^a	46.0 ^a	25.6 ^{c-e}	27.4 ^c	32.6 ^a	28.5 ^a	32.1 ^{c-e}	33.9 ^{bc}	45.8 ^a	37.3 ^a
	M ₂	37.7 ^b	39.9 ^b	41.7 ^b	39.8 ^b	25.6 ^{c-e}	26.4 ^{cd}	30.2 ^b	27.4 ^a	31.7 ^{c-e}	33.2 ^{b-d}	36.0 ^b	33.6 ^b
Target		36.3 ^b	37.9 ^b	43.7 ^a		24.4 ^c	25.4 ^b	27.9 ^a		30.4 ^b	31.6 ^b	35.8 ^a	
Control		37.3				25.3				31.3			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		34.4 ^c	35.5	37.0	35.7 ^a	23.2 ^d	23.8 ^d	24.4 ^{cd}	23.8 ^a	28.8 ^c	29.7 ^{bc}	30.7 ^{bc}	29.7 ^a
N ₂		38.1 ^{bc}	40.2	50.4	42.9 ^a	25.6 ^{bc}	26.9 ^b	31.4 ^a	28.0 ^a	31.9 ^{ab}	33.6 ^a	40.9 ^d	35.4 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		36.6 ^b	38.3 ^b	48.1 ^a	41.0 ^a	24.5 ^c	25.7 ^{bc}	28.5 ^a	26.3 ^a	30.6 ^c	32.0 ^{bc}	38.3 ^a	33.6 ^a
M ₂		35.9 ^b	37.4 ^b	39.3 ^b	37.6 ^a	24.3 ^c	25.0 ^c	27.2 ^{ab}	25.5 ^a	30.1 ^c	31.2 ^{bc}	33.3 ^b	31.5 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		4.4				1.15				2.3			
T		5.4				1.8				2.8			
M		4.4				1.5				2.3			
N x T		7.6				2.5				3.9			
M x T		7.6				2.5				3.9			
N x M		6.2				2.1				3.2			
N x T x M		10.7				3.6				5.6			
Control Vs Rest		2.2		6.5		0.79		2.3		1.2		3.5	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 182. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on soil available potassium (kg ha⁻¹) under direct seeded condition after harvest during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	342.0 ^{bc}	351.4 ^{bc}	360.9 ^{a-c}	351.4 ^{bc}	360.7 ^a	364.0 ^a	369.1 ^a	364.6 ^a	351.3 ^{cd}	357.7 ^{b-d}	365.0 ^{b-d}	358.0 ^{bc}
	M ₂	332.0 ^c	349.2 ^{bc}	359.0 ^{a-c}	346.8 ^c	359.6 ^a	360.8 ^a	369.0 ^a	363.1 ^a	345.8 ^d	355.0 ^{cd}	364.0 ^{b-d}	354.9 ^c
N ₂	M ₁	357.0 ^{bc}	372.0 ^{a-c}	399.4 ^a	376.2 ^a	367.4 ^a	375.6 ^a	386.6 ^a	376.6 ^a	362.2 ^{b-d}	373.8 ^{a-c}	393.0 ^a	376.4 ^a
	M ₂	356.7 ^{bc}	366.0 ^{a-c}	382.6 ^{ab}	368.4 ^{ab}	365.9 ^a	373.3 ^a	384.1 ^a	374.4 ^a	361.3 ^{b-d}	369.6 ^{a-d}	383.3 ^{ab}	371.4 ^{ab}
Target		346.9 ^b	359.7 ^{ab}	375.5 ^a		363.4 ^b	368.4 ^{ab}	377.2 ^a		355.2 ^b	364.1 ^{ab}	376.3 ^a	
Control		355.6				365.5				360.5			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		337.0 ^c	350.3 ^{bc}	359.9 ^{bc}	349.1 ^a	360.2 ^b	362.4 ^b	369.1 ^{ab}	363.9 ^a	348.6 ^c	356.4 ^{bc}	364.5 ^{bc}	356.5 ^a
N ₂		356.9 ^{bc}	369.0 ^{ab}	391.0 ^a	372.3 ^a	366.7 ^b	374.5 ^{ab}	385.3 ^a	375.5 ^a	361.8 ^{bc}	371.7 ^b	388.2 ^a	373.9 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		349.5 ^b	361.7 ^{ab}	380.1 ^a	363.8 ^a	364.1 ^a	369.8 ^a	377.9 ^a	370.6 ^a	356.8 ^{bc}	365.8 ^{a-c}	379.0 ^a	367.2 ^a
M ₂		344.4 ^b	357.6 ^{ab}	370.8 ^{ab}	357.6 ^a	362.8 ^a	367.0 ^a	376.5 ^a	368.8 ^a	353.6 ^c	362.3 ^{a-c}	373.7 ^{ab}	363.2 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		23.7				16.1				15.7			
T		29.0				19.8				19.2			
M		23.7				16.1				15.7			
N x T		41.0				27.9				27.2			
M x T		41.0				27.9				27.2			
N x M		33.5				22.8				22.2			
N x T x M		57.9				39.5				38.5			
Control Vs Rest		12.33		35.9		8.1		23.7		8.0		23.4	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Two factor interactions were also significant. In that, STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher K (388.2), while NE with 6 t ha^{-1} (N_1T_1) had lower soil available K (348.6), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum available K (373.7) with higher target (8 t ha^{-1}) coupled with micronutrients and organics (T_3M_2) while lower yield target coupled with micronutrient/organics (T_1M_2) had lower K (353.6), and among nutritional approaches and micronutrient + organics supply across yield targets, STCR approach and micronutrients + organics (N_2M_2) recorded the maximum available K (371.4), while NE and no micronutrient + organics supply (N_1M_1) had the lower soil available K (358.0).

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + no micronutrient supply ($N_2T_3M_1$) registered the maximum soil available K (393.0), while lower K (345.8) occurred with NE + 6 t ha^{-1} yield target + micronutrient and organics ($N_1T_1M_2$); other combinations fared in between.

Of all the N-T-M combinations $N_2T_3M_1$ was significantly superior to control (360.5); other combinations were at par while NE + 6 t ha^{-1} yield target + micronutrient and organics ($N_1T_1M_2$) had significantly lower soil available K compared to control.

4.2.1.3.4 Soil available iron (mg kg^{-1}) (c.f. Table 183)

Trends in soil available Fe were quite different and most of the variations due to nutritional approaches, yield targets and micronutrient + organics application and their interactions during both the years and on pooled basis were also significant.

Among yield targets, higher target of 8 t ha^{-1} (T_3) registered lower Fe status (12.11) and the content increased with decreasing yield targets wherein lower yield target of 6 t ha^{-1} (T_1) recorded higher Fe (13.28). Main effects due to nutritional approaches and micronutrient + organic levels were not significant.

Two factor interactions were significant, in that STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded lower available Fe (12.04), while NE with 6 t ha^{-1} (N_1T_1) had higher soil available Fe (13.52), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the

Table 183. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on soil available iron (mg kg⁻¹) under direct seeded condition after harvest during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	11.85 ^{b-f}	10.67 ^{d-f}	10.22 ^f	10.91 ^b	13.35 ^{ab}	12.49 ^{ab}	12.27 ^{ab}	12.70 ^b	12.60 ^{a-d}	11.58 ^{cd}	11.24 ^d	11.81 ^b
	M ₂	13.86 ^a	13.46 ^{ab}	12.53 ^{a-d}	13.28 ^a	15.00 ^a	13.77 ^{ab}	13.69 ^{ab}	14.16 ^a	14.43 ^a	13.62 ^{ab}	13.11 ^{a-d}	13.72 ^a
N ₂	M ₁	11.13 ^{c-f}	10.55 ^{ef}	10.03 ^f	10.57 ^b	13.05 ^{ab}	12.46 ^{ab}	12.25 ^{ab}	12.58 ^b	12.09 ^{b-d}	11.51 ^d	11.14 ^d	11.58 ^b
	M ₂	13.55 ^{ab}	12.91 ^{ac}	12.41 ^{a-e}	12.95 ^a	14.47 ^{ab}	14.19 ^{ab}	13.47 ^{ab}	14.05 ^a	14.01 ^{ab}	13.55 ^{a-c}	12.94 ^{a-d}	13.50 ^a
Target		12.60 ^a	11.90 ^{ab}	11.30 ^b		13.97 ^a	13.23 ^a	12.92 ^a		13.28 ^a	12.56 ^{ab}	12.11 ^b	
Control		11.5				13.0				12.3			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		12.86 ^a	12.06 ^{ab}	11.37 ^b	12.10 ^a	14.17 ^a	13.13 ^a	12.98 ^a	13.43 ^a	13.52 ^b	12.60 ^{bc}	12.18 ^a	12.76 ^a
N ₂		12.34 ^{ab}	11.73 ^{ab}	11.22 ^b	11.76 ^a	13.76 ^a	13.33 ^a	12.86 ^a	13.32 ^a	13.05 ^{bc}	12.53 ^{bc}	12.04 ^c	12.54 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		11.49 ^{bc}	10.61 ^{cd}	10.12 ^d	10.74 ^a	13.20 ^{ab}	12.47 ^b	12.26 ^b	12.64 ^a	12.35 ^{bc}	11.54 ^c	11.19 ^c	11.69 ^a
M ₂		13.70 ^a	13.18 ^a	12.47 ^{ab}	13.12 ^a	14.74 ^a	13.98 ^{ab}	13.58 ^{ab}	14.10 ^a	14.22 ^a	13.58 ^{ab}	13.03 ^{ab}	13.61 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		1.14				1.50				1.15			
T		1.39				1.83				1.41			
M		1.14				1.50				1.15			
N x T		1.97				2.59				2.00			
M x T		1.97				2.59				2.00			
N x M		1.61				2.12				1.63			
N x T x M		2.79				3.66				2.82			
Control Vs Rest		0.57		1.67		0.75		2.18		0.50		1.48	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

maximum Fe (14.22) with lower target (6 t ha⁻¹) coupled with micronutrients and organics (T₁M₂) while higher yield target and no micronutrient/organics (T₃M₁) had lower Fe status (11.19), and among nutritional approaches and micronutrient + organics supply across yield targets, STCR approach and micronutrients + organics (N₂M₂) recorded the maximum Fe status (13.5), while NE and without and with micronutrient + organics supply (N₁M₁₋₂) had lower Fe status (11.81 and 11.58, respectively).

Among the three factors interaction, NE + 6 t ha⁻¹ yield target + micronutrient supply (N₁T₁M₂) registered the maximum Fe status (14.43), while lower status (11.14) occurred with STCR + 8 t ha⁻¹ yield target + no-micronutrient (N₂T₃M₁); other combinations fared in between.

All N-T-M combinations were on par with recommended control (12.3) except N₁₋₂T₁M₂ which had higher soil available Fe status.

4.2.1.3.5 Soil available zinc (mg kg⁻¹) (c.f. Table 184)

Trends in Zn uptake were much similar to iron but the values were of lower order and most of the variations due to nutritional approaches, yield targets and micronutrient + organics application and their interactions during both the years and on pooled basis were significant.

Among yield targets, higher target of 8 t ha⁻¹ (T₃) registered lower Zn status (2.88) and the content increased with decreasing yield targets wherein lower yield target of 6 t ha⁻¹ (T₁) recorded higher Zn (3.73). Main effects due to nutritional approaches and micronutrient/organic levels were not significant.

Two factor interactions were significant. NE approach coupled with lower yield target across micronutrients (N₁T₁) recorded higher available Zn (12.04), while STCR with 8 t ha⁻¹ (N₂T₃) had lower soil available Zn (2.81), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum Zn (4.48) with lower target (6 t ha⁻¹) coupled with micronutrients and organics (T₁M₂) while higher yield target and no micronutrient/organics (T₃M₁) had lower Zn status (2.25), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics (N₂M₁) recorded the minimum Zn status (2.44), while NE and without and with micronutrient + organics supply (N₁M₁₋₂) had higher Zn status (4.09 and 3.74, respectively).

Table 184. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on soil available zinc (mg kg⁻¹) under direct seeded condition after harvest during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	2.58 ^{a-d}	2.25 ^{cd}	2.01 ^d	2.28 ^b	3.77 ^{b-d}	3.04 ^{de}	2.63 ^e	3.14 ^b	3.17 ^{ce}	2.64 ^{ef}	2.32 ^f	2.71 ^b
	M ₂	4.61 ^a	3.14 ^{bc}	2.71 ^{b-d}	3.49 ^a	5.10 ^a	4.51 ^{ab}	4.45 ^{ab}	4.68 ^a	4.85 ^a	3.82 ^{bc}	3.58 ^{bc}	4.09 ^a
N ₂	M ₁	2.30 ^{cd}	2.02 ^d	1.97 ^d	2.10 ^b	3.25 ^{c-e}	2.69 ^e	2.38 ^e	2.78 ^b	2.78 ^{d-f}	2.36 ^f	2.18 ^f	2.44 ^b
	M ₂	3.48 ^b	2.87 ^{b-d}	2.66 ^{b-d}	3.00 ^a	4.73 ^{ab}	4.50 ^{ab}	4.21 ^{a-c}	4.48 ^a	4.11 ^b	3.69 ^{bc}	3.43 ^{b-d}	3.74 ^a
Target		3.24 ^a	2.57 ^b	2.34 ^b		4.21 ^a	3.69 ^b	3.42 ^b		3.73 ^a	3.13 ^b	2.88 ^b	
Control		2.55				3.29				2.98			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		3.59 ^a	2.69 ^b	2.36 ^b	2.88 ^a	4.43 ^a	3.77 ^{ab}	3.54 ^b	3.91 ^a	4.01 ^a	3.23 ^{bc}	2.95 ^{bc}	3.40 ^a
N ₂		2.89 ^b	2.45	2.32 ^b	2.55 ^a	3.99 ^{ab}	3.60 ^b	3.29 ^b	3.63 ^a	3.44 ^b	3.02 ^{bc}	2.81 ^c	3.09 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		2.44 ^{b-d}	2.13 ^{cd}	1.99 ^d	2.19 ^a	3.51 ^b	2.87 ^{dc}	2.50 ^c	2.96 ^a	2.98 ^c	2.50 ^d	2.25 ^d	2.57 ^a
M ₂		4.04 ^a	3.01 ^b	2.69 ^{bc}	3.25 ^a	4.92 ^a	4.50 ^a	4.33 ^a	4.58 ^a	4.48 ^a	3.76 ^b	3.51 ^e	3.91 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.58				0.60				0.43			
T		0.71				0.74				0.53			
M		0.58				0.60				0.43			
N x T		1.00				1.04				0.75			
M x T		1.00				1.04				0.75			
N x M		0.81				0.85				0.61			
N x T x M		1.41				1.48				1.05			
Control Vs Rest		0.29		0.87		0.33		0.96		0.22		NS	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Among the three factors interaction, NE + 6 t ha⁻¹ yield target + micronutrient supply (N₁T₁M₂) registered the maximum Zn status (4.85), while lower status (2.18) was occurred with STCR + 8 t ha⁻¹ yield target + no-micronutrient (N₂T₃M₁); other combinations fared in between.

Of the N-T-M combinations, N₂T₁₋₃M₂, N₁T₁M₂ and N₁T₂M₂ had higher soil available Zn while N₁T₃M₁ and N₂T₃M₁ had lower soil available Zn status than control (2.98).

4.2.1.3.6 Soil available copper (mg kg⁻¹) (c.f. Table 185)

Soil available Cu also varied due to nutritional approaches, yield targets and micronutrient + organics application and their interactions during both the years and on pooled basis, however, the values were of lower order among micronutrients.

Among yield targets, higher target of 8 t ha⁻¹ (T₃) registered lower Cu status (2.74) and the content increased with decreasing yield targets wherein lower yield target of 6 t ha⁻¹ (T₁) recorded higher Cu (2.99). Main effects due to nutritional approaches and micronutrient/organic levels were not significant.

Two factor interactions were significant. NE approach coupled with lower yield target across micronutrients (N₁T₁) recorded higher available Cu (3.03), while STCR with 8 t ha⁻¹ (N₂T₃) had lower soil available Cu (2.72); NE with similar yield target was on par, micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum Cu (3.89) with lower target (6 t ha⁻¹) coupled with micronutrients and organics (T₁M₂) while medium yield target and no micronutrients/organics (T₂M₁) had lower Cu status (2.62), and among nutritional approaches and micronutrient + organics supply across yield targets, STCR approach and micronutrients + organics (N₂M₁) recorded the minimum Zn status (2.67), while NE and without and with micronutrient + organics supply (N₁M₁₋₂) had higher Cu status (3.02 and 2.96, respectively).

Among the three factors interaction, STCR + 6 t ha⁻¹ yield target + micronutrient supply (N₂T₁M₂) registered the maximum Cu status (3.12), while lower status (2.58) occurred with STCR + 8 t ha⁻¹ yield target + no-micronutrient (N₂T₃M₁); other combinations fared in between.

Table 185. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on soil available copper (mg kg⁻¹) under direct seeded condition after harvest during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	1.95 ^a	1.82 ^a	1.80 ^a	1.86 ^a	3.70 ^{bc}	3.57 ^{bc}	3.52 ^{bc}	3.60 ^{bc}	2.83 ^{bc}	2.70 ^c	2.66 ^c	2.73 ^b
	M ₂	2.26 ^a	2.05 ^a	2.00 ^a	2.10 ^a	4.22 ^a	3.83 ^{a-c}	3.74 ^d	3.93 ^a	3.24 ^a	2.94 ^{a-c}	2.87 ^{bc}	3.02 ^a
N ₂	M ₁	1.91 ^a	1.81 ^a	1.75 ^a	1.82 ^a	3.63 ^d	3.53 ^{bc}	3.41 ^{cd}	3.52 ^c	2.77 ^{bc}	2.67 ^c	2.58 ^c	2.67 ^b
	M ₂	2.21 ^a	2.01 ^a	1.99 ^a	2.07 ^a	4.03 ^{ab}	3.75 ^{a-c}	3.74 ^{a-c}	3.84 ^{ab}	3.12 ^{ab}	2.88 ^{bc}	2.87 ^{bc}	2.96 ^a
Target		2.09 ^a	1.92 ^a	1.89 ^a		3.90 ^a	3.67 ^{ab}	3.60 ^b		2.99	2.80	2.74	
Control		1.95				3.63				2.79			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		2.11 ^a	1.94 ^a	1.90 ^a	1.98 ^a	3.96 ^a	3.70 ^{ab}	3.63 ^{ab}	3.76 ^a	3.03 ^a	2.82 ^{ab}	2.77 ^b	2.87 ^a
N ₂		2.06 ^a	1.91 ^a	1.87 ^a	1.95 ^a	3.83 ^{ab}	3.64 ^{ab}	3.57 ^b	3.68 ^a	2.95 ^{ab}	2.78 ^{ab}	2.72 ^b	2.81 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		1.93 ^a	1.81 ^a	1.77 ^a	1.84 ^a	3.66 ^b	3.55 ^b	3.46 ^b	3.56 ^a	2.80 ^{bc}	2.68 ^{bc}	2.62 ^c	2.70 ^a
M ₂		2.24 ^a	2.03 ^a	2.00 ^a	2.09 ^a	4.13 ^a	3.79 ^b	3.74 ^b	3.89 ^a	3.18 ^a	2.91 ^b	2.87 ^{bc}	2.99 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.39				0.30				0.21			
T		0.48				0.37				0.26			
M		0.39				0.30				0.21			
N x T		0.68				0.52				0.37			
M x T		0.68				0.52				0.37			
N x M		0.55				0.43				0.30			
N x T x M		0.96				0.74				0.52			
Control Vs Rest		0.19		0.58		0.15		0.45		0.13		NS	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Of the N-T-M combinations, $N_2T_1M_2$ had higher Cu than control (2.79) while others were on par with it.

4.2.1.3.7 Soil available manganese (mg kg^{-1}) (c.f. Table 186)

Similar to other essential nutrients uptake, data on manganese (Mn) uptake revealed significant variations similar to other micronutrients due to nutritional approaches, yield targets and micronutrient + organics application and their interactions during both the years and on pooled basis.

Among yield targets, higher target of 8 t ha^{-1} (T_3) registered lower Mn status (8.30) and the content increased with decreasing yield targets wherein lower yield target of 6 t ha^{-1} (T_1) recorded higher Mn (8.91). Main effects due to nutritional approaches and micronutrient/organic levels were not significant.

Two factor interactions were significant. NE approach coupled with lower yield target across micronutrients (N_1T_1) recorded higher available Mn (9.07), while STCR with 8 t ha^{-1} (N_2T_3) had lower soil available Mn (5.24); NE with similar yield target was on par, micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum Mn (9.33) with lower target (6 t ha^{-1}) coupled with micronutrients and organics (T_1M_2) while higher yield target and no micronutrients/organics (T_2M_1) had lower Mn status (7.87), and among nutritional approaches and micronutrient + organics supply across yield targets, STCR approach and no micronutrients + organics (N_2M_1) recorded the minimum Mn status (8.05), while NE and without and with micronutrient + organics supply (N_1M_{1-2}) had higher Mn status (9.12 and 8.91, respectively).

Among the three factors interaction, NE + 6 t ha^{-1} yield target + micronutrient supply ($N_1T_1M_2$) registered the maximum Mn status (9.53), while lower status (7.77) was recorded with STCR + 8 t ha^{-1} yield target + no-micronutrient ($N_2T_3M_1$); other combinations fared in between.

Of the N-T-M combinations $N_1T_1M_2$ had higher Mn than control (2.79) while others were on par with it.

4.2.1.4 Economics (c.f. Table 187-189)

Gross returns followed more or less trends in grain yield and the variations were significant due to three factor combinations during both the years and on pooled basis.

Table 186. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on available manganese (mg kg⁻¹) under direct seeded condition after harvest during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	6.21 ^{ab}	5.99 ^b	5.79 ^b	6.00 ^{bc}	11.02 ^c	10.66 ^{ab}	10.14 ^{ab}	10.61 ^b	8.61 ^{a-d}	8.33 ^{b-d}	7.96 ^{cd}	8.30 ^b
	M ₂	7.20 ^a	6.49 ^{ab}	6.32 ^{ab}	6.67 ^a	11.87 ^a	11.66 ^a	11.18 ^a	11.57 ^a	9.53 ^a	9.08 ^{ab}	8.75 ^{a-d}	9.12 ^a
N ₂	M ₁	6.01 ^b	5.85 ^b	5.63 ^b	5.83 ^c	10.71 ^{ab}	10.19 ^{ab}	9.91 ^b	10.27 ^b	8.36 ^{b-d}	8.02 ^{cd}	7.77 ^d	8.05 ^b
	M ₂	6.57 ^{ab}	6.39 ^{ab}	6.30 ^{ab}	6.42 ^{ab}	11.69 ^a	11.41 ^a	11.13 ^a	11.41 ^{ab}	9.13 ^{ab}	8.90 ^{a-c}	8.71 ^{a-d}	8.91 ^a
Target		6.50 ^a	6.18 ^{ab}	6.01 ^b		11.32 ^a	10.98 ^a	10.59 ^a		8.91 ^a	8.58 ^a	8.30 ^b	
Control		6.08				10.84				8.46			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		6.70 ^a	6.24 ^a	6.05 ^a	6.33 ^a	11.44 ^a	11.16 ^a	10.66 ^a	11.09 ^a	9.07 ^a	8.70 ^{ab}	8.36 ^b	8.71 ^a
N ₂		6.29 ^a	6.12 ^a	5.97 ^a	6.12 ^a	11.20 ^a	10.80 ^a	10.52 ^a	10.84 ^a	8.74 ^{ab}	8.46 ^{ab}	8.24 ^b	8.48 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		6.11 ^{bc}	5.92 ^{bc}	5.71 ^c	5.91 ^a	10.87 ^{a-c}	10.42 ^{bc}	10.03 ^c	10.44 ^a	8.49 ^{bd}	8.17 ^{cd}	7.87 ^d	8.18 ^a
M ₂		6.88 ^a	6.44 ^{ab}	6.31 ^{a-c}	6.54 ^a	11.78 ^a	11.53 ^{ab}	11.15 ^{a-c}	11.49 ^a	9.33 ^a	8.99 ^{ab}	8.73 ^{a-c}	9.02 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		1.08				1.02				0.57			
T		1.33				1.25				0.69			
M		1.08				1.02				0.57			
N x T		1.88				1.76				0.98			
M x T		1.88				1.76				0.98			
N x M		1.53				1.44				0.80			
N x T x M		2.65				2.49				1.39			
Control Vs Rest		0.32		2.18		0.52		1.52		0.30		0.90	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Among three factors the combinations, higher level of all the factors i.e. STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered the maximum gross returns (₹ 1,56,242) followed by similar combination but with medium yield target (N₂T₂M₂ – ₹ 1,53,904), while among NE maximum returns were recorded with N₁T₃M₂ (₹ 1,52,406) followed by N₁T₃M₁ (₹ 1,49,537) while lower gross returns (₹ 1,18,363) among all were obtained with NE + 6 t ha⁻¹ yield target + no-micronutrient (N₁T₁M₁) which was lower than the control with recommended practice (₹ 1,23,580).

Variations in net returns were significant but interestingly, net returns followed slightly different trend wherein Nutrient expert based nutrition for higher yield of 8 t ha⁻¹ without any micronutrient or organics supply (N₁T₃M₁) recorded the maximum net returns (₹ 1,14,338) followed by NE + 7 t ha⁻¹ yield target without micronutrient supply (N₁T₂M₁ – ₹ 1,11,043), while lower net returns (₹ 80,035) among all were obtained with NE + 6 t ha⁻¹ yield target + micronutrient (N₁T₁M₂) which was lower than the control with recommended practice (₹ 88,369). The returns were higher by ₹ 25,969 and ₹ 22,674, respectively with N₁T₃M₁ and N₁T₂M₂ over control (Fig. 30a).

Variations in B: C ratios were significant but again the trend revealed slightly different pattern. In all, NE was superior to STCR wherein higher B: C ratio (4.25) occurred with NE based nutrition for a yield target of 7 t ha⁻¹ without supply of micronutrients + organics (N₁T₂M₁) followed by NE based nutrition for 8 t ha⁻¹ yield target (N₁T₃M₁ – 4.01). Similar yield targets with STCR based nutrition but without micronutrient + organics (N₂T₁M₁ and N₂T₂₋₃M₁) were 3.40 and 3.3, respectively which were higher than with micro nutrient + organics (N₂T₂M₂ and N₂T₂M₂ with 2.54 and 2.67, respectively). The B: C ratio with the latter was lower than that of control with recommended practice (3.51). Among all the lowest B: C (2.54) was obtained with STCR + 6 t ha⁻¹ yield target + micronutrients + organics supply (N₂T₁M₂) (Fig. 30b).

Table 187. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on gross returns (₹ ha⁻¹) under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	111474 ^f	144552 ^c	148432 ^{bc}	134820 ^c	125251 ^h	145680 ^{d-f}	150641 ^{b-d}	140524 ^c	118363 ^h	145116 ^e	149537 ^{cd}	137672 ^c
	M ₂	121318 ^e	145965 ^c	152867 ^{ab}	140050 ^b	138655 ^g	148934 ^{c-e}	151945 ^{bc}	146511 ^b	129987 ^g	147449 ^{de}	152406 ^{bc}	143281 ^b
N ₂	M ₁	122716 ^e	132653 ^d	145020 ^c	133463 ^c	141811 ^{fg}	143004 ^{fg}	146612 ^{c-f}	143809 ^b	132263 ^g	137828 ^f	145816 ^e	138636 ^c
	M ₂	136557 ^d	152980 ^{ab}	154403 ^a	147980 ^a	143753 ^{e-g}	154829 ^{ab}	158081 ^a	152221 ^a	140155 ^f	153904 ^{ab}	156242 ^a	150100 ^a
Target		123016 ^c	144038 ^b	150181 ^a		137367 ^c	148112 ^b	151820 ^a		130192 ^c	146075 ^b	151000 ^a	
Control		120960				126200				123580			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		116396 ^d	145259 ^b	150650 ^a	137435 ^a	131953 ^d	147307 ^b	151293 ^a	143518 ^a	124175 ^d	146283 ^b	150972 ^a	140476 ^a
N ₂		129637 ^c	142816 ^b	149712 ^a	140721 ^a	142782 ^c	148916 ^{ab}	152346 ^a	148015 ^a	136209 ^c	145866 ^b	151029 ^a	144368 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		117095 ^e	138603 ^c	146726 ^b	134141 ^a	133531 ^d	144342 ^c	148627 ^b	142166 ^a	125313 ^f	141472 ^d	147676 ^a	138154 ^a
M ₂		128938 ^d	149473 ^b	153635 ^a	144015 ^a	141204 ^c	151881 ^a _b	155013 ^a	149366 ^a	135071 ^e	150677 ^b	154324 ^c	146691 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		3378				2198				5325			
T		4138				2691				6521			
M		3378				2198				5325			
N x T		5851				3806				9223			
M x T		5851				3806				9223			
N x M		4778				3108				7530			
N x T x M		8275				5383				13043			
Control Vs Rest		2278		6687		1912		5613		1531		4495	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 188. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on net returns (₹ ha⁻¹) under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	77898 ^e	110479 ^a	113233 ^a	100537 ^a	91674 ^c	111607 ^a	115442 ^a	106241 ^a	84786 ^d	111043 ^a	114338 ^a	103389 ^a
	M ₂	71367 ^f	95517 ^c	101293 ^b	89393 ^b	88704 ^c	98486 ^b	100371 ^b	95853 ^c	80035 ^e	97001 ^c	100832 ^b	92623 ^c
N ₂	M ₁	83671 ^d	91109 ^c	101013 ^b	91931 ^b	103121 ^b	10186 ^b	103007 ^b	102665 ^b	93396 ^c	96487 ^c	102010 ^b	97298 ^b
	M ₂	81137 ^{de}	95061 ^c	94021 ^c	90073 ^b	88689 ^c	97315 ^b	98101 ^b	94702 ^c	84913 ^d	96188 ^c	96061 ^c	92387 ^c
Target		78518 ^c	98042 ^b	102390 ^a		93047 ^b	102318 ^a	104230 ^a		85783 ^c	100180 ^b	103310 ^a	
Control		85749				90988				88369			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		74632 ^f	102998 ^b	107263 ^a	94965 ^a	90189 ^d	105046 ^a	107907 ^a	101047 ^a	82411 ^f	104022 ^b	107585 ^a	98006 ^a
N ₂		82404 ^e	93085 ^d	97517 ^c	91002 ^a	95905 ^c	99590 ^{bc}	100554 ^b	98683 ^a	89155 ^e	96337 ^d	99035 ^c	94843 ^a
Micronutrient/organics (M) x Target (T)					M	M x T			M	M x T			M
M ₁		80785 ^d	100794 ^b	107123 ^a	96234 ^a	97398 ^b	106736 ^a	109225 ^a	104453 ^a	89091 ^d	103765 ^b	108174 ^a	100343 _a
M ₂		76252 ^e	95289 ^c	97657 ^{bc}	89733 ^a	88696 ^c	97900 ^b	99236 ^b	95278 ^a	82474 ^e	96595 ^c	98447 ^c	92505 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		3378				3463				2197			
T		4137				4242				2691			
M		3378				3463				2197			
N x T		5851				5999				3806			
M x T		5851				5999				3806			
N x M		4778				4898				3108			
N x T x M		8275				8483				5383			
Control Vs Rest		2277		6648		1912		5579		1531		4468	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 189. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on B:C ratio under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	3.32 ^b	4.24 ^a	4.22 ^a	3.93 ^a	3.73 ^b	4.28 ^a	4.28 ^a	4.10 ^a	3.53 ^b	4.26 ^a	4.25 ^a	4.01 ^a
	M ₂	2.43 ^f	2.89 ^d	2.96 ^d	2.76 ^c	2.78 ^e	2.95 ^d	2.95 ^d	2.89 ^c	2.60 ^{ef}	2.92 ^d	2.96 ^d	2.83 ^c
N ₂	M ₁	3.14 ^c	3.19 ^{bc}	3.30 ^{ab}	3.21 ^b	3.67 ^b	3.48 ^c	3.36 ^c	3.50 ^b	3.40 ^c	3.33 ^c	3.33 ^c	3.36 ^b
	M ₂	2.46 ^f	2.64 ^e	2.56 ^{ef}	2.55 ^c	2.61 ^f	2.69 ^{ef}	2.64 ^{ef}	2.65 ^d	2.54 ^f	2.67 ^e	2.60 ^{ef}	2.60 ^d
Target		2.84 ^b	3.24 ^a	3.26 ^a		3.20 ^b	3.35 ^a	3.31 ^a		3.02 ^b	3.30 ^a	3.28 ^a	
Control		3.44				3.58				3.51			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		2.87 ^{bc}	3.57 ^a	3.59 ^a	3.34 ^a	3.25 ^c	3.61 ^a	3.61 ^b	3.49 ^a	3.06 ^b	3.59 ^a	3.60 ^a	3.42 ^a
N ₂		2.80 ^c	2.92 ^b	2.93 ^b	2.88 ^a	3.14 ^d	3.08 ^{de}	3.00 ^e	3.07 ^a	2.97 ^c	3.00 ^c	2.96 ^c	2.98 ^b
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		3.23 ^b	3.72 ^a	3.76 ^a	3.57 ^a	3.70 ^b	3.88 ^a	3.82 ^a	3.80 ^a	3.46 ^b	3.80 ^a	3.79 ^a	3.68 ^a
M ₂		2.45 ^d	2.77 ^c	2.76 ^a	2.66 ^a	2.69 ^d	2.82 ^c	2.79 ^c	2.77 ^a	2.57 ^d	2.79 ^c	2.78 ^c	2.71 ^b
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.09				0.09				0.05			
T		0.11				0.11				0.07			
M		0.09				0.09				0.05			
N x T		0.16				0.16				0.09			
M x T		0.16				0.16				0.09			
N x M		0.13				0.13				0.08			
N x T x M		0.23				0.23				0.13			
Control Vs Rest		0.07		0.20		0.05		0.15		0.04		0.12	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

4.2.2 Summer season

4.2.2.1 Growth observations

4.2.2.1.1 Plant height (cm) (c.f. Table 190)

Plant height increased with the advancement of crop age reaching the highest at harvest and the variations were significant due to different treatments (Nutritional approaches-N, yield targets-T, and micronutrient supplementation-M, and their combinations) at all the stages of observations (45, 67, 90 DAS and harvest).

At 45 DAS, differences in plant height varied significantly due to main effects due to yield targets and due to interaction effects. Higher yield target of 8 t ha⁻¹ (T₃) recorded taller plants (31.7) while lower plant height (26.1) was observed with T₁ with lower yield target of 6 t ha⁻¹. Effects due to nutritional approach and micronutrients + organics levels were not significant.

All the two factor interactions (N x T, M x T & N x M) were significant, among these STCR for higher yield target of 8 t ha⁻¹ (N₂T₃) produced taller plants (32.7) while N₁T₁ recorded lower plant height (24.4), among yield targets and micronutrient + organic levels T₃M₂ produced taller plants (33.1) while T₂M₁ recorded lower plant height (25.6), and among nutritional approaches and micronutrients + organics, STCR coupled with micronutrients + organics supply (N₂M₂) produced taller plants (31.3) while NE and no micronutrients or organics supply (N₁M₁) recorded lower plant height (27.9).

Among N-T-M combinations, significantly taller plants (31.7) were observed with STCR based nutrition for 8 t ha⁻¹ alongwith supply micronutrients + organics (N₂T₃M₂), however, all the combinations involving higher and medium yield targets were at par with the former treatment except treatment combination N₂T₂M₁, while lower height (23.5) was observed with NE based nutrition for 6 t ha⁻¹ yield target without micronutrients and organics (N₁T₁M₁).

In comparison with control (33.7) combinations involving STCR with micronutrient + organics supply yield targets of 7t ha⁻¹ and 8 t ha⁻¹ (N₂T₂₋₃M₂) were superior.

At 90 DAS and at harvest more or less similar trend prevailed. In the main effects due to factors only yield target varied significantly wherein crop height increased with increase in targets vis-a-vis nutrition and taller (92.7 and 100.4, respectively at 90

Table 190. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on plant height (cm) under direct seeded condition during summer season

N x T x M		45 DAS				90 DAS				At harvest			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	23.5 ^d	29.7 ^{ab}	30.5 ^{ab}	27.9 ^b	80.3 ^c	92.0 ^b	92.4 ^b	88.2 ^c	94.9 ^b	98.5 ^{ab}	100.2 ^{ab}	97.9 ^a
	M ₂	25.3 ^{cd}	30.3 ^a	30.8 ^a	28.8 ^b	90.6 ^b	92.4 ^b	94 ^{ab}	92.3 ^b	96.7 ^{ab}	98.9 ^{ab}	101.0 ^{ab}	98.9 ^a
N ₂	M ₁	27.7 ^{bc}	27.0 ^c	30.0 ^a	28.2 ^b	91.4 ^b	91.5 ^b	92.3 ^b	91.7 ^b	97.5 ^{ab}	98.0 ^{ab}	98.8 ^{ab}	98.1 ^a
	M ₂	27.7 ^{bc}	31.0 ^a	35.3 ^{ab}	31.3 ^a	91.6 ^b	94.7 ^{ab}	99.1 ^a	95.1 ^a	98.4 ^{ab}	101.2 ^a	101.5 ^a	100.4 ^a
Target		26.1 ^c	29.5 ^b	31.7 ^a		88.5 ^b	88.5 ^b	92.7 ^a		96.9 ^b	99.2 ^a	100.4 ^a	
Control		33.7				87.8				95.3			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		24.4 ^e	30.0 ^{bc}	30.7 ^b	28.4 ^a	85.4 ^c	92.2 ^b	93.2 ^{ab}	90.3 ^a	95.8 ^b	98.7 ^{ab}	100.6 ^a	98.4 ^a
N ₂		27.7 ^d	29.0 ^{cd}	32.7 ^a	29.8 ^a	91.5 ^b	93.1 ^{ab}	96.7 ^a	93.8 ^a	97.9 ^{ab}	99.6 ^{ab}	100.1 ^a	99.2 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		25.6 ^d	28.3 ^c	30.3 ^b	28.1 ^a	85.9 ^c	91.7 ^b	92.4 ^b	90.0 ^a	96.2 ^b	98.3 ^{ab}	99.5 ^{ab}	98.0 ^a
M ₂		26.5 ^d	30.7 ^b	33.1 ^a	30.1 ^a	91.1 ^b	93.5 ^b	97.5 ^a	94.0 ^a	97.6 ^{ab}	100.0 ^{ab}	101.3 ^a	99.6 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		1.5				3.3				3.5			
T		1.8				4.0				4.3			
M		1.5				3.3				3.5			
N x T		2.6				5.7				6.1			
M x T		2.6				5.7				6.1			
N x M		2.1				4.7				4.9			
N x T x M		2.3				4.1				4.8			
Control Vs Rest		3.6		10.6		8.1		23.7		8.6		NS	

DAS - Days after sowing

NS – Not significant

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

DAS and at harvest) plants were observed with yield target of 8 t ha⁻¹ (T₃) while, plants with 6 t ha⁻¹ yield target (T₁) had lower height (88.5 and 66.9, respectively at 90 DAS and at harvest).

Two factor interactions were significant wherein among N x T, STCR and 8 t ha⁻¹ yield target across micronutrients (N₂T₃) resulted in taller plants (96.7 and 101.1, respectively at 90 DAS and at harvest) followed often by other combination with higher and medium yield targets which were at par with the former treatment combination while NE with lower yield target of 6 t ha⁻¹ (N₁T₁) recorded lower plant height (84.5 and 95.8, respectively at 90 DAS and at harvest). Among yield targets and micronutrient supply, higher yield target and micronutrient + organics supply (T₃M₂) produced taller plants (94.0 and 101.3, respectively at 90 DAS and at harvest); higher target without micronutrient + organics and medium yield target with micronutrient + organics were next in the line and were on par with former treatment while 6 t ha⁻¹ without micronutrient + organics (T₁M₁) recorded lower plant height (85.9 and 96.2, respectively at 90 DAS and at harvest), and among nutritional approaches and micronutrients across yield targets, STCR coupled with micronutrient + organics (N₂M₂) registered taller plants (95.8 and 100.4, respectively at 90 DAS and at harvest) with higher target coupled with micro-nutrition (T₃M₂), however all the combinations were at par at harvest while lower yield target and no micro-nutrition (T₁M₁) recorded dwarf plants (88.2 at 90 DAS).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered significantly taller plants (99.1 and 101.5, respectively at 90 DAS and at harvest), however, all combinations were at par at harvest while lower height (80.3 and 94.9, respectively at 90 DAS and at harvest) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁); other treatment combinations fared in between.

All combinations involving medium to higher yield target (T₂₋₃) and micronutrient supply + organics supply (M₂) under both approaches of nutrition (N₁₋₂) fared superior to control (66.8).

4.2.2.1.2 Tiller count (no. m⁻¹ length) (c.f. Table 191)

Tiller count increased throughout crop growth recording the maximum at harvest and the variations were significant due to different factors and their interactions at all the stages of observations.

At 45 DAS, variations in tiller count due to yield targets only were significant wherein the tiller count increased with increase in yield targets corresponding with nutrition and more tillers (65.7) were observed with yield target of 8 t ha⁻¹ (T₃) while, plants with 6 t ha⁻¹ yield target (T₁) had lower tiller count (53.3).

Two factor interactions were significant wherein STCR approach coupled with higher yield target across micronutrients (N₂T₃) recorded more tiller count (62.0) while NE with 6 t ha⁻¹ (N₁T₁) recorded lower tiller count (51.8), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum tiller count (69.3) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂) followed by medium targets with micronutrients + organics while lower yield target and no micronutrient/organics (T₁M₁) recorded lower tiller count (53.2), and among nutritional approaches and yield targets across micronutrient supply, STCR approach and 8 t ha⁻¹ (N₂T₃) recorded more tillers m⁻¹ length (66.9) while NE and lower yield target of 6 t ha⁻¹ (N₁T₁) recorded lower tiller count (57.3), however all other levels except the former treatment combinations were at par.

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered significantly more number of tillers (66.9) followed by similar combination except medium (N₂T₂M₂ – 66.9) and lower (N₂T₁M₂ – 66.9) yield targets and , while lower tiller count (57.3) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁), however all other treatment combinations were at par with N₁T₁M₁.

In comparison with control (52.0) only combinations involving STCR and micronutrient + organics supply irrespective of yield targets (N₂T₁₋₃M₁₂) were superior.

More or less similar trend prevailed at 90 DAS and harvest. All the factors (N-T-M) and their interactions varied significantly except main effects due to nutritional approaches (N) and micronutrient supplementation (M). Among the yield targets significantly more number of tillers (148.8 and 154.7, respectively at 90 DAS and at harvest) occurred with higher yield target of 8 t ha⁻¹ (T₃) while, plants with 6 t ha⁻¹ yield target (T₁) had lower tiller count (143.3 and 143.2, respectively at 90 DAS and at harvest).

Two factor interactions were significant wherein higher yield target across micronutrients with STCR approach (N₂T₃) recorded more number of tillers (149.4 and

Table 191. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on number of tillers m⁻¹ under direct seeded condition during summer season

N x T x M		45 DAS				90 DAS				At harvest			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	57.3 ^b	57.3 ^b	57.3 ^b	57.3 ^b	139.7 ^d	145.8 ^{a-d}	147.8 ^{a-c}	144.4 ^b	135.6 ^f	152.7 ^{c-f}	161.3 ^{b-d}	149.9 ^b
	M ₂	59.2 ^b	59.2 ^b	59.2 ^b	59.2 ^b	144.3 ^{cd}	147.3 ^{a-c}	148.7 ^{a-c}	146.8 ^b	142.7 ^{ef}	159.7 ^{b-e}	167 ^{a-c}	156.5 ^c
N ₂	M ₁	57.0 ^b	57.0 ^b	57.0 ^b	57.0 ^b	144.3 ^{cd}	144.3 ^{cd}	147.2 ^{a-c}	145.3 ^{ab}	144.5 ^{d-f}	149.5 ^{c-f}	109 ^g	134.3 ^b
	M ₂	66.9 ^a	66.9 ^a	66.9 ^a	66.9 ^a	144.7 ^{b-d}	150.9 ^{ab}	151.6 ^a	149.1 ^a	149.9 ^{c-f}	175.9 ^{ab}	181.6 ^a	169.1 ^a
Target		53.3 ^c	61.4 ^b	65.7 ^a		143.3 ^c	147.1 ^b	148.8 ^a		143.2 ^c	159.5 ^a	154.7 ^b	
Control		52.0				144.1				138.7			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		51.8 ^c	59.8 ^b	63.2 ^b	58.3 ^a	142.0 ^c	146.6 ^{ab}	148.3 ^{ab}	145.6 ^a	139.0 ^c	156.2 ^{ab}	164.2 ^a	153.2 ^a
N ₂		54.7 ^c	63.0 ^b	68.2 ^a	62.0 ^a	144.5 ^{bc}	147.6 ^{ab}	149.4 ^a	147.2 ^a	147.2 ^{bc}	162.7 ^a	145.3 ^{bc}	151.7 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		53.2 ^c	56.3 ^c	62.0 ^b	57.2 ^a	142.0 ^d	145.1 ^{b-d}	147.5 ^{a-c}	144.9 ^a	140.0 ^{bc}	151.1 ^b	135.2 ^c	142.1 ^a
M ₂		53.3 ^c	66.5 ^a	69.3 ^a	63.0 ^a	144.5 ^{cd}	149.1 ^{ab}	150.2 ^a	147.9 ^a	146.3 ^{bc}	167.8 ^a	174.3 ^a	162.8 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		4.1				3.7				10.4			
T		5.0				4.6				12.7			
M		4.1				3.7				10.4			
N x T		7.1				6.5				17.9			
M x T		7.1				6.5				17.9			
N x M		5.8				5.3				14.7			
N x T x M		10.1				9.15				25.4			
Control Vs Rest		4.2		12.4		2.1		6.08		5.21=		15.2	

DAS - Days after sowing

NS – Not significant,

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

145.3, respectively at 90 DAS and at harvest) followed by other combinations involving medium and higher targets which were at par with N_2T_3 while SSNM with 6 t ha^{-1} (N_1T_1) recorded lower tiller count (142.0 and 139.0, respectively at 90 DAS and at harvest), micronutrients across approaches in combinations with yield targets registered more tiller count (150.2 and 174.2, respectively at 90 DAS and at harvest) with higher target coupled with micronutrient and organics supply (T_3M_2) while lower yield target and no micronutrient supply (T_1M_1) recorded lower tiller count (142.0 and 140.0, respectively at 90 DAS and at harvest), and among approaches and yield targets across micronutrient supply, STCR approach and 8 t ha^{-1} yield target (N_1T_3) registered higher tiller count (149.1 and 174.2, respectively at 90 DAS and at harvest) while NE and lower yield target of 6 t ha^{-1} (N_1T_1) recorded lower plant height (144.4 and 149.4, respectively at 90 DAS and at harvest).

Among three factor combinations, significantly higher tiller counts (181.6 and 151.6, respectively at 90 DAS and at harvest) throughout were observed with STCR + 8 t ha^{-1} + micronutrient supply ($N_2T_3M_2$) and many of the high and medium yield targets at 90 DAS and $N_2T_2M_2$ and $N_1T_3M_2$ at harvest were at par with $N_2T_3M_2$, while NE + 6 t ha^{-1} + no micronutrient supply ($N_1T_1M_1$) resulted in poor tiller count (1139.7 and 135.6, respectively at 90 DAS and at harvest) among all. Other treatment combinations had intermediary heights.

In between control and rest of the treatments, all combinations except $N_1T_1M_{1-2}$, $N_2T_1M_1$ and $N_1T_2M_2$ at 90 DAS and $N_{1-2}T_1M_{1-2}$, $N_2T_2M_1$ and $N_1T_2M_1$ at harvest fared superior to control (138.7 and 144.1, respectively at 90 DAS and at harvest).

4.2.2.1.3 Leaf area ($\text{cm}^2 \text{ plant}^{-1}$) (c.f. Table 192)

Leaf area (LA) increased till 90 DAS and decreased thereafter due to onset of senescence and the variations were significant due to different factors and their interactions at all the stages of observations. Overall, the trend remained same throughout.

At 45 DAS, variations in LA due to main effects of yield targets were significant while those due to nutritional approaches (N) were not significant. LA increased with increase in yield targets corresponding with nutrition and higher LA (526.0) was observed with yield target of 8 t ha^{-1} (T_3) closely followed by T_2 while, plants with 6 t ha^{-1} yield target (T_1) had lower LA (466.3).

Two factor interactions were significant wherein STCR approach coupled higher yield target across micronutrients (N_2T_3) recorded higher LA (521.3) followed by NE with similar yield target (N_1T_3) which was at par while NE with 6 t ha⁻¹ (N_1T_1) recorded the lowest LA (466.3), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum LA (542.0) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T_3M_2) while lower yield target and no micronutrient/organics (T_1M_1) recorded lower LA (457.8), and among nutritional approaches and micronutrient + organics supply across yield targets, STCR approach and micronutrients + organics (N_2M_2) recorded higher LA (525.5) while NE and no micronutrient + organics supply (N_1M_1) recorded lower LA (486.6) and STCR with micronutrient + organics (N_2M_1) was on par with N_1M_1 .

Among the three factors interactions, STCR + 8 t ha⁻¹ yield target + micronutrient supply ($N_2T_3M_2$) registered significantly higher LA (545.2) followed by similar combination with medium yield target ($N_2T_2M_2$ – 542.2) and similar combination with NE ($N_1T_3M_2$ – 538.8), while lower LA (443.8) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient ($N_1T_1M_1$); other treatment combinations fared in between.

All N-T-M combinations except $N_1T_1M_{1-2}$ were significantly superior to recommended control (443.8) with regard to LA.

More or less similar trend prevailed at 90 DAS and at harvest. All the factors (N-T-M) and their interactions varied significantly except main effects due to nutritional approaches (N) at 90 DAS and at harvest and micronutrient supplementation (M) at harvest. Among the yield targets significantly higher LA (1401.7 and 800.8, respectively at 90 DAS and at harvest) occurred with higher yield target of 8 t ha⁻¹ (T_3) while, plants with 6 t ha⁻¹ yield target (T_1) had lower LA (1221.3 and 704.7, respectively at 90 DAS and at harvest), and among micronutrient + organics levels at 90 DAS micronutrient + organics supply (M_3) recorded higher leaf area (1367.1).

All the two factor interactions were significant. Among N x T, higher yield target across micronutrients with STCR approach (N_2T_3) recorded higher LA (1420.5 and 819.3, respectively at 90 DAS and at harvest) followed by N_1T_3 which was at par at 90 DAS while SSNM with 6 t ha⁻¹ (N_1T_1) recorded lower LA (1175.6 and 686.8, respectively at 90 DAS and at harvest), micronutrients across approaches in combinations with yield targets registered higher LA (1445.9 and 831.3, respectively at

Table 192. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on leaf area (cm² plant⁻¹) under direct seeded condition during summer season

N x T x M		45 DAS				90 DAS				At harvest			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	443.8 ^f	493.5 ^c	522.5 ^b	486.6 ^c	1124.2 ^h	1334.9 ^{de}	1364.9 ^{cd}	1274.7 ^c	661.3 ^e	758.0 ^{b-d}	779.8 ^{bc}	733.0 ^b
	M ₂	460.8 ^e	511.8 ^b	538.8 ^a	503.8 ^b	1226.9 ^g	1356.9 ^{cd}	1401.1 ^{bc}	1328.3 ^b	712.2 ^d	777.5 ^{bc}	785.0 ^b	758.2 ^b
N ₂	M ₁	471.8 ^{de}	485.8 ^{cd}	497.5 ^c	485.1 ^c	1243.2 ^{fg}	1265.8 ^{fg}	1350.2 ^{cd}	1286.4 ^c	714.4 ^d	729.8 ^{cd}	761.0 ^{b-d}	735.1 ^b
	M ₂	488.8 ^c	542.5 ^a	545.2 ^a	525.5 ^a	1291.0 ^{ef}	1436.1 ^b	1490.8 ^a	1405.9 ^a	730.8 ^{cd}	794.0 ^b	877.6 ^a	800.8 ^a
Target		466.3 ^c	508.4 ^b	526.0 ^a		1221.3 ^c	1348.4 ^b	1401.7 ^a		704.7 ^c	764.8 ^b	800.8 ^a	
Control		457.8				1157.4				680.0			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		452.3 ^e	502.7 ^c	530.7 ^a	495.2 ^a	1175.6 ^d	1345.9 ^b	1383.0 ^{ab}	1301.5 ^a	686.8 ^d	767.8 ^b	782.4 ^b	745.6 ^a
N ₂		480.3 ^d	514.2 ^b	521.3 ^{ab}	505.3 ^a	1267.1 ^c	1350.9 ^b	1420.5 ^a	1346.2 ^a	722.6 ^c	761.9 ^b	819.3 ^a	767.9 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		457.8 ^f	489.7 ^d	510.0 ^c	485.8 ^b	1183.7 ^f	1300.3 ^d	1357.6 ^c	1280.5 ^b	687.8 ^e	743.9 ^{cd}	770.4 ^{bc}	734.1 ^a
M ₂		474.8 ^e	527.2 ^b	542.0 ^a	514.7 ^a	1259.0 ^e	1396.5 ^b	1445.9 ^a	1367.1 ^a	721.5 ^d	785.8 ^b	831.3 ^a	779.5 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		9.2				34.8				30.5			
T		11.3				42.7				37.4			
M		9.2				34.8				30.5			
N x T		16.0				60.4				52.9			
M x T		16.0				60.4				52.9			
N x M		13.1				49.3				43.2			
N x T x M		22.6				85.4				74.8			
Control Vs Rest		4.6		13.5		17.7		51.8		17.2		50.2	

DAS - Days after sowing

Nutrient approach (N)

Yield Targets (T)

Micronutrient & Organics (M)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

90 DAS and at harvest) with higher target coupled with micronutrient and organics supply (T₃M₂) while lower yield target and no micronutrient supply (T₁M₁) recorded lower LA (1183.7 and 687.8, respectively), and among approaches and micronutrient +

organics supply across yield targets, STCR approach and micronutrient + organics supply (N_1M_2) registered higher LA (1405.9 and 800.8, respectively at 90 DAS and at harvest) while NE and no micronutrient + organics supply (N_1N_2) recorded lower LA (1274.7 and 733.0, respectively).

Among three factor combinations, significantly higher LA (1490.8 and 800.8, respectively at 90 DAS and at harvest) throughout was observed with STCR + 8 t ha⁻¹ + micronutrient supply ($N_2T_3M_2$) while NE + 6 t ha⁻¹ + no micronutrient supply ($N_1T_1M_1$) resulted in poor LA (1124.2 and 661.3, respectively at 90 DAS and at harvest). Other treatment combinations had intermediary LA.

In between control and rest of the treatments, all combinations except $N_1T_1M_1$ at 90 DAS, and combinations involving medium and high yield targets ($N_{1-2}T_{2-3}M_{1-2}$) except $N_2T_2M_1$ and all T_1 combinations and $N_2T_1M_2$ were superior to control (1157.4 and 680.0, respectively at 90 DAS and at harvest).

4.2.2.1.4 Leaf area index (c.f. Table 193)

Leaf area index (LAI) followed trends in leaf area and increased till 90 DAS and decreased thereafter due to onset of senescence and the variations were significant due to different factors and their interactions at all the stages of observations. Overall, the trend remained same throughout.

Variations in LAI due to main effects of yield targets and micronutrients alongwith organics (M) at all the stages and those due to nutritional approaches (N) at 45 and 90 DAS were significant. LAI increased with increase in yield targets corresponding with nutrition and higher LAI (2.63, 7.01 and 4.00, respectively at 45 and 90 DAS at harvest) was observed with yield target of 8 t ha⁻¹ (T_3) closely followed by T_2 while, plants with 6 t ha⁻¹ yield target (T_1) had lower LAI (2.33, 6.11 and 3.52, respectively at 45 and 90 DAS at harvest).

Two factor interactions were significant. STCR approach coupled higher yield target across micronutrients (N_2T_3) recorded higher LAI (2.61, 6.75 and 4.10, respectively at 45 and 90 DAS at harvest) and NE with similar yield target was on par at 45 DAS while NE with 6 t ha⁻¹ (N_1T_1) recorded the lowest LAI (2.31, 3.87, 6.00 and 4.48, respectively at 45 and 90 DAS at harvest), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum LAI (2.71, 4.29,

Table 193. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on leaf area index under direct seeded condition during summer season

N x T x M		45 DAS				90 DAS				At harvest			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	2.22 ^g	2.47 ^d	2.61 ^b	2.43 ^c	5.62 ^h	6.67 ^{de}	6.82 ^{cd}	6.37 ^c	3.31 ^e	3.79 ^{b-d}	3.90 ^{bc}	3.67 ^b
	M ₂	2.30 ^f	2.56 ^{bc}	2.69 ^a	2.52 ^b	6.13 ^g	6.78 ^{cd}	7.01 ^{bc}	6.64 ^b	3.56 ^d	3.89 ^{bc}	3.92 ^b	3.79 ^b
N ₂	M ₁	2.36 ^{ef}	2.43 ^{de}	2.49 ^{cd}	2.43 ^c	6.22 ^{fg}	6.33 ^{fg}	6.75 ^{cd}	6.43 ^c	3.57 ^d	3.65 ^{cd}	3.81 ^{b-d}	3.68 ^b
	M ₂	2.44 ^d	2.71 ^a	2.73 ^a	2.63 ^a	6.45 ^{ef}	7.18 ^b	7.45 ^a	7.03 ^a	3.65 ^{cd}	3.97 ^b	4.39 ^a	4.00 ^a
Target		2.33 ^c	2.54 ^b	2.63 ^a		6.11 ^c	6.74 ^b	7.01 ^a		3.52 ^c	3.82 ^b	4.00 ^a	
Control		2.29				5.79				3.42			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		2.26 ^e	2.51 ^c	2.65 ^a	2.48 ^a	5.88 ^d	6.73 ^b	6.91 ^b	6.51 ^a	3.43 ^d	3.84 ^b	3.91 ^b	3.73 ^a
N ₂		2.40 ^d	2.57 ^b	2.61 ^{ab}	2.53 ^a	6.34 ^c	6.75 ^b	7.10 ^a	6.73 ^a	3.61 ^c	3.81 ^b	4.10 ^a	3.84 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		2.29 ^f	2.45 ^d	2.55 ^c	2.43 ^{ab}	5.92 ^f	6.50 ^d	6.79 ^c	6.40 ^a	3.44 ^e	3.72 ^{cd}	3.85 ^{bc}	3.67 ^a
M ₂		2.37 ^e	2.64 ^b	2.71 ^a	2.57 ^a	6.29 ^e	6.98 ^b	7.23 ^a	6.84 ^a	3.61 ^d	3.93 ^b	4.16 ^a	3.90 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.05				0.17				0.15			
T		0.06				0.21				0.19			
M		0.05				0.17				0.15			
N x T		0.08				0.30				0.26			
M x T		0.08				0.30				0.26			
N x M		0.07				0.25				0.22			
N x T x M		0.11				0.43				0.37			
Control Vs Rest		0.02		0.06		0.08		0.25		0.08		0.25	

DAS - Days after sowing

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

7.23 and 4.16, respectively at 45 and 90 DAS at harvest) with higher target (8 t ha^{-1}) coupled with micronutrients and organics (T_3M_2) while lower yield target and no micronutrient/organics (T_1M_1) recorded lower LAI (2.29, 3.88, 5.92 and 3.44, respectively at 45 and 90DAS at harvest), and among nutritional approaches and micronutrient + organics levels across yield targets, STCR approach and micronutrients + organics supply (N_2M_2) recorded higher LAI (2.63, 7.03 and 4.00, respectively at 45 and 90 DAS at harvest) while NE and no micronutrient + organics supply (N_1M_1) recorded lower LAI (2.43, 6.37 and 3.67, respectively at 45 and 90DAS at harvest) and N_1M_2 was on par with it throughout.

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + micronutrient supply ($N_2T_3M_2$) registered significantly higher LAI (2.73, 7.45, and 4.29, respectively at 45 and 90 DAS and at harvest) and at 45 and 90 DAS $N_2T_2M_2$ was on par, while lower LAI (2.22, 5.62 and 3.31, respectively at 45 and 90 DAS and at harvest) was recorded with NE + 6 t ha^{-1} yield target + no micronutrient ($N_1T_1M_1$); other treatment combinations fared in between.

All combinations except $N_1T_1M_{1-2}$ at 45 DAS, $N_1T_1M_1$ at 90 DAS, and combinations involving higher yield target ($N_{1-2}T_3M_{1-2}$) at harvest were significantly superior to control (2.29, 5.79 and 3.42, respectively at 45 and 90 DAS and at harvest) with regard to LAI.

4.2.2.1.5 Dry matter accumulation in leaves (g plant^{-1}) (c.f. Table 194 and Fig. 31a)

Dry matter (DM) in leaf increased throughout crop growth till harvest recording the maximum at harvest and the variations were significant due to different factors and their interactions at all the stages of observations except at 45 DAS.

At 90 DAS and at harvest among the main effects variations due to nutritional approaches (N) and micronutrient + organics levels (M) were not significant while those due to yield targets (T) revealed significant variations. DM increased with increase in yield targets corresponding with increase in nutrition and higher DM (10.90 and 15.0, respectively at 90 DAS and at harvest) occurred with yield target of 8 t ha^{-1} (T_3) while, plants with 6 t ha^{-1} yield target (T_1) had lower DM (7.40 and 11.7, respectively at 90 DAS and at harvest).

Table 194. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on dry matter accumulation in leaves (g plant⁻¹) under direct seeded condition during summer season

N x T x M		45 DAS				90 DAS				At harvest			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	0.54 ^a	0.54 ^a	0.57 ^a	0.55 ^a	6.70 ^b	8.90 ^{de}	10.80 ^c	8.80 ^c	10.70 ^c	13.80 ^{ab}	15.00 ^a	13.20 ^b
	M ₂	0.53 ^a	0.57 ^a	0.57 ^a	0.56 ^a	7.10 ^a	10.00 ^f	11.50 ^e	9.50 ^d	11.60 ^c	14.60 ^a	14.70 ^a	13.60 ^b
N ₂	M ₁	0.58 ^a	0.57 ^a	0.57 ^a	0.57 ^a	7.10 ^a	7.30 ^c	9.30 ^c	7.90 ^b	12.00 ^{bc}	12.30 ^{bc}	15.00 ^a	13.10 ^{ab}
	M ₂	0.55 ^a	0.58 ^a	0.59 ^a	0.57 ^a	8.80 ^e	11.90 ^{cd}	12.00 ^c	10.90 ^a	12.40 ^{bc}	15.40 ^a	15.40 ^a	14.40 ^a
Target		0.55 ^a	0.57 ^a	0.58 ^a		7.40 ^c	9.50 ^b	10.90 ^a		11.70 ^c	14.00 ^b	15.00 ^a	
Control		0.52				6.92				11.07			
Approach-N(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		0.53 ^a	0.56 ^a	0.57 ^a	0.55 ^a	6.90 ^d	9.42 ^b	11.12 ^a	9.10 ^a	11.20 ^b	14.20 ^a	14.80 ^a	13.40 ^a
N ₂		0.57 ^a	0.57 ^a	0.58 ^a	0.57 ^a	7.95 ^c	9.60 ^b	10.62 ^a	9.40 ^a	12.20 ^b	13.90 ^a	15.20 ^a	13.80 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		0.56 ^a	0.56 ^a	0.57 ^a	0.56 ^a	6.90 ^d	8.08 ^c	10.02 ^b	8.30 ^a	11.30 ^c	13.10 ^b	15.00 ^a	13.10 ^a
M ₂		0.54 ^a	0.57 ^a	0.58 ^a	0.56 ^a	7.95 ^c	10.93 ^a	11.72 ^a	10.20 ^a	12.00 ^{bc}	15.00 ^a	15.00 ^a	14.00 ^a
Comparison	S.Em±	LSD 0.05				S.Em±	LSD 0.05			S.Em±	LSD 0.05		
N	0.04					0.76				1.26			
T	0.05					0.93				1.54			
M	0.04					0.76				1.26			
N x T	0.07					1.32				2.18			
M x T	0.07					1.32				2.18			
N x M	0.06					1.08				1.78			
N x T x M	0.11					1.87				3.08			
Control Vs Rest	0.02	NS				0.44	1.30			0.66	1.95		

DAS - Days after sowing

Nutrient approach (N)

Yield Targets (T)

Micronutrient & Organics (M)

NS – Not significant,

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Combination of two factors resulted in significant variation in leaf DM. DM was higher and at parity (11.12 – 10.62 and 14.80 -15.2, respectively at 90 DAS and at harvest) with both the approaches with yield target of 8 t ha⁻¹ (N₁₋₂T₃) while NE with 6 t ha⁻¹ (N₁T₁) recorded the lowest DM (1.55, 8.5 and 14.4, respectively 90 DAS and at harvest), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum DM (11.72 and 15.00, respectively at 90 DAS and at harvest) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂) followed by similar combination with medium yield target (T₂M₂) and higher target and no micronutrient (T₃M₁) which were on par with the former treatment while lower yield target and no micronutrient/organics (T₁M₁) recorded lower DM (6.90 and 11.3, respectively 90 DAS and at harvest), and among nutritional approaches and micronutrient levels across yield targets, STCR approach and 8 t ha⁻¹ yield target (N₂T₃) recorded higher DM (10.89 and 14.40, respectively 90 DAS and at harvest) while NE and lower yield target of 6 t ha⁻¹ (N₁T₁) recorded lower DM (8.78 and 13.20, respectively 90 DAS and at harvest) in leaves.

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered the maximum DM (12.00 and 15.4, respectively 90 DAS and at harvest) and all combinations involving medium and high yield targets except N₂T₂M₁ were on par with N₂T₃M₂ at harvest, while lower DM (6.70 and 10.7, respectively at 90 DAS and at harvest) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient or organics (N₁T₁M₁) whereas all combinations involving 6 t ha⁻¹ yield target were at par with N₁T₁M₁ at harvest among all; other treatment combinations fared in between.

All (three factor) combinations involving medium and higher yield target (T₂₋₃) irrespective of nutritional approaches (N₁₋₂) and micronutrient supply (M₁₋₂) except N₂T₂M₁ at 90 DAS, and all combinations involving medium and high yield targets except N₁T₂M₁ at harvest were superior to control with recommended practices (6.92 and 11.07, respectively at 90 DAS and at harvest).

4.2.2.1.6 Dry matter accumulation in stem (g plant⁻¹) (c.f. Table 195 and Fig. 31b)

DM in stem increased throughout crop growth till harvest recording the maximum at harvest and the variations due to all the factors and their interactions at all the stages of observations were significant on most occasions. At 45 DAS, only variations in DM due to yield targets were significant wherein the DM increased with

increase in yield targets corresponding with higher fertilization and higher DM (1.19) occurred with yield target of 8 t ha⁻¹ (T₃) while, plants with 6 t ha⁻¹ yield target (T₁) had lower DM (0.60). Differences due to nutritional approaches (N) and micronutrient + organic levels (M) were not significant.

Two factor interactions were significant wherein STCR approach coupled with higher yield target across micronutrients (N₂T₃) recorded higher DM (1.23); N₁T₃ was at par while NE with 6 t ha⁻¹ (N₁T₁) recorded the lowest DM (0.49), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum DM (1.42) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂) while lower yield target and no micronutrient/organics (T₁M₁) recorded lower DM (0.54), and among nutritional approaches and micronutrient levels across yield targets, STCR approach and micronutrient + organics supply (N₂M₂) recorded higher DM (1.23) while NE and no micronutrient + organics supply (N₁M₁) recorded lower DM (0.76) in stem.

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered the maximum DM (1.57), while lower DM (0.40) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁) among all; other treatment combinations fared in between.

All combinations involving medium to higher yield target (T₂₋₃) irrespective of nutritional approaches (N₁₋₂) and micronutrient supply (M₁₋₂) except N₂T₂M₁ fared better than control with recommended practices (0.62).

More or less similar trend prevailed at 90 DAS and at harvest. Among the main effects variations in DM due to yield targets were significant. DM increased with increase in yield targets corresponding with increase in nutrition and higher DM (13.20 and 23.90, respectively 90 DAS and at harvest) occurred with yield target of 8 t ha⁻¹ (T₃) while, plants with 6 t ha⁻¹ yield target (T₁) had lower DM (10.70 and 21.60, respectively 90 DAS and at harvest). Differences due to nutritional approaches (N) and micronutrient + organic supply (M) were not significant.

Combination of two factors also resulted in significant variation in stem DM. DM was always higher (12.73 and 24.20, respectively at 90 DAS and at harvest) with STCR approach with yield target of 8 t ha⁻¹ (N₂T₃), while NE with 6 t ha⁻¹ (N₁T₁) recorded the lowest DM (10.05 and 21.30, respectively 90 DAS and at harvest),

Table 195. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on dry matter accumulation in stem (g plant⁻¹) under direct seeded condition during summer season

N x T x M		45 DAS				90 DAS				At harvest			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	0.40 ^h	0.84 ^{c-f}	1.04 ^c	0.76 ^c	9.00 ^d	11.57 ^c	12.53 ^{bc}	11.00 ^c	21.20 ^c	22.40 ^{bc}	23.10 ^{bc}	22.20 ^b
	M ₂	0.57 ^{gh}	0.97 ^{cd}	1.26 ^b	0.93	11.10 ^c	12.37 ^{bc}	13.6 ^{ab}	12.40 ^c	21.40 ^c	22.50 ^{bc}	24.10 ^b	22.70 ^b
N ₂	M ₁	0.67 ^{fg}	0.71 ^{e-g}	0.89 ^{c-e}	0.76 ^b	11.3 ^c	11.37 ^c	11.93 ^c	11.50 ^b	21.70 ^c	22.40 ^{bc}	22.30 ^{bc}	22.10 ^b
	M ₂	0.77 ^{d-g}	1.34 ^b	1.57 ^a	1.23 ^a	11.43 ^c	14.1 ^a	14.63 ^a	13.40 ^a	22.20 ^c	24.10 ^b	26.20 ^a	24.20 ^a
Target		0.60 ^c	0.97 ^b	1.19 ^a		10.70 ^c	12.40 ^b	13.20 ^a		21.60 ^c	22.90 ^b	23.90 ^a	
Control		0.62				10.8				21.21			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		0.49 ^e	0.91 ^c	1.15 ^{ab}	0.85 ^a	10.05 ^d	11.97 ^{bc}	13.07 ^a	11.70 ^a	21.30 ^d	22.50 ^{b-d}	23.60 ^{bc}	22.50 ^a
N ₂		0.72 ^d	1.02 ^{bc}	1.23 ^a	0.99 ^a	11.37 ^c	12.73 ^{ab}	13.28 ^a	12.50 ^a	21.90 ^{cd}	23.20 ^b	24.20 ^a	23.10 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		0.54 ^e	0.77 ^d	0.97 ^c	0.76 ^a	10.15 ^d	11.47 ^{bc}	12.23 ^b	11.30 ^a	21.40 ^d	22.40 ^{b-d}	22.70 ^{bc}	22.20 ^a
M ₂		0.67 ^{de}	1.16 ^b	1.42 ^a	1.08 ^a	11.27 ^c	13.23 ^a	14.12 ^a	12.90 ^a	21.80 ^{cd}	23.30 ^b	25.10 ^a	23.40 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.13				0.84				1.08			
T		0.15				1.03				1.32			
M		0.13				0.84				1.08			
N x T		0.22				1.46				1.87			
M x T		0.22				1.46				1.87			
N x M		0.18				1.19				1.52			
N x T x M		0.31				2.06				2.64			
Control Vs Rest		0.06		0.18		0.47		1.37		0.57		1.67	

DAS - Days after sowing

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

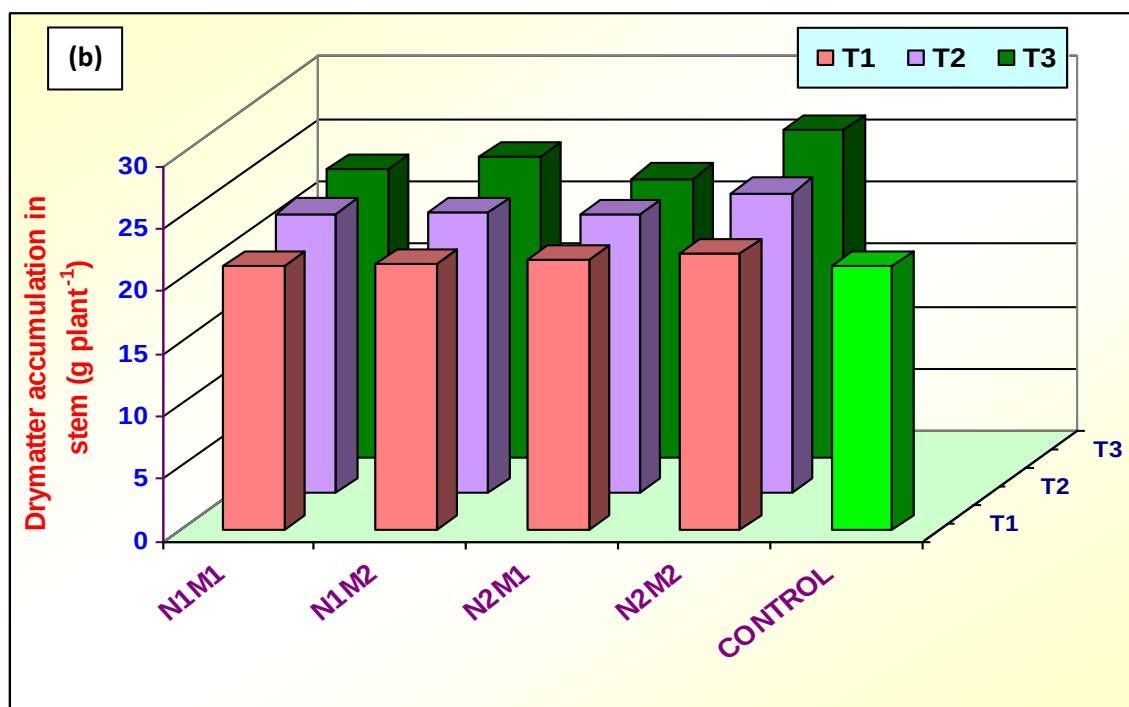
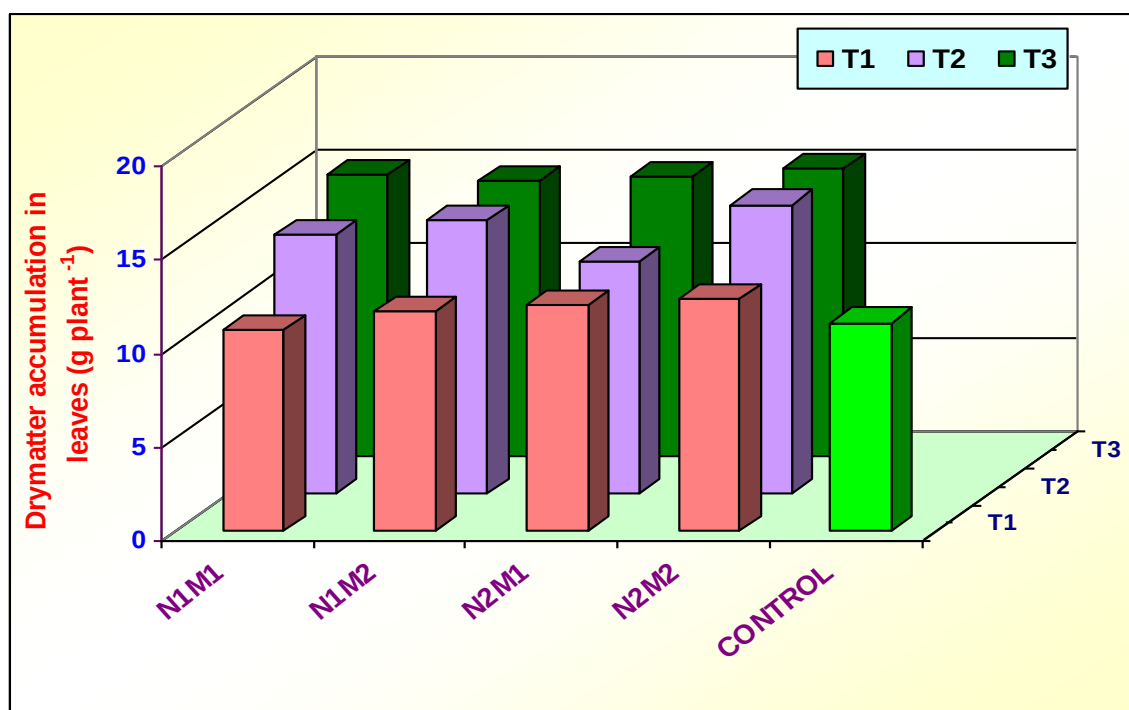
: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT



LEGEND		
Nutritional approaches (N):	N ₁ - Nutrient Expert,	N ₂ - Soil Test Crop Response approach
Yield Targets (T):	T ₁ - 6 t ha ⁻¹ ,	T ₂ - 7 t ha ⁻¹ , T ₃ - 8 t ha ⁻¹
Micronutrient & Organics (M):	M ₁ - Without FeSO ₄ +ZnSO ₄ + Organics,	M ₂ - With FeSO ₄ +ZnSO ₄ + Organics

Fig. 31. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on dry matter accumulation in (a) leaves and (b) stem (g plant⁻¹) at harvest under direct seeded condition during summer season

micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum DM (14.12 and 25.10, respectively at 90 DAS and at harvest) with higher target (8 t ha^{-1}) coupled with micronutrients and organics (T_3M_2); T_3M_2 was on par at 90 DAS while lower yield target and no micronutrients + organics (T_1M_1) recorded lower DM (10.15 and 21.4, respectively at 90 DAS and at harvest), and among nutritional approaches and micronutrient supply across yield targets STCR approach and supply of micronutrient + organics (N_2M_2) recorded higher DM (13.39 and 24.1, respectively at 90 DAS and at harvest) while NE and no micronutrient + organics supply (N_1M_1) recorded lower DM (11.03 and 22.2, respectively at 90 DAS and at harvest) in stem.

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + micronutrient supply ($N_2T_3M_2$) registered the maximum DM (14.63 and 21.20, respectively at 90 DAS and at harvest); $N_2T_2M_2$ was at par at 90 DAS, while lower DM (9.00 and 24.1, respectively at 90 DAS and at harvest) was recorded with NE + 6 t ha^{-1} yield target + no micronutrient or organics ($N_1T_1M_1$) among all; other treatment combinations fared in between.

Among the three factor combinations, all the medium and higher yield targets (T_{2-3}) irrespective of nutritional approaches (N_{1-2}) and micronutrient supply (M_{1-2}) except $N_1T_2M_1$ and $N_2T_2M_1$ at 90 DAS and all maximum yield target combinations and $N_2T_2M_2$ at harvest were superior to control with recommended practices (10.8 and 21.21, respectively at 90 DAS and at harvest).

4.2.2.1.7 Dry matter accumulation in panicles (g plant^{-1}) (c.f. Table 196 and Fig.32a)

DM in reproductive parts was measured only at harvest. Data revealed significant variations due to factors under study and their combinations. Main effects due to only yield targets (T) revealed significant variations in DM in panicle while different methods of nutrition (N) and levels of micronutrient + organics (M) failed to induce significant differences. Higher DM (30.20) occurred with yield target of 8 t ha^{-1} (T_3) while, plants with 6 t ha^{-1} yield target (T_1) had lower DM (22.90).

All the two factor interactions were significant, in that nutritional approach x yield target revealed significantly higher DM (30.40 and 29.90, respectively with STCR and NE) with higher yield target irrespective of the approaches ($N_{1-2}T_3$) used, while lower DM (20.80) among these combinations occurred with NE approach and lower

Table 196. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on dry matter accumulation in panicle (g plant⁻¹) at harvest under direct seeded condition during summer season

N x T x M		Dry matter accumulation in panicle (g plant ⁻¹)			
		T ₁	T ₂	T ₃	N x M
N ₁	M ₁	19.50 ^g	26.50 ^d	29.70 ^{bc}	25.20 ^b
	M ₂	22.10 ^f	27.70 ^{cd}	30.10 ^{bc}	26.60 ^b
N ₂	M ₁	23.70 ^{ef}	25.40 ^{de}	27.00 ^d	25.40 ^b
	M ₂	26.20 ^{de}	30.70 ^b	33.90 ^a	30.30 ^a
Target		22.90 ^c	27.60 ^b	30.20 ^a	
Control		21.47			
Approach-N-(NE/STCR) x Target (T)					N
N ₁		20.80 ^d	27.10 ^b	29.90 ^a	25.90 ^a
N ₂		24.90 ^c	28.10 ^b	30.40 ^a	27.80 ^a
Micronutrient/org. (M) x Target (T)					M
M ₁		21.6 ^e	26.0 ^c	28.30 ^b	25.30 ^a
M ₂		24.1 ^d	29.2 ^b	32.00 ^a	28.40 ^a
Comparison		S.Em±		LSD 0.05	
N		1.58			
T		1.93			
M		1.58			
N x T		2.73			
M x T		2.73			
N x M		2.23			
N x T x M		3.87			
Control Vs Rest		1.67		0.18	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

yield target (N_1T_1). In $T \times M$, T_3M_2 had significantly higher DM in panicles (32.00) while T_1M_1 recorded lower DM (21.6), and in case of $N \times M$, N_2M_2 recorded significantly higher DM in panicles (30.30) while N_1M_1 recorded lower DM (25.20) in panicles at harvest.

Among the three factors ($N \times T \times M$) interactions, STCR + 8 t ha⁻¹ yield target + micronutrient supply ($N_2T_3M_2$) registered the maximum DM content in panicles (33.90), while lower DM (19.50) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient ($N_1T_1M_1$) among all; other treatment combinations fared in between.

All combinations involving medium to higher yield targets (T_{2-3}) irrespective of nutrition approach (N_{1-2}) and micronutrient supply (M_{1-2}) except $N_2T_2M_1$ fared better than control with recommended practices (21.47) at harvest with regard to DM in panicles.

4.2.2.1.8 Total dry matter production (g plant⁻¹) (c.f. Table 197 and Fig. 32b)

Total dry matter (TDM) increased throughout crop growth till harvest recording the maximum at harvest and the variations were significant due to all the factors studied and their interactions at all the stages of observations.

At 45 DAS, the means due to NE and STCR (N_{1-2}) were at par (1.40 and 1.60, respectively), as par yield targets were concerned TDM revealed significant variations wherein higher yield target of 8 t ha⁻¹ (T_3) recorded higher TDM (1.80) while lower target (T_1 – 6 t ha⁻¹) recorded lower TDM (1.20), and among the micronutrient and organics, again the differences were not significant (1.30 - 1.60).

All the two factor interactions were significant. In $N \times T$, STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher TDM (1.80) followed by NE with similar yield target (N_1T_3 – 1.70) which was on par while NE with 6 t ha⁻¹ (N_1T_1) recorded the lowest TDM (1.00), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum TDM (2.00) with higher yield target (8 t ha⁻¹) coupled with micronutrients and organics (T_3M_2) while lower yield target and no micronutrient + organics (T_1M_1) recorded lower TDM (1.10), and among nutritional approaches and micronutrient + organics levels across yield targets higher TDM (1.80) was observed with STCR + micronutrient supply

(N₂M₂) while lower TDM (1.31) was recorded with NE + no micronutrient /organics supply (N₁M₁).

Among the three factors (N x T x M) interactions, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered the maximum TDM (2.20), while lower TDM (1.00) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁) among all; other treatment combinations fared in between.

All combinations involving medium to higher yield targets (T₂₋₃) irrespective of nutritional approaches (N₁₋₂) and micronutrient supply (M₁₋₂) except N₂T₂M₁ fared better than control with recommended practices (1.14).

Similar trend prevailed at 90 DAS and at harvest. The means due to nutritional approaches (NE/STCR - N₁₋₂) were at par (20.90/21.80 and 61.80/64.70, respectively at 90 DAS and at harvest). As par yield targets were concerned TDM revealed significant variations wherein higher yield target of 8 t ha⁻¹ (T₃) recorded the maximum TDM (24.10 and 69.10, respectively) while lower target (T₁ – 6 t ha⁻¹) recorded lower TDM (18.10 and 56.10, respectively at 90 DAS and at harvest. Again variations due to levels of micronutrient and organics were not significant.

All the two factor interactions were significant. Among N x T, STCR and NE approaches coupled with higher yield target across micronutrients (N₁₋₂T₃) were at par and superior to others in TDM (23.90, 24.20 and 60.80, 68.30 –STCR, NE, respectively at 90 DAS and at harvest) while NE with 6 t ha⁻¹ (N₁T₁) recorded lower TDM (17.00 and 53.30, respectively at 90 DAS and at harvest), micronutrients+ organics across nutritional approaches in combination with yield targets registered the maximum TDM (25.80 and 72.10, respectively at 90 DAS and at harvest) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂) while lower yield target and no micronutrient + organics (T₁M₁) recorded lower TDM (17.10 and 54.40, respectively at 90 DAS and at harvest), and among nutritional approaches and micronutrient levels across yield targets higher TDM (24.20 and 68.80, respectively at 90 DAS and at harvest) was observed with STCR + micronutrient supply (N₂M₂) while NE + no micronutrient/organics supply (N₁M₁) recorded lower TDM (19.80 and 60.60, respectively).

Table 197. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on total dry matter production (g plant⁻¹) under direct seeded condition during summer season

N x T x M		45 DAS				90 DAS				At harvest			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	1.00 ^g	1.40 ^{de}	1.60 ^{cd}	1.30 ^c	15.70 ^g	20.40 ^e	23.30 ^c	19.80 ^c	51.40 ^h	62.80 ^e	67.70 ^{b-d}	60.60 ^b
	M ₂	1.10 ^{fg}	1.60 ^{cd}	1.80 ^{bc}	1.50 ^c	18.20 ^f	22.30 ^{cd}	25.10 ^b	21.90 ^c	55.10 ^{gh}	64.80 ^{c-e}	68.90 ^{bc}	62.90 ^b
N ₂	M ₁	1.30 ^{ef}	1.30 ^{ef}	1.50 ^{de}	1.30 ^b	18.40 ^f	18.70 ^f	21.20 ^{de}	19.40 ^b	57.30 ^{fg}	60.10 ^{ef}	64.20 ^{de}	60.50 ^b
	M ₂	1.30 ^{ef}	1.90 ^b	2.20 ^a	1.80 ^a	20.20 ^e	26.00 ^{ab}	26.60 ^a	24.30 ^a	60.70 ^{ef}	70.20 ^b	75.40 ^a	68.80 ^a
Target		1.20 ^c	1.50 ^b	1.80 ^a		18.10 ^c	21.90 ^b	24.10 ^a		56.10 ^c	64.50 ^b	69.10 ^a	
Control		1.14				17.70				53.75			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		1.00 ^e	1.50 ^c	1.70 ^{ab}	1.40 ^a	17.00 ^d	21.40 ^b	24.20 ^a	20.90 ^a	53.30 ^d	63.80 ^b	68.30 ^a	61.80 ^a
N ₂		1.30 ^d	1.60 ^{bc}	1.80 ^a	1.60 ^a	19.30 ^c	22.30 ^b	23.90 ^a	21.80 ^a	59.00 ^c	65.20 ^b	69.80 ^a	64.70 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		1.10 ^e	1.33 ^d	1.53 ^c	1.30 ^a	17.10 ^e	19.60 ^d	22.30 ^c	19.70 ^a	54.40 ^d	61.50 ^b	66.00 ^a	60.60 ^a
M ₂		1.21 ^{de}	1.73 ^b	2.00 ^a	1.60 ^a	19.20 ^d	24.20 ^b	25.80 ^a	23.10 ^a	57.90 ^c	67.50 ^b	72.10 ^a	65.80 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.14				0.93				2.79			
T		0.17				1.14				3.42			
M		0.14				0.93				2.79			
N x T		0.24				1.61				4.84			
M x T		0.24				1.61				4.84			
N x M		0.19				1.31				3.95			
N x T x M		0.34				2.28				6.85			
Control Vs Rest		0.06		0.20		0.50		1.46		2.31		6.74	

DAS - Days after sowing

Nutrient approach (N)

Yield Targets (T)

Micronutrient & Organics (M)

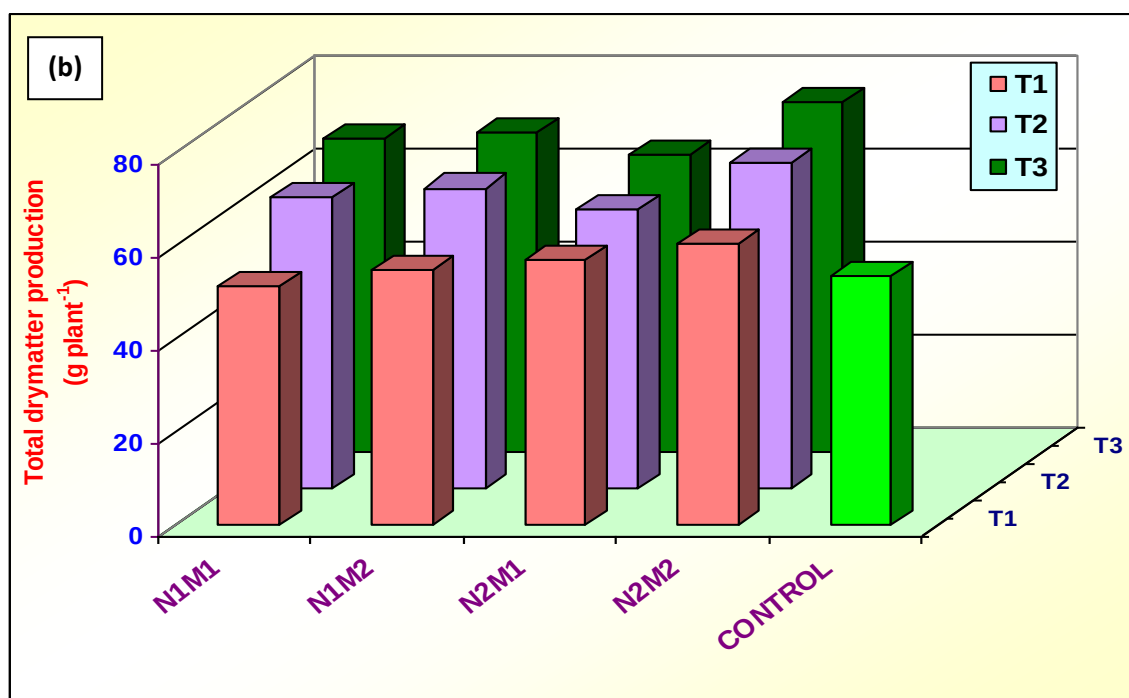
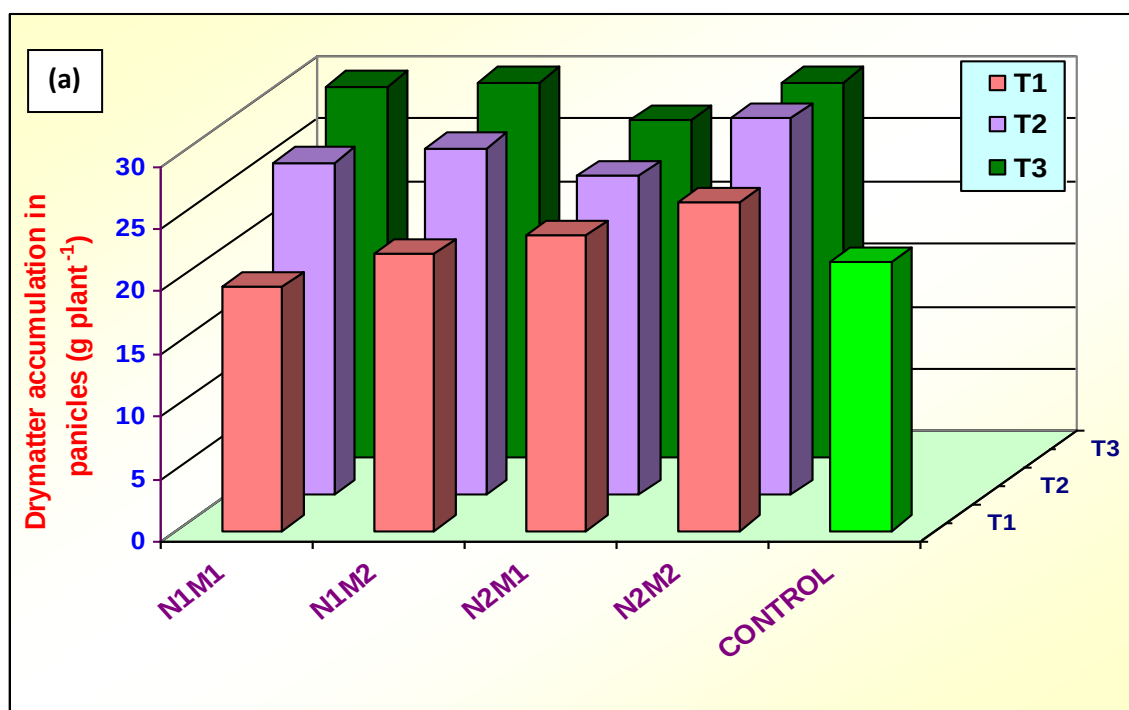
: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT



LEGEND

Nutritional approaches (N): N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
 Yield Targets (T): T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
 Micronutrient & Organics (M): M₁ - Without FeSO₄+ZnSO₄ + Organics, M₂ - With FeSO₄+ZnSO₄ + Organics

Fig. 32. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on (a) dry matter accumulation in panicles (g plant^{-1}) and (b) total dry matter production (g plant^{-1}) at harvest under direct seeded condition during summer season

Among the three factors (N x T x M) interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered the maximum TDM (26.60 and 75.40, respectively at 90 DAS and at harvest), while lower TDM (15.70 and 51.40, respectively at 90 DAS and at harvest) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁) among all; other treatment combinations fared in between.

All combinations involving medium to higher yield target (T₂₋₃) irrespective of nutritional approaches (N₁₋₂) and micronutrient supply (M₁₋₂) and N₂T₁M₂ except N₂T₂M₁ both at 90 DAS and at harvest observed to be superior in TDM over recommended control (17.70 and 53.75, respectively at 90 DAS and at harvest).

4.2.2.1.9 Spectral indices

4.2.2.1.9.1 SPAD values (leaf chlorophyll) (c.f. Table 198)

SPAD chlorophyll values increased with crop age and revealed significant variations with some of the factors and interactions. At 45 and 90 DAS, main effects only due to yield targets were significant while other factors did not influence SPAD chlorophyll appreciably. Among the yield targets higher yield target of 8 t ha⁻¹ recorded significantly higher SPAD value (25.9 and 30.9, respectively at 45 and 90 DAS) closely followed by medium yield target (T₂) which was at par while lower yield target (T₃) recorded significantly lower SPAD values (27.1 and 29.2, respectively at 45 and 90 DAS).

Among the two factor interactions, N x T were significant only at 45 DAS wherein STCR and higher yield target (N₂T₃) had higher SPAD chlorophyll values (30.3), however all treatments except NE with lower yield target (N₁T₁ – 26.7) were at par with N₂T₃. In micronutrients + organics levels and yield targets significant variations occurred at both the stages wherein higher yield target and supply of micronutrients and organics recorded higher SPAD values (31.2 and 31.4, respectively at 45 and 90 DAS); all other combinations were at par except lower yield target irrespective of nutritional approaches used (N₁₋₂T₁) which recorded lower SPAD values (26.8 and 27.4, 28.7 and 29.0 respectively with NE and STCR at 45 and 90 DAS). Interactions due to N x M were not significant at both the stages.

Among the three factors interaction (N x T x M), at 45 DAS STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered significantly higher SPAD

Table 198. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on SPAD values (leaf chlorophyll) under direct seeded condition during summer season

		45 DAS				90 DAS			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	26.4 ^b	28.0 ^b	29.1 ^{ab}	27.8 ^a	28.5 ^a	30.0 ^a	30.8 ^a	29.8 ^a
	M ₂	27.0 ^b	28.1 ^b	29.7 ^{ab}	28.3 ^a	28.9 ^a	30.4 ^a	31.0 ^a	30.1 ^a
N ₂	M ₁	27.1 ^b	27.7 ^b	28.0 ^b	27.6 ^a	29.0 ^a	29.1 ^a	30.2 ^a	29.4 ^a
	M ₂	27.8 ^b	29.7 ^{ab}	32.7 ^a	30.1 ^a	29.2 ^a	31.4 ^a	31.7 ^a	30.8 ^a
Target		27.1 ^b	28.4 ^{ab}	29.9 ^a		28.9 ^b	30.2 ^{ab}	30.9 ^a	
Control		26.6				28.8			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N
N ₁		26.7 ^b	28.0 ^{ab}	29.4 ^{ab}	28.0 ^a	28.7 ^a	30.2 ^a	30.9 ^a	29.9 ^a
N ₂		27.4 ^{ab}	28.7 ^{ab}	30.3 ^a	28.8 ^a	29.1 ^a	30.2 ^a	31.0 ^a	30.1 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M
M ₁		26.8 ^b	27.8 ^b	28.6 ^{ab}	27.7 ^a	28.7 ^b	29.5 ^{ab}	30.5 ^{ab}	29.6 ^a
M ₂		27.4 ^b	28.9 ^{ab}	31.2 ^a	29.2 ^a	29.0 ^b	30.9 ^{ab}	31.4 ^a	30.4 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		2.7				2.0			
T		3.3				2.4			
M		2.7				2.0			
N x T		4.6				3.4			
M x T		4.6				3.4			
N x M		3.8				2.8			
N x T x M		6.6				4.8			
Control Vs Rest		1.4		NS		1.0		NS	

DAS - Days after sowing

Nutrient approach (N)

Yield Targets (T)

Micronutrient & Organics (M)

NS – Not significant,

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

chlorophyll (32.7); all combination involving higher yield target (N₁₋₂T₃M₁₋₂) and N₂T₂M₂ except N₂T₃M₁ were at par with N₂T₃M₂ while the lower value (26.4) was

recorded with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁); other treatment combinations involving medium and lower yield targets were at par with N₁T₁M₁. Variations at 90 DAS were not significant.

SPAD values due to three factor treatment combinations at both the stages did not deviate significantly from recommended control (26.6 and 28.8, respectively at 45 and 90 DAS), however except N₁T₁M₁ other combinations had higher SPAD values than control at both the stages.

4.2.2.1.9.2 NDVI (Green seeker) readings (c.f. Table 199)

NDVI values increased with advancement in age of crop and the variations were significant due to few of the main and interaction effects due to different nutritional approaches, yield targets and micronutrient + organic supply at all the stages of observations.

At 45 DAS, differences in main effects due to nutritional approaches (0.42/0.44, 0.61/0.62 with NE/STCR, respectively at 45 and 90 DAS), and micronutrient supply (0.42/0.43, 0.61/0.63 with M₁/M₂, respectively at 45 and 90 DAS - 33.7) were not significant whereas those due to yield targets were significant wherein higher yield target of 8 t ha⁻¹ (T₃) recorded higher value (0.47 and 0.64, respectively at 45 and 90 DAS) closely followed by medium yield target which was at par with it at 90 DAS while lower target of 6 t ha⁻¹ (T₁) recorded lower index (0.39 and 0.59, respectively at 45 and 90 DAS).

Two factor interactions were significant wherein STCR coupled with higher yield target (N₂T₃) across micronutrients recorded higher value (0.48 and 0.64 at 45 and 90 DAS) and N₁T₃ and N₂T₂ at 45 DAS and N₁T₂ at harvest were on par while NE with 6 t ha⁻¹ (N₁T₁) recorded lower index (0.38 0.59 at 45 and 90 DAS), micronutrients in combinations with yield targets across nutritional approaches registered higher index (0.48 and 0.65, respectively at 45 and 90 DAS) with higher target coupled with micronutrients & organics (T₃M₂) and T₃M₁ and T₂M₂ were on par while lower yield target and no micronutrient/organics (T₁M₁) recorded lower index (0.39 and 0.59, respectively at 45 and 90 DAS), and variations in NDVI due to nutritional approaches and micronutrient levels were not significant both at 45 and 90 DAS.

Table 199. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on NDVI values (green seeker) readings under direct seeded condition during summer season

N x T x M		45 DAS				90 DAS			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	0.38 ^c	0.4 ^{bc}	0.45 ^{a-c}	0.41 ^a	0.59 ^b	0.61 ^{ab}	0.63 ^{ab}	0.61 ^a
	M ₂	0.38 ^c	0.43 ^{a-c}	0.46 ^{ab}	0.42 ^a	0.59 ^b	0.62 ^{ab}	0.63 ^{ab}	0.61 ^a
N ₂	M ₁	0.4 ^{bc}	0.43 ^{a-c}	0.47 ^{ab}	0.43 ^a	0.59 ^b	0.6 ^{ab}	0.62 ^{ab}	0.60 ^a
	M ₂	0.4 ^{bc}	0.43 ^{a-c}	0.49 ^a	0.44 ^a	0.6 ^{ab}	0.65 ^{ab}	0.66 ^a	0.64 ^a
Target		0.39 ^b	0.42 ^b	0.47 ^a		0.59 ^b	0.62 ^a	0.64 ^a	
Control		0.38				0.59			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N
N ₁		0.38 ^c	0.42 ^{bc}	0.46 ^{ab}	0.42 ^a	0.59 ^b	0.62 ^{ab}	0.63 ^{ab}	0.61 ^a
N ₂		0.40 ^c	0.43 ^{a-c}	0.48 ^a	0.44 ^a	0.60 ^{ab}	0.62 ^{ab}	0.64 ^a	0.62 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M
M ₁		0.39 ^c	0.42 ^{bc}	0.46 ^{ab}	0.42 ^a	0.59 ^c	0.60 ^{bc}	0.63 ^{a-c}	0.61 ^a
M ₂		0.39 ^c	0.43 ^{a-c}	0.48 ^a	0.43 ^a	0.59 ^c	0.64 ^{ab}	0.65 ^a	0.63 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.04				0.04			
T		0.05				0.05			
M		0.04				0.04			
N x T		0.08				0.07			
M x T		0.08				0.07			
N x M		0.06				0.05			
N x T x M		0.11				0.09			
Control Vs Rest		0.02		0.06		0.01		NS	

DAS - Days after sowing

Nutrient approach (N)

Yield Targets (T)

Micronutrient & Organics (M)

NS – Not significant,

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Among the three factors interaction (N x T x M), STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered significantly higher index (0.50 and 0.66, respectively at 45 and 90 DAS) and all combinations involving medium and high yield targets were on par at both the stages except N₁T₂M₁ at 90 DAS while the lower NDVI value (0.38 and 0.59, respectively at 45 and 90 DAS) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁).

All combinations involving higher yield target (N₁₋₂T₃M₁₋₂) at both the stages except N₂T₃M₁ at 90 DAS fared superior to control (0.38 and 0.59, respectively at 45 and 90 DAS).

4.2.2.1.10 Days to 50% flowering (c.f. Table 200)

Data pertaining days to 50% flowering did not reveal significant variation due to nutritional approach and levels of micronutrients, however variations due to yield targets were significant wherein higher yield target of 8 t ha⁻¹ (T₃) took more days (94.28) to days to 50%; T₂ with medium target was next in the order and was on par with T₃, while T₁ with lower yield target was early (89.27) in flowering.

Mean effects due to N x T revealed more days (96.21) to 50% flowering with STCR approach coupled with higher yield target across micronutrients (N₂T₃) other combinations were at par except N₁₋₂T₁ which recorded early flowering (88.20 and 90.08, respectively with NE and STCR), among T x M across nutritional approaches the maximum days (97.18) were registered for 50% flowering with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂); T₂M₂ was on par while lower yield target and no micronutrient/organics (T₁M₁) flowered early (88.23), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics (N₂M₂) took more days (95.12) for 50% flowering, while NE and no micronutrient + organics supply (N₁M₁) was early to flower (89.95); other combinations were on par with it.

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered the maximum days (101.20) to 50% flowering and similar combination with medium yield target (N₂T₂M₂) was on par while early flowering (93.57) occurred with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁) and all other combinations were on par with it.

Table 200. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on 50 per cent flowering (days) under direct seeded condition during summer season

N x T x M		50 per cent flowering (days)			
		T ₁	T ₂	T ₃	N x M
N ₁	M ₁	86.84 ^c	91.10 ^{bc}	91.92 ^{bc}	89.95 ^b
	M ₂	89.57 ^{bc}	91.43 ^{bc}	93.17 ^{bc}	91.39 ^b
N ₂	M ₁	89.62 ^{bc}	89.81 ^{bc}	91.23 ^{bc}	90.22 ^b
	M ₂	90.55 ^{bc}	96.01 ^{ab}	101.20 ^a	95.92 ^a
Target		89.14 ^b	92.09 ^{ab}	94.38 ^a	
Control		89.27			
Approach-N-(NE/STCR) x Target (T)					N
N ₁		88.20 ^b	92.91 ^{ab}	92.54 ^{ab}	90.67 ^b
N ₂		90.08 ^b	92.91 ^{ab}	96.21 ^b	93.07 ^b
Micronutrient/org. (M) x Target (T)					M
M ₁		88.23 ^c	90.46 ^{bc}	91.58 ^{bc}	90.09 ^b
M ₂		90.06 ^{bc}	93.72 ^{ab}	97.18 ^a	93.65 ^b
Comparison		S.Em±		LSD 0.05	
N		3.96			
T		4.85			
M		3.96			
N x T		NS			
M x T		NS			
N x M		NS			
N x T x M		NS			
Control Vs Rest		2.02		5.92	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Among all combinations, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) and similar combinations but with 7 t ha⁻¹ (N₂T₂M₂) took more days to flowering than control (89.27).

4.2.2.2 Yield components and yield

4.2.2.2.1 Unproductive tiller at harvest (no. m⁻²) (c.f. Table 201)

Number of unproductive tillers at harvest varied significantly due to main effects and interaction of nutritional approaches, yield targets and micronutrient + organic levels except main effects due to nutritional approaches (N) and micronutrient + organic levels (M). Effects due to yield targets were significant wherein the unproductive tiller count decreased with increase in yield targets and the lowest unproductive tillers (49.3) occurred with T₃ (8 t ha⁻¹ yield target) while the maximum count (62.7) occurred with T₁ with 6 t ha⁻¹ yield target.

Two factor interactions were significant wherein both NE and STCR approaches coupled with higher yield target across micronutrients (N₁₋₂T₃) recorded lower unproductive tillers (50.3 – 48.4 with NE and STCR, respectively) while NE with 6 t ha⁻¹ (N₁T₁) recorded the highest count (67.7), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the minimum unproductive tiller count (48.2 and 50.5 with T₃M₂ and T₃M₁, respectively) with higher target (8 t ha⁻¹) irrespective of levels of micronutrients and organics (T₃M₂) while lower yield target and no micro-nutrition (T₁M₁) recorded higher count (67.2), and among nutritional approaches and levels of micronutrient and organics yield targets, STCR + micronutrient/organic supply (N₂M₂) recorded least number of unproductive tillers (48.8) while NE whether micronutrient supplied or not recorded higher unproductive tiller count (57.1 and 59.0 with N₁M₁ and N₁M₂, respectively).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered significantly less number of unproductive tillers (47.0) similar combination except medium yield target (N₂T₂M₂) was on par, while the maximum unproductive tiller count (70.0) was observed with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁); other treatment combinations fared in between.

Of all the combinations, combinations involving lower yield target (N₁₋₂T₁M₁₋₂) including N₂T₂M₁ except N₁T₁M₂ were at par with recommended control (69.6) while others had significantly lower number of unproductive tillers.

4.2.2.2.2 Productive tillers at harvest (no. m⁻²) (c.f. Table 201 and Fig. 33a)

Data on tiller count m⁻² revealed significant variations due to different factors and their interactions except main effects due to nutritional approaches and levels of micronutrient + organics. In the main effects variations in tiller count due to yield targets were significant wherein the tiller count increased with increase in fertilization for higher yield targets and highest total tiller count (337.5) occurred with 8 t ha⁻¹ yield target (T₃) and T₂ with 7 t ha⁻¹ was on par with next best values while lower tiller count (295.2) occurred with 6 t ha⁻¹. Nutritional approaches and supply of micronutrients alongwith organic did not induce significant effects individually.

Two factor interactions were significant wherein NE approach coupled with higher yield target across micronutrients (N₁T₃) recorded more tiller count (360.1) and combinations involving medium target were on par while NE with 6 t ha⁻¹ (N₁T₁) recorded the lowest tiller count (280.2), among micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum tiller count (387.6) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂) followed by T₂M₂ which was on par while lower yield target and no micronutrient/organics (T₁M₁) recorded lower tiller count (282.9), and among nutritional approaches and micronutrient supply across yield targets, STCR approach and micronutrient supply (N₂M₂) recorded more tillers m⁻² (374.1); T₂M₂ was on par while NE and no micronutrient supply (N₁M₁) recorded lower tiller count (276.8).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered significantly more number of tillers (407.0) followed by similar combination but with medium yield target (N₂T₂M₂) which was at par, while lower tiller count (370.2) was recorded with STCR + 8 t ha⁻¹ yield target + no micronutrient (N₂T₃M₁) among all; other treatment combinations fared in between.

All combinations involving medium and high yield targets and N₂T₁M₂ except N₂T₂₋₃M₁ were significantly superior to the recommended control (277.2) with regard to productive tiller count.

4.2.2.2.3 Total tillers at harvest (no. m⁻²) (c.f. Table 201)

Tiller count varied significantly due to different nutrition approach used, pre-set yield targets and micronutrient + organics supply and their interactions at harvest

Table 201. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on number of tillers, unproductive tillers and panicles or productive tillers (m^{-2}) under direct seeded condition during summer season

N x T x M		Number of tillers (m ⁻²)				Unproductive tillers (m ⁻²)				Panicles or productive tillers (m ⁻²)			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	339 ^f	381.7 ^{c-f}	403.3 ^{b-d}	374.7 ^b	70.0 ^a	50.0 ^c	51.3 ^c	57.1 ^{ab}	269.0 ^g	331.7 ^{ef}	352.0 ^e	317.6 ^b
	M ₂	356.7 ^{ef}	399.2 ^{b-e}	417.5 ^{a-c}	391.1 ^c	65.3 ^{ab}	49.0 ^c	49.3 ^c	54.5 ^a	291.3 ^{fg}	350.2 ^e	368.2 ^b	336.6 ^a
N ₂	M ₁	361.2 ^{d-f}	373.7 ^{c-f}	272.5 ^g	335.8 ^b	64.3 ^b	63.0 ^b	49.7 ^c	59.0 ^b	296.8 ^{fg}	310.7 ^{e-g}	222.8 ^c	276.8 ^b
	M ₂	374.8 ^{c-f}	439.8 ^{ab}	454 ^a	422.9 ^a	51.0 ^c	48.3 ^c	47.0 ^c	48.8 ^c	323.8 ^{ef}	391.5 ^a	407.0 ^d	374.1 ^a
Target		357.9 ^b	398.6 ^a	386.8 ^a		62.7 ^a	52.6 ^b	49.3 ^c		295.2 ^b	346.0 ^a	337.5 ^a	
Control		346.8				69.6				277.2			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		347.8 ^c	390.4 ^{ab}	410.4 ^a	382.9 ^a	67.7 ^a	49.5 ^c	50.3 ^c	55.8 ^a	280.2 ^d	340.9 ^{ab}	360.1 ^a	327.1 ^a
N ₂		368.0 ^{bc}	406.8 ^a	363.3 ^{bc}	379.4 ^a	57.7 ^b	55.7 ^b	48.4 ^c	53.9 ^a	310.3 ^c	351.1 ^a	314.9 ^{bc}	325.4 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		350.1 ^{bc}	377.7 ^b	337.9 ^c	355.2 ^a	67.2 ^b	56.5 ^b	50.5 ^c	58.1 ^a	282.9 ^c	321.2 ^b	287.4 ^c	297.2 ^a
M ₂		365.8 ^{bc}	419.5 ^a	435.8 ^a	407.0 ^a	58.2 ^c	48.7 ^c	48.2 ^c	51.7 ^a	307.6 ^{bc}	370.8 ^a	387.6 ^{aa}	355.3 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		25.9				3.1				25.9			
T		31.7				3.8				31.7			
M		25.9				3.1				25.9			
N x T		44.9				5.3				44.8			
M x T		44.9				5.3				44.8			
N x M		36.6				4.4				36.6			
N x T x M		63.5				7.6				63.3			
Control Vs Rest		13.0		38.0		3.5		10.3		13.1		38.2	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

(Table 9). Among the main effects, both the nutritional approaches and micronutrient levels did not induce significant variations, however, STCR approach and micronutrient + organic supply (M_2) were numerically superior (379.4 and 407.0, respectively), while the count increased with increase in yield targets corresponding with increased nutrition, and more tillers (386.8) occurred with medium yield target of 7 t ha^{-1} (T_2) and higher yield target of 8 t ha^{-1} (T_3) was on par while 6 t ha^{-1} yield target (T_1) had lower tiller count (357.9).

Two factor interactions were significant wherein NE approach coupled with higher yield target across micronutrients (N_1T_2) recorded more tiller count (410.8) and similar combination but with medium yield target (N_2T_2) was on par while NE with 6 t ha^{-1} (N_1T_1) recorded the lowest tiller count (347.8), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum tiller count (435.8) with higher target (8 t ha^{-1}) coupled with micronutrients and organics (T_3M_2) and T_2M_2 had next higher productive count and was on par while lower yield target and no micronutrients + organics (T_1M_1) recorded lower tiller count (350.1), and among nutritional approaches and micronutrient supply across yield targets, STCR approach with micronutrient & organic supply (N_2M_2) recorded more productive tillers m^{-2} (422.9) while NE and no micronutrient + organics (N_1M_1) recorded lower productive tiller count (374.7).

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + micronutrient supply ($N_2T_3M_2$) registered significantly more number of tillers (454) followed by similar combination but with medium yield target ($N_1T_2M_2$ – 439.8), while lower tiller count (339) was recorded with NE + 6 t ha^{-1} yield target + no micronutrient ($N_1T_1M_1$) among all; other treatment combinations fared in between.

All combinations involving medium and high yield targets ($N_{1-2}T_{2-3}M_{1-2}$) were significantly superior to recommended control (346.8).

4.2.2.2.4 Panicle length (cm) (c.f. Table 203)

Panicle length varied significantly due to nutritional approaches, yield targets and micronutrient supply and their interactions. Among the main effects both nutritional approach and micronutrient levels did not induce significant changes in panicle length while effects due to varied fertilization for different yield targets revealed significant

variations in that higher yield target (T_3) recorded longer panicle (24.6); medium yield target was on par whereas lower yield target (T_1) recorded shorter panicle (23.0).

Two factor interactions were significant wherein NE/STCR approaches coupled with higher yield target across micronutrients ($N_{1-2}T_3$) were at par and recorded longer panicle (24.6 and 24.7, respectively) so was N_2T_2 , while NE with 6 t ha⁻¹ (N_1T_1) recorded the shorter panicle (22.7), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum panicle length (24.8) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T_3M_2); T_3M_1 and T_2M_2 were next best and on par with the former treatment while lower panicle length (22.7) was observed with lower target coupled with and no micronutrient/organics (T_1M_1), and variations due to nutritional approaches and micronutrient + organics were not significant.

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply ($N_2T_3M_2$) registered significantly longer panicle (25); in fact all combinations were at par except $N_1T_1M_1$ which registered shorter panicle (22.5).

All the combinations involving high yield targets except $N_2T_3M_1$, and $N_2T_2M_2$ and $N_1T_2M_2$ were significantly superior to the recommended control (22.7) with regard to panicle length.

4.2.2.2.5 Unfilled grains per panicle (no.) (c.f. Table 202)

Data on unfilled grains per panicle revealed significant variations due to nutritional approaches, yield targets and micronutrient supply and their interactions. Among the main effects nutritional approach and micronutrients + organics levels were not significant whereas number of unfilled grains decreased with increasing yield target. 6 t ha⁻¹ yield target (T_1) recorded more unfilled grains (37.8) while 8 t ha⁻¹ (T_3) recorded lower number of filled grains (24.7).

Two factor interactions were significant wherein both NE and STCR approach coupled with higher yield target across micronutrients ($N_{1-2}T_3$) recorded lower unfilled grains per panicle (32.0 and 29.4, respectively) while NE with 6 t ha⁻¹ (N_1T_1) recorded the maximum unfilled grains (40.6), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum unfilled grains panicle⁻¹ (40.2) with lower target (6 t ha⁻¹) with no micronutrients and organics (T_1M_1)

while lower number unfilled grains (20.6) was observed higher target coupled with micronutrient + organic supply (T_3M_2), and among nutritional approaches and micronutrient supply across yield targets, STCR approach and micronutrient supply (N_2M_2) recorded less number of unfilled grains (24.5) while NE with or without micronutrient & organic supply (N_1M_{1-2}) recorded higher unfilled grains per panicle (34.2 and 34.1, respectively).

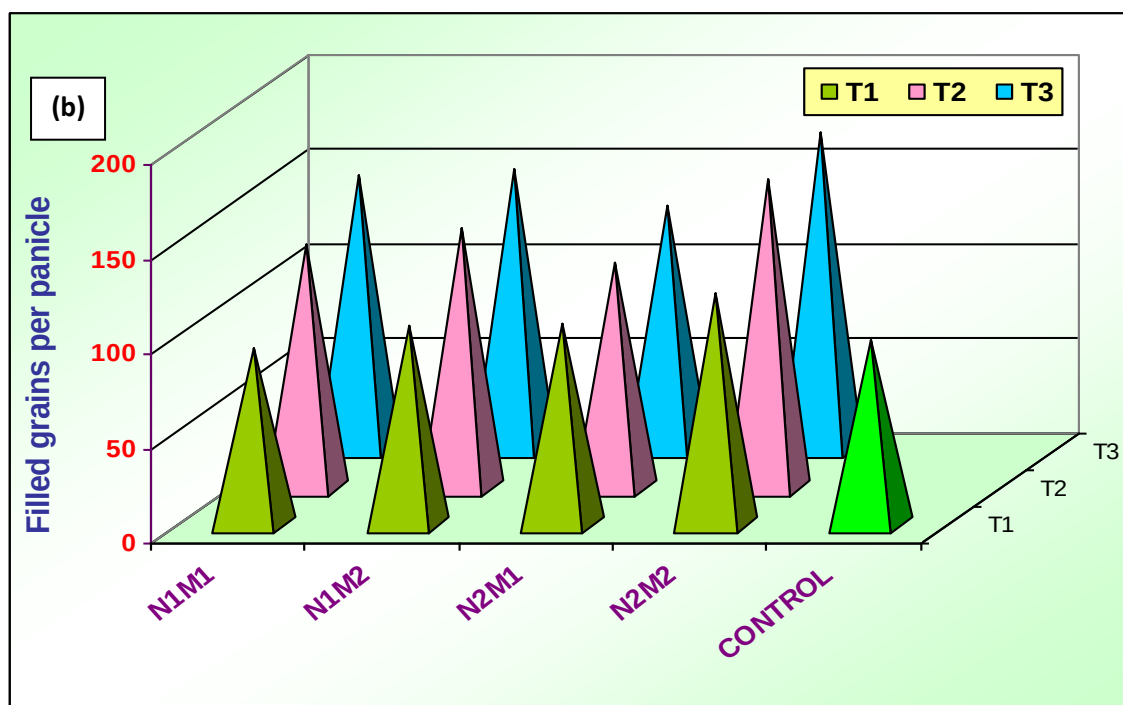
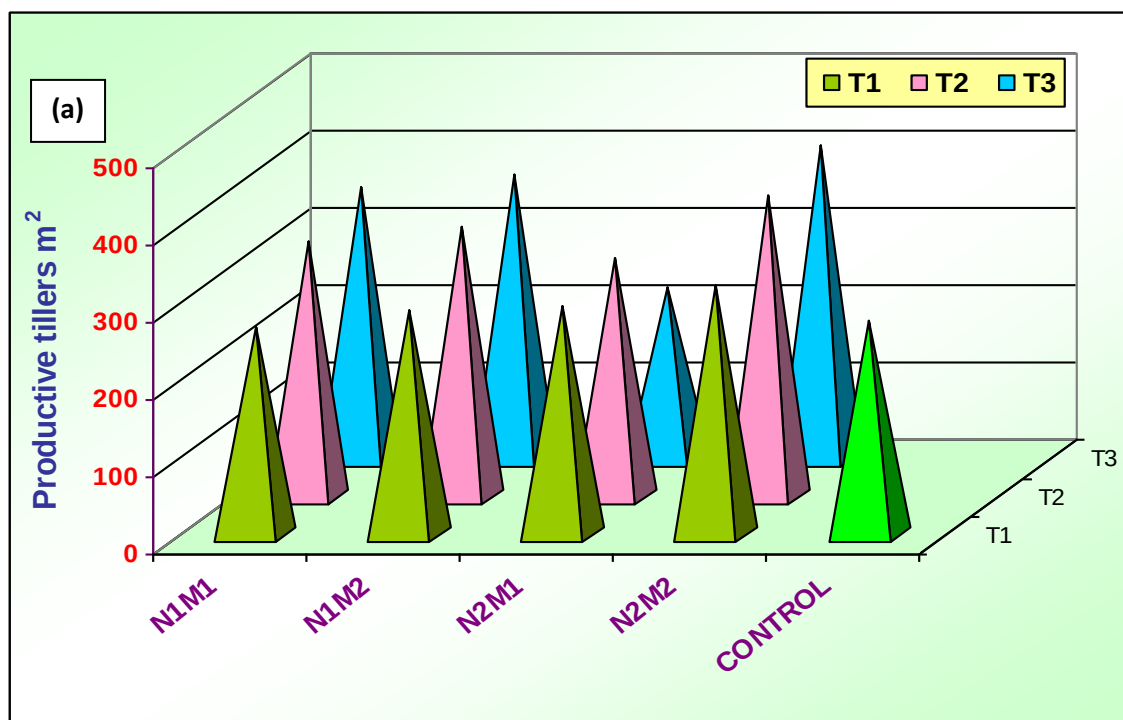
Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply ($N_2T_3M_2$) registered significantly lower unfilled grains (19.5); similar was the performance $N_2T_2M_2$ which was at par while maximum unfilled grains panicle⁻¹ (44.1) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient ($N_1T_1M_1$) among all; other treatment combinations fared in between.

All treatment combinations except $N_1T_1M_1$ had significantly lower number of unfilled grains than control with recommended nutritional practice (43.4).

4.2.2.2.6 Filled grains per panicle (no.) (c.f. Table 202 and Fig. 33b)

Data on filled grains per panicle revealed significant variations due to nutritional approaches, yield targets and micronutrient supply and their interactions. Among the main effects nutritional approach and micronutrient + organics supply did not induce significant changes in number of filled grains while the effects due to varied fertilization were significant. 8 t ha⁻¹ yield target (T_3) recorded more filled grains (148.5) while 6 t ha⁻¹ (T_1) recorded lower number of filled grains (107.3).

Two factor interactions were significant wherein both the approaches coupled with higher yield target across micronutrients ($N_{1-2}T_3$) recorded more filled grains per panicle (147.5 and 149.5, respectively with NE and STCR), so was N_2T_2 (141.4) which was on par while NE with 6 t ha⁻¹ (N_1T_1) recorded less filled grains per panicle (99.7), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum filled grains (159.0) with higher yield target (8 t ha⁻¹) coupled with micronutrients and organics (T_3M_2); T_2M_2 was on par while less number of filled grains (100.4) was observed lower target coupled with and no micronutrient/organics (T_1M_1), and among nutritional approaches and micronutrient supply across yield targets, STCR approach and micronutrient supply (N_2M_2) recorded more filled grains (151.6) while NE and no micronutrient supply (N_1M_1) recorded less filled grains (122.9).



LEGEND

Nutritional approaches (N): N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T): T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M): M₁ - Without FeSO₄+ZnSO₄ + Organics, M₂ - With FeSO₄+ZnSO₄ + Organics

Fig. 33. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on (a) productive tillers m^{-2} and (b) filled grains panicle⁻¹ at harvest under direct seeded condition during summer season

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered significantly more filled grains (168.6); N₂T₂M₂ had next higher value and was on par while less filled grains (94.2) were recorded with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁) among all; other treatment combinations fared in between.

All the medium and high yield targets irrespective of nutritional approaches and micronutrient levels (N₁₋₂T₂₋₃M₁₋₂) and N₂T₁M₂ were significantly superior to the recommended control (97.8) with regard to filled grains per panicle.

4.2.2.2.7 Total grains per panicle (no.) (c.f. Table 202)

Total grains per panicle varied on most occasions significantly due to nutritional approaches, yield targets and micronutrient supply and their interactions except main effects due to nutritional approaches and levels of micronutrients + organics. The effects due to varied fertilization for pre-set yield target resulted significant variations wherein 8 t ha⁻¹ yield target (T₃) recorded more grains (173.1); T₂ was on par with next higher value while 6 t ha⁻¹ (T₁) recorded lower total number of grains (145.1).

Two factor interactions were significant wherein both NE and STCR approach coupled with higher yield target across micronutrients (N₁₋₂T₃) recorded higher total number of grains per panicle (171.2 and 175.1, respectively with NE and STCR); similar was the performance with medium yield target while NE with 6 t ha⁻¹ (N₁T₁) recorded the minimum total grains (140.3) followed by N₂T₁ which was on par with the latter treatment combination, micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum grains panicle⁻¹ (179.6) with higher target (8 t ha⁻¹) with micronutrients and organics (T₃M₂) followed by T₂M₂ which was on par while lower number of grains (140.6) was observed lower target and without micronutrient + organic supply (T₁M₁), and among nutritional approaches and micronutrient supply across yield targets, STCR approach and micronutrient supply (N₂M₂) recorded more number of grains (176.2) while NE with or without micronutrient and organic supply (N₁M₁₋₂) recorded lower grains per panicle (157.0 and 160.5, respectively).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered significantly more number of grains (188.1); N₂T₂M₂ had

next higher grain number and was on par, while minimum grains panicle⁻¹ (138.3) were recorded with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁) among all; other treatment combinations fared in between.

Among the N x T x M combinations except all combinations involving higher yield target (N₁₋₂T₃M₁₋₂) and N₁T₂M₂ and N₂T₂M₂ were superior to recommended control (141.3).

4.2.2.2.8 Sterility percentage (c.f. Table 203 and Fig. 34a)

Sterility per cent varied significantly due to nutritional approaches, yield targets and micronutrient supply and their interactions. Among the main effects nutritional approach and levels of micronutrient + organics did not induce significant changes in sterility per cent while the effects due to varied fertilization for different yield targets resulted in significant variations and among them, 8 t ha⁻¹ yield target (T₃) recorded lower sterility per cent (14.5) while 6 t ha⁻¹ (T₁) recorded higher sterility per cent (26.4).

Two factor interactions were significant wherein both NE and STCR approach coupled higher yield target across micronutrients (N₁₋₂T₃) recorded lower sterility per cent (13.9 and 15.0, respectively) while NE with 6 t ha⁻¹ (N₁T₁) recorded the maximum sterility per cent (29.1), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum sterility per cent (28.8) with lower target (6 t ha⁻¹) + no micronutrients and organics (T₁M₁) while lower sterility per cent (11.5) was observed with higher yield target and micronutrient + organic supply (T₃M₂), and among nutritional approaches and micronutrient supply across yield targets, STCR approach and micronutrient supply (N₂M₂) recorded significantly lower sterility per cent (14.5) while others were at par except STCR coupled with no micronutrients and organics (N₂M₁) which had higher sterility per cent (19.1).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered significantly lower sterility per cent (10.4), while the maximum sterility per cent (32.1) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁) among all; other treatment combinations fared in between.

The entire N x T x M combinations except N₁T₁M₁₋₂ and N₂T₁M₁ were superior to recommended control (31.9) with lower sterility per cent.

Table 202. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on filled grains, unfilled grains and total grains panicle⁻¹ under direct seeded condition during summer season

N x T x M		Filled grains panicle ⁻¹				Unfilled grains panicle ⁻¹				Total grains panicle ⁻¹			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	94.3 ^g	128.9 ^{de}	145.6 ^{b-d}	122.9 ^{bc}	44.1 ^a	32.5 ^{bc}	25.7 ^d	34.1 ^a	138.3 ^e	161.4 ^c	171.3 ^{bc}	157.0 ^b
	M ₂	105.2 ^{fg}	137.2 ^{c-e}	149.3 ^{bc}	130.6 ^c	37.1 ^b	30.9 ^c	21.7 ^{de}	29.9 ^a	142.3 ^{de}	168.1 ^{bc}	171 ^{bc}	160.5 ^b
N ₂	M ₁	106.5 ^{fg}	119.7 ^{ef}	130.3 ^{c-e}	118.8 ^b	36.3 ^b	34.5 ^{bc}	31.8 ^{bc}	34.2 ^b	142.9 ^{de}	154 ^{c-e}	162.1 ^c	153.0 ^b
	M ₂	123.2 ^{ef}	163.1 ^{ab}	168.6 ^a	151.6 ^a	33.7 ^{bc}	20.3 ^e	19.5 ^e	24.5 ^c	156.9 ^{cd}	183.5 ^{ab}	188.1 ^a	176.2 ^a
Target		107.3 ^c	137.2 ^b	148.5 ^a		37.8 ^a	29.6 ^b	24.7 ^c		145.1 ^b	166.8 ^a	173.1 ^a	
Control		97.8				43.4				141.3			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		99.7 ^d	133.1 ^b	147.5 ^a	126.8 ^a	40.6 ^a	31.7 ^b	23.7 ^d	32.0 ^a	140.3 ^b	164.8 ^a	171.2 ^a	158.8 ^a
N ₂		114.9 ^c	141.4 ^{ab}	149.5 ^a	135.3 ^a	35.0 ^b	27.4 ^c	25.7 ^{cd}	29.4 ^a	149.9 ^b	168.8 ^a	175.1 ^a	164.6 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		100.4 ^d	124.3 ^c	138.0 ^b	120.9 ^a	40.2 ^a	33.5 ^b	28.8 ^c	34.2 ^a	140.6 ^e	157.8 ^{cd}	166.7 ^{bc}	155.0 ^a
M ₂		114.2 ^c	150.2 ^{ab}	159.0 ^a	141.1 ^a	35.4 ^b	25.6 ^c	20.6 ^d	27.2 ^a	149.6 ^{de}	175.8 ^{ab}	179.6 ^a	168.3 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		11.5				3.1				10.1			
T		14.1				3.8				12.4			
M		11.5				3.1				10.1			
N x T		20.0				5.4				17.9			
M x T		20.0				5.4				17.9			
N x M		16.3				4.4				14.3			
N x T x M		28.3				7.7				24.9			
Control Vs Rest		7.4		21.7		2.0		5.6		6.8		20.0	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 203. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on sterility percentage, panicle length (cm) and 1000- grain weight (g) under direct seeded condition during summer season

N x T x M		Sterility (%)				Panicle length (cm)				Test weight or 1000 grain (g)			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	32.1 ^a	20.4 ^c	15.1 ^{de}	22.5 ^a	22.5 ^b	23.7 ^{ab}	24.4 ^{ab}	23.5 ^a	23.6 ^a	24.8 ^a	25.2 ^a	24.5 ^a
	M ₂	26.1 ^b	18.4 ^{cd}	12.7 ^e	19.1 ^a	22.9 ^{ab}	24.3 ^{ab}	24.7 ^a	24.0 ^a	24.6 ^a	25.2 ^a	26.2 ^a	25.3 ^a
N ₂	M ₁	25.5 ^b	22.4 ^{bc}	19.7 ^{cd}	22.5 ^b	23.0 ^{ab}	23.2 ^{ab}	24.3 ^a	23.5 ^a	24.6 ^a	24.7 ^a	24.8 ^a	24.7 ^a
	M ₂	22 ^{bc}	11.1 ^e	10.4 ^e	14.5 ^c	23.7 ^{ab}	25 ^a	25 ^a	24.6 ^a	24.8 ^a	26.3 ^a	26.4 ^a	25.8 ^a
Target		26.4 ^a	18.1 ^b	14.5 ^c		23.0 ^b	24.1 ^a	24.6 ^a		24.4 ^a	25.3 ^a	25.7 ^a	
Control		31.9				22.7				24.3			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		29.1 ^a	19.4 ^c	13.9 ^d	20.8 ^a	22.7 ^b	24.0 ^{ab}	24.6 ^a	23.8 ^a	24.1 ^a	25.0 ^a	25.7 ^a	24.9 ^a
N ₂		23.7 ^b	16.7 ^{cd}	15.0 ^d	18.5 ^a	23.3 ^{ab}	24.1 ^a	24.7 ^a	24.0 ^a	24.7 ^a	25.5 ^a	25.6 ^a	25.3 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		28.8 ^a	21.4 ^b	17.4 ^c	22.5 ^a	22.7 ^c	23.5 ^{a-c}	24.4 ^{ab}	23.5 ^a	24.1 ^b	24.7 ^{ab}	25.0 ^{ab}	24.6 ^a
M ₂		24.0 ^b	14.7 ^{cd}	11.5 ^d	16.7 ^a	23.3 ^{bc}	24.7 ^a	24.8 ^a	24.3 ^a	24.7 ^{ab}	25.8 ^{ab}	26.3 ^a	25.6 ^a
Comparison	S.E.m±	LSD 0.05				S.E.m±	LSD 0.05			S.E.m±	LSD 0.05		
N	3.0					1.1				1.7			
T	3.7					1.5				2.1			
M	3.0					1.2				1.7			
N x T	5.2					2.0				3.0			
M x T	5.2					2.0				3.0			
N x M	4.3					1.7				2.4			
N x T x M	7.4					2.9				4.2			
Control Vs Rest	1.9	5.6				0.6	1.7			0.9	2.5		

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

4.2.2.2.9 Test weight or 1000-grain weight (g) (c.f. Table 203)

Data on 1000-grain weight (test weight) revealed that neither the main effects nor the interactions due to nutritional approaches, yield targets and micronutrient supply were significant. The main effects ranged between 24.9 - 25.3, 24.4 - 25.7 and 24.6 - 25.6, respectively due to nutritional approaches, yield targets and levels of micronutrient + organic supply. Among all combinations numerically higher test weight (26.4) occurred with $N_2T_3M_2$ while lower test weight (23.6) was observed with $N_1T_1M_1$, while recommended control recorded 24.2g.

4.2.2.2.10 Grain weight (g plant⁻¹) (c.f. Table 204)

Grain weight varied due to nutritional approaches. Yield targets and micronutrient supply and their interactions revealed significant variations except the main effects due to nutritional approaches (33.2 – 34.1) and micronutrient + organics levels (32.5 - 34.8). In the yield targets, 8 t ha⁻¹ yield target (T_3) recorded the maximum grain weight (35.1) while 6 t ha⁻¹ (T_1) recorded lower grain weight (31.8).

STCR and NE approaches coupled higher yield target across micronutrients ($N_{1-2}T_3$) recorded higher weights (35.0 and 35.2, respectively) while NE with 6 t ha⁻¹ (N_1T_1) recorded lower grain weight (31.4), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum grain weight (36.9) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T_3M_2) while lower yield (31.6) was observed lower target coupled with no micronutrient (T_1M_1), and among nutritional approaches and micronutrient supply across yield targets, STCR approach and micronutrient supply (N_2M_2) recorded higher grain weight (35.7) while STCR and NE without micronutrient supply ($N_{1-2}M_1$) recorded lower grain weight (32.6).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply ($N_2T_3M_2$) registered significantly higher grain weight (37.5) followed by STCR + 7 t ha⁻¹ yield target + micronutrient supply ($N_2T_2M_2$ – 37.1) which was on par, while lower weight (31.1) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient ($N_1T_1M_1$).

All the N-T-M combinations except $N_1T_1M_{1-2}$, $N_2T_1M_1$ and $N_1T_2M_1$ were significantly superior to the recommended control (31.2) with regard to grain weight.

Table 204. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on grain yield per plant under direct seeded condition during summer season

N x T x M		Grain weight plant ⁻¹ (g)			
		T ₁	T ₂	T ₃	N x M
N ₁	M ₁	31.1 ^d	32.9 ^{a-d}	33.9 ^{a-d}	32.6 ^b
	M ₂	31.6 ^{cd}	33.8 ^{a-d}	36.2 ^{a-c}	33.9 ^{ab}
N ₂	M ₁	32.0 ^{cd}	32.2 ^{b-d}	32.9 ^{a-d}	32.4 ^b
	M ₂	32.6 ^{a-d}	37.1 ^{ab}	37.5 ^a	35.7 ^a
Target		31.8 ^c	34.0 ^b	35.1 ^a	
Control		31.2			
Approach-N-(NE/STCR) x Target (T)					N
N ₁		31.4 ^b	33.3 ^{ab}	35.0 ^a	33.2 ^a
N ₂		32.3 ^{ab}	34.6 ^{ab}	35.2 ^a	34.1 ^a
Micronutrient/org. (M) x Target (T)					M
M ₁		31.6 ^c	32.5 ^{bc}	33.4 ^{bc}	32.5 ^a
M ₂		32.1 ^{bc}	35.4 ^{ab}	36.9 ^a	34.8 ^a
Comparison		S.Em±		LSD 0.05	
N		2.8			
T		3.5			
M		2.8			
N x T		4.9			
M x T		4.9			
N x M		4.0			
N x T x M		7.0			
Control Vs Rest		1.4		4.2	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

4.2.2.2.11 Grain yield (kg ha^{-1}) (c.f. Table 205 and Fig. 34b)

Grain yield varied due to nutritional approaches, yield targets and micronutrient supply and their interactions. Among the main effects nutritional approaches and micronutrient + organics levels did not induce significant changes (5766 – 6410 with N_1 and N_2 , and 5721 and 6455 with M_1 and M_2 respectively) while the effects due to varied fertilization and micronutrient + organic supply resulted in significant variations. In the yield targets, 8 t ha^{-1} yield target (T_3) recorded the maximum grain yield (6547) while 6 t ha^{-1} (T_1) recorded lower yield (5638).

Two factor interactions were significant wherein STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher yield (6709) while NE with 6 t ha^{-1} (N_1T_1) recorded the lower yield (5163), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum yield (7061) with higher target (8 t ha^{-1}) coupled with micronutrients and organics (T_3M_2) while lower yield (5306) was observed lower target coupled with and no micronutrient/organics (T_1M_1), and among nutritional approaches and micronutrient supply across yield targets, STCR approach and micronutrient supply (N_2M_2) recorded higher grain yield (6878) while NE and no micronutrient supply (N_1M_1) recorded lower grain yield (5501).

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + micronutrient supply ($N_2T_3M_2$) registered significantly higher yield (7385) followed by STCR + 7 t ha^{-1} yield target + micronutrient supply ($N_2T_2M_2$ - 7444) which was on par, while lower yield (4988) was recorded with NE + 6 t ha^{-1} yield target + no micronutrient ($N_1T_1M_1$).

All the N-T-M combinations except $N_1T_1M_{1-2}$, $N_2T_1M_1$ and $N_1T_2M_1$ were significantly superior to the recommended control (5288) with regard to grain yield.

4.2.2.2.12 Straw yield (kg ha^{-1}) (c.f. Table 205 and Fig. 34a)

Similar to grain yield, straw yield varied due to nutritional approaches, yield targets and micronutrient supply and their interactions. Main effects only due to yield targets produced significant variations wherein, 8 t ha^{-1} yield target (T_3) recorded the maximum straw yield (8741) while 6 t ha^{-1} (T_1) recorded lower yield (7298).

Two factor interactions were significant wherein among $N \times T$, both NE and STCR approaches coupled with higher yield target across micronutrients ($N_{1-2}T_3$)

Table 205. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on grain and straw yield and harvest index under direct seeded condition during summer season

N x T x M		Grain yield (kg ha ⁻¹)				Straw yield (kg ha ⁻¹)				Harvest index			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	4988 ^e	5484 ^d	6032 ^c	5501 ^c	6941 ^e	8062 ^{cd}	8548 ^{a-c}	7850 ^{bc}	0.42 ^a	0.4 ^a	0.42 ^a	0.41 ^b
	M ₂	5338 ^d	6016 ^c	6737 ^b	6030 ^b	7169 ^e	8195 ^{b-d}	8642 ^{ab}	8002 ^b	0.43 ^a	0.42 ^a	0.44 ^a	0.43 ^{ab}
N ₂	M ₁	5624 ^d	6168 ^c	6033 ^c	5942 ^b	7203 ^e	7699 ^d	8085 ^{cd}	7662 ^c	0.44 ^a	0.45 ^a	0.43 ^a	0.44 ^{ab}
	M ₂	6603 ^b	6648 ^b	7385 ^a	6879 ^a	7880 ^d	8708 ^{ab}	8741 ^a	8443 ^a	0.46 ^a	0.43 ^a	0.46 ^a	0.45 ^a
Target		5638 ^c	6079 ^b	6547 ^a		7298 ^c	8166 ^b	8504 ^a		0.44 ^a	0.43 ^a	0.44 ^a	
Control		5288				7167				0.43			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		5163 ^e	5750 ^d	6384 ^b	5766 ^a	7055 ^d	8129 ^b	8595 ^a	7926 ^a	0.42 ^a	0.41 ^a	0.43 ^a	0.42 ^a
N ₂		6113 ^c	6408 ^b	6709 ^a	6410 ^a	7542 ^c	8203 ^b	8413 ^{ab}	8053 ^a	0.45 ^a	0.44 ^a	0.44 ^a	0.44 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		5306 ^e	5826 ^d	6032 ^{cd}	5721 ^a	7072 ^e	7881 ^c	8316 ^b	7756 ^a	0.43 ^a	0.43 ^a	0.42 ^a	0.43 ^a
M ₂		5971 ^c	6332 ^b	7061 ^a	6455 ^a	7525 ^d	8451 ^{ab}	8692 ^a	8223 ^a	0.44 ^a	0.43 ^a	0.45 ^a	0.44 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		202.2				321.8				0.04			
T		247.6				394.2				0.05			
M		202.2				321.8				0.04			
N x T		350.2				557.4				0.07			
M x T		350.2				557.4				0.07			
N x M		285.9				455.1				0.06			
N x T x M		495.2				788.3				0.10			
Control Vs Rest		107.5		313.8		198.6		519.8		0.21		NS	

NS – Not significant

Nutrient approach (N)

Yield Targets (T)

Micronutrient & Organics (M)

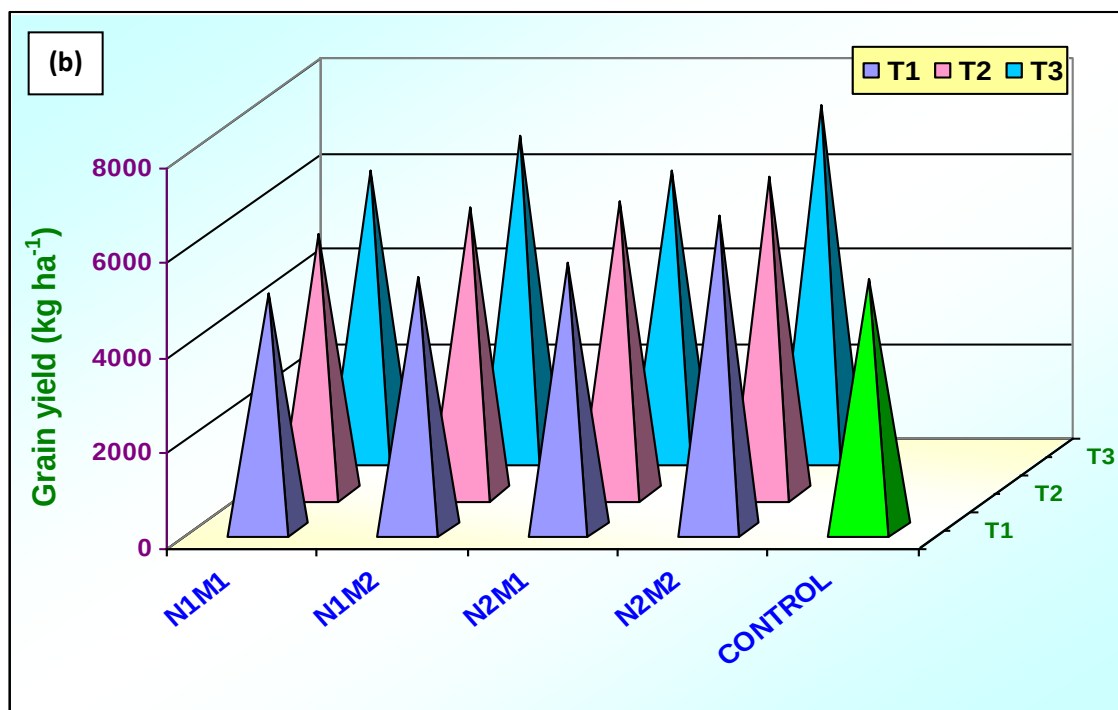
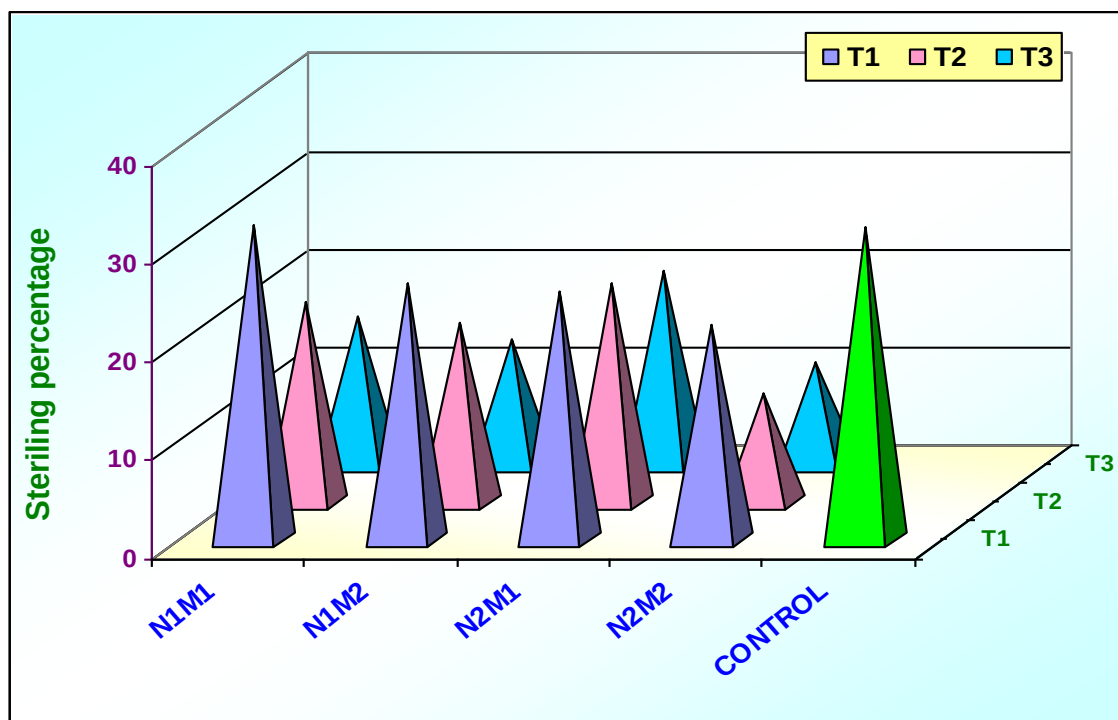
: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for eac



LEGEND		
Nutritional approaches (N):	N ₁ - Nutrient Expert,	N ₂ - Soil Test Crop Response approach
Yield Targets (T):	T ₁ - 6 t ha ⁻¹ ,	T ₂ - 7 t ha ⁻¹ , T ₃ - 8 t ha ⁻¹
Micronutrient & Organics (M):	M ₁ - Without FeSO ₄ +ZnSO ₄ + Organics,	M ₂ - With FeSO ₄ +ZnSO ₄ + Organics

Fig. 34. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on (a) sterility percentage and (b) grain yield (kg ha^{-1}) under direct seeded condition during summer season

recorded higher yield (8595 – 8413, respectively) while NE with 6 t ha⁻¹ (N₁T₁) recorded the lower straw yield (5766), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum yield (8692) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂) followed by T₂M₂ which was on par while lower yield (7072) was observed lower target coupled with and no micronutrient/organics (T₁M₁), and among nutritional approaches and micronutrient supply across yield targets, STCR approach and micronutrient supply (N₂M₂) recorded higher straw yield (8443) while NE and no micronutrient supply (N₁M₁) recorded lower straw yield (7850) and N₂M₂ was on par.

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered significantly higher yield (8741) followed by STCR + 7 t ha⁻¹ yield target + micronutrient supply (N₂T₂M₂ - 8708) and NE + 8 t ha⁻¹ yield target with or without micronutrients + organics (N₂T₃M₁₋₂ -8548 and 8642 respectively) which were on par, while lower yield (6941) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁).

All the medium and high yield targets irrespective of nutritional approaches and micronutrient levels (N₁₋₂T₂₋₃M₁₋₂) including N₂T₁M₂ were significantly superior to the recommended control (7167) with regard to straw yield.

4.2.2.2.13 Harvest index (c.f. Table 205)

None of the main effects and interactions due to due to nutritional approaches, yield targets or micronutrient + organic levels was significant with regard to harvest index. The indices hovered around 0.42 and 0.46, respectively with N₁T₁M₁ and N₂T₃M₂ being numerically lowest and highest among all. Control recorded 0.43 harvest index.

4.2.2.3 Grain composition

4.2.2.3.1 Grain nitrogen (%) (c.f. Table 206)

Data pertaining grain N content revealed non-significant variations due to main effects and interaction among nutritional approaches, yield targets and micronutrient + organics application except N x M during summer except two-way interaction due to N x M wherein STCR approach in combination with micronutrients + organics (N₂M₂)

registered higher grain N (1.16), while both NE and STCR with no micronutrients and organics ($N_{1-2}M_1$) recorded lower grain N (1.09 and 1.11, respectively).

All N-T-M combinations were comparable with recommended control (1.09).

4.2.2.3.2 Grain phosphorus (%) (c.f. Table 206)

Grain P content revealed significant variation due to main effects due to yield targets (T) wherein higher target of 8 t ha^{-1} (T_3) had significantly higher grain P content (0.27) and it decreased with decrease in yield targets recording the lowest (0.22) with lower yield target (T_1). Other main effects and two-way and three-way interactions were not significant. Recommended control had grain P content of 0.24% and was comparable with N-T-M combinations.

4.2.2.3.3 Grain potassium (%) (c.f. Table 206)

Unlike N and P, grain K content revealed significant variation due to main effects, due to yield targets and interactions due to nutritional approaches, yield targets and micronutrient + organics application except $N \times M$. In main effects, nutritional approaches and levels of micronutrients and organics did not differ significantly, higher yield target (T_3) had significantly higher grain K (0.42) and it decreased with decrease in yield targets recording the lowest (0.39) with lower yield target (T_1).

Two factor interactions were also significant. In that, both NE/STCR approaches coupled with higher yield target across micronutrients ($N_{1-2}T_3$) recorded higher K content (0.42 each), while NE with 6 t ha^{-1} (N_1T_1) had lower K content (0.38). Similarly, micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum grain K (0.42 and 0.43, respectively) with higher target (8 t ha^{-1}) whether micronutrients and organics are applied or not (T_3M_{1-2}); medium yield target combinations were on par while lower yield target but without micronutrient/organics (T_1M_1) had lower grain K (0.38).

Among the three factors interaction, all combinations involving medium and high yield targets ($N_{1-2}T_{2-3}M_{1-2}$) except $N_2T_2M_1$ were superior to $N_1T_1M_1$ which recorded lower grain K (0.37) among all. Among N-T-M combinations except $N_1T_1M_1$ all other combinations had numerically higher grain K than recommended control (0.37).

Table 206. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on grain nitrogen, grain phosphorus and grain potassium under direct seeded condition during summer season

N x T x M		Grain nitrogen (%)				Grain phosphorus (%)				Grain potassium (%)			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	1.07 ^a	1.13 ^a	1.17 ^a	1.13 ^a	0.23 ^a	0.26 ^a	0.27 ^a	0.26 ^a	0.37 ^b	0.42 ^a	0.42 ^a	0.40 ^a
	M ₂	1.10 ^a	1.16 ^a	1.18 ^a	1.15 ^a	0.25 ^a	0.27 ^a	0.27 ^a	0.26 ^a	0.39 ^{ab}	0.42 ^a	0.42 ^a	0.41 ^a
N ₂	M ₁	1.11 ^a	1.11 ^a	1.16 ^a	1.13 ^a	0.25 ^a	0.26 ^a	0.26 ^a	0.26 ^a	0.39 ^{ab}	0.39 ^{ab}	0.42 ^a	0.40 ^a
	M ₂	1.12 ^a	1.19 ^a	1.19 ^a	1.16 ^a	0.26 ^a	0.28 ^a	0.28 ^a	0.27 ^a	0.41 ^{ab}	0.43 ^a	0.43 ^a	0.42 ^a
Target		1.10 ^a	1.15 ^a	1.18 ^a		0.25 ^a	0.27 ^a	0.27 ^a		0.39 ^b	0.41 ^{ab}	0.42 ^a	
Control		1.09				0.24				0.39			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		1.09 ^a	1.15 ^a	1.17 ^a	1.14 ^a	0.24 ^a	0.26 ^a	0.27 ^a	0.26 ^a	0.38 ^b	0.42 ^a	0.42 ^a	0.41 ^a
N ₂		1.11 ^a	1.15 ^a	1.18 ^a	1.15 ^a	0.25 ^a	0.27 ^a	0.27 ^a	0.27 ^a	0.40 ^{ab}	0.41 ^{ab}	0.42 ^a	0.41 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		1.09 ^a	1.12 ^a	1.17 ^a	1.13 ^a	0.24 ^a	0.26 ^a	0.27 ^a	0.26 ^a	0.38 ^b	0.40 ^{ab}	0.42 ^a	0.40 ^a
M ₂		1.11 ^a	1.18 ^a	1.18 ^a	1.16 ^a	0.25 ^a	0.27 ^a	0.28 ^a	0.27 ^a	0.40 ^{ab}	0.42 ^a	0.43 ^a	0.42 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.08				0.03				0.03			
T		0.10				0.04				0.03			
M		0.08				0.03				0.03			
N x T		0.15				0.06				0.05			
M x T		0.15				0.06				0.05			
N x M		0.12				0.05				0.04			
N x T x M		0.21				0.08				0.07			
Control Vs Rest		0.04		0.12		0.01		NS		0.01		NS	

NS – Not significant

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

4.2.2.3.4 Grain iron (mg kg^{-1}) (c.f. Table 207)

Grain Fe content revealed significant variation due to main effects due to yield targets and interactions due to nutritional approaches, yield targets and micronutrient + organics application. In the main effects, higher yield target (T_3) had significantly higher grain Fe (35.2) and it decreased with decrease in yield targets recording the lowest (24.0) with lower yield target (T_1).

Two factor interactions were also significant. In that, STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher Fe content (35.9), while NE with 6 t ha^{-1} (N_1T_1) had lower Fe content (21.3), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum grain Fe (38.1) with higher target (8 t ha^{-1}) applied with micronutrients and organics supply (T_3M_2) while lower yield target but without micronutrient/organics (T_1M_1) had lower grain Fe (22.4), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics supply (N_2M_2) recorded the maximum grain Fe (38.1), while NE without micronutrient + organics supply (N_1M_1) had the lowest Fe content (26.9).

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + with micronutrient and organic supply ($N_2T_3M_2$) registered the maximum grain Fe (40.4) followed by $N_2T_2M_2$ (39.6) which was on par, while lower grain Fe (18.3) was observed with NE + 6 t ha^{-1} yield target + no micronutrient and organics ($N_1T_1M_1$); other combinations fared in between.

Among N-T-M, all combinations except $N_1T_1M_{1-2}$ were superior to recommended control (18.6).

4.2.2.3.5 Grain zinc (mg kg^{-1}) (c.f. Table 207)

Data on grain Zn content revealed significant variations due to main effects of yield targets and two-way interactions due to $N \times T$ and $T \times M$. In main effects among yield targets, higher yield target (T_3) had significantly higher grain Zn (13.7) and it decreased with decrease in yield targets recording the lowest (12.1) with lower yield target (T_1).

In two factor interactions, NE and STCR approaches coupled with higher yield target across micronutrients ($N_{1-2}T_3$) recorded higher Zn content (13.8 and 13.7,

Table 207. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on grain iron and grain zinc under direct seeded condition during summer season

N x T x M		Iron (mg kg ⁻¹)				Zinc (mg kg ⁻¹)			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	18.3 ^f	29. ^{2c-e}	33.1 ^{bc}	26.9 ^c	11.5 ^a	12.7 ^a	13.7 ^a	12.6 ^a
	M ₂	24.2 ^e	32.3 ^{b-d}	35.9 ^{ab}	30.8 ^b	12.1 ^a	13.5 ^a	13.8 ^a	13.2 ^a
N ₂	M ₁	26.6 ^{de}	26.6 ^{de}	31.5 ^{a-d}	28.2 ^{bc}	12.3 ^a	12.4 ^a	13.0 ^a	12.6 ^a
	M ₂	26.9 ^{c-e}	39.6 ^a	40.4 ^a	35.7 ^a	12.5 ^a	14.4 ^a	14.4 ^a	13.8 ^a
Target		24.0 ^c	32.0 ^b	35.2 ^a		12.1 ^b	13.2 ^{ab}	13.7 ^a	
Control		18.6				11.7			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N
N ₁		21.3 ^d	30.8 ^b	34.5 ^{ab}	28.8 ^a	11.8 ^b	13.1 ^{ab}	13.8 ^a	12.9 ^a
N ₂		26.7 ^c	33.1 ^{ab}	35.9 ^a	31.9 ^a	12.4a ^b	13.4 ^{ab}	13.7 ^{ab}	13.2 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M
M ₁		22.4 ^d	27.9 ^c	32.3 ^b	27.5 ^a	11.9 ^b	12.6 ^{ab}	13.3 ^{ab}	12.6 ^a
M ₂		25.6 ^{cd}	36.0 ^{ab}	38.1 ^a	33.2 ^a	12.3 ^{ab}	13.9 ^a	14.1 ^a	13.5 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		3.8				1.63			
T		4.6				1.99			
M		3.8				1.63			
N x T		6.5				2.82			
M x T		6.5				2.82			
N x M		5.3				2.30			
N x T x M		9.2				3.99			
Control Vs Rest		2.6		7.6		0.84		NS	

DAS - Days after sowing

NS – Not significant,

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

respectively), while NE with 6 t ha⁻¹ (N₁T₁) had lower Zn content (11.8). Three factors interaction did not reveal significant variations, however, STCR + 8 t ha⁻¹ yield target + with micronutrient and organic supply (N₂T₃M₂) registered the maximum grain Zn (14.4), while lower grain Zn (11.5) was observed with NE + 6 t ha⁻¹ yield target + no micronutrient and organics (N₁T₁M₁) which was numerically lower than control (11.7) while other N-T-M combinations exceeded control.

4.2.2.3.6 Grain copper (mg kg⁻¹) (c.f. Table 208)

Data on grain Cu content revealed significant variations due to main effects of yield targets and interactions due to nutritional approaches, yield targets and micronutrient + organics application except two-way interactions of N x M. In main effects among yield targets, higher yield target (T₃) had significantly higher grain Cu (1.64) and it decreased with decrease in yield targets recording the lowest (1.35) with lower yield target (T₁). In the two factor interactions, NE and STCR approaches coupled with higher yield target across micronutrients (N₁₋₂T₃) recorded higher Cu content (1.49 and 1.54, respectively), while NE with 6 t ha⁻¹ (N₁T₁) had lower Cu content (1.25), and micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum grain Cu (1.69) with higher target (8 t ha⁻¹) with micronutrients and organics supply (T₃M₂) followed by T₂M₂ (1.65) which was on par, while lower yield target but without micronutrient/organics (T₁M₁) had lower grain Cu (1.26).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + with micronutrient and organic supply (N₂T₃M₂) registered the maximum grain Cu (1.70) followed by N₂T₂M₂ (1.68) which was on par and the next best, while lower grain Cu (1.15) was observed with NE + 6 t ha⁻¹ yield target + no micronutrient and organics (N₁T₁M₁); other combinations fared in between.

Among N-T-M, all combinations except N₁T₁M₁₋₂ were numerically superior to recommended control (1.30) with regard to grain Cu.

4.2.2.3.7 Grain manganese (mg kg⁻¹) (c.f. Table 208)

Grain Mn content revealed significant variations due to main effects of yield targets and interactions due to nutritional approaches, yield targets and micronutrient +

Table 208. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on grain copper and manganese under direct seeded condition during summer season

N x T x M		Copper (mg kg ⁻¹)				Manganese (mg kg ⁻¹)			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	1.15 ^{bc}	1.53 ^{ab}	1.63 ^a	1.44 ^a	26.49 ^c	30.66 ^{bc}	32.23 ^{a-c}	29.79 ^b
	M ₂	1.35 ^c	1.62 ^a	1.67 ^a	1.55 ^a	27.95 ^{bc}	31.81 ^{a-c}	32.75 ^{ab}	30.84 ^{ab}
N ₂	M ₁	1.38 ^{a-c}	1.42 ^{ab}	1.56 ^{ab}	1.46 ^a	29.27 ^{bc}	29.66 ^{bc}	31.16 ^{bc}	30.03 ^b
	M ₂	1.50 ^{ab}	1.68 ^a	1.70 ^a	1.63 ^a	30.11 ^{bc}	33.48 ^{ab}	37.32 ^a	33.63 ^a
Target		1.35 ^b	1.56 ^a	1.64 ^a		28.46 ^b	31.40 ^a	33.36 ^a	
Control		1.30				27.64			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N
N ₁		1.25 ^b	1.58 ^a	1.65 ^a	1.49 ^a	27.22 ^c	31.23 ^{ab}	32.49 ^{ab}	30.32 ^a
N ₂		1.44 ^{ab}	1.55 ^a	1.63 ^a	1.54 ^a	29.69 ^{bc}	31.57 ^{ab}	34.24 ^a	31.83 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M
M ₁		1.26 ^b	1.48 ^{ab}	1.59 ^a	1.45 ^a	27.88 ^c	30.16 ^{bc}	31.69 ^{a-c}	29.91 ^a
M ₂		1.43a ^b	1.65 ^a	1.69 ^a	1.59 ^a	29.03 ^{bc}	32.64 ^{ab}	35.03 ^a	32.23 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.25				3.29			
T		0.31				4.03			
M		0.25				3.29			
N x T		0.43				5.70			
M x T		0.43				5.70			
N x M		0.35				4.65			
N x T x M		0.61				8.06			
Control Vs Rest		0.14		NS		1.65		4.83	

DAS - Days after sowing

NS – Not significant,

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

organics application. In main effects among yield targets, higher yield target (T_3) had significantly higher grain Mn (33.36) and it decreased with decrease in yield targets recording the lowest (28.46) with lower yield target (T_1).

Two factor interactions were also significant. In that, all combination involving medium and high yield targets were comparable and STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher Mn content (34.24), while NE with 6 t ha⁻¹ (N_1T_1) had lower Mn content (27.22), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum grain Mn (35.03) with higher target (8 t ha⁻¹) applied with micronutrients and organics (T_3M_1), while lower yield target but without micronutrient/organics (T_1M_1) had lower grain Mn (27.88), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics supply (N_2M_2) recorded the maximum grain Mn (35.03), while NE without micronutrient + organics supply (N_1M_1) had the lowest Mn content (27.88).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + with micronutrient and organic supply ($N_2T_3M_2$) registered the maximum grain Mn (37.32) followed by $N_2T_2M_2$ (33.48) which was next best, so were $N_1T_2M_2$ and $N_1T_3M_2$, while lower grain Mn (24.69) was observed with NE + 6 t ha⁻¹ yield target + no micronutrient and organics ($N_1T_1M_1$); other combinations fared in between.

All N-T-M combinations involving medium and high yield targets and $N_2T_1M_2$ were significantly superior to recommended control (27.64).

4.2.2.3.8 Grain protein (%) (c.f. Table 209 and Fig. 35b)

Data on grain protein content followed trends in grain N content and revealed significant variations due to main effects of yield targets and interactions due to nutritional approaches, yield targets and micronutrient + organics application did not differ significantly.

In the main effects, nutritional approaches differed significantly, higher yield target (T_3) had significantly higher grain protein (6.98) and it decreased with decrease in yield targets recording the lowest (6.54) with T_1 . Among the nutritional approaches and micronutrient/organics, numerically higher protein was observed with STCR approach (N_2 – 6.81) and supply of micronutrients and organics (M_2 – 6.87).

Table 209. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on grain protein content under direct seeded condition during summer season

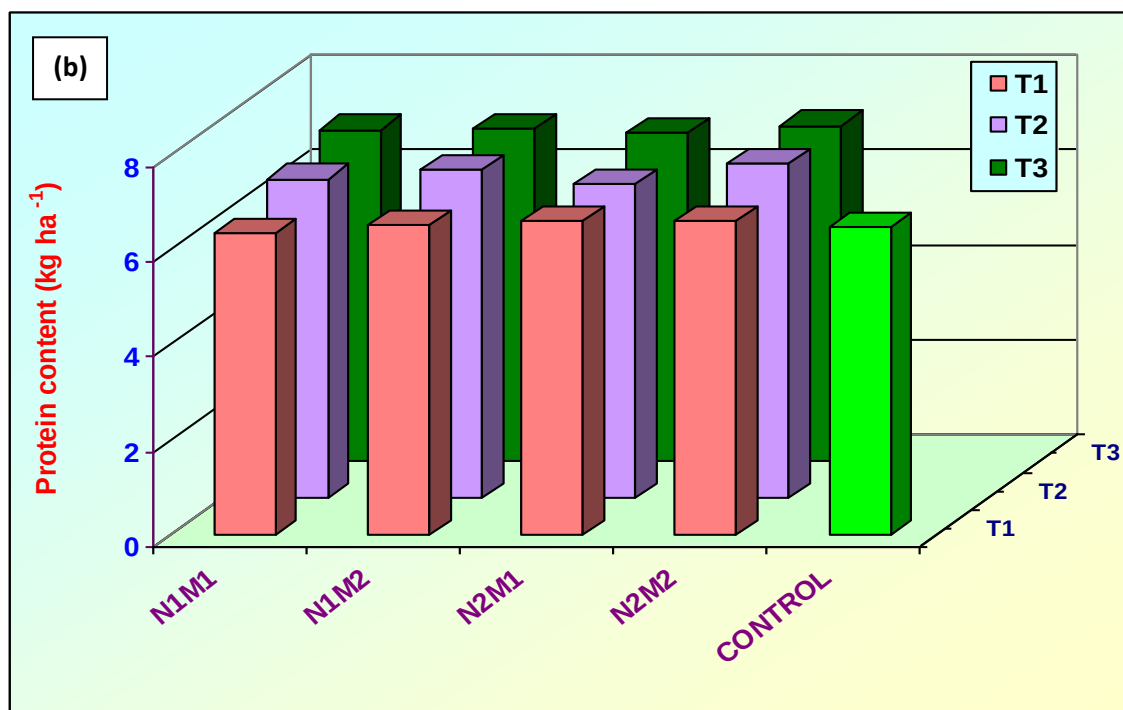
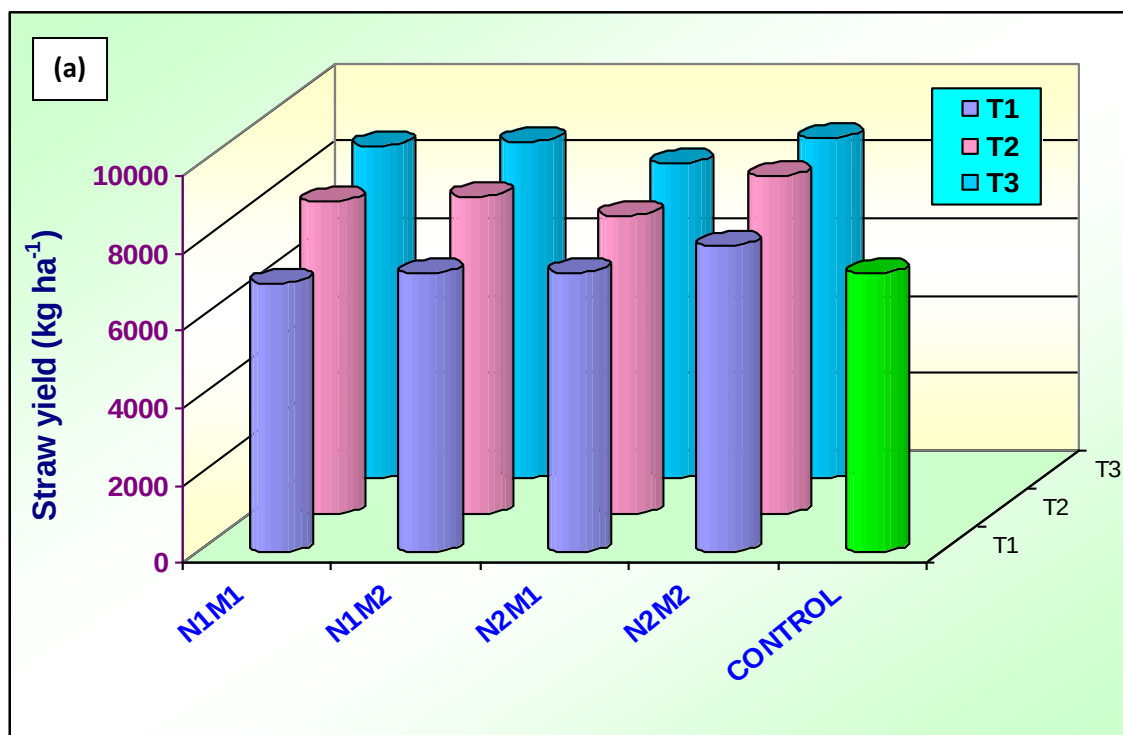
N x T x M		Grain protein content (%)			
		T ₁	T ₂	T ₃	N x M
N ₁	M ₁	6.38 ^a	6.72 ^a	6.97 ^a	6.69 ^a
	M ₂	6.55 ^a	6.91 ^a	6.99 ^a	6.82 ^a
N ₂	M ₁	6.61 ^a	6.62 ^a	6.90 ^a	6.71 ^a
	M ₂	6.63 ^a	7.06 ^a	7.06 ^a	6.92 ^a
Target		6.54 ^b	6.83 ^{ab}	6.98 ^a	
Control		6.50			
Approach-N-(NE/STCR) x Target (T)					N
N ₁		6.46 ^a	6.81 ^a	6.98 ^a	6.75 ^a
N ₂		6.62 ^a	6.84 ^a	6.98 ^a	6.81 ^a
Micronutrient/org. (M) x Target (T)					M
M ₁		6.49 ^a	6.67 ^a	6.94 ^a	6.70 ^a
M ₂		6.59 ^a	6.98 ^a	7.02 ^a	6.87 ^a
Comparison		S.Em±		LSD 0.05	
N		0.50			
T		0.62			
M		0.50			
N x T		0.87			
M x T		0.87			
N x M		0.71			
N x T x M		1.23			
Control Vs Rest		0.25		0.73	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT



LEGEND

Nutritional approaches (N): N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T): T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M): M₁ - Without FeSO₄+ZnSO₄ + Organics, M₂ - With FeSO₄+ZnSO₄ + Organics

Fig. 35. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on (a) straw yield (kg ha⁻¹) and (b) grain protein content (%) under direct seeded condition during summer season

Two factor interactions did not differ significantly. However, STCR and NE approach coupled with higher yield target across micronutrients ($N_{1-2}T_3$) recorded higher grain protein content (6.98 each); NE with similar target was on par (7.22), while NE with 6 t ha^{-1} (N_1T_1) had lower protein content (6.46), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum grain protein (7.02) with higher target (8 t ha^{-1}) applied with micronutrients and organics (T_3M_2) while lower yield target but without micronutrient/organics (T_1M_1) had lower grain protein (6.49), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics supply (N_2M_2) recorded the maximum grain protein (6.92), while NE without micronutrient + organics supply (N_1M_1) had the lower grain protein content (6.69).

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + with micronutrient and organic supply ($N_2T_3M_2$) registered the maximum grain protein (7.06), while lower grain protein (6.38) was observed with NE + 6 t ha^{-1} yield target + no micronutrient and organics ($N_1T_1M_1$); other combinations fared in between.

All N-T-M combinations involving medium and high yield targets ($N_{1-2}T_{1-3}M_{1-2}$) and were superior to recommended control (6.50).

4.2.2.4 Nutrient uptake

4.2.2.4.1 Nitrogen Uptake (kg ha^{-1}) (c.f. Table 210 and Fig. 36a)

Data pertaining N uptake revealed significant variation due to main effects of yield targets and interactions due to nutritional approaches, yield targets and micronutrient + organics application.

In the main effects due to yield targets, higher yield target ($T_3 - 143.7$) registered higher N uptake which decreased with decrease in yield targets and the lowest uptake was observed with lower yield target ($T_1 - 113.9$). Other main effects due to nutritional approaches and levels of micronutrients + organics were not significant.

Two factor interactions were significant. In that, STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher N uptake (137.6) followed by NE with similar target (137.2) which was on par, while NE with 6 t ha^{-1} (N_1T_1) had lower uptake of N (105.6), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum uptake (145.1)

with higher target (8 t ha^{-1}) coupled with micronutrients and organics (T_3M_2) while lower yield target and no micronutrient/organics (T_1M_1) had lower N uptake (106.5), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics (N_2M_2) recorded the maximum uptake (139.0), while NE and no micronutrient + organics supply (N_1M_1) had the lowest N uptake (118.6) and STCR without micronutrients + organics was on par.

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + micronutrient supply ($N_2T_3M_2$) registered the maximum uptake of N (149.4), while lower uptake (98.6) was occurred with NE + 6 t ha^{-1} yield target + no micronutrient ($N_1T_1M_1$); other combinations fared in between.

All N-T-M combinations except $N_1T_1M_{1-2}$ and $N_2T_1M_1$ were significantly superior to the recommended control (108.4) with regard to N uptake.

4.2.2.4.2 Phosphorus uptake (kg ha^{-1}) (c.f. Table 210 and Fig. 36b)

Variations in P uptake were more or less similar to N uptake except that the values were of lower order. P uptake varied significantly due to main effects of yield targets and due to all two-way and three-way interactions.

In the main effects due to yield targets, higher yield target irrespective of the approaches followed registered higher P uptake (22.1 and 24.3, respectively with NE and STCR) which decreased with decrease in yield targets and the lowest uptake (19.9) was observed with lower yield target (T_1). Other main effects due to nutritional approaches and levels of micronutrients + organics were not significant.

Two factor interactions were also significant. In that, both NE and STCR approaches coupled with higher yield target across micronutrients (N_2T_3) recorded higher P uptake (25.6 and 26.4, respectively), while NE with 6 t ha^{-1} (N_1T_1) had lower uptake of P (22.6), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum uptake (28.2) with higher target (8 t ha^{-1}) coupled with micronutrients and organics (T_3M_2) while lower yield target and no micronutrients/ organics (T_1M_1) had lower P uptake (18.4), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics (N_2M_2) recorded the maximum uptake (26.7), while NE and no micronutrient + organics supply (N_1M_1) had the lowest P uptake (21.0).

Table 210. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on total nitrogen, phosphorus and potassium uptake under direct seeded condition during summer season

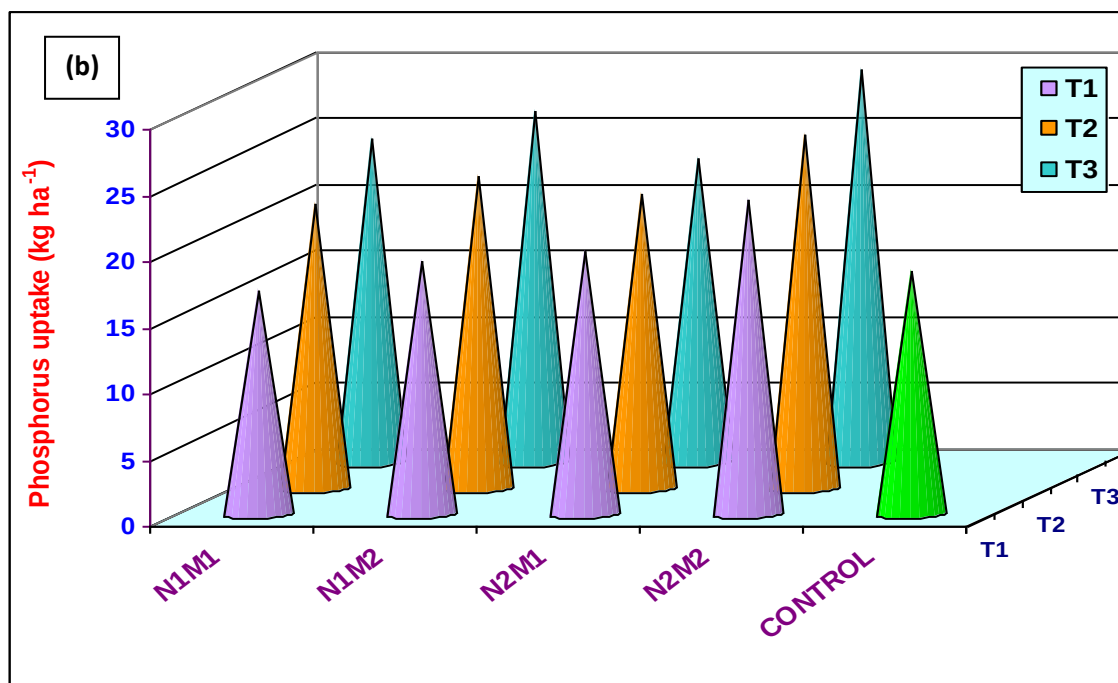
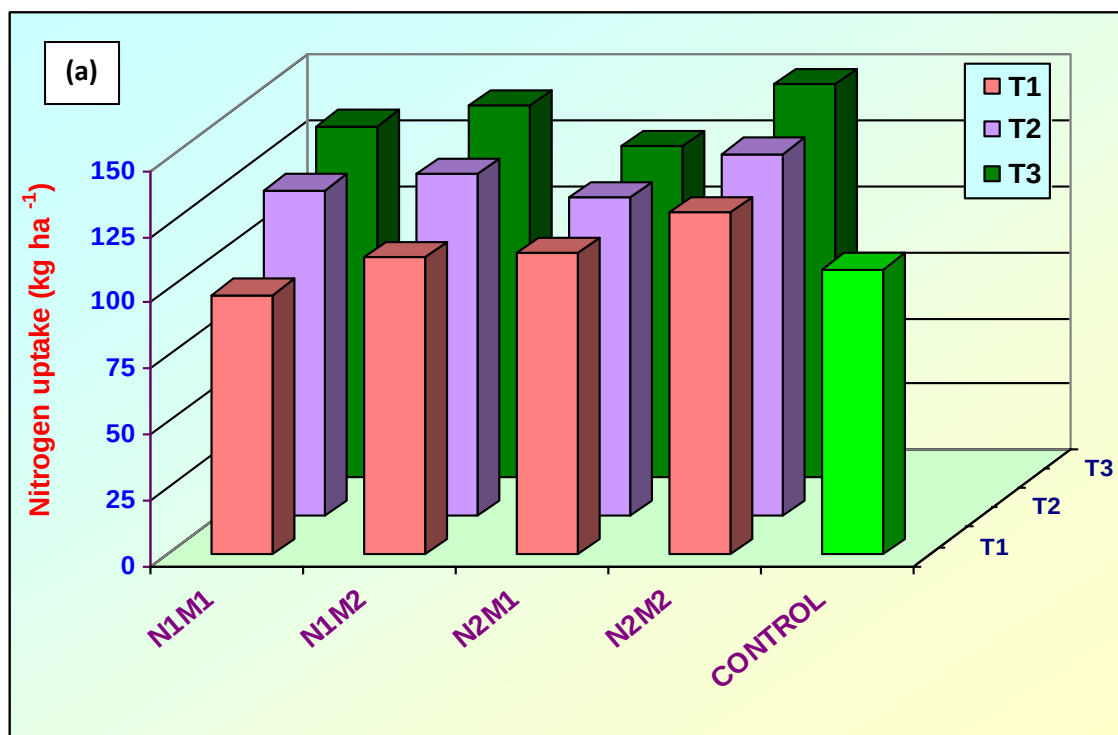
N x T x M		Nitrogen (kg ha ⁻¹)				Phosphorus (kg ha ⁻¹)				Potassium(kg ha ⁻¹)			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	98.6 ^h	123.6 ^{de}	133.4 ^g	118.6 ^c	16.9 ^f	21.6 ^{c-e}	24.5 ^{a-c}	21.0 ^c	101.0 ^g	125.4 ^{de}	136.5 ^{b-d}	121.0 ^C
	M ₂	112.6 ^g	129.6 ^d	140.9 ^B	127.7 ^b	19.1 ^{ef}	23.7 ^{b-d}	26.7 ^{ab}	23.2 ^b	109.5 ^g	131.6 ^{c-e}	142.4 ^{a-c}	127.8 ^b
N ₂	M ₁	114.4 ^{fg}	121.0 ^{ef}	125.9 ^{de}	120.4 ^c	20.0 ^{d-f}	22.3 ^{c-e}	23.0 ^{cd}	21.8 ^{bc}	111.4 ^{fg}	121.7 ^{ef}	129.6 ^{de}	120.9 ^c
	M ₂	130.1 ^{cd}	137.5 ^{bc}	149.4 ^a	139.0 ^a	23.7 ^{bc}	26.8 ^a	29.7 ^a	26.7 ^a	126.2 ^{de}	146.6 ^{ab}	152.2 ^A	141.7 ^a
Target		113.9 ^c	127.9 ^b	137.4 ^a		19.9 ^c	23.6 ^b	26.0 ^a		112.0 ^c	131.3 ^b	140.2 ^a	
Control		108.4				18.4				109.2			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		105.6 ^d	126.6 ^{bc}	137.2 ^a	123.1 ^a	18.0 ^d	22.6 ^{bc}	25.6 ^a	22.1 ^a	105.2 ^d	128.5 ^c	139.4 ^b	124.4 ^a
N ₂		122.3 ^c	129.3 ^b	137.6 ^a	129.7 ^a	21.9 ^c	24.5 ^{ab}	26.4 ^a	24.3 ^a	118.8 ^{ab}	134.2 ^a	140.9 ^a	131.3 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		106.5d	122.3c	129.7b	119.5 ^B	18.4 ^c	21.9 ^b	23.8 ^a	21.4 ^a	106.2 ^d	123.5 ^c	133.1 ^b	120.9 ^a
M ₂		121.4c	133.5b	145.1a	133.3 ^B	21.4 ^b	25.2 ^a	28.2 ^a	25.0 ^a	117.9 ^c	139.1 ^b	147.3 ^a	134.8 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		4.67				0.6				7.37			
T		5.72				0.8				9.03			
M		4.67				0.6				7.37			
N x T		8.09				1.1				12.76			
M x T		8.09				1.1				12.76			
N x M		6.60				0.9				10.42			
N x T x M		11.44				1.5				18.05			
Control Vs Rest		2.43		7.10		0.3		1.0		4.08		11.90	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT



LEGEND		
Nutritional approaches (N):	N ₁ - Nutrient Expert,	N ₂ - Soil Test Crop Response approach
Yield Targets (T):	T ₁ - 6 t ha ⁻¹ ,	T ₂ - 7 t ha ⁻¹ , T ₃ - 8 t ha ⁻¹
Micronutrient & Organics (M):	M ₁ - Without FeSO ₄ +ZnSO ₄ + Organics,	M ₂ - With FeSO ₄ +ZnSO ₄ + Organics

Fig. 36. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on (a) nitrogen uptake (kg ha⁻¹) and (b) phosphorus uptake (kg ha⁻¹) under direct seeded condition during summer season

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered the maximum uptake of P (55.2) followed by N₂T₂M₂ (53.9) which was on par, while lower uptake (38.6) occurred with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁); other combinations fared in between.

All N-T-M combinations involving medium and high yield targets including N₂T₁M₂ except N₁T₂M₁ and N₂T₂M₁ were significantly superior to the recommended control (40.7) with regard to P uptake.

4.2.2.4.2 Potassium uptake (kg ha⁻¹) (c.f. Table 210 and Fig. 37a)

Trends in K uptake were similar to N and P while the values were at same level as those of N. Variation in uptake were also significant due to nutritional approaches, yield targets and micronutrient + organics application and their interactions except main effects due to nutritional approaches and levels of micronutrients.

Among the main effects due to yield targets, higher yield target (T₃) recorded K uptake (140.2) which decreased with lowering of yield targets and recorded lowest K uptake (112.0) with lower yield target (T₁).

Two factor interactions were also significant. In that, STCR approach coupled with higher yield target across micronutrients (N₂T₃) recorded higher K uptake (140.9), while NE with 6 t ha⁻¹ (N₁T₁) had lower uptake of N (105.2), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum uptake (147.3) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂) while lower yield target and no micronutrient/organics (T₁M₁) had lower K uptake (106.2), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics (N₂M₂) recorded the maximum uptake (141.7), while NE and no micronutrient + organics supply (N₁M₁) had the lowest K uptake (121.0).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered the maximum uptake of K (152.2), while lower uptake (101.0) was occurred with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁); other combinations fared in between.

All N-T-M combinations comprising of medium and high yield targets including N₂T₁M₂ were significantly superior to the recommended control (109.2) with regard to K uptake.

4.2.2.4.4 Iron uptake (g ha^{-1}) (c.f. Table 211 and Fig. 37b)

Trends in Fe uptake were similar to major nutrients and the variations in uptake were also significant due to nutritional approaches, yield targets and micronutrient + organics application and their interactions except main effects due to nutritional approaches.

Among yield targets, higher target of 8 t ha^{-1} (T_3) registered higher Fe uptake (1589.4) and the uptake decreased with decreasing yield targets wherein lower yield target of 6 t ha^{-1} (T_1) recorded lower Fe uptake (1064.6). In micronutrients + organics levels, the treatments receiving both the components (M_2) registered higher Fe uptake (1521.7) while in the absence of them (M_1) the uptake was the lowest (1197.7)

Two factor interactions were significant. In that, STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher Fe uptake (1672.4), while NE with 6 t ha^{-1} (N_1T_1) had lower uptake of Fe (966.7), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum uptake (1798.0) with higher target (8 t ha^{-1}) coupled with micronutrients and organics (T_3M_2) while lower yield target and no micronutrient/organics (T_1M_1) had lower Fe uptake (985.6), and among nutritional approaches and micronutrient + organics supply across yield targets, STCR approach and micronutrients + organics (N_2M_2) recorded the maximum uptake (1719.7), while NE and no micronutrient + organics supply (N_1M_1) had the lowest Fe uptake (1201.2).

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + micronutrient supply ($N_2T_3M_2$) registered the maximum uptake of Fe (2025.7), while lower uptake (898.1) was occurred with NE + 6 t ha^{-1} yield target + no micronutrient ($N_1T_1M_1$); other combinations fared in between.

All N-T-M combinations except $N_1T_1M_1$ and $N_1T_1M_2$ were significantly superior to the recommended control (974.1) with regard to Fe uptake.

4.2.2.4.5 Zinc uptake (g ha^{-1}) (c.f. Table 211 and Fig. 38)

Trends in Zn uptake were similar to iron but the uptake was of lower order and the variations in uptake were also significant due to nutritional approaches, yield targets and micronutrient + organics application except the main effects due to nutritional approaches.

Table 211. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on total iron and zinc uptake under direct seeded condition during summer season

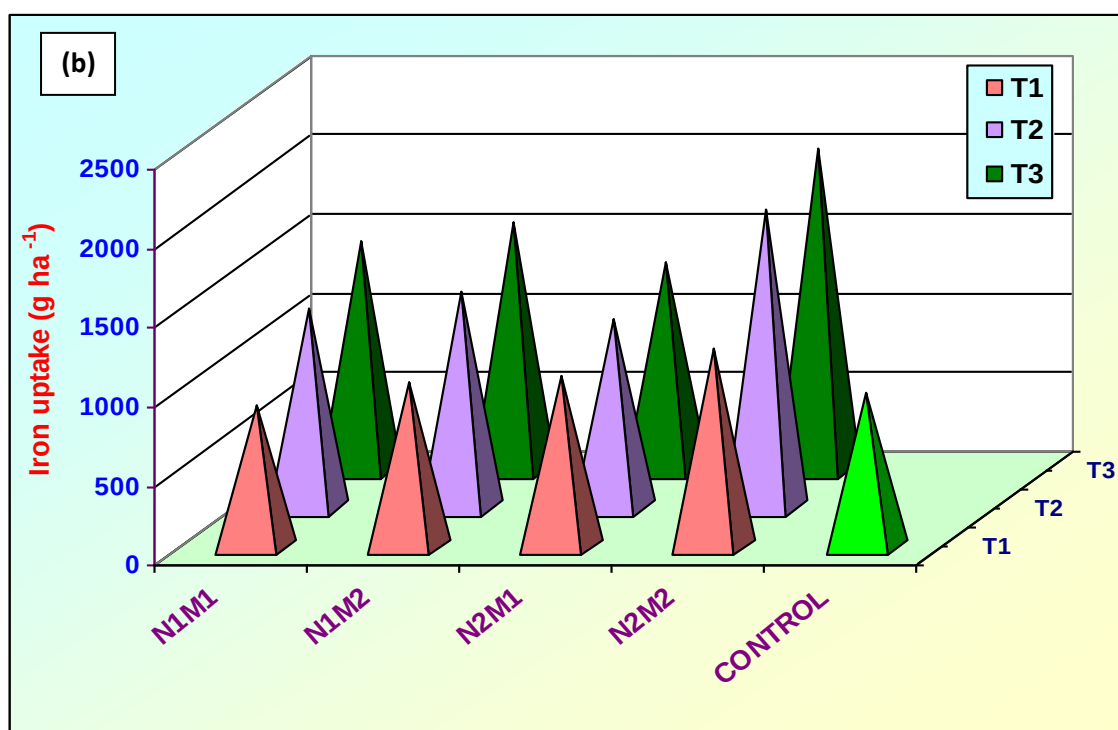
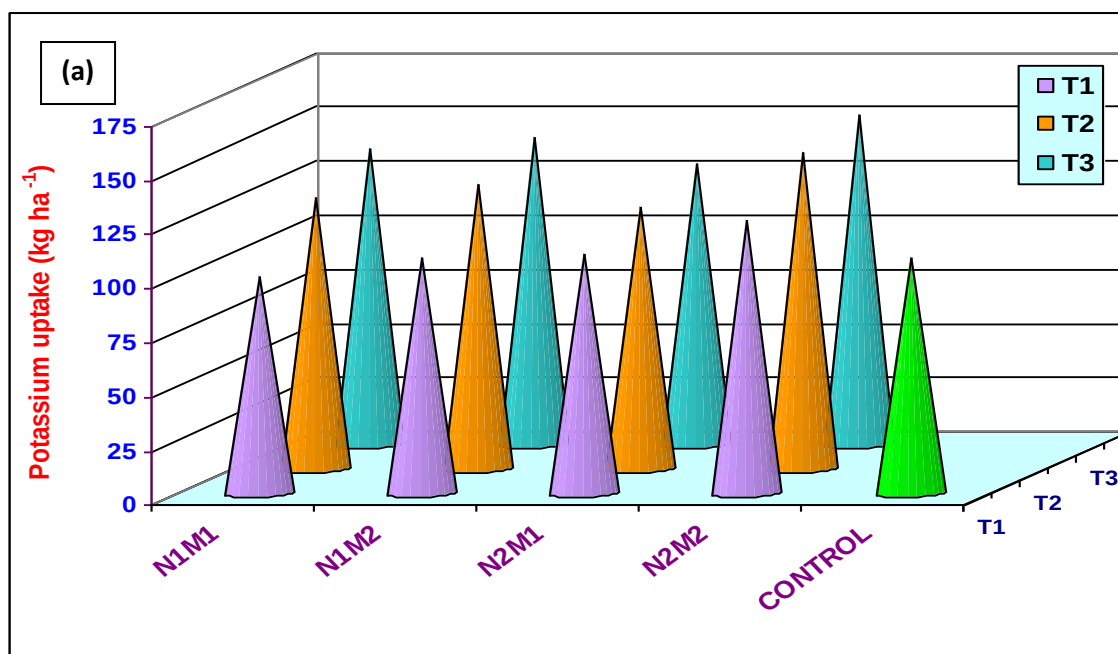
N x T x M		Iron (g ha ⁻¹)				Zinc (g ha ⁻¹)			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	898.1 ⁱ	1262.9 ^{fg}	1442.5 ^d	1201.2 ^c	208.6 ⁱ	300.2 ^{fg}	348.2 ^d	285.7 ^c
	M ₂	1035.3 ^h	1365.7 ^e	1570.2 ^c	1323.7 ^b	242.3 ^h	330.3 ^e	363.8 ^c	312.2 ^b
N ₂	M ₁	1073.0 ^h	1190.6 ^g	1319.1 ^{ef}	1194.2 ^c	248.0 ^h	282.2 ^b	312.2 ^f	280.8 ^c
	M ₂	1252.1 ^g	1881.3 ^b	2025.7 ^a	1719.7 ^a	295.4 ^g	385.5 ^b	401.7 ^a	360.9 ^a
Target		1064.6 ^c	1425.1 ^b	1589.4 ^a		248.6 ^c	324.6 ^b	356.5 ^a	
Control		974.1				237.1			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N
N ₁		966.7 ^e	1314.3 ^c	1506.4 ^b	1262.4 ^a	225.4 ^e	315.2 ^c	356.0 ^a	298.9 ^a
N ₂		1162.6 ^d	1536.0 ^b	1672.4 ^a	1457.0 ^a	271.7 ^d	333.9 ^b	356.9 ^a	320.8 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M
M ₁		985.6 ^f	1226.8 ^d	1380.8 ^c	1197.7 ^b	228.3 ^f	291.2 ^d	330.2 ^c	283.2 ^b
M ₂		1143.7 ^e	1623.5 ^b	1798.0 ^a	1521.7 ^a	268.9 ^e	357.9 ^b	382.8 ^a	336.5 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		47.6				9.7			
T		58.4				11.8			
M		47.6				9.7			
N x T		82.5				16.7			
M x T		82.5				16.7			
N x M		67.4				13.7			
N x T x M		116.7				23.7			
Control Vs Rest		27.7		80.8		5.5		16.2	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

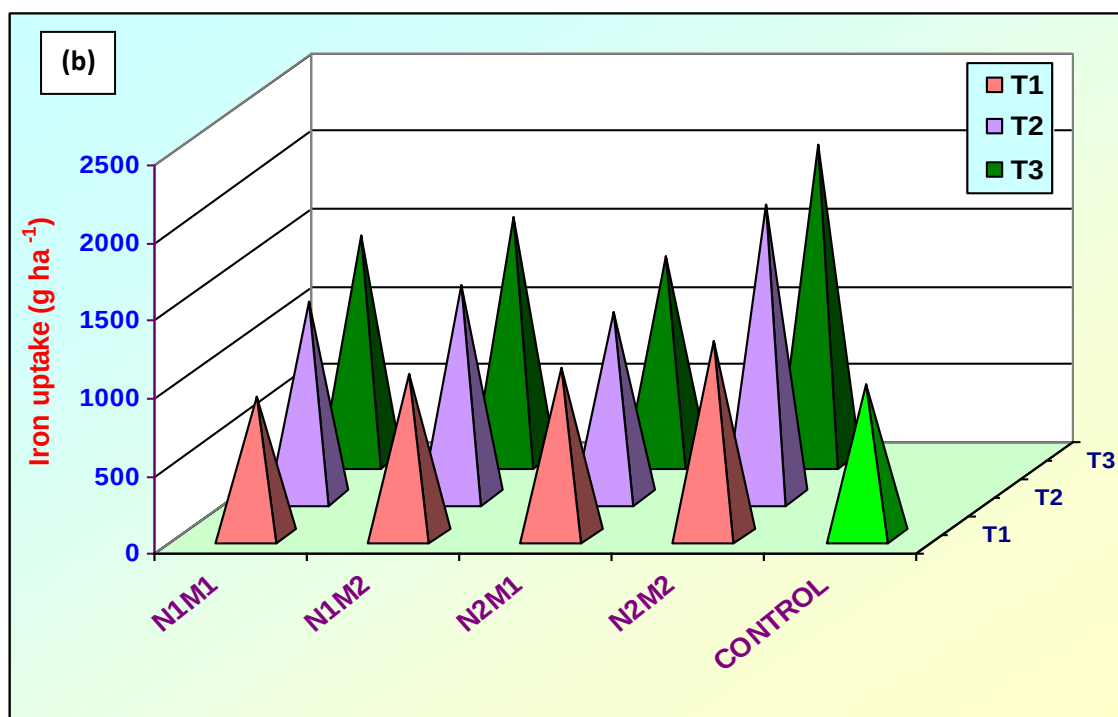
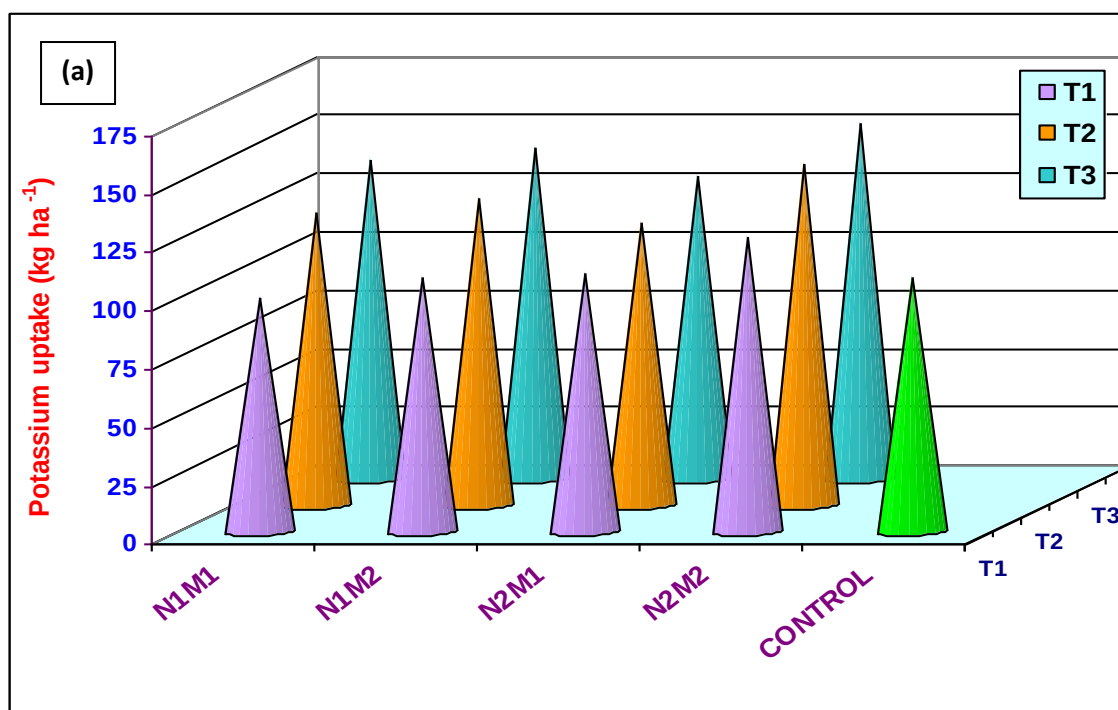
Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT



LEGEND

Nutritional approaches (N): N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T): T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M): M₁ - Without FeSO₄+ZnSO₄ + Organics, M₂ - With FeSO₄+ZnSO₄ + Organics

Fig. 37. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on (a) potassium uptake (kg ha^{-1}) and (b) iron uptake (g ha^{-1}) under direct seeded condition during summer season



LEGEND

Nutritional approaches (N): N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
 Yield Targets (T): T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
 Micronutrient & Organics (M): M₁ - Without FeSO₄+ZnSO₄ + Organics, M₂ - With FeSO₄+ZnSO₄ + Organics

Fig. 37. Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on (a) potassium uptake (kg ha^{-1}) and (b) iron uptake (g ha^{-1}) under direct seeded condition during summer season

Among yield targets, higher target of 8 t ha⁻¹(T₃) registered higher Zn uptake (365.5) and the uptake decreased with decreasing yield targets wherein lower yield target of 6 t ha⁻¹ (T₁) recorded lower Fe uptake (248.6). In micronutrients + organics levels, the treatments receiving both the components (M₂) registered higher Zn uptake (336.5) while in the absence of them (M₁) the uptake was the lowest (283.2).

Two factor interactions were significant. In that, both NE and STCR approaches coupled with higher yield target across micronutrients (N₁₋₂T₃) recorded higher Zn uptake (356.0 and 356.9, respectively), while NE with 6 t ha⁻¹ (N₁T₁) had lower uptake of Zn (225.4), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum uptake (382.8) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T₃M₂) while lower yield target and no micronutrients/ organics (T₁M₁) had lower Zn uptake (228.3), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics (N₂M₂) recorded the maximum uptake (360.9), while NE and no micronutrient + organics supply (N₁M₁) had the lowest Zn uptake (285.7).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered the maximum uptake of Zn (401.7), while lower uptake (208.6) was occurred with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁); other combinations fared in between.

All N-T-M combinations except N₁T₁M₁ and N₁T₁M₂ were significantly superior to the recommended control (237.1) with regard to Zn uptake.

4.2.2.4.6 Copper uptake (g ha⁻¹) (c.f. Table 212)

Data on copper (Cu) uptake revealed significant variations due to nutritional approaches, yield targets and micronutrient + organics application and their interactions except the main effects due to nutritional approaches and the uptake was of lower order among micronutrients.

Among yield targets, higher target of 8 t ha⁻¹ (T₃) registered higher Cu uptake (34.0) and the uptake decreased with decreasing yield targets wherein lower yield target of 6 t ha⁻¹ (T₁) recorded lower Cu uptake (25.4). In micronutrients + organics levels, the treatments receiving both the components (M₂) registered higher Cu uptake (32.4) while in the absence of them (M₁) the uptake was the lowest (28.0).

Table 212. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on total copper and manganese uptake under direct seeded condition during summer season

N x T x M		Copper (g ha ⁻¹)				Manganese (g ha ⁻¹)			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	21.6 ^h	29.6 ^e	32.8 ^c	28.0 ^c	2470.9 ^f	3359.8 ^c	3711.4 ^b	3180.7 ^c
	M ₂	24.7 ^g	31.6 ^{cd}	34.9 ^b	30.4 ^b	2793.7 ^e	3491.2 ^c	3795.1 ^b	3360.0 ^b
N ₂	M ₁	25.5 ^g	28.0 ^f	30.8d ^e	28.1 ^c	2905.5 ^e	3121.4 ^d	3409.6 ^c	3145.5 ^c
	M ₂	29.8 ^e	35.6 ^b	37.5 ^a	34.3 ^a	3309.2 ^{cd}	3855.1 ^b	4171.7 ^a	3778.7 ^a
Target		25.4 ^c	31.2 ^b	34.0 ^a		2869.8 ^c	3456.9 ^b	3771.9 ^a	
Control		24.2				2599.0			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N
N ₁		23.1 ^e	30.6 ^e	33.9 ^a	29.2 ^a	2632.3 ^d	3425.5 ^b	3753.2 ^a	3270.3
N ₂		27.7 ^d	31.8 ^b	34.2 ^a	31.2 ^a	3107.3 ^c	3488.3 ^b	3790.7 ^a	3462.1
Micronutrient/org. (M) x Target (T)					M	M x T			M
M ₁		23.5 ^f	28.8 ^d	31.8 ^c	28.0 ^b	2688.2 ^e	3240.6 ^c	3560.5 ^b	3163.1 ^b
M ₂		27.3 ^e	33.6 ^b	36.2 ^a	32.4 ^a	3051.4 ^d	3673.2 ^b	3983.4 ^a	3569.3 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.9				127.8			
T		1.1				156.5			
M		0.9				127.8			
N x T		1.6				221.3			
M x T		1.6				221.3			
N x M		1.3				180.7			
N x T x M		2.2				313.0			
Control Vs Rest		0.53		1.54		75.23		219.60	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Two factor interactions were significant. In that, STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher Cu uptake (34.2) followed by N_1T_3 (33.9) which was on par, while NE with 6 t ha⁻¹ (N_1T_1) had lower uptake of Cu (23.1), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum uptake (36.2) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T_3M_2) while lower yield target and no micronutrients/ organics (T_1M_1) had lower Cu uptake (23.5), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics (N_2M_2) recorded the maximum uptake (34.2), while NE and no micronutrient + organics supply (N_1M_1) had the lowest Cu uptake (28.0).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply ($N_2T_3M_2$) registered the maximum uptake of Cu (37.5), while lower uptake (21.6) occurred with NE + 6 t ha⁻¹ yield target + no micronutrient ($N_1T_1M_1$); other combinations fared in between.

All N-T-M combinations involving medium and high yield targets including $N_2T_1M_2$ were significantly superior to the recommended control (24.2) with regard to Cu uptake.

4.2.2.4.7 Manganese uptake (g ha⁻¹) (c.f. Table 212)

Similar to other essential nutrients' uptake, data on manganese (Mn) uptake revealed significant variations due to nutritional approaches, yield targets and micronutrient + organics application, and the uptake was of higher order among micronutrients.

All the main effects due to nutritional approaches, yield targets and micronutrient + organics application were significant while those due to nutritional approaches were not significant. STCR (3462.1) was numerically superior to NE (3270.3). Among yield targets, higher target of 8 t ha⁻¹ (T_3) registered higher Mn uptake (3771.9) and the uptake decreased with decreasing yield targets wherein lower yield target of 6 t ha⁻¹ (T_1) recorded lower Mn uptake (2599.0). In micronutrients + organics levels, the treatments receiving both the components (M_2) registered higher Mn uptake (3569.3) while in the absence of them (M_1) the uptake was the lowest (3163.1).

Two factor interactions were significant, in that, STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded higher Mn uptake (3790.7)

followed by N_1T_3 (3753.2) which was on par, while NE with 6 t ha⁻¹ (N_1T_1) had lower uptake of Mn (2632.3), micronutrients + organics across nutritional approaches in combinations with yield targets registered the maximum uptake (3983.4) with higher target (8 t ha⁻¹) coupled with micronutrients and organics (T_3M_2) while lower yield target and no micronutrient/organics (T_1M_1) had lower Mn uptake (2688.2), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and micronutrients + organics (N_2M_2) recorded the maximum uptake (3778.7), while NE and no micronutrient + organics supply (N_1M_1) had the lowest Mn uptake (3180.7).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + micronutrient supply ($N_2T_3M_2$) registered the maximum uptake of Mn (4171.7), while lower uptake (2470.9) was occurred with NE + 6 t ha⁻¹ yield target + no micronutrient ($N_1T_1M_1$); other combinations fared in between.

All N-T-M combinations except $N_1T_1M_1$ and $N_1T_1M_2$ were significantly superior to the recommended control (2599.0) with regard to Mn uptake.

4.2.2.5 Soil chemical properties after harvest

4.2.2.5.1 Soil pH (c.f. Table 213)

Soil pH of the experimental site during 2014-15 summer ranged from 8.01- 8.18 and revealed significant variations only due to N x T, N x M and N x T x M interactions. Among N x T, STCR and higher yield target (N_2T_3) recorded higher pH (8.14), while N_1T_2 had lower pH (8.02), in N x M combinations N_2M_1 had higher pH (8.11) while N_1M_1 registered lower pH (8.03) and N_1M_2 was on par, and among N x T x M combinations $N_2T_3M_1$ registered higher pH (8.18) while $N_1T_2M_2$ recorded lower pH (8.01) among all. Control recorded a moderate pH of 8.07.

4.2.2.5.2 Soil EC (dS m⁻¹) (c.f. Table 213)

Soil EC was within the permissible limits and among treatments during summer varied from 0.66 to 0.99 and revealed significant variations only due to N x T, N x M and N x T x M interactions. Among N x T, NE and medium yield target (N_1T_2) recorded higher EC (0.96), while N_2T_3 had lower EC (0.67), in N x M combinations N_1M_2 had higher EC (0.92) while N_2M_1 registered lower EC (0.74) and N_2M_2 was on par with the latter, and among N x T x M combinations $N_2T_3M_1$ registered lower EC (0.66) while control recorded a moderately lower EC of 0.74.

Table 213. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on available pH, EC and Organic carbon (OC) under direct seeded condition after harvest during summer season

N x T x M		pH				EC (d Sm ⁻¹)				OC (%)			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	8.05 ^{ab}	8.02 ^b	8.03 ^b	8.03 ^b	0.85 ^{a-d}	0.93 ^{ab}	0.86 ^{a-d}	0.88 ^a	0.49 ^{ab}	0.48 ^{ab}	0.49 ^{ab}	0.49 ^a
	M ₂	8.04 ^b	8.01 ^b	8.03 ^b	8.03 ^b	0.86 ^{a-d}	0.99 ^a	0.91 ^{a-c}	0.92 ^a	0.49 ^{ab}	0.46 ^b	0.48 ^{ab}	0.48 ^a
N ₂	M ₁	8.07 ^{ab}	8.09 ^{ab}	8.18 ^a	8.11 ^a	0.80 ^{a-d}	0.75 ^{b-d}	0.66 ^d	0.74 ^b	0.50 ^{ab}	0.52 ^{ab}	0.56 ^a	0.52 ^a
	M ₂	8.05 ^{ab}	8.08 ^{ab}	8.09 ^{ab}	8.07 ^{ab}	0.82 ^{a-d}	0.75 ^{b-d}	0.68 ^{cd}	0.75 ^b	0.50 ^{ab}	0.50 ^{ab}	0.53 ^{ab}	0.51 ^a
Target		8.05 ^a	8.05 ^a	8.08 ^a		0.83 ^a	0.85 ^a	0.78 ^a		0.49	0.49	0.51	
Control		8.07				0.78				0.50			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		8.04 ^b	8.02 ^b	8.03 ^b	8.03 ^a	0.85 ^{ab}	0.96 ^a	0.89 ^{ab}	0.90 ^a	0.49 ^{ab}	0.47 ^b	0.49 ^{ab}	0.48 ^a
N ₂		8.06 ^{ab}	8.08 ^{ab}	8.14 ^a	8.09 ^a	0.81 ^{ac}	0.75 ^{bc}	0.67 ^c	0.74 ^a	0.50 ^{ab}	0.51 ^{ab}	0.54 ^a	0.52 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		8.06 ^a	8.05 ^a	8.11 ^a	8.07 ^a	0.82 ^a	0.84 ^a	0.76 ^a	0.81 ^a	0.49 ^a	0.50 ^a	0.52 ^a	0.51 ^a
M ₂		8.04 ^a	8.05 ^a	8.06 ^a	8.05 ^a	0.84 ^a	0.87 ^a	0.79 ^a	0.83 ^a	0.49 ^a	0.48 ^a	0.51 ^a	0.49 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.08				0.13				0.05			
T		0.10				0.20				0.07			
M		0.08				0.13				0.05			
N x T		0.14				0.23				0.09			
M x T		0.14				0.23				0.09			
N x M		0.11				0.19				0.08			
N x T x M		0.19				0.33				0.13			
Control Vs Rest		0.04		NS		0.06		NS		0.03		NS	

NS – Not significant

Nutrient approach (N)

Yield Targets (T)

Micronutrient & Organics (M)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

4.2.2.5.3 Organic carbon (%) (c.f. Table 213)

Organic carbon (OC) values were almost in low range except with $N_2T_3M_{1-2}$, $N_2T_2M_{1-2}$ and $N_2T_1M_{1-2}$ irrespective of treatments with a range of 0.46 to 0.56 and revealed significant variations due to varied yield targets and interaction among factors under study. Higher yield target (T_3) had higher soil OC (0.51) and it decreased with lowering of yield target and registered lower soil OC (0.49) with lower yield target (T).

Two factor interactions were significant, in that, STCR approach coupled higher yield target across micronutrients (N_2T_3) recorded higher OC (0.54), while NE with 7 t ha^{-1} (N_1T_2) had lower OC value (0.47). Micronutrients+ organics across nutritional approaches in combinations with yield targets did not reveal significant differences; however, numerically higher OC (0.51) was registered with micronutrients and organics (T_3M_2). Similar was the variations among nutritional approaches and micronutrient + organics.

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + no micronutrient supply ($N_2T_3M_1$) registered the maximum OC (0.56), while lower OC (0.46 each) was recorded with NE + 7 t ha^{-1} yield target + micronutrient and organics ($N_1T_2M_2$); other combinations fared in between.

Control with recommended fertilization had moderate OC content (0.50) and was comparable with STCR based nutrition irrespective of yield levels and levels of micronutrient and organics.

4.2.2.6 Soil available nutrient status

4.2.2.6.1 Available nitrogen (kg ha^{-1}) (c.f. Table 214)

Data pertaining soil available N revealed significant variation only due to interactions due to $N \times T$, $N \times M$ and $N \times T \times M$. In that, STCR approach coupled higher yield target across micronutrients (N_2T_3) recorded higher N status (257.8), while NE with 7 t ha^{-1} (N_1T_2) had lower soil available N (228.9) followed by N_1T_3 which was on par. Among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and no supply of micronutrients + organics (N_2M_1) recorded the maximum soil N (255.1) followed by N_2M_2 which was on par, while NE and micronutrient + organics supply (N_1M_2) had the lower available N (235.8).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + without or with micronutrient supply (N₂T₃M₁₋₂) registered the maximum soil available N (259.2 and 256.4, respectively), while lower N (227.7) was observed with NE + 7 t ha⁻¹ yield target + micronutrient and organics (N₁T₂M₂) followed by N₁T₂M₁ (230.2) which was on par; other combinations fared in between.

Among N-T-M combinations N₁T₂₋₃M₁₋₂ had significantly lower soil available N than recommended control (252.6) while rest were at par with control.

4.2.2.6.2 Soil available phosphorus (kg ha⁻¹) (c.f. Table 214)

Data on soil available P uptake revealed similar trend as that of soil available N at harvest and the variations were significant only due to interactions of N x T, N x M and N x T x M. In that, STCR approach coupled with higher yield target across micronutrients (N₂T₃) recorded higher P status (37.9), while NE with 6 t ha⁻¹ (N₁T₁) had lower soil available P (28.6). Among nutritional approaches and micronutrient + organics supply across yield targets STCR approach and no supply of micronutrients + organics (N₂M₁) recorded the maximum soil P (37.0) followed by N₂M₂ which was on par, while NE and micronutrient + organics supply (N₁M₂) had the lower available P (29.9).

Among the three factors interaction, STCR + 8 t ha⁻¹ yield target + without or with micronutrient supply (N₂T₃M₁₋₂) registered the maximum soil available P (38.5 and 37.4, respectively), while lower P (27.6) was observed with NE + 6 t ha⁻¹ yield target + micronutrient and organics (N₁T₁M₂); other combinations fared in between and were at par with one another.

Recommended control registered moderate soil P (33.5).

4.2.2.6.3 Soil available potassium (kg ha⁻¹) (c.f. Table 214)

Soil available K almost varied non - significantly except main effects due to yield targets and N x T (Table), in that higher yield target of 8 t ha⁻¹(T₃) recorded higher soil available K (372.1) and it decreased with decrease in yield targets and recorded lower soil available K (359.0) with lower yield target (T₁). In N x T interactions, STCR approach based higher yield target (N₂T₃) recorded significantly higher soil available K (377.1) while, NE and lower yield target (N₁T₁) registered lower soil available K (353.6) at harvest. Recommended control had moderate soil K status (362.4).

Table 214. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on available nitrogen, phosphorus and potassium under direct seeded condition after harvest during summer season

N x T x M		Nitrogen (kg ha ⁻¹)				Phosphorus (kg ha ⁻¹)				Potassium (kg ha ⁻¹)			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	248.6 ^{a-c}	230.2 ^{de}	239.4 ^{b-e}	239.4 ^b	29.7 ^{ab}	30.4 ^{ab}	32.8 ^{ab}	31.0 ^{bc}	353.8 ^a	361.5 ^a	367.2 ^a	360.9 ^a
	M ₂	246.0 ^{a-d}	227.7 ^e	233.7 ^{c-e}	235.8 ^b	27.6 ^b	30.3 ^{ab}	31.8 ^{ab}	29.9 ^c	353.3 ^a	359.4 ^a	367.1 ^a	359.9 ^a
N ₂	M ₁	251.8 ^{ab}	254.4 ^{ab}	259.2 ^a	255.1 ^a	35.5 ^{ab}	37.0 ^{ab}	38.5 ^a	37.0 ^a	365.0 ^a	368.8 ^a	377.5 ^a	370.4 ^a
	M ₂	250.6 ^{a-c}	253.3 ^{ab}	256.4 ^{ab}	253.4 ^a	34.9 ^{ab}	35.6 ^{ab}	37.4 ^{ab}	36.0 ^{ab}	363.9 ^a	368.5 ^a	376.7 ^a	369.7 ^a
Target		249.2 ^a	241.4 ^a	247.2 ^a		31.9 ^a	33.3 ^a	35.1 ^a		359.0 ^b	364.6 ^a _b	372.1 ^a	
Control		252.6				33.5				362.4			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		247.3 ^a	228.9 ^b	236.6 ^b	237.6 ^a	28.6 ^c	30.4 ^{bc}	32.3 ^{a-c}	30.4 ^a	353.6 ^b	360.4 ^{ab}	367.2 ^{ab}	360.4 ^a
N ₂		251.2 ^a	253.8 ^a	257.8 ^a	254.3 ^a	35.2	36.3 ^{ab}	37.9 ^a	36.5 ^a	364.4 ^{a-b}	368.7 ^{ab}	377.1 ^a	370.0 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		250.2 ^a	242.3 ^a	249.3 ^a	247.3 ^a	32.6 ^a	33.7 ^a	35.6 ^a	34.0 ^a	359.4 ^a	365.2 ^a	372.3 ^a	365.6 ^a
M ₂		248.3 ^a	240.5 ^a	245.1 ^a	244.6 ^a	31.2 ^a	33.0 ^a	34.6 ^a	32.9 ^a	358.6 ^a	363.9 ^a	371.9 ^a	364.8 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		10.1				5.7				15.2			
T		12.3				6.9				18.7			
M		10.1				5.7				15.2			
N x T		17.4				9.8				26.4			
M x T		17.4				9.8				26.4			
N x M		14.2				8.0				21.6			
N x T x M		24.6				13.9				37.3			
Control Vs Rest		5.0		14.7		2.9		NS		7.6		NS	

NS – Not significant

Nutrient approach (N)

Yield Targets (T)

Micronutrient & Organics (M)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

4.2.2.6.4 Soil available iron (mg kg^{-1}) (c.f. Table 215)

Trends in soil available Fe was quite different and most of the variations due to nutritional approaches, yield targets and micronutrient + organics application and their interactions were also significant. Among yield targets, higher target of 8 t ha^{-1} (T_3) registered lower Fe status (12.9) and the content increased with decreasing yield targets wherein lower yield target of 6 t ha^{-1} (T_1) recorded higher Fe (14.4). Main effects due to nutritional approaches and micronutrient + organic levels were not significant.

Two factor interactions were significant. In that, STCR approach coupled with higher yield target across micronutrients (N_2T_3) recorded lower available Fe (12.7), while NE with 6 t ha^{-1} (N_1T_1) had higher soil available Fe (14.7), micronutrients+ organics across nutritional approaches in combinations with yield targets registered the maximum Fe (12.0) with higher yield target (8 t ha^{-1}) coupled with no supply of micronutrients and organics (T_3M_1) while lower yield target but with micronutrients/ organics (T_1M_2) had higher Fe status (15.3), and among nutritional approaches and micronutrient + organics supply across yield targets STCR approach but without micronutrients + organics (N_2M_1) recorded lower soil Fe status (12.7), while NE without micronutrient + organics supply (N_1M_2) followed by N_2M_2 had higher Fe status (14.6 and 14.2, respectively).

Among the three factors interaction, STCR + 8 t ha^{-1} yield target + no micronutrient supply ($N_2T_3M_1$) registered the minimum Fe status (11.8), while higher status (15.7) was recorded with NE + 6 t ha^{-1} yield target + micronutrient ($N_1T_1M_2$); other combinations fared in between. Control (13.5) with recommended fertilization fared moderately.

4.2.2.6.5 Soil available zinc (mg kg^{-1}) (c.f. Table 215)

Trends in Zn uptake revealed significant differences due to $T \times M$, $N \times M$ and $N \times T \times M$ interactions. Among $T \times M$, lower yield target whether with micronutrients and organics supply (T_1M_2) registered higher soil available Zn (3.8 each) while higher yield target with no supply of micronutrient and organics (T_3M_1) recorded lower soil available Zn (2.7), and among nutritional approaches and micronutrient + organics supply across yield targets NE approach coupled with micronutrients + organics (N_1M_2) recorded the maximum Zn status (3.6), while STCR and without micronutrient + organics supply (N_2M_1) had lower Zn status (2.8).

Table 215. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on available iron and zinc under direct seeded condition after harvest during summer season

N x T x M		Iron (mg kg ⁻¹)				Zinc (mg kg ⁻¹)			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	13.7 ^{a-c}	13.2 ^{a-c}	12.3 ^{bc}	13.0^{bc}	3.0 ^{ab}	2.9 ^{ab}	2.9 ^{ab}	2.9^{bc}
	M ₂	15.7 ^a	14.2 ^{a-c}	13.8 ^{a-c}	14.6^a	3.8 ^a	3.6 ^{ab}	3.2 ^{ab}	3.6^a
N ₂	M ₁	13.5 ^{a-c}	12.7 ^{bc}	11.8 ^c	12.7^c	3.0 ^{ab}	2.9 ^{ab}	2.6 ^a	2.8^c
	M ₂	14.9 ^{ab}	14.1 ^{a-c}	13.7 ^{a-c}	14.2^{ab}	3.7 ^a	3.3 ^{ab}	3.1 ^{ab}	3.4^{ab}
Target		14.4 ^a	13.6 ^{ab}	12.9 ^b		3.4 ^a	3.2 ^a	3.0 ^a	
Control		13.5				3.0			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N
N ₁		14.7 ^a	13.7 ^{ab}	13.0 ^{ab}	13.8^a	3.4 ^a	3.3 ^a	3.0 ^a	3.2^a
N ₂		14.2 ^{ab}	13.4 ^{ab}	12.7 ^b	13.5^a	3.4 ^a	3.1 ^a	2.9 ^a	3.1^a
Micronutrient/org. (M) x Target (T)					M	M x T			M
1		13.6 ^{a-c}	13.0 ^{bc}	12.0 ^c	12.9^a	3.0 ^{bc}	2.9 ^{bc}	2.7 ^c	2.9^a
M ₂		15.3 ^a	14.2 ^{ab}	13.7 ^{a-c}	14.4^a	3.8 ^a	3.5 ^{a-b}	3.2 ^{a-c}	3.5^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		1.6				0.6			
T		2.0				0.7			
M		1.6				0.6			
N x T		2.8				1.0			
M x T		2.8				1.0			
N x M		2.3				0.8			
N x T x M		3.9				1.4			
Control Vs Rest		1.0		NS		0.3		NS	

NS – Not significant

Nutrient approach (N)

Yield Targets (T)

Micronutrient & Organics (M)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Among the three factors interaction, NE + 6 t ha⁻¹ yield target + micronutrient supply (N₁T₁M₂) registered the maximum Zn status (3.8), while lower status (2.6) was recorded with STCR + 8 t ha⁻¹ yield target + no micronutrient (N₂T₃M₁); other combinations fared in between.

Control with 3.0 mg kg⁻¹ soil available Zn fared moderately.

4.2.2.6.6 Soil available copper (mg kg⁻¹) (c.f. Table 216)

Soil available Cu did not reveal any significant differences due to main or interaction effects due to nutritional approaches, yield targets and micronutrient + organics levels. The values varied between 2.87 to 3.31.

4.2.2.6.7 Soil available manganese (mg kg⁻¹) (c.f. Table 216)

Variations in soil available Mn ranged from 10.10 to 11.59 and were also not significant due to main or interaction effects due to nutritional approaches, yield targets and micronutrient + organics levels except T x M wherein lower yield target coupled with micronutrients and organics (T₁M₂) recorded higher soil Mn status (11.53) while higher yield status and no supply of micronutrients of organics (T₃M₁) recorded lower soil available Mn (10.21) . Recommended control recorded soil available manganese of 10.97 mg ha⁻¹.

4.2.2.7 Economics (c.f. Table 217)

Gross returns followed more or less trends in grain yield and the variations were significant due to three factor combinations during summer season.

Among all the combinations, higher level of all the factors *i.e.* STCR + 8 t ha⁻¹ yield target + micronutrient supply (N₂T₃M₂) registered the maximum gross returns (₹ 1,57,789) followed by similar combination but with medium yield target (N₂T₂M₂ – ₹ 1,43,727), while among NE maximum returns were recorded with N₁T₃M₂ (₹ 1,45,280) followed by N₁T₃M₁ (₹ 1,31,709) while lower gross returns (₹ 1,08,653) among all were obtained with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁) which was lower than the control with recommended practice (₹ 1,14,816).

Variations in net returns were significant and significantly higher net returns (₹ 97,786) were obtained with STCR based nutrition for 8 t ha⁻¹ yield target supplied with micronutrients and organics (N₂T₃M₂) followed by NE based nutrition for 8 t ha⁻¹

Table 216. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on available copper and manganese under direct seeded condition after harvest during summer season

N x T x M		Copper (mg kg ⁻¹)				Manganese(mg kg ⁻¹)			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	3.01 ^a	2.96 ^a	2.91 ^a	2.96 ^a	11.07 ^a	10.57 ^a	10.33 ^a	10.66 ^a
	M ₂	3.31 ^a	3.13 ^a	3.05 ^a	3.16 ^a	11.59 ^a	11.37 ^a	11.23 ^a	11.40 ^a
N ₂	M ₁	2.98 ^a	2.95 ^a	2.87 ^a	2.93 ^a	10.67 ^a	10.51 ^a	10.10 ^a	10.43 ^a
	M ₂	3.21 ^a	3.07 ^a	3.04 ^a	3.11 ^a	11.47 ^a	11.35 ^a	11.23 ^a	11.35 ^a
Target		3.13 ^a	3.03 ^a	2.97 ^a		11.20 ^a	10.95 ^a	10.72 ^a	
Control		2.99				10.97			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N
N ₁		3.16 ^a	3.04 ^a	2.98 ^a	3.06 ^a	11.33 ^a	10.97 ^a	10.78 ^a	11.03 ^a
N ₂		3.09 ^a	3.01 ^a	2.96 ^a	3.02 ^a	11.07 ^a	10.93 ^a	10.67 ^a	10.89 ^a
Micronutrient/org. (M) x Target (T)					M	M x T			M
M ₁		3.00 ^a	2.95 ^a	2.89 ^a	2.95 ^a	10.87 ^{ab}	10.54 ^{ab}	10.21 ^b	10.54 ^a
M ₂		3.26 ^a	3.10 ^a	3.05 ^a	3.13 ^a	11.53 ^a	11.36 ^{ab}	11.23 ^{ab}	11.37 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.42				1.08			
T		0.52				1.33			
M		0.42				1.08			
N x T		0.73				1.87			
M x T		0.73				1.87			
N x M		0.60				1.53			
N x T x M		1.03				2.65			
Control Vs Rest		0.22		NS		0.69		NS	

NS – Not significant

Nutrient approach (N)

Yield Targets (T)

Micronutrient & Organics (M)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

: M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

Table 217. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics on economics under direct seeded condition during summer season

N x T x M		Gross returns (₹ ha ⁻¹)				Net returns (₹ ha ⁻¹)				B: C			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	108653 ^e	120321 ^d	131709 ^c	120228 ^c	75095 ^e	86248 ^{b-d}	96510 ^a	85951 ^b	3.24 ^c	3.53 ^b	3.74 ^a	3.50 ^a
	M ₂	115764 ^d	130688 ^c	145280 ^b	130578 ^b	65831 ^f	80240 ^{de}	93706 ^a	79926 ^c	2.32 ^g	2.59 ^f	2.82 ^e	2.58 ^c
N ₂	M ₁	121258 ^d	132584 ^c	130790 ^c	128210 ^b	82516 ^{cd}	91349 ^{ab}	87162 ^{bc}	87009 ^b	3.13 ^{cd}	3.22 ^c	3.00 ^d	3.11 ^b
	M ₂	141216 ^b	143727 ^b	157789 ^a	147578 ^a	86099 ^{b-d}	86118 ^{b-d}	97786 ^a	90001 ^a	2.56 ^f	2.49 ^f	2.63 ^f	2.56 ^c
Target		121723 ^c	131830 ^b	141392 ^a		77385 ^c	85989 ^b	93791 ^a		2.81 ^c	2.96 ^b	3.05 ^a	
Control		114816				79605				3.26			
Approach-N-(NE/STCR) x Target (T)					N	N x T			N	N x T			N
N ₁		112209 ^d	125505 ^c	138495 ^b	125403 ^a	70463 ^d	83244 ^c	95108 ^a	82938 ^a	2.78 ^c	3.06 ^b	3.28 ^a	3.04 ^a
N ₂		131237 ^c	138155 ^b	144290 ^a	137894 ^a	84308 ^c	88734 ^b	92474 ^{ab}	88505 ^a	2.85 ^c	2.86 ^c	2.81 ^c	2.84 ^b
Micronutrient/org. (M) x Target (T)					M	M x T			M	M x T			M
M ₁		114956 ^e	126453 ^d	131250 ^c	124219 ^a	78805 ^d	88799 ^b	91836 ^a	86480 ^a	3.18 ^b	3.37 ^a	3.37 ^a	3.31 ^a
M ₂		128490 ^{cd}	137208 ^b	151535 ^a	139078 ^a	75965 ^d	83179 ^c	95746 ^a	84963 ^a	2.44 ^d	2.54 ^d	2.72 ^c	2.57 ^b
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		3957				3958				0.09			
T		4847				4847				0.11			
M		3957				3958				0.09			
N x T		6854				6855				0.16			
M x T		6854				6855				0.16			
N x M		5597				5597				0.13			
N x T x M		9694				9694				0.23			
Control Vs Rest		2070		6049				6049				0.14	

DAS - Days after sowing

NS – Not significant,

Nutrient approach (N)

: N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T)

: T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M)

: M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

yield target no supplement of micronutrients and organics ($N_1T_3M_1$ - ₹ 96,510), while lower net returns (₹ 65,831) among all were obtained with NE + 6 t ha⁻¹ yield target + no micronutrient ($N_1T_1M_2$) which was lower than the control with recommended practice (₹ 79,605) (Fig. 39a).

Variations in B:C ratios were significant but again the trend revealed slightly different pattern. In all, NE was superior to STCR wherein higher B:C ratio (3.47) occurred with NE based nutrition for a yield target of 8 t ha⁻¹ without supply of micronutrients + organics ($N_1T_2M_1$) followed by NE based nutrition for 7t ha⁻¹ yield target again without supplementation of micronutrients and organics ($N_1T_2M_1$ – 3.53). Similar yield targets with STCR based nutrition but without micronutrient + organics ($N_2T_2M_1$ and $N_2T_3M_1$) were 3.22 and 3.00, respectively which were higher than with micro nutrient + organics ($N_2T_2M_2$ and $N_2T_3M_2$ with 2.49 and 2.63, respectively). The B:C ratio with the latter was lower than that of control with recommended practice (3.26). Among all the lowest B:C ratio (2.32) was obtained with NE + 6 t ha⁻¹ yield target + micronutrients + organics supply ($N_1T_1M_2$) (Fig. 39b).

4.2.2.8 Performance of Factors over seasons (c.f. Table 218)

In general, yield levels during summer were a little lower (12.24%) compared to rainy season though same factors were studied. Nutritional approaches performed differently during rainy and summer seasons wherein NE revealed significant variations with better performance during rainy season with reductions in yield by 15.11% during summer while STCR performed evenly across seasons with almost half (8.27%) the variations in comparison to NE. Among the yield targets, the seasonal differences in 7 t ha⁻¹ yield target were significant while those of 6 and 8 t ha⁻¹ yield targets were not significant. In other words deviation from the rainy season over summer with medium yield target was the maximum of 14.07% while those with 6 and 8 t ha⁻¹ was of lower order (10.49 and 10.30%, respectively).

Table 218. Effect of nutrient approach, yield targets and supplementation of micronutrient and organics under direct seeded condition across the season

Treatments	Yield (kg ha ⁻¹)		S.E.	‘t’ test
	<i>Kharif</i>	Summer		
N-Approach				
Nutrient Expert	6793	5766	368.36	2.788 [*]
STCR	6988	6410	309.42	1.868 ^{NS}
Targets				
6.0 t ha ⁻¹	6299	5638	414.42	1.595 ^{NS}
7.0 t ha ⁻¹	7074	6079	286.99	3.467 [*]
8.0 t ha ⁻¹	7299	6547	242.28	2.197 ^{NS}
Seasonal Mean	6867	6026	257.97	3.260 [*]

*Significant at 5 % NS- not significant

V. DISCUSSION

The world needs more grain for food and more so rice. Today this has to be achieved even with diminishing arable land, water scarcity, rising cost of cultivation and inclement weather due to climate change. As mentioned, rice is one of the most important staple food crops of the world and India. India having an estimated population of 1.4 billion by 2025 requires another 30 m t or more of grains over the present production of 272 m t (2015-16) and this production has to come from improved productivity enabled through technological advances. Rice, being a predominant cereal needs intensive research. To meet the challenge of producing more rice from suitable lands, it is necessary to use rice varieties with higher yield potential and greater yield stability (Khush, 2004). That apart, generation of suitable production practices is another necessity. Here addressing the water issue takes the precedence. Already there is a shift from transplanted puddled rice (Tp-Pu) to direct seeded rice (DSR) even in the irrigation commands principally to tide over water scarcity which would aggravate in the years to come due to escalating pace of climate change.

Direct seeding helps to reduce water consumption by about 30 per cent (0.9 million litres acre⁻¹) as it eliminates raising of seedling in a nursery, puddling, transplanting under puddle soil and maintaining 4-5 inches (farmers use still higher levels) of water at the base of transplanted seedlings (Pepsico International, 2011). Reports indicate that yield levels of DSR are comparable to CT-TPR in many studies and some reports claim similar or even higher yields of DSR with good management practices (Joshi *et al.*, 2013). For this reason DSR is fast spreading in TBP and UKP irrigation command particularly with the interventions from University of Agricultural Sciences, Raichur, Karnataka and CIMMYT run CISSA South Asia project in the region. Already over 95,000 acres of rice area in the command is under DSR and is spreading further. Nevertheless, lack of optimum production technologies both during rainy season and summer is the main constraint in harnessing better returns. Therefore, the present investigation on identification suitable cultivars, seed rate, identification and optimising micronutrient needs and potentiality of realising set yield targets through adequate nutrition was carried out twice during rainy season and once in summer season during

2014-15 and 2015-16 at Agricultural Research Station, Dhadesugur, Ballari District falling under Tunga Bhadra irrigation command. The results are discussed in this chapter.

5.1 Effect of Weather on Crop Growth

The plant growth and development is a complex process and two classes of mechanisms that can influence and regulate the developmental pattern of plants have been recognized. The first is a system of endogenous chemical messengers called hormones, that co-ordinate the development of individual organs as well as the plant as a whole. The second class of mechanism comprises extrinsic factors such as light, water, temperature and gravity which, originate outside the organism and convey the information about the environment. Thus, the final pattern of development and behaviour of each individual plant is the result of a complex interplay between genetic, hormonal and environmental factors, and rice grown under different ecosystems and cultures is much influenced by prevailing weather. In this context, the weather during the cropping considering as a growth influencing factor is briefed here.

The experiment was conducted under irrigation at Agricultural Research Farm, Dhadesugur, Ballari, of University of Agricultural Sciences (UAS), Raichur, Karnataka, India. It is situated on the latitude of 15° 6' North, longitude of 76° 8' East and at an elevation of 358 metres above mean sea level and is located in North Eastern Dry Zone of Karnataka. Temperature during *kharif* season (June 2015 to December 2016) indicated that the maximum temperature was 37.0° C during June and minimum temperature was 18.0° C recorded during December, while during experimental year 2016-17 maximum temperature was 44.8° C during May and the minimum temperature was 22.6° C during January. This temperature range was quite adequate for the growth and development of paddy during both the years. Total receipt of rainfall during year 2015-16 and 2016-17 was 603.0 mm and 512.9 mm, respectively i.e. about 40.84% higher and 40.90% lower than average rainfall for the regions in respective years (Table 1 and Fig. 1). However, the rainfall was well distributed during early crop growth period during 2015-16 rainy season whereas during summer 2016 and rainfall distribution was not uniform. This probably had little impact on yield trend. Otherwise, crop being irrigated from Tunga Bhadra river and hence in reality rainfall did not had any limiting effect on crop growth unless otherwise through relative impact through variations in humidity and this too had

no significant effect as any diseases or pests on paddy occurred due to prophylactic measures taken in the study.

However, during rainy season 2015-16, the experiments were initiated quite early in the season in the area making use of river water, and as fresh water has not entered the river by then due to failure of pre-monsoon and early monsoon showers, the water had little higher EC_e because of which there was sporadic death of tender seedlings which resulted in resowing of first experiment. Heat units accrued earlier with higher heat use efficiency (Table 41 and 94 and Fig.6a and 15a) because of clear skies and high prevailing temperature during summer compared to rainy season and, therefore, crop flowered early and matured early during summer.

5.2 Performance of Cultivars

Almost no varietal selection and breeding efforts have been made for developing rice cultivars suitable for alternate tillage and establishment method especially in unpuddled or zero tillage with direct seeding in general (dry DSR) (Fukai, 2002) and in particular in the TBP irrigation command. Therefore, available popular cultivars grown under puddled condition were screened in the present investigation during both the seasons. In the present investigation during rainy season, cv. MTU 1010 recorded significantly higher grain yield of 5917 kg ha⁻¹ over cvs. GGV 0501 (5115 kg ha⁻¹) and BPT 5204 (4663 kg ha⁻¹) (Table 52 and Fig. 8a and 17a). The increase in yield with cv. MTU 1010 was to the tune of 15.6 and 26.9% respectively over cvs. GGV 0501 and BPT 5204. Similar was the trend in straw yield wherein cv. MTU 1010 recorded higher straw yield (6641 kg ha⁻¹) than cvs. GGV 0501 (6380 kg ha⁻¹) and BPT 5204 (5974 kg ha⁻¹) (Table 53 Fig. 8a and 17a) which was again higher by 4.09 and 11.16 per cent with the former cultivar over latter cultivars, respectively (plate 7 and 8).

While, during summer the trend was a little different wherein cv. GGV 0501 recorded higher grain yield (5524 kg ha⁻¹) than cvs. RNR 15048 (4429 kg ha⁻¹) and BPT 5204 (4270 kg ha⁻¹) (Table 99 Fig. 8a and 17a) and the improvements in yield with cv. GGV 0501 over cvs. RNR 15048 and BPT 5204 were to the tune of 24.7 and 29.4 per cent, respectively. Again, similar was the trend in straw yield (6409, 6269 and 5767 kg ha⁻¹ with GGV 0501, RNR 15048 and BPT 5204, respectively). Higher yield with cv. MTU 1010 during rainy season was on the expected line as MTU 1010 is a coarse cultivar (pova/puff cultivar) with higher yield potential while cv. GGV 0501 is medium



Plate 7. Cv. MTU 1010 + 30 kg ha⁻¹ seed rate + micronutrients (FeSO₄ + ZnSO₄ each to Soil @ 25 kg ha⁻¹ + to the foliage @ 0.5% twice at 15 and 30 DAS) at harvest during rainy season



Plate 8. Cv. GGV 0501 + 30 kg ha⁻¹ seed rate + micronutrients (FeSO₄ + ZnSO₄ each to Soil @ 25 kg ha⁻¹ + to the foliage @ 0.5% twice at 15 and 30 DAS) at harvest during summer season

fine rice cultivar with grains little bolder than cv. BPT 5204, the ruling fine rice cultivar. Besides, GGV 0501 is tolerant to salinity, probably for this reason it fared better under relatively higher irrigation water E_{Ce} during summer. Thus, coarse grain cultivar, MTU 1010 is found suitable for DSR ecosystem with higher yield potential and alternatively cv. GGV 0501 could be used during either of the seasons. Besides, MTU 1010 being early 10-15 days it could be preferred over others under moisture constraint situations to make best use of the scarce moisture and the available season, and this cultivar facilitates early sowing of second crop in succession because of early harvest of rainy season crop, and during summer water availability with advance in the season being limiting while crop water need being increasing, early harvest avoids embarrassing situations or total crop failures at times with long duration cultivars due to closure of canals in the command. Similarly, at Bapatla, Andhra Pradesh Priyadarshini and Prasad (2003) obtained higher grain yield with Pusa Sugangha-5 over Taraori Basmati in scented cultivars. Zhao *et al.* (2007), Awan *et al.* (2011) and Yadav *et al.* (2017) in aerobic rice reported differential yield performances of cultivars under different rice ecosystems. The finding draws its strength from Kiran *et al.* (2015) who also worked in the TBP irrigation command earlier and reported superior performance of cv. JKPH 3333, followed by cvs. GGV 0501 and BPT 5204.

Better performance of cv. MTU 1010 during rainy and cv. GGV 0501 during summer could be ascribed to higher yields of individual plants in these cultivars (34.8 and 32.7 g, respectively) (Table 51 and 98) compared to other cultivars. The per plant yield with cv. MTU 1010 was higher by 8.07 and 9.09 per cent during rainy season over GGV 0501 and BPT 5204, respectively and with cv. GGV 0501 it was higher by 11.22 and 13.14 per cent during summer over RNR 15048 and BPT 5204, respectively. Better performance per plant was mainly due to longer panicles (25.09 and 26.4 cm, respectively), more grain number panicle⁻¹ (93.2 and 101.8, respectively) and lower spikelet sterility (8.9 and 9.6%, respectively) (Table 49 and 97, Fig.7b and 16b) in cvs.MTU 1010 and GGV 0501 during rainy season and during summer in comparison with other cultivars tested in the study. In fact relatively poor performance of cv.BPT 5204 could be ascribed to its higher spikelet sterility (19.6 and 39.7%, respectively). Besides, cv. MTU 1010 during rainy season and cv. GGV 0501 during summer had more number of tillers (442.5 and 350.3 m², respectively) particularly the productive tillers (345.6 and 328.2 m², respectively) (Table 43 and 95 Fig.6b and 15b). Similar reports

were made by Asif Ameen *et al.* (2014). Chandrika *et al.* (2015) reported maximum panicle length, and number of productive tillers per metre square in genotypes cvs. RNR 15048, HR 12 and TN 1.

Improved yield components with cvs. MTU 1010 and GGV 0501 in the present investigation could further be traced back to their rapid growth and better development. In other words, days required to fifty per cent flowering with MTU 1010 (87.4 days) (Table 40) was lower during rainy season and with RNR 15048 (86.6 days) (Table 93 and plate 5 and 6) during summer, besides higher heat use efficiency (1.90 and 1.84, respectively) (Table 41 and 94, Fig.6a and 15a) with MTU 1010 and GGV 0501. Gines *et al.* (1978) suggested that early flowering rice varieties such as IR 36 with 105 days duration with better drought tolerance are better suited for dry seeded rice situation. This was further evidenced from higher photosynthesis as revealed from leaf area (767.0 and 771.7 cm², respectively in MTU 1010 and GGV 0501) (Table 16 and 85), LAI (3.87 and 3.86, respectively in MTU 1001 and GGV 050301) (Table 20 and 86) and higher dry matter accumulation in leaves (20.80 and 13.60 g plant⁻¹, respectively in MTU 1010 and GGV 0501) (Table 24 and 87, Fig.4a and 13a) which enabled these cultivars to synthesize more photosynthates. Chandrika *et al.* (2015) also accounted better performance in terms of yield components in cvs. RNR 15048, HR 12 and TN 1 to higher leaf area and leaf area index with these cultivars.

Consequent upon higher photosynthesis, dry matter production (96.02 and 89.9 g TDM with MTU 1010 and GGV 0501, respectively) and apportioning of greater portion of it to the developing grain *i.e.*, dry matter accumulation in panicle (42.56 and 41.4 g plant⁻¹, respectively with cvs. MTU 1001 and GGV 050301) occurred in these cultivars over other cultivars during respective seasons (Table 33 and 90, Fig. 5a and 14a). Similarly, Rajesh *et al.* (2016) also attributed higher yield in best performing genotype JKPH 3333 to higher dry matter accumulation in panicle compared with cv. BPT 5204 in the Tunga Bhadra irrigation command.

Better growth performance of cv. MTU 1010 and cv. GGV 0501 could further be telescoped to improved uptake of major (N -117.9 and 116.7 kg ha⁻¹, P -24.5 and 21.7 kg ha⁻¹ and K-116.0 and 124.6 kg ha⁻¹, respectively) (Table 63-65 and 104) and micronutrients (Fe - 1992.6 and 1176.8 g ha⁻¹, Zn - 541.7 and 267.2 g ha⁻¹, Cu - 38.4 and 33.9 g ha⁻¹ and Mn - 4343.6 g ha⁻¹ and 2934.3 g ha⁻¹) (Table 66-69 and 105-106) during



Plate 5. Cv. MTU 1010 + 30 kg ha⁻¹ seed rate + micronutrients (FeSO₄ + ZnSO₄ each to Soil @ 25 kg ha⁻¹ + to the foliage @ 0.5% twice at 15 and 30 DAS) at 90 DAS during rainy season



Plate 6. Cv. GGV 0501 + 30 kg ha⁻¹ seed rate + micronutrients (FeSO₄ + ZnSO₄ each to Soil @ 25 kg ha⁻¹ + to the foliage @ 0.5% twice at 15 and 30 DAS) at 90 DAS during Summer season

rainy and summer seasons respectively over other cultivars during these seasons. Consequently, these cultivars had lower availability of these nutrients at harvest (N - 246.4 and 245.7 kg ha⁻¹, P - 29.4 and 27.6 kg ha⁻¹, and K - 351.6 and 355.4 kg ha⁻¹, respectively) (Table 73-75 and 108) during rainy and summer seasons respectively compared to other cultivars used in the study. Similarly, in the earlier study by Rajesh *et al.* (2016) higher nitrogen uptake in cv. JKPH 3333, a best performing genotype, against lower available N with cv. BPT 5204, a poor performing cultivar were observed.

Apart from yield superiority, it is the quality that matters as far nutrition is concerned. Grain protein content also varied with different cultivars in the study and significantly higher grain protein was observed in cv. MTU 1010 and cv. GGV 0501 (7.47% and 7.69%) (Table 62 and 103, Fig.9a and 18a) during *kharif* and summer seasons respectively over other cultivars. This could be attributed to higher grain N content (Table 55 and 100) as a consequence of higher N uptake (Table 63 and 104) as already mentioned in the previous paragraph with these cultivars over other cultivars studied.

5.3 Response to Seed Rate

Crop establishment is one of the key factors that affect the success of grain crop. Apart from seed bed conditions, the optimum seed rate greatly influences crop performance mainly through optimizing plant density in commensuration with supply of inputs and prevailing growth factors by modifying competitiveness among plants/tillers to the advantage of crop. Optimum crop establishment not only improves crop performance but also reduces the seeding rate needed for field planting (De Datta, 1986). Earlier, studies revealed a wide range of seed rates up to 200 kg to grow a DSR crop (Guyer and Quadranti, 1985). At Punjab, Gill *et al.* (2006) studied seed rate up to 75 kg ha⁻¹ and Yadav *et al.* (2017) used up to 50 kg ha⁻¹ for cv. Basmati rice.

In the present investigation, a medium seed rate of 30 kg ha⁻¹ across cultivars recorded higher grain (5684 kg ha⁻¹ and 4984 kg ha⁻¹, respectively) and straw yields (6909 and 6301 kg ha⁻¹, respectively) during rainy and summer seasons. The grain yield with 30 kg ha⁻¹ was higher to the tune of 4.85 and 2.84 per cent over lower and higher seed rate of 25 and 35 kg ha⁻¹ during rainy and summer seasons, respectively. Similarly in China, Wu *et al.* (2008) found a seed rate of 20-25 kg ha⁻¹ as optimum for DSR including zero till condition (ZT-dry-DSR). In the Indo-Gangetic plain, in India also a seed rate of

20-25 kg ha⁻¹ was found optimum for medium fine grain rice cultivars (Gopal *et al.*, 2010).

Further, better performance of DSR with moderate seed rate in terms of seed yield and straw yield during rainy and summer seasons was due to better performance of growth and yield components under moderate seed rate. Immediate and parallel improvement observed in the study was in the grain weight per plant (Table 51 and 98). Seed rate of 30 kg ha⁻¹ recorded significantly higher grain weight (34.8 and 32.7 g plant⁻¹, respectively) during rainy and summer seasons. This was mainly due to higher number of productive tillers (316.1 and 307.5 m², respectively, Table 43 and 95, Fig.6b and 15b), longer panicle length (23.1 and 24.5 cm, respectively, Table 45 and 97), more number of seeds per panicle (100.8 and 118.5) particularly the filled grains (93.2 and 107.8 panicle⁻¹) and the consequent lower grain sterility percentage (13.8 and 24.2, respectively, Table 49 and 97 Fig.7b and 16b) during the seasons of study with the use of 30 kg ha⁻¹ seed rate over lower or higher seed rates. On the other hand, lower and higher seed rate had lower grain weight per plant (29.7 and 28.9 g, respectively), number of productive tillers (293.5 and 272.6, respectively, Fig.6b and 15b), and length of panicle (22.4 and 23.8 cm) but higher grain sterility per cent (13.8 and 39.7%, respectively) during rainy and summer seasons. Similar findings were reported by Pridashry *et al.* (2000) who observed lower sterility percentage with higher seed rate of 45 kg ha⁻¹ (21.76%) than those with other seed rates and the lowest with 35 kg ha⁻¹ seed rate (21.38%). Anisuzzaman *et al.* (2010) also made similar observation.

Ling *et al.* (2011) observed that optimum seed rate enabled better space for leaf growth for better light interception and higher dry matter accumulation which would result in higher grain yield. Probably for this reason significantly improved growth was recorded with seed rate of 30 kg ha⁻¹ over lower or higher seed rates (25 or 35 kg ha⁻¹). For instance, plants were taller (88.8 cm and 95.8 cm, respectively) and had more tillers (418.9 and 334.7, respectively) with 30 kg ha⁻¹ compared to lower and higher seed rates during rainy and summer seasons. This enabled plant to put up more photosynthetic area *i.e.* leaf area and leaf area index (Table 16 and 85 and 20 and 86). LA (762.2 and 756.2 cm², respectively) and LAI (3.77 and 3.78, respectively) were higher with 30 kg ha⁻¹ seed rate during both the seasons irrespective of the cultivars used and other production practices followed. Consequently, tiller count particularly the productive tillers as already indicated, and accumulation of dry matter in leaf (19.3 and 13.2 g, respectively,

Table 43 and 95) and more apportioning of photosynthates to reproductive parts as evidenced from dry matter in panicles (37.2 and 35.2 g, respectively, Table 29 and 89, Fig.5a and 14a) and total dry matter production (85.4 and 80.9 g plant⁻¹, respectively, Table 33 and 90, Fig.5b and 14b) occurred with the seed rate of 30 kg ha⁻¹ during both the seasons. The findings corroborate well with those of Yadav *et al.* (2017) who reported that the dry matter accumulation increases with increased seed rate up to a maximum and thereafter declines.

Better growth performance with moderate seed rate was further assisted by reduced below ground competition for growth resources particularly the nutrients. Consequently, higher nutrient uptake (N- 107.7 and 104.1 kg ha⁻¹, P- 21.0 and 18.4 kg ha⁻¹, K- 118.3 and 115.3 kg ha⁻¹, Fe- 1649 and 727.7 g ha⁻¹ and Zn 499.4 g ha⁻¹ and 208.7 g ha⁻¹, respectively) during rainy and summer seasons occurred with moderate seed rate, where of lower or higher seed rates recorded higher soil available nutrients at harvest (Table 73-79 and 108 -110) due lower uptake of nutrients by the crop with these seed rates.

5.4 Response to Micronutrients

As early as in 70s Ponnamperna (1972) opined that lower availability of several nutrients including N, P, S and micronutrients such as Zn and Fe is likely to be a major constraint in drill sown rice. Deficiencies of zinc and iron are more common in anaerobic/non flooded rice systems than in flooded systems (Hongbin *et al.*, 2006, Choudhary *et al.*, 2007, Pal *et al.*, 2008 and Yadvinder Singh *et al.*, 2008). Further, Singh *et al.* (2005) ascribed poor performance of DSR compared TPR mainly to poor crop stand and high percentage of panicle sterility. Therefore, Kumar and Ladha (2015) suggested that micronutrient management is critical in dry DSR. Basal application of zinc to the soil or subsequent top dressing up to about 45 DAS to foliage 2-3 times at interval of 7-15 days after the appearance of deficiency symptoms has been recommended elsewhere (Anon., 2010), while in Karnataka a basal application of 25 kg ha⁻¹ each of ZnSO₄ and FeSO₄ alongwith recommended NPK is the blanket recommendation at present (Anon., 2015).

In the TBP and UKP irrigation commands area paddy is cultivated on medium to deep black soil and micronutrient deficiencies are commonly observed from the beginning due to initial aerobic type of cultivation in DSR unlike transplanted rice where

due to puddling and water impounding availability of micronutrient would be far better. Since, recommendations based on systematic studies are not forthcoming in DSR, in the present investigation efforts were made evaluate crop response to individual and combined use of iron and zinc in sulphate forms to soil as well as to the foliage (FeSO_4 and ZnSO_4 at 25 kg ha^{-1} basal and to foliage at 0.5 per cent twice at 15 and 30 DAS singly and in combination). Across cultivars and seed rates combined application of FeSO_4 and ZnSO_4 both basally to the soil and to the foliage subsequently recorded high grain and straw yields (6804 and 6277 kg ha^{-1} grain and 8285 and 8241 kg ha^{-1} straw, respectively during rainy and summer seasons) followed by application of ZnSO_4 alone both during rainy and summer seasons.

The yield improvement with former treatment over no application of micronutrient was to the tune of 9.82 and 22.46 per cent during rainy and summer seasons, respectively. In other words, paddy fields respond to the supply of both the nutrients in DSR and zinc is relatively more critical and more so during second season i.e. summer with further depletion of nutrient by already harvested rainy season crop. Gill and Walia (2015) reported significant response in Basmati rice to three foliar sprays of 1.0% FeSO_4 ; however he did not observe significant response to ZnSO_4 at Ludhiana. Probably the difference lies in soil type, in Karnataka it is Vertisols (Black cotton soil) whereas in Punjab it is sandy loam soil. While at Parbhani, similar to present finding Jadhav *et al.* (2014) obtained significantly higher yields with combined application of FeSO_4 and ZnSO_4 at 10 kg ha^{-1} each. In case of aerobic rice Joshi *et al.* (2013) observed the superiority of foliar applied Fe.

Zinc is essential for several biochemical processes such as cytochrome and nucleotide synthesis, enzyme activation, chlorophyll production, maintenance of membrane activity and enhance rate of seed and stalk maturation. Similarly, Fe is structural component of porphyrin molecules: cytochrome, hemes, hemacin, ferrichrome, etc. These substances are involved in oxidation-reduction reactions in respiration and photosynthesis. It helps in the formation of chlorophyll and as much as 75% of cell Fe is associated with chloroplasts and up to 90% of Fe in leaves occurs with lipoprotein in chloroplast and mitochondria membranes. It does not appear to be translocated from older tissues to the tip meristem and as a result growth ceases in its deficiency. Iron is also a structural component of nonheme molecules like ferredoxins (stable Fe-S

proteins). Ferredoxin is the first stable redox compound of the photosynthetic electron transport chain.

The response to applied Fe and Zn in the present study could be further explained in terms of enhancement of growth promoting processes through alleviation of their deficiencies in DSR. Emergence of zinc (Zn) deficiency is now widespread in most of the rice growing soils and more so in DSR. Reasons for Zn deficiency in rice fields include low redox potential, high carbonate content and high pH (Mandal *et al.*, 2000) as found in TBP irrigation command. The soil pH in the experimental fields at harvest hovered around 8.0. A pH below neutral in the rhizosphere increases solubility of P and Zn and hence their availability (Kim and Bajita, 1995). Therefore, a shift from TPR to DSR may also affect Zn bioavailability in rice (Gao *et al.*, 2006). Joshi *et al.* (2013) suggested basal application of zinc sulphate heptahydrate to the soil at 25–50 kg ha⁻¹ and if a basal application is missed, the deficiency could be corrected through topdressing up to 45 days with foliar spray of 0.5% zinc sulphate two to three times at intervals of 7-15 days just after the appearance of deficiency symptoms.

In case of iron, drilling of 0.5 kg of labile Fe into the soil at sowing time has been found quite promising (Joshi *et al.*, 2013). Foliar application, however, was observed to be superior to soil application. Foliar-applied Fe is easily translocated acropetally and even retranslocated basipetally. Some experiments revealed that both soil and foliar spray of Fe conjointly results in better yield compared to their sole application. Yadav *et al.* (2011) observed that the crop quickly oxidizes iron sulphate applied under aerobic condition into ferric forms (Fe³⁺) that is not taken up. Therefore, these nutrients have to be supplied basally to the soil and subsequently fortified through foliar application twice at 15 and 30 DAS each at 0.5% concentration in the present investigation. With this improved availability of these nutrients, the necessary growth processes accelerated resulting in better growth and development and ultimately crop productivity.

Beneficial influences of micronutrients on yield performances in rice could be related to better performance of growth and yield components in presence of micronutrients. Immediate and parallel improvement observed in the study was in the grain weight per plant (Table 51 and 98). Combined application of FeSO₄ and ZnSO₄ both to the soil and foliage recorded significantly higher grain weight (37.8 and 34.3 g plant⁻¹, respectively) during rainy and summer seasons. This was mainly due to higher

number of productive tillers (334.1 and 337.6 m², respectively, Table 43 and 95), longer panicle length (23.4 and 21.5cm, respectively, Table 45 and 97), more number of seeds per panicle (115.2 and 125.6, respectively) particularly the filled grains (102.8 and 106.0, respectively), 1000-grain weight (23.8 and 22.4 g, respectively) and lower grain sterility percentage (11.2 and 16.5, respectively) during rainy and summer seasons (Table 49 and 97, Fig.7b and 16b) with the use of critical micronutrients over no supply. On the other hand, no supply of micronutrients resulted in lower grain weight per plant (27.2 and 26.0 g, respectively), number of productive tillers (279.6 and 247.8, respectively), and length of panicle (21.8 and 23.0 cm, respectively) but higher grain sterility per cent (17.3 and 63.3, respectively) during rainy and summer seasons.

Further, because of the synergy of these micronutrients with major nutrients enabled improved growth of paddy plants which ultimately led to better performance of yield components. For instance, plants were taller (90.0 and 96.2 cm, respectively) and had more tillers (427.3 and 352.3, respectively) during rainy and summer seasons with combined application of FeSO₄ and ZnSO₄ over no application of these critical nutrients. This enabled plant to put up more photosynthetic area i.e. leaf area and leaf area index (Table 16 and 85). LA (766.0 and 747.2 cm² plant⁻¹, respectively) and LAI (3.83 and 3.74, respectively) were higher with application of FeSO₄ + ZnSO₄ during both the seasons irrespective of the cultivars used and other production practices followed. Consequently, tiller count particularly the productive tillers as already indicated, and accumulation of dry matter in leaf (21.90 and 14.6 g, respectively, Table 24 and 87, Fig.4a and 13a) and more apportioning of photosynthates to reproductive parts as evidenced from dry matter in panicles (37.19 and 37.4 g plant⁻¹, respectively, Table 29 and 89) and total dry matter production (85.42 and 80.9 g plant⁻¹, respectively, Table 33 and 90) occurred with micronutrient supply (FeSO₄ + ZnSO₄) during both the seasons. These results are in line with Shaygany *et al.* (2010). Further, the findings also corroborate well with Gill and Walia (2015) who reported the positive effect of micronutrients application by foliar sprays on grain yield of Basmati rice and attributed it to increased photosynthesis due to higher LAI which enabled capture of more solar radiation that resulted in enhanced values of growth parameter and yield attributing characters.

Better growth performance with supplementation of micronutrients was further assisted by better utilization of below ground growth resources particularly the nutrients.

Higher uptake of major nutrients (N- 107.7 and 104.1 kg ha⁻¹, P- 21.0 and 18.4 kg ha⁻¹ and K- 118.3 and 115.3 kg ha⁻¹) and essential micronutrients (Fe-1649 and 727.7 g ha⁻¹ and Zn 499.4 and 208.7g ha⁻¹, respectively) during rainy and summer seasons, resulted in lower soil available nutrients with these treatments whereas no supply of these elements resulted in higher soil available nutrients at harvests (Table 73-78 and 108-110) due lower uptake of nutrients by the crop for growth and development.

Besides yield advantages, micronutrient application improved grain quality. For instance iron content increased from 42.27 mg kg⁻¹ in grain with no application of micronutrient to 43.1 mg kg⁻¹ with FeSO₄ application and further to 44.7 mg kg⁻¹ with combined application of FeSO₄ and ZnSO₄. Similarly, Saha *et al.* (2015) observed increased concentration of zinc in milled grains to the extent of 29.5 and 109.5 per cent upon soil application and foliar application of zinc fertilizers. Further, grain protein content was also enhanced with supplementation of micronutrient from 6.79 with no micronutrient to 6.84, 6.89 and to a maximum of 7.00 per cent with FeSO₄, ZnSO₄ and FeSO₄ + ZnSO₄, respectively. Thus, micronutrient supplementation in DSR augmented Fe and Zn deficiencies initially and enhanced the yield and further fortified seed with Fe, Zn and grain protein.

5.5 Performance of variety X seed rate X micronutrient

Yield in the manifestation of potential of cultivar under optimum growing conditions and, therefore, optimum plant stand and nutritional supply become critical to exploit yield potential of the cultivar. In the present investigation cv. MTU 1010 sown with 30 kg ha⁻¹ seed rate and applied with both FeSO₄ and ZnSO₄ besides recommended NPK (150:75:75 kg ha⁻¹) recorded higher grain and straw yields (6804 and 8295 kg ha⁻¹, respectively) during rainy season, while the ruling cultivar cv. BPT 5204 sown using lower seed rate and supplied without any micronutrient recorded lower grain and straw yields (3136 and 5138 kg ha⁻¹, respectively), and cv.GGV 0501 fared in between. The yield with MTU 1010 was higher by 16.9 per cent over cv. BPT 5204 during rainy season. Whereas, during summer cv. GGV 0501 sown with similar seed rate (30 kg ha⁻¹) and supplied with FeSO₄ and ZnSO₄ both to the soil basally and to the foliage recorded higher grain and straw yields (6277 and 8241 kg ha⁻¹, respectively), closely followed by similar seed rate with application of ZnSO₄ only (6215 and 7089 kg ha⁻¹, respectively), while cv. RNR15048 sown using 25 kg ha⁻¹ seed rate recorded lower grain yield of 3513

kg⁻¹; lower than cv. BPT 5204 which with higher seed rate 35 kg ha⁻¹ and without micronutrient application recorded lower grain (4131kg ha⁻¹) and straw (4273 kg ha⁻¹) yields.

Similarly, Yadav *et al.* (2017) obtained higher yield of hybrid cultivars DRRH-3 and PAC 837 with higher seed rate of 35 kg ha⁻¹ under aerobic cultivation, and it being coarse cultivar with bold grains higher seed rate could be expected unlike other cultivars used in present study. As far micronutrient nutrition is concerned, Gill *et al.* (2006) obtained higher yield with foliar nutrition of MnSO₄ and FeSO₄ with Basmati rice at Ludhiana. Further, Asif Ameen *et al.* (2014) revealed superior performance of coarse rice KSK133 over fine rice (cv. Super Basmati) at Faisalabad, Pakistan. In the present investigation also coarse cultivar MTU 1010 during rainy season out yielded other fine cultivars. During summer cv. GGV 0501 recorded higher grain and straw yields. In this instance cv. GGV 0501 belonged to medium fine while other two were fine cultivars. The per cent improvements cv. GGV 0501 over cvs. RNR 15048 and BPT 5204 were to the tune of 24.7 and 29.36 per cent. Probably for this reason cv. GGV 0501 stood second among cultivars even during rainy season. Results are well supported by Asif Ameen *et al.* (2014). Another season for superior performance of GGV 0501 is due to its tolerance to salinity which is common in TBP particularly during summer (pH -7.94 and EC 0.88, Table 107).

Application of zinc fertilizer enhances the transfer of photosynthates from shoot to grain (Saha *et al.*, 2015). Fe being component of chlorophyll, its supply enhanced leaf area per plant (807.0 and 840.7 cm², respectively, Table 16 and 85) and per unit land area (4.01 and 4.20, respectively, Table 20 and 86) and dry matter accumulation in leaves (24.30 and 17.9 g plant⁻¹, respectively, Table 24 and 87). This was further facilitated by optimum plant stand with medium seed rate (30 kg ha⁻¹) which helped in better interception of light. For instance Ling *et al.* (2011) opined that optimum seed rate enables better space for leaf growth for better light interception and higher dry matter accumulation which would result in higher grain yield. In the present investigation improved LA, LAI and light interception enabled enhanced photosynthates production resulting in more biomass as a consequence of more height (102.0 and 111.1cm, respectively, Table 9 and 83), and tillers per m⁻² (540.2 and 440.7, respectively) particularly the productive tillers (413.8 and 411.5, respectively Table 43 and 94, Fig.6b and 15b) and further, due to enhanced enzymatic activity mediated through Fe and Zn

helped to assort major part of photosynthates to the reproductive parts more precisely to the developing grain.

Thus, due to higher availability of photosynthates the seed could able to develop fully, therefore, resulted in higher test weight (26.0 and 27.6g, respectively, Table 50 and 97) with cvs. MTU 1010 and with GGV 0501 with medium seed rate and supplementation of $\text{FeSO}_4 + \text{ZnSO}_4$. On the other hand, lower seed weight of rice with BPT 5204 during rainy season and RNR 15048 during summer with 25 kg ha^{-1} seed rate and no micronutrient supply was mainly attributed to less than adequate plant stand, plant photosynthetic and sink architecture and reduced stimulatory enzyme activity resulting in poor performance of growth and yield parameters ultimately causing lower test weight.

In the present investigation higher grain and straw yields with MTU 1010 and medium fine grain cv. GGV 0501 at 30 kg ha^{-1} seed rate and application of both the micro nutrients could be attributed better yield components viz., grain yield per plant (49.9 and $40.0 \text{ g plant}^{-1}$, respectively, Table 51 and 98) which in turn was due to higher number of tillers particularly the productive tillers (413.8 and 411.5 , respectively, Table 43 and 94), more number of grains per panicle (121.4 and 156.5 , respectively, Table 48 and 96) and again the filled grains per panicle (115.8 and 151.5 , respectively, Table 47 and 94, Fig.7a and 16a), and lower sterility percentage (5.9 and 3.5% , respectively, Table 49 and 97). This improvement in yield components could be telescoped to better growth and development in these cultivars, viz., plant height (102.0 and 111.1 cm , respectively, Table 9 and 83), leaf area (807.0 and $840.7 \text{ cm}^2 \text{ plant}^{-1}$, respectively, Table 16 and 85), LAI (4.01 and 4.20 , respectively, Table 20 and 86), dry matter accumulation in leaves (24.3 and $17.9 \text{ g plant}^{-1}$, respectively, Table 24 and 87) and consequent higher total dry matter productions (112.91 and $107.2 \text{ g plant}^{-1}$, respectively, Table 33 and 90, Fig.5b and 14b) and finally greater apportioning of DM in to panicles (44.4 and $50.1 \text{ g plant}^{-1}$, respectively, Table 29 and 89) during rainy and summer seasons. This was further evidenced by significant improvement in SPAD value and NDVI values which when recorded at panicle initiation stage explain to a large extent the variability in rice at maturity (Ali *et al.* 2015).

Better growth performance in these cultivars sown using medium seed rate and supplemented with critical micronutrient basally and foliar fortification further assisted

in improved utilization of below ground resources, particularly the essential plant elements present in soil. Higher uptake of major nutrients (N- 107.7 and 104.1 kg ha⁻¹, P- 21.0 and 18.4 kg ha⁻¹ and K- 118.3 and 115.3 kg ha⁻¹, Table 63-65 and 104) and micronutrients (Fe- 1649 and 727.7 g ha⁻¹ and Zn 499.4 g ha⁻¹ and 208.7 g ha⁻¹, respectively, Table 66-69 and 104-106) during rainy and summer seasons occurred with cv.MTU 1010 and with medium fine grain cv. GGV 0501 at 30 kg ha⁻¹ seed rate and application of both the micronutrients, whereas no supply of these elements resulted in higher soil available nutrients at harvests (Table 73-79 and 104-106) due lower uptake of nutrients by the crop because of poor sink development in other cultivars and seed rates.

Not just yield but grain quality which is equally important in the staple crop like rice was also improved remarkably with cvs. MTU 1010 and GGV 0501 sown using 30 kg ha⁻¹ and supplied with micronutrients (Table 62 and 103). The grain protein content was higher with micronutrient supply and medium seed rate of 30 kg ha⁻¹ with cv. MTU 1010 (7.96%) and cv. GGV 0501 (8.11%) in rainy and summer seasons, respectively. Besides, grains were further found fortified particularly with Fe (49.93 and 35.2 mg kg⁻¹, respectively, Table 58 and 101) and Zn (22.02 and 16.9 mg kg⁻¹, respectively, Table 59 and 101). This could be explained in terms of higher nutrient uptake observed with these treatments (explained in previous paragraph), and partly due to probably positive association between grain yield with grain zinc and grain iron as found in the study. Similar findings were reported by Kim and Bajita (1995) and Pal *et al.* (2008).

Differential performances of cultivars, seed rate and micronutrient supplementation, and varied market price for rice grain, economics of production varied significantly (Table 80-82 and 111). Higher grain yield in cv. MTU 1010 followed by cvs. GGV 0501 and BPT 5204, gross and net returns and B:C ratio were also higher with cvs. MTU 1010 followed by cv. BPT 5204 sown using 30 kg ha⁻¹ and applied with both FeSO₄ and ZnSO₄ (` 1,31, 210 and ` 1,29,929 ha⁻¹ gross returns, ` 78,084 and 76,533 ha<sup>-1</sup> net returns and 2.47 and 2.43 B:C ratio, respectively) during rainy season, while cv. GGV 0501 recorded higher net returns ( ` 81,969 ha⁻¹) followed by RNR 15048 (` 68,564 ha⁻¹) with medium seed rate and combined application of FeSO₄ and ZnSO₄ during summer. That is why selection of cultivars by rice growers is mainly market driven hence, it is a challenge to the technologists to improve the cultivars, and extension specialists should motivate farmers to cultivate better yielding cultivars.

5.6 Nutritional Approaches, Yield Targets and Micronutrient and Organics Supplementation

Fertilizer is the one of the costliest inputs in agriculture and use of right amount of fertilizer is fundamental for farm profitability and environmental protection (Kimetu *et al.*, 2004). Often to get more and more yield farmers inclined to the excess use of chemical fertilizers in the TBP irrigation command but the decision on fertilizer use requires knowledge of the expected crop yield response to nutrient application, which is a function of crop nutrient needs, supply of nutrients from indigenous sources, and the short- and long-term fate of the fertilizer applied (Dobermann *et al.*, 2003). Dumping of fertilizers by the farmers in the fields without information on soil fertility status and nutrient requirement by crop causes adverse effects on soil and crop regarding both nutrient toxicity and deficiency either by overuse or inadequate use (Ray *et al.*, 2000) besides polluting surface and ground water as is happening now in TBP irrigation command. Managing the location specific variability in nutrient supply is, therefore, a key strategy to overcome the current mismatch of fertilizer rates and crop nutrient demand in irrigated rice environments (Dobermann and Cassman, 2002).

Traditionally to determine the optimum fertilizer doses the most appropriate method considered during 1956-57 was based on soil-test-crop-response-studies which was semi-quantitative in nature. This was subsequently refined during 1977-78 under AICRP on STCRC (soil test crop response correlation) wherein crop requirements for a known target yields were defined using multiple regression equation for grain yield considering the basic data on nutrient requirement (kg q^{-1}) to produce a quintal of rice yield, soil, fertilizer and organic manure efficiency and per cent contribution from soil, fertilizer nitrogen, phosphorus, and potassium, and FYM. Soil test based application of plant nutrient helps to realize higher response ratio and benefit: cost ratio as the nutrients are applied in proportion to the magnitude of the deficiency of a particular nutrient and the correction of the nutrients imbalance in soil helps to harness the synergistic effects of balanced fertilization (Rao and Srivastava, 2000). The technique facilitates location specific fertilizer recommendations for soils of varying fertility, resource conditions of farmers and levels of targeted yield for similar soil classes and environment (Ahmed *et al.*, 2002).

In the mid 90's concept of site specific nutrient management (SSNM) was developed and evaluated (Dobermann and White, 1999 and Dobermann *et al.*, 2002). SSNM aims at dynamic field specific management of N, P, and K fertilizer to optimize the balance between supply and demand of nutrients. The plant's need for N, P or K fertilizer is determined from the indigenous sources as measured with a nutrient omission plot and the demand of rice crop for that nutrient as estimated from the total nutrient required. Based on the information generated from 1997 to 2000 a decision support system 'Nutrient Expert (NE)' has been developed by International Plant Nutritional Institute (IPNI) for use by rice farmers (www.software.ipni.net/articles/nutrient-expert-2011).

In the present investigation STCR approach (6988 and 6410 kg ha⁻¹, respectively during rainy and summer seasons) fared better than Nutrient expert (6793 and 5766 kg ha⁻¹, respectively) particularly during summer with a yield advantage of 2.87 and 11.16 per cent during rainy and summer seasons respectively (Table 159 and 205, Fig. 25b and 34b). In the yield targets, higher yield of 8 t ha⁻¹ (7299 and 6547 kg ha⁻¹, respectively) was significantly superior to other targets during rainy and summer seasons. Though, set target of 6 and 7 t ha⁻¹ were comfortably achieved during rainy season (6298 and 7073 kg ha⁻¹, respectively) in fact with marginal advantage of 5.11 and 1.02 per cents while with yield target of 8 t ha⁻¹ across other factors the average achievement was 91.23 per cent (plate 10 and 11).

The yield performances were still lower with a difference of 362, 921 and 1453 kg against targets of 6000, 7000 and 8000 kg ha⁻¹ during summer with greater gap with 8 t ha⁻¹ yield target. Satyanarayana *et al.* (2013) also observed seasonal variations in nutrient requirement and recommended slightly higher N, P₂O₅ and K₂O rates during post rainy season (*rabi*). They attributed it to the fact that nutrient rates generated through NE are based on estimated response to NPK application and NE estimated relatively high response in *rabi* season over *kharif* season. Further this highlights the importance of factor/s other than NPK with higher target of 8 t ha⁻¹ set during summer. Bera *et al.* (2006) suggested that for efficient utilization of applied fertilizer some other parameters like soil pH, organic carbon status, soil texture, bulk density, water holding



LEGEND

Nutrient approach: STCR-Soil Test Crop Response,
 Micronutrients: Application of $\text{FeSO}_4 + \text{ZnSO}_4$ each to soil @ 25 kg ha^{-1} + to the
 foliage @ 0.5% + organics

Plate 10. (a) Nutrient expert + 8 t ha^{-1} micronutrient/organics and (b) STCR + 8 t ha^{-1} + micronutrient/organics at 110 DAS



LEGEND

Nutrient approach: STCR-Soil Test Crop Response,
Micronutrients: Application of FeSO_4 + ZnSO_4 each to soil @ 25 kg ha^{-1} + to the
foliage @ 0.5% + organics

Plate 11. STCR + 8 t ha^{-1} + micronutrient/organics at harvest

capacity, soil drainage, etc. are important, since these are the major determining factors of soil nutrient retention. It is also presumed that irrigation water ECe is important which was rather high during summer in the present investigation. These need consideration for the development of an effective fertilizer schedule as well as nutrient supply source in view of the better nutrient absorption and assimilation by the plants particularly for summer crop.

Besides major nutrients, supply of critical micronutrients and organics appeared significant in the present study. Supplementation of organics and micronutrient (7098 and 6455 kg ha⁻¹, respectively) recorded 6.20 and 7.01 per cent increased yield during rainy and summer seasons, respectively over no supplementation (6683 and 6032 kg ha⁻¹, respectively) (Table 159 and 205 Fig.25b and 34b). Overall, nearly 94.45 per cent of yield (7556 kg ha⁻¹) with 8 t ha⁻¹ yield target and 6.34 and 13.28 per cent higher with 7 (7444 kg ha⁻¹) and 6 t ha⁻¹ (6797 kg ha⁻¹) were achieved with supply of micronutrients and organics. This leads to the presumption that set yield targets could be achieved during rainy season. Yields with similar treatment combination during summer were 6603, 6648 and 7385 kg ha⁻¹ with 110.05, 94.97 and 92.31 per cent realization with 6, 7 and 8 t ha⁻¹ respectively. Thus, the targets set were achievable but higher target warrants additional strategy during summer as deliberated previously. One of the observations made during the study was that there was increase in the irrigation water ECe during summer due to draining of water from the rice fields in the command in to the *nalas* which ultimately made bulk of the river flow during summer which was used for crop irrigation in the study.

Interestingly, yield with targets of 6, 7 and 8 t ha⁻¹ based on STCR were higher by 13.83 (N- 122.9, P- 131.5, K- 81.5 kg ha⁻¹), 24.62 (N- 157.4, P- 159.7, K- 101.5 kg ha⁻¹) and 26.54 (N- 191.9, P- 187.9, K- 121.5 kg ha⁻¹) and based on NE were by 5.33 (N- 118.0, P- 37.0, K- 62.0 kg ha⁻¹) and 19.49 (N- 125, P- 41.0, K- 69.0 kg ha⁻¹) and 23.40 (N- 141, P-50, K- 85 kg ha⁻¹) per cent, respectively over blanket recommendation (150:75:75 kg ha⁻¹ NPK) during rainy season, while during summer yield with targets of 6, 7 and 8 t ha⁻¹ based on STCR were higher by 24.86 (N- 124.0, P- 125.8, K- 80.4 kg ha⁻¹), 25.71 (N- 158.5, P- 154.1, K-101.0 kg ha⁻¹) and 39.65 (N- 193.0, P- 182.0, K- 121.0 kg ha⁻¹) and those based on NE were by 0.94 (N-117.0, P- 37.0, K- 62.0 kg ha⁻¹), 16.64 (N-125, P-41.0, K-69.0 kg ha⁻¹) and 14.08 (N- 141, P- 50.0, K- 85.0 kg ha⁻¹) per cent, respectively over blanket recommendation (150:75:75 kg ha⁻¹).

Bera *et al.* (2006) working at Bardhaman district, West Bengal, India achieved yield targets of 7 and 8 t ha⁻¹ for rice (cv. IR 36) within -10% yield deviation, and they reported that grain yields of rice through general recommendation (GRD) of fertilizers lagged behind the yield obtained at 7 and 8 t ha⁻¹ fixed target. These results accorded with the findings of Ray *et al.* (2000). Similar to the present study, Bera *et al.* (2006) too observed relatively higher response ratio with lower target of 7 t ha⁻¹ than with 8 t ha⁻¹ though it had also recorded higher yields. This might be due to the better use efficiency of applied NPK fertilizers at low yield target levels (Santhi *et al.*, 2002).

Similarly, Bera *et al.* (2006) also reported better performance of 8 t ha⁻¹ yield target through STCR over farmers practice and general recommendation. Further, Srinivasan and Kangayarkanni (2010) reported better performance of STCR approach when FYM and *Azospirillum* were provided, and similarly Keram *et al.* (2012) observed better performance of inorganic supply when supplemented partly through FYM in rice. Two points emerge out of this; one is that it is possible to achieve higher yield target both during rainy and summer seasons with supportive nutrition (micronutrients and organics in this instance) either through NE or through STCR approach. Another important point that could be made out is among the two approaches it is NE which makes use of lesser nutrients to achieve the target than STCR approach and when the N P K ratio is 2:1:1 in blanket recommendation it is almost 2:1:1.8 highlighting the need for more K (Table 3-5). This brings the fact that potassium is more important in achieving higher yield target and one reason could be association of the nutrient with better translocation of photosynthates to the sink apart from the synergy it provides in association with other nutrients. Bera *et al.* (2006) also observed greater contributions of K₂O while Ray *et al.*, (2000) attributed it to the interaction effect of higher doses of N, P and the primary effect of starter K doses resulting in the higher uptake from the native soil sources by the crop. Similar type of higher efficiency to potassic fertilizer in rice was reported by Ahmed *et al.* (2002) in alluvial soil.

The variation in grain yield and yield parameters in the present investigation could be basically attributed to corresponding variation in growth and development throughout crop life cycle. Yield parameters were directly influenced by growth parameters. The improvement in panicles per plant, panicles per meter square, panicle length, grain yield per plant and test weight was mainly due to improved growth performance represented by plant height, number of tillers per meter, leaf area, leaf area

index, days to fifty per cent flowering, dry matter accumulation in various plant parts, total dry matter production and heat use efficiency. Generally, the rate of partitioning of dry matter into various parts of plant is dependent on the stage of the crop. From emergence to panicle initiation, the entire dry matter accumulation (up to 45 DAS) is very slow because the plant had very limited photosynthetic surface to utilize available photosynthetically active radiation besides restricted root proliferation to absorb nutrients.

In the present investigation, numerically higher growth and yield attributes were recorded in STCR approach than in NE. The grain weight per plant (36.7 and 34.1g, respectively, Table 158 and 204) during rainy and summer seasons) was higher with either approaches which in turn was due to higher number of tillers (440.4 and 379.4 m², respectively, Table 116 and 190), particularly the productive tillers (379.4 and 325.4 m², respectively, Table 150 and 201), longer panicle (27.0 and 24.0 cm, respectively, Table 152 and 203), number of filled grains (168.0 and 135.3, respectively, Table 154 and 202), test weight (23.8 and 25.3g, respectively Table 157 and 203) and lower spikelet sterility percentage (11.0 and 18.5, respectively, Table 156 and 203, Fig.25a and 34a) during rainy and summer seasons. The results are in line with Saha *et al.* (2015) who reported that application of nutrients based on STCR alongwith FYM recorded significantly higher effective tillers, panicle length and number of filled grains per panicle and test weight.

Shukla *et al.* (2015) opined that the improvement in yield attributes of rice were found to differ significantly due to applied fertilizer levels consequent upon variations in growth components; and the improvement in yield attributing traits may be ascribed to improved vegetative growth due to balanced fertilization for a set yield target that facilitated photosynthesis besides improving translocation of organic food materials towards reproductive organs which enhanced the formation of fertile grains (Gunri and Choudhury, 2004 and Parihar, 2004).

Therefore, the improvements in yield components in the present study also could be further traced back to improved growth in terms of plant height (104.3 and 99.2 cm, respectively, Table 116 and 190), tiller count m⁻¹ length (182.5 and 153.2, respectively Table 120 and 191), leaf area (769.6 and 767.9 cm², respectively, Table 124 and 192), leaf area index (3.85 and 3.84, respectively Table 128 and 193), accumulation of dry

matter in leaves (16.09 and 13.80 g, respectively Table 132 and 194, Fig.22a and 31a), late flowering (94.41 and 93.07 days, respectively, Table 148 and 200). Consequent upon higher photosynthetic area with STCR/NE based nutrition for higher yield target (8 t ha⁻¹), the plants manufactured higher quantity of photosynthates making use of native as well as applied resources and produced more dry matter (74.68 and 64.70 g, respectively, Table 141 and 197) besides, apportioning most of it to developing panicle at reproductive phase (31.4 and 27.80 respectively, Table 137 and 196) facilitated by K, Zn and Fe supplemented through nutrition and physically and biologically improved soil rhizosphere due to supplementation of organic matter. As a result, panicle had more dry matter (31.40 and 27.80 g plant⁻¹, respectively, Table 137 and 196 Fig.23a and 32a), it was longer (27.0 and 24.0 cm, respectively, Table 152 and 203), had more grains (188.5 and 164.6, respectively, Table 155 and 202) particularly the count of filled grains (168.9 and 135.3, respectively, Table 154 and 202, Fig. 24b and 33b) with lower grain sterility (11.0 and 18.5%, respectively, Table 156 and 203, Fig.25a and 34a) during rainy and summer seasons (plate 9).

In earlier studies taller plants and higher tiller count with STCR based plant nutrition was reported by Ramesh and Chandrashekaran (2007). Balsubramanian (2002) attributed higher plant height and dry matter accumulation in STCR based nutrient application to optimum availability of nutrition at the time when crop is most responsive as evidenced from increases in LA and LAI and number of tillers. This fact holds true in the present investigation also.

Similarly, NE approach also recorded comparable number productive tillers, grain weight (35.2 and 33.2 g plant⁻¹, respectively, Table 158 and 204), panicle length (26.4 and 24.9 cm, respectively, Table 152 and 203) higher number productive tillers (361.5 and 382.9, respectively, Table 150 and 201, Fig.24a and 33a), total grains (180.1 and 158.8, respectively, Table 155 and 202), number of filled grains (158.0 and 126.8, respectively, Table 154 and 202 Fig.24b and 33b), test weight (23.7 and 24.9 g, respectively, Table 157 and 203) and lower sterility percentage (13.2 and 20.8, respectively, Table 156 and 203 Fig.25a and 34a) during rainy and summer seasons consequent upon improved growth in terms of plant height (103.8 and 98.4 cm, respectively Table 116 and 190), leaf area (747.8 and 745.6 cm², respectively, Table 124 and 192), leaf area index (3.74 and 3.73, respectively, Table 128 and 193) and dry matter accumulation in panicle (29.00 and 25.90 g plant⁻¹, respectively, Table 137 and 196,



LEGEND

Nutrient approach: STCR-Soil Test Crop Response,
 Micronutrients: Application of FeSO_4 + ZnSO_4 each to soil @ 25 kg ha^{-1} + to the
 foliage @ 0.5% + organics

Plate 9. (a) SPAD reading and (b) NDVI reading (STCR + 8 t ha^{-1} + micronutrient/organics) at (a) 90 DAS

Fig.23a and 32a) during rainy and summer seasons. Earlier, more number of grains per panicle were obtained with higher nitrogen rates which were presumed to be due to better nitrogen status of plant during panicle growth period (Awan *et al.* (2011).

Further, higher yield and growth attributes were recorded with set target of 8 t ha⁻¹ with NE based nutrition viz. grain weight per plant (38.3 and 35.1g plant⁻¹, respectively, Table 158 and 204) which in turn was due to higher number productive tillers (401.7 and 337.5 m⁻², respectively, Table 150 and 201), number of filled grains (185.1 and 148.5, respectively, Table 154 and 202), longer panicle (27.4 and 24.6 cm, respectively, Table 152 and 203), test weight (24.2 and 25.7 g, respectively, Table 157 and 203) and lower sterility percentage (8.6 and 14.5%, respectively, Table 156 and 203). These yield attributes directly correlate with growth components viz. plant height (105.7 and 100.4 cm, respectively, Table 116 and 190), leaf area (795.9 and 800.8 cm² plant⁻¹, respectively, Table 124 and 192), leaf area index (3.98 and 4.00, respectively, Table 128 and 193) during rainy and summer seasons, and the improvement in latter attributes resulted in higher photosynthesis contributing to higher dry matter accumulation in different parts of plants especially in panicle (34.50 and 30.20 g, respectively) (Table 137 and 196, Fig.23a and 32a) and developing grains.

Yields (7098 and 6455, respectively) were also enhanced numerically with application of FeSO₄+ ZnSO₄ alongwith organic supplementation. As stated earlier, zinc is essential for several biochemical processes such as cytochrome and nucleotide synthesis, enzyme activation, chlorophyll production, maintenance of membrane activity, increase rate of seed and stalk maturation. Similarly, iron helps in the formation of chlorophyll. It does not appear to be translocated from older tissues to the tip meristem and as a result under its deficiency growth ceases. Iron is also a structural component of nonheme molecules like ferredoxins (stable Fe-S proteins). Ferredoxin is the first stable redox compound of the photosynthetic electron transport chain. The response to applied Fe and Zn in the present study could be further explained in terms of enhancement of these growth promoting processes through alleviation of their deficiencies in DSR.

Further, better yield performance could be ascribed better growth and development (Table 116 and 190) in terms of taller plants (105.0 and 99.6 cm, respectively), higher leaf area (786.0 and 779.5 cm², respectively, Table 124 and 192) and leaf area index (3.90 and 3.90, respectively, Table 128 and 193). The latter

contributed through higher photosynthates to higher accumulation of dry matter in different parts of plant especially in panicle (32.20 and 28.40 g plant⁻¹, respectively, Table 137 and 196, Fig.23a and 32a) and developing grain. As a consequence of these improvements individual plant grain weight was enhanced (37.4 and 34.8 g, respectively, Table 158 and 204) due to longer panicle (27.0 and 24.3 cm, respectively, Table 152 and 203), increased test weight (24.1 and 25.6 g, respectively, Table 157 and 203) and lower sterility percentage (10.3 and 16.5, respectively, Table 156 and 203, Fig.25a and 34a) during rainy and summer seasons over recommended control. This coupled with increased number of productive tillers (388.0 and 355.3, respectively, Table 150 and 201) ultimately resulted in higher yield per ha⁻¹ that was witnessed in the present study. Similar improvements in growth, yield components and yield were reported with chemical fertilizers supply integrated with organic manure (Yang *et al.*, 2004, Nayak *et al.*, 2007 and Mohanty *et al.*, 2013). Singh *et al.* (2015) revealed the importance of biofertilizers and micronutrients. They reported remarkable improvement in growth and yield parameters with NPK application based on STCR + BGA @ 12 kg ha⁻¹ + PSB @ 1.5 kg and Zn @ 5 kg ha⁻¹ over farmers' practice.

Overall, in the present investigation crop performance was better when SCTR based nutrition for yield target of 8 t ha⁻¹ with application of micronutrient and organics, (7556 and 7385, respectively during rainy and summer seasons). Nevertheless NE, approach (7368 and 6737, respectively) was on par with STCR with similar yield target and supplementation of micronutrient and organics during both rainy and summer seasons (Table 158 and 205 Fig. 34b and 25b). Yield improvement with these treatments over recommended control (5971 and 5288, respectively) was to the tune of 23.39-26.54 and 24.40-39.65 per cents during rainy and summer seasons, respectively with STCR and NE approaches. That apart, there was saving of 9 and 25 kg ha⁻¹N, and P with these approaches over control. STCR/NE based nutritional approach for pre-set yield target is important from the points of reduction in ground water pollution and economics as well.

Similarly Singh *et al.*(2005) obtained improved yield attributes viz., grains per panicle, panicles m⁻² and grain and straw yields with 200:100:50 kg ha⁻¹, N, P₂O₅ and K₂O, respectively. In Cauvery irrigation command of Karnataka application of 200 kg ha⁻¹ N improved tillers per hill, panicle length, test weight, filled grains panicle⁻¹ (Thimmegowda, 2006). Higher yields with STCR/NE based nutrition for higher yield target of 8 t ha⁻¹ supplemented with micronutrients and organics could be ascribed to

higher grain yield per plant (41.2 and 37.5 g, respectively Table 158 and 204) during rainy and summer seasons which in turn was due to higher number of productive tillers (436.0 and 407.0, respectively Table 150 and 201), more number of filled grains (204.3 and 168.6 panicle⁻¹, respectively Table 154 and 202, Fig.24b and 33b), longer panicle (28.3 and 25.0 cm, respectively Table 152 and 203), lower sterility percentage (6.0 and 10.4, respectively Table 156 and 203, Fig.25a and 34a) and higher test weight (24.6 and 26.4 g, respectively, Table 157 and 203) during both the seasons.

Further, these yield attributes were directly correlated with growth components viz. plant height (107.6 and 101.5 cm, respectively - Table 116 and 190), number of tillers (478.5 and 454.0, respectively - Table 153 and 201), leaf area (854.4 and 877.6 cm², respectively - Table 124 and 192), leaf area index (4.27 and 4.39, respectively - Table 128 and 193) and dry matter accumulation in leaves (17.76 and 15.40 g plant⁻¹, respectively - Table 132 and 194, , Fig.22a and 31a). Particularly the latter attributes representing photosynthetically active leaf surface contributed directly to higher dry matter accumulation in different parts of plants especially in panicles (38.0 and 33.90 g plant⁻¹, respectively) and developing grain especially during reproductive cycle (Table 137 and 196, Fig.32a and 23a).

Apart from photosynthetically active leaf surface, improved growth with these treatments could also be attributed to higher nutrient uptake facilitated by higher availability and probably also due improved root activity owing to improved bio-pysico-chemical characters of soil upon addition of organic matter in the treatment, and further improved physiological and hormonal processes in the plant upon uptake of applied critical micronutrients. This could be evidenced from higher uptake of major (N- 156.5 and 149.4 kg ha⁻¹, P- 30.5 and 29.7 kg ha⁻¹, K- 173.2 and 152.2 kg ha⁻¹ with STCR and N- 145.3 and 140.9 kg ha⁻¹, P- 25.9 and 26.7 kg ha⁻¹, K- 156.5 and 142.4 kg ha⁻¹ with NE and micronutrients Fe- 2003.5 and 2025 g ha⁻¹ and Zn- 677.7 and 401.7 g ha⁻¹ with STCR and Fe (1845.0 and 1570 g ha⁻¹ and Zn- 633.3 and 363.8 g ha⁻¹ with NE, respectively - Table 170-176 and 210-212) during rainy and summer seasons respectively. Apoorva *et al.* (2010) attributed improvement in nutrient uptake with addition of organics to improved microbial activity with organic inoculants which facilitated utilization of applied nutrients efficiently according to need of crop and enriched nutrients reserve.

Another thing observed in the study was that to achieve almost same yield targets STCR approach used more nutrients than NE. This fact is reflected in returns wherein in spite of numerically higher grain yield, gross returns (₹ 1,40,476 and 1,25,403 ha⁻¹, respectively), and net returns (₹ 98,006 and 82938 ha⁻¹, respectively) and B:C ratio (3.48 and 3.04) were higher with NE approach during both rainy and summer seasons (Table 187-189 and 217, Fig.30a and 39a). Since economics is the robust tool that helps to arrive at pragmatic decisions with regard to recommendations of productions technologies and in the present instance either of the approaches could be used, and preferably Nutrient Expert for its simplicity, farmer friendly nature besides monetary advantage.

Further, one need take in to consideration the quality in staple crop like rice. Grain protein was higher (7.00 and 6.81%, respectively) with STCR based nutrition for higher yield target alongwith supplementation of micronutrients and organics during rainy and summer seasons. Besides, grains were also nutritionally fortified with iron (44.9 and 31.9 mg kg⁻¹, respectively) and zinc (16.5 and 13.2 mg kg⁻¹, respectively during rainy and summer seasons) with treatment

5.7 Performance of Interventions over Seasons

In general, yield levels during summer were a little lower (8.3 and 12.24%, respectively in I and II Experiments) compared to rainy season in both the experiments (Table 112 and 218). This could be probably due to little late sowing in the season apart from other factors such as ECe of irrigation water etc. Further, performance trends in cvs. GGV 0501 and BPT 5204 remained same across seasons, while those of cv. MTU 1010 and RNR 150418 significantly varied; MTU 1010 out yielded other cultivars during rainy season, while RNR 15048 performed poorly in comparison to other cultivars during summer. However, these variations could also be due to absence of cultivation of these cultivars in other seasons. Variations due to seed rate were not significant and performance trend remained identical during both the seasons. Similar was the performance due to levels of micronutrients; consequent upon similar behaviour across seasons the variations were not significant. In nutritional approaches, NE revealed significant variations with better performance during rainy season with reductions in yield to the tune of 15.11% during summer while STCR performed evenly across seasons with almost half (8.27%) the variations in comparison to NE. Among the yield

targets, the seasonal difference in 7 t ha⁻¹ yield target was significant while those of 6 and 8 t ha⁻¹ yield targets were not significant. In other words deviation from the rainy season over summer with medium yield target was the maximum of 14.07% while those with 6 and 8 t ha⁻¹ were of lower order (10.49 and 10.30%, respectively).

5.8 Points of practical utility

The investigation on ‘yield maximization of direct seeded rice in Tunga Bhadra Project irrigation command’ carried out at Agricultural Research Station, Dhadesugur, Bellary, University of Agricultural Sciences, Raichur, Karnataka during 2014-15 and 2015-16 brought forth following points of practical significance

1. Coarse rice cultivar cv. MTU 1010 outperformed the medium fine cv. GGV 0501 and fine cv. BPT 5204 cultivars during rainy season, while during summer medium fine cultivar cv. GGV 0501 fared better over fine cultivars (cvs. BPT 5204 and RNR 15048) under direct seeded condition.
2. Medium seed rate of 30 kg ha⁻¹ proved superior to lower (25 kg ha⁻¹) or higher (35 kg ha⁻¹) seed rates in terms of yield and economics during both the seasons.
3. In DSR basal (25 kg ha⁻¹ each) and foliar nutrition (@ 0.5% each twice at 15 and 30 DAS) using FeSO₄ and ZnSO₄ is critical from the point of early seedling vigour, high yield and economics.
4. Besides successful establishment and higher yield, FeSO₄ and ZnSO₄ enriched rice grain with Fe, Zn and protein which is of nutraceutical importance in rice predominated dietary population.
5. Further, rice can be intensively fertilized using STCR or NE to achieve a target of 7 t ha⁻¹ or more during both the seasons with required micronutrients and organics supplementation. NE is a better option as it can save N (16.6%), P (45.3%) and K (8%) over blanket recommendation and still achieve high yield targets economically.

5.8 Future line of work

The investigation tend to address basic agronomy of DSR during rainy and summer seasons, however there is a scope of further research for enhancing productivity and production efficiency for which following points need attention.

1. Usually DSR is practiced in one of the two seasons because of voluntary rice problem, rice being part of double cropping system studies on system based agronomy need to be taken up.
2. The deviation in yield for the set targets being large during summer investigation on the other factors of production for instance time of planting needs to be integrated with plant nutrition.
3. With days to come micro irrigation would be a rule rather than exception in paddy, and hence pre set yield targets need to be studied under different micro irrigation systems. Cv.BPT 5204, in spite of lower yields among cultivars; hence there is need for intensive research in this cultivar under drill sown condition in the irrigation command for yield maximization.
4. Attempts for breeding cultivars for DSR as done in SRI method and refinement of agronomy could be a perpetual consideration.

VI. SUMMARY AND CONCLUSIONS

The investigations on ‘Yield maximization in direct seeded rice in Tunga Bhadra project irrigation command’ comprising of two field experiments were conducted twice during rainy season and once in summer during the growing seasons of 2014-15 and 2015-16 at Agricultural research station, Dhadesugur, Ballari Karnataka under irrigation. The first experiment comprised of three cultivars (*viz.*, GGV 0510, MTU 1010 (rainy season) / RNR 15048 (summer) and BPT 5204), three seed rates (25, 30 and 35 kg ha⁻¹) and four levels of micronutrients (nil, FeSO₄, ZnSO₄ and FeSO₄ + ZnSO₄), and the second experiment consisted of two nutritional approaches (NE-Nutrient expert and STCR-Soils test crop response), three yield targets (6, 7 and 8 t ha⁻¹) and two levels of micronutrients + organics (without and with); first experiment was laid out in Split – split plot design while the second experiment was laid out using Randomized block design with three replications. The results are summarized in this chapter.

I Response of rice genotypes to seed rates and micronutrients under direct seeded condition

Rainy season

Cv. MTU 1010 sown using medium seed rate (30 kg ha⁻¹) and supplied with FeSO₄ + ZnSO₄ recorded taller plants (102.0 cm at harvest), higher tillers count (540.2) and leaf area (LA) (506.3, 851.0, 1380.2 and 807.0cm². at 45 67 and 90 DAS and at harvest, respectively) while lower values (74.4cm and 311.5, height and tiller count, respectively) were recorded with cv. BPT 5204 with higher seed rate (35 kg ha⁻¹) and no supply of any micronutrient while lower LA was recorded with cv. BPT 5204 with lower seed rate and no supplementation of any micronutrient.

Significantly larger TDM occurred throughout with cv. MTU 1010 sown using medium seed rate and supplied with ZnSO₄ alone and with both the micronutrients (2.72, 3.28, 53.77 and 112.91 g, at 45, 67 and 90 DAS and at harvest, respectively) while lower TDM was recorded with cvs. GGV 0501 and BPT 5204 with lower or higher seed rate and no supplementation of any micronutrient (1.17, 2.00, 22.87, and 60.23 with GGV 0501 and 1.12, 2.08, 15.90 and 57.26 with BPT 5204, at 45, 67 and 90 DAS and at harvest respectively).

Cv. BPT 5204 sown using 30 kg ha⁻¹ seed rate and provided with FeSO₄ + ZnSO₄ recorded higher SPAD reading (34.4), while lower SPAD value (29.5) was recorded with cv. GGV 0501 with 35 kg seed rate and no micronutrient application. At 90 DAS the values were marginally lower and the differences narrowed and different treatments were at parity. Green seeker reading varied significantly due to use of micronutrients and interactions except seed rate X micronutrient only at 45 DAS and no significant differences occurred due to any factor or their combinations except variety x seed rate at 90 DAS. Further, cv. BPT 5204 irrespective of seed rate and micronutrient particularly with FeSO₄ + ZnSO₄ took more days to 50 % flowering (118.8), while fewer days (80.6) were recorded with cv. MTU 1010 sown using 35 kg ha⁻¹ seed rate and not supplemented with micronutrients. Whereas, Higher heat use efficiency (HUE- 2.11) was recorded with cv. MTU 1010 sown with 30 kg seed rate and applied with both FeSO₄ and ZnSO₄, while lower HUE (1.13) was recorded with cv. BPT 5204 sown using 35 kg ha⁻¹ seed rate and supplied with no micronutrient.

Higher total tiller number, productive tillers and filled grains (540.2, 413.8 and 115.8, respectively) occurred with cv. MTU 1010 sown using 30 kg seed rate and applied with both FeSO₄ + ZnSO₄, while the lower values were recorded with cv. BPT 5204 irrespective of seed rates with no micronutrient application (311.5 and 229.4, total and productive tillers respectively) whereas BPT 5204 sown using 35 kg ha⁻¹ seed rate and no supplementation of micronutrient recorded lower filled grains among all. Further, significantly higher sterility percentage (24.2) was observed with cv. BPT 5204 sown with 30 kg seed rate and without application of micronutrients, while lower sterility percentage was recorded with cv. MTU 1010 sown using 30 kg ha⁻¹ seed rate and supplied with both the micronutrients.

Significantly higher panicle length and test weight (26.4 cm and 26.0 g respectively) were registered with cv. MTU 1010 sown with 30 kg seed rate and applied with both FeSO₄ and ZnSO₄, while lower panicle length was recorded with cv. BPT 5204 irrespective of seed rates (30 kg ha⁻¹) but without micronutrient application (17.6). Similarly, lower test weight was recorded with both cv. BPT 5204 sown using 35 or 25 kg ha⁻¹ seed rate and supplied with no micronutrient (17.7 or 18.6, respectively).

In all, significantly higher grain and straw yields (6804 and 8285 kg ha⁻¹, respectively) were recorded with cv. MTU 1010 sown using 30 kg seed rate and supplied

with both FeSO_4 and ZnSO_4 , closely followed ZnSO_4 (6583 kg ha^{-1}), while lower grain yield (3136 kg ha^{-1}) was recorded with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient whereas lower straw yield (5138 kg ha^{-1}) was recorded again with cv. BPT 5204 sown using 35 kg ha^{-1} seed rate and supplied with no micronutrient. Further, significantly higher harvest index (HI- 0.50) was observed with cv. MTU 1010 sown with 25 kg seed rate without application of micronutrients, while lower HI (0.42) was recorded with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied either with FeSO_4 or not supplied with any micronutrient at all.

As far grain quality was concerned, significantly higher Fe content (49.93) was recorded with cv. MTU 1010, while lower content was obtained with cv. BPT 5204. Again, cv. MTU 1010 with combined application of FeSO_4 and ZnSO_4 recorded higher Zn content in grain (22.02), while lower Zn (11.57) occurred with cv. BPT 5204 when no micronutrient was supplied. Higher protein content in grain (7.96) was observed with cv. MTU 1010 sown with 30 kg seed rate and applied with both FeSO_4 and ZnSO_4 ; while lower protein content in grain (6.29) was recorded with cv. GGV 0501 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient.

Among nutrients, higher N, P and K uptake (159.5 , 28.5 and 148.8 kg ha^{-1} , respectively) was observed with cv. MTU 1010 sown with 30 kg seed rate and applied with both $\text{FeSO}_4 + \text{ZnSO}_4$, while lower uptake of N, P and K (67.5 , 11.1 and 72.8 kg ha^{-1} , respectively) occurred with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient.

At harvest, soil pH did not reveal significant differences due to main effects and third order interactions, while Soil EC revealed favorable range; cv. MTU 1010 sown using 35 kg ha^{-1} seed rate and supplied with $\text{FeSO}_4 + \text{ZnSO}_4$ recorded higher EC (0.89 dS m^{-1}) while lower soil EC (0.69 dS m^{-1}) occurred with cv. GGV 0501 sown using 30 kg seed rate and supplied with FeSO_4 only. Overall, soil organic carbon (OC) was in medium range. Cv. GGV 0501 sown using 25 kg ha^{-1} seed rate and without supplementation of micronutrients had higher OC, while lower soil OC (0.47%) occurred with cv. BPT 5204 sown using 25 kg seed rate and supplied with ZnSO_4 only.

Again, higher soil available N (266.4 kg ha^{-1}) was observed with cv. BPT 5204 sown with 25 kg seed rate and with supply of both the micronutrients; in fact all combinations of cv. BPT 5204 were on par, while lower N (236.6 kg ha^{-1}) was recorded

with cv. MTU 1010 sown using 30 kg ha⁻¹ seed rate and supplied with FeSO₄. Cv.BPT 5204 sown with 25 kg seed rate and without any micronutrients recorded significantly higher available P and K (49.4 and 418.6 kg ha⁻¹, respectively), while lower values were recorded with cv. MTU 1010s own using 30 kg ha⁻¹ seed rate with application FeSO₄ + ZnSO₄ (26.0 and 341.7 kg ha⁻¹, respectively).

Among all, significantly higher gross and net returns were obtained with cv. MTU 1010 sown with 30 kg seed rate and applied with both FeSO₄ and ZnSO₄ (₹ 1,31,210/- and 78,084/-, respectively); while lower gross and net returns (₹ 87,400 /- and 35,394/-, respectively) were recorded with cv. BPT 5204 sown using 35 kg ha⁻¹ seed rate and supplied with no micronutrient. Similar trend was observed in B:C ratio.

Summer Season

Cv. GGV 0501 sown using medium seed rate (30 kg ha⁻¹) and supplied with FeSO₄ + ZnSO₄ recorded taller plants (111.1 cm at harvest), higher tillers count (440.7 m⁻²) and leaf area (LA) (535.0, 1345.4 and 840.7 cm². at 45 and 90 DAS and at harvest, respectively) while lower values (76.8 cm and 87.2 m⁻², height and tiller count respectively) were recorded with cv. BPT 5204 sown with higher seed rate and no supply of any micronutrient while lower LA was recorded with cv. BPT 5204 with lower seed rate and no supplementation of any micronutrient.

Significantly higher TDM was registered with cv. GGV 0501 sown using medium seed rate and supplied with both the micronutrients throughout (5.2, 46.7 and 107.2 g, at 45 and 90 DAS and at harvest, respectively) while lower TDM was recorded with cvs. RNR 15048 and BPT 5204 with lower seed rate and no supplementation of any micronutrient (2.2 24.1, and 49.1 with RNR 15048 and 2.5, 29.0 and 50.7 with BPT 5204, at 45 and 90 DAS and at harvest, respectively).

Cv.BPT 5204 sown using 30 kg ha⁻¹seed rate and provided with FeSO₄ + ZnSO₄ recorded higher SPAD reading (35.8), while lower SPAD value (29.1) was recorded with cv. RNR 15048 with 30 kg seed rate and no micronutrient application. At 90 DAS the values were marginally lower and the differences narrowed and different treatments were at parity. Green seeker reading varied significantly due to use of micronutrients and interactions except seed rate x micronutrient only at 45 DAS and no significant difference occurred due to any factor or combinations except variety x seed rate at

90 DAS. Further, cv.BPT 5204 irrespective of seed rate and micronutrient particularly with $\text{FeSO}_4 + \text{ZnSO}_4$ took more days to 50% flowering (118.8), while fewer days (82.6) were recorded with cv. RNR 15048 sown using 35 kg ha^{-1} seed rate and not supplemented with micronutrients. Higher heat use efficiency (HUE- 2.07) was recorded with cv. GGV 0501 sown with 30 kg seed rate and applied with both FeSO_4 and ZnSO_4 , while lower HUE (1.25) was recorded with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient.

Higher total tiller number, productive tillers and filled grains (440.7, 411.5 and 151.5, respectively) occurred with cv. GGV 0501 sown using 30 kg seed rate and applied with both $\text{FeSO}_4 + \text{ZnSO}_4$, while the lower values were recorded with cv. RNR 15048 irrespective of seed rates and no micronutrient application (217.5 and 202.7, total and productive tillers respectively). Further, significantly higher sterility percentage (86.8) was observed with cv. BPT 5204 sown with 30 kg seed rate and without application of micronutrients, while lower sterility percentage was recorded with cv. GGV 0501 sown using 25 and 30 kg ha^{-1} seed rates and supplied with both the micronutrients.

Significantly higher panicle length and test weight (28.1cm and 27.6 g respectively) were registered with cv. GGV 0501 sown with 30 kg seed rate and applied with both FeSO_4 and ZnSO_4 , while lower panicle length was recorded with cv. BPT 5204 irrespective of seed rates (30 kg ha^{-1}) but without micronutrient application (18.7cm) whereas lower test weight was recorded with both cvs. BPT 5204 and RNR 15048 sown using 35 or 25 kg ha^{-1} seed rate, and supplied with no micronutrient (16.9 and 17.4 g, respectively).

Similarly, significantly higher grain and straw yields (6277 and 8241 kg ha^{-1} , respectively) were recorded with cv. GGV 0501 sown using 30 kg seed rate and supplied with both FeSO_4 and ZnSO_4 , closely followed ZnSO_4 (6215 kg ha^{-1}), while lower grain yield (3513 kg ha^{-1}) was recorded with cv. RNR 15048 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient whereas lower straw yield (4131 kg ha^{-1}) was recorded with cv. BPT 5204 sown using 35 kg ha^{-1} seed rate and supplied with no micronutrient. However, significantly higher HI (0.50) was observed with cv. BPT 5204 sown with 35 kg seed rate without application of micronutrients, while lower HI (0.36) was recorded with cv. RNR 15048 sown using 35 kg ha^{-1} seed rate and supplied with FeSO_4 alone.

Grain enrichment with Fe (35.2 mg kg^{-1}) was observed with cv. GGV 0501, while lower content was obtained with cvs. RNR 15048 and BPT 5204 and both were at par. Again, cv. GGV 0501 with combined application of FeSO_4 and ZnSO_4 recorded higher Zn content in grain (16.9 mg kg^{-1}), while lower Zn (11.5 mg kg^{-1}) occurred with cv. BPT 5204 when no micronutrient was supplied. Higher protein content in grain (8.11%) was observed with cv. GGV 0501 sown with 30 kg seed rate and applied with both FeSO_4 and ZnSO_4 ; while lower protein content in grain (6.36%) was recorded with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient.

Among nutrients higher N, P and K uptake (148.2 , 28.6 and 179.5 kg ha^{-1} , respectively) was observed with cv. GGV 0501 sown with 30 kg seed rate and applied with both $\text{FeSO}_4 + \text{ZnSO}_4$, while the lower uptake of N and P (69.3 and 9.9 kg ha^{-1} , respectively) occurred with cv. BPT 5204 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient, while lower K uptake (70.1 kg ha^{-1}) was recorded with cv. BPT 5204 sown with 35 kg ha^{-1} seed rate and supplied with no micronutrient.

Soil pH at harvest did not reveal significant differences due to main effects and third order interactions, while soil EC revealed favorable range; cv. GGV 0501 sown using 25 kg ha^{-1} seed rate and supplied with $\text{FeSO}_4 + \text{ZnSO}_4$ recorded higher EC (0.91 dS m^{-1}) while lower soil EC (0.80 dS m^{-1}) occurred with cv. RNR 15048 sown using 35 kg seed rate and supplied with ZnSO_4 only. Overall, soil organic carbon (OC) was in medium range. GGV 0501 sown using 35 kg ha^{-1} seed rate and supplied with $\text{FeSO}_4 + \text{ZnSO}_4$ had higher OC, while lower soil OC (0.50%) occurred with cv. BPT 5204 sown using 25 kg seed rate and supplied with ZnSO_4 only.

At crop harvest, higher soil available N (265.8 kg ha^{-1}) was observed with cv. BPT 5204 sown with 25 kg seed rate and with no supply of micronutrient; in fact all combinations of cv. BPT 5204 were on par, while lower N (236.6 kg ha^{-1}) was recorded with cv. GGV 0501 sown using 30 kg ha^{-1} seed rate and supplied with $\text{FeSO}_4 + \text{ZnSO}_4$. BPT 5204 sown with 25 kg seed rate and without application of micronutrients recorded significantly higher (48.2 and 413.8 kg ha^{-1} , respectively) available P and K, while lower values were recorded with cv. GGV 0501 sown using 30 kg ha^{-1} seed rate with application $\text{FeSO}_4 + \text{ZnSO}_4$ (25.0 and 341.7 kg ha^{-1} , respectively).

In all, net returns varied from ` 29,525/- (RNR 15048 + 25 kg + no micronutrient) to ` 81,969/- (GGV 0501 + 30 kg + $\text{FeSO}_4 + \text{ZnSO}_4$). Significantly higher BC ratio (

2.52) occurred with cv. GGV 0501 sown with 30 kg seed rate and applied with both FeSO_4 and ZnSO_4 or Zn SO_4 alone (2.79 each), while lower BC ratio (1.57) was recorded with cv. RNR 15048 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient.

II. Response of Direct Sown Rice to Nutrient Management for Varied Yield Targets

Rainy season

Taller plants (107.6 cm), higher tiller count (197.7), LA (553.5, 899.8, 1472.6 and 854.4 cm^2 , respectively at 45, 67 and 90 DAS and at harvest) and higher LAI (2.77, 4.50, 7.36 and 4.27, respectively at 45, 67 and 90 DAS and at harvest) throughout were observed with STCR + 8 t ha^{-1} + micronutrient & organics supply while NE, + 6 t ha^{-1} + no micronutrient supply resulted in dwarf plants (101.3 cm), poor tiller count (156.1), lower LA (455.5, (749.5, 1157.4 and 674.4 cm^2 , respectively) and lower LAI (2.28, 3.75, 5.79 and 3.37, respectively).

Further, STCR + 8 t ha^{-1} yield target + micronutrient & organics supply registered the maximum TDM (2.51, 5.73, 31.67 and 85.62, respectively at 45, 67 and 90 DAS and at harvest), SPAD chlorophyll (35.4, 35.1 and 33.0, respectively) and NDVI values (0.49 and 0.71, respectively at 67 and 90 DAS) while lower TDM (1.53, 2.70, 19.13 and 57.91, respectively) and SPAD (28.1, 27.4 and 30.1, respectively at 45, 67, 90 DAS and at harvest) were recorded with NE + 6 t ha^{-1} yield target + no micronutrient/organics. STCR + 8 t ha^{-1} yield target + micronutrient & organics supply registered the maximum days (107.28) to 50% flowering, while early flowering (93.57) occurred with NE + 6 t ha^{-1} yield target + no micronutrient.

Significantly more number of productive and total tillers (436.0 and 461.7, respectively), longer panicle (28.3 cm) and more number of grains panicle $^{-1}$ (217.3) were recorded with STCR + 8 t ha^{-1} yield target + micronutrient supply, while lower tiller count (291.5 and 370.2, respectively), shorter panicle (24.9 cm) and minimum grains (147.4 panicle $^{-1}$) were recorded with NE + 6 t ha^{-1} yield target + no micronutrient. Consequently, STCR + 8 t ha^{-1} yield target + micronutrient supply registered significantly higher grain and straw yields (7556 and 8739 kg ha^{-1} , respectively) followed by STCR + 7 t ha^{-1} yield target + micronutrient supply (7444 and 8739 kg ha^{-1} ,

respectively) which was on par, while lower yields (5705 and 6755 kg ha⁻¹, respectively) were recorded with NE + 6 t ha⁻¹ yield target + no micronutrient. The harvest indices ranged from 0.46 to 0.47.

STCR + 8 t ha⁻¹ yield target + with micronutrient and organic supply also had enriched grain with Fe, Zn and protein (44.9 mg kg⁻¹, 16.5 mg kg⁻¹ and 7.49%, respectively), while lower grain values (0.34, 13.0 and 6.29, respectively) were observed with NE + 6 t ha⁻¹ yield target + no micronutrient and organics.

The maximum uptake of N, P and K (156.5, 30.5 and 173.2 kg ha⁻¹, respectively), and higher EC (0.85 dS m⁻¹) were recorded with STCR + 8 t ha⁻¹ yield target + micronutrient & organics supply, while lower uptake (93.71, 16.2 and 91.6 kg ha⁻¹, respectively) and EC (0.65dS m⁻¹) occurred with NE + 6 t ha⁻¹ yield target + no-micronutrient. STCR + 8 t ha⁻¹ yield target + no micronutrient supply also registered the maximum OC (0.74%), while lower OC (0.54% each) was recorded with NE + 7 t ha⁻¹ yield target + micronutrient and organics.

Further, STCR + 8 t ha⁻¹ yield target + without micronutrient supply registered the maximum soil available N, P and K (268.0, 45.8 and 393.0 kg ha⁻¹, respectively), while lower N (234.6 kg ha⁻¹) was observed with NE + 7 t ha⁻¹ yield target + micronutrient and organics whereas lower available P and K (28.6 and 345.8 kg ha⁻¹, respectively) occurred with NE + 6 t ha⁻¹ yield target + micronutrient/organics.

Finally, STCR + 8 t ha⁻¹ yield target + micronutrient & organics supply registered the maximum gross returns (₹ 1,56,242), while among NE maximum returns were recorded 8 t ha⁻¹ yield target + micronutrient supply (₹ 1,52,406) followed by 8 t ha⁻¹ yield target + without micronutrient supply (₹ 1,49,537) while lower gross returns (₹ 1,18,363) among all were obtained with NE + 6 t ha⁻¹ yield target + no micronutrient which was lower than the recommended practice (₹ 1,23,580). Further, Nutrient expert based nutrition for higher yield of 8 t ha⁻¹ without any micronutrient or organics supply recorded the maximum net returns (₹ 1,14,338) followed by NE + 7 t ha⁻¹ yield target + no micronutrient supply (₹ 1,11,043) while lower net returns (₹ 80,035) among all were obtained with NE+ 6 t ha⁻¹ yield target + micronutrient/organics which was again lower than the control with recommended practice (₹ 88369/-). In all, NE was superior to STCR with higher B:C ratio (4.26) with yield target of 7 t ha⁻¹ without supply of micronutrients + organics followed by 8 t ha⁻¹ yield target (4.25). Similar yield targets

with STCR based nutrition but without micronutrient + organics had lower B:C ratio (3.33 each) which were, however, higher than with micronutrient + organics (2.67 and 2.60, respectively). The B:C ratio with the latter was lower than that of control with recommended practice (3.28). Among all the lowest B:C (2.54) was obtained with STCR + 6 t ha⁻¹ yield target + micronutrients + organics supply (N₂T₁M₂).

Summer season

Similar to rainy season, STCR + 8 t ha⁻¹ yield target + micronutrient & organics supply registered significantly taller plants (101.5 cm), more number of tillers (181.6 at harvest), higher LA (525.5, 1490.8 and 877.6 cm², respectively at 45 and 90 DAS and at harvest), and TDM (75.40 g), while lower height (94.9 cm harvest), lower tiller count (135.6), lower LA (443.8, 1124.2 and 661.3 cm², respectively at 45 and 90 DAS and at harvest), and TDM (51.40 g) were recorded with NE + 6 t ha⁻¹ yield target + no micronutrient (N₁T₁M₁); other treatment combinations fared in between.

Further, STCR + 8 t ha⁻¹ yield target + micronutrient & organics supply registered significantly higher SPAD chlorophyll (32.7 at 45 DAS), NDVI (0.50 and 0.66, respectively at 45 and 90 DAS) and the maximum days (101.20) to 50% flowering, while lower SPAD value (26.4 at 45 DAS), NDVI value (0.38 and 0.59, respectively at 45 and 90 DAS) and early flowering (93.57) were observed with NE + 6 t ha⁻¹ yield target + no-micronutrient. Variations in SPAD at 90 DAS were not significant.

Significantly more number of tillers at harvest (407.0), longer panicle (25 cm), lower unfilled grains panicle⁻¹ (19.5) more number of grains panicle⁻¹ (188.1), and lower sterility per cent (10.4) were recorded with STCR + 8 t ha⁻¹ yield target + micronutrient & organics supply followed by similar combination but with medium yield target which was at par, while lower tiller count (370.2), shorter panicle (22.5 cm), maximum unfilled grains panicle⁻¹ (44.1), minimum grains panicle⁻¹ (138.3), and maximum sterility per cent (32.1) were recorded with NE + 6 t ha⁻¹ yield target + no micronutrient among all. Data on 1000-grain weight did not reveal significant differences due to nutritional approaches, yield targets and micronutrient levels (26.4 with former and 23.6 with latter treatment).

STCR + 8 t ha⁻¹ yield target + micronutrient & organics supply registered significantly higher grain and straw yields (7385 and 8741 kg ha⁻¹, respectively) followed by STCR + 7 t ha⁻¹ yield target + micronutrient & organics supply (7444 and

8708 kg ha⁻¹, respectively) which was on par, while lower yield (4988 and 6941 kg ha⁻¹, respectively) was recorded with NE + 6 t ha⁻¹ yield target + no micronutrient. However, harvest index did not differ significantly (0.42 and 0.46, respectively with latter and former treatments). As far grain quality was concerned, STCR + 8 t ha⁻¹ yield target + with micronutrient and organic supply registered the maximum grain Fe, Zn and protein (40.4 mg kg⁻¹, 14.4 mg kg⁻¹ and 7.49%, respectively), while lower grain contents (18.3 mg kg⁻¹, 11.5 mg kg⁻¹ and 6.29%, respectively) were observed with NE + 6 t ha⁻¹ yield target + no micronutrient and organics.

STCR + 8 t ha⁻¹ yield target + micronutrient & organics supply also recorded the maximum uptake of N, P and K (149.4, 55.2 and 152.2 kg ha⁻¹, respectively), while lower uptake (98.6, 38.6 and 101.0 kg ha⁻¹, respectively) occurred with NE + 6 t ha⁻¹ yield target + no-micronutrient. Besides, STCR + 8 t ha⁻¹ yield target + no micronutrient supply registered the higher pH (8.18) and OC (0.56%) and lower EC (0.66 dS m⁻¹), while lower OC (0.46% each) moderately lower EC of 0.74 dS m⁻¹ and pH of 8.07 were recorded with NE + 7 t ha⁻¹ yield target + micronutrient and organics.

STCR + 8 t ha⁻¹ yield target + without or with micronutrient supply registered the maximum soil available N and P (259.2 and 256.4 N, and 38.5 and 37.4 P, kg ha⁻¹ respectively), while lower soil available N (227.7 kg ha⁻¹) was observed with NE + 7 t ha⁻¹ yield target + micronutrient and organics followed by similar combination with no micronutrient whereas lower P (27.6 kg ha⁻¹) was observed with NE + 6 t ha⁻¹ yield target + micronutrient and organics.

STCR + 8 t ha⁻¹ yield target + micronutrient supply registered the maximum gross and net returns (₹ 1,57,789 and 96,061 respectively) followed by similar combination but with medium yield target (₹ 1,43,727 and 86,118/-, respectively), while among NE maximum gross and net returns were recorded with 8 t ha⁻¹ yield target supplied with micronutrients and organics (₹ 1,45,280 and 93,706/-, respectively), while lower gross and net returns (₹ 1,08,653/- and ₹ 75,095/-, respectively) among all were obtained with NE + 6 t ha⁻¹ yield target + micronutrient which was lower than the control with recommended practice (₹ 1,14,816 and 79,605/-, respectively). Further, gross return and net return were numerically higher with target of 7 t ha⁻¹ yield target + no micronutrient both NE and STCR approaches. In all, NE was superior to STCR with higher B:C ratio (3.74) for a yield target of 8 t ha⁻¹ without supply of micronutrients +

organics followed by NE based nutrition for 7 t ha⁻¹ yield target again without supplementation of micronutrients and organics (3.53). Similarly, yield targets of 8 and 7 t ha⁻¹ with STCR based nutrition without micronutrient + organics had higher B:C (3.22 and 3.00, respectively) than those with micronutrient + organics (2.49 and 2.63, respectively). The B:C ratio with the latter was lower than that of control with recommended practice (3.26). Among all, the lowest B:C (2.32) was obtained with NE + 6 t ha⁻¹ yield target + micronutrients + organics supply.

Conclusion

- Performance of cvs. MTU 1010 and GGV 0501 were found better during rainy and summer seasons, respectively under direct seeded rice. Among the different seed rates used medium seed rate of 30 kg ha⁻¹ was most advantageous than higher or lower seed rate (25 or 35 kg ha⁻¹ seeds). Further, application of FeSO₄ + ZnSO₄ to soil (25 kg ha⁻¹ each) and to the foliage (0.5% each twice at 15 and 30 DAS) increased the yield.
- Application of nutrients following either NE or STCR approaches enabled higher yield with set target yield of 8 t ha⁻¹ with application of micronutrient + organics during both the seasons with 94.45 and 92.31 % realization during rainy and summer seasons respectively. However, from the points of savings on fertilizer inputs and net returns NE is preferable to STCR, besides it is easy to follow by farmers.

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APPENDIX - I

Effect of genotypes, seed rates and micro nutrients on nitrogen content (%) in rice straw under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	0.67 ^{cd}	0.67 ^{cd}	0.75 ^{ab}	0.70 ^{b-d}	0.33 ^c	0.53 ^{j-o}	0.33 ^s	0.40 ^h	0.50 ^m	0.60 ^{h-j}	0.54 ^{k-m}	0.55 ^d
	M ₂	0.67 ^{cd}	0.67 ^{cd}	0.60 ^e	0.65 ^e	0.33 ^s	0.65 ^{e-g}	0.41 ^{qr}	0.46 ^g	0.50 ^m	0.66 ^{d-g}	0.51 ^m	0.56 ^d
	M ₃	0.69 ^{bc}	0.69 ^{bc}	0.62 ^{de}	0.67 ^{de}	0.53 ^{j-o}	0.74 ^{c-d}	0.44 ^{p-r}	0.57 ^d	0.61 ^{g-j}	0.72 ^{a-c}	0.53 ^{l-m}	0.62 ^c
	M ₄	0.69 ^{bc}	0.69 ^{bc}	0.62 ^{c-e}	0.67 ^{de}	0.56 ^{h-m}	0.82 ^b	0.59 ^{g-k}	0.66 ^{bc}	0.62 ^{g-j}	0.75 ^{ab}	0.61 ^{g-j}	0.66 ^b
S ₂	M ₁	0.69 ^{bc}	0.69 ^{bc}	0.66 ^{c-e}	0.68 ^{c-e}	0.39 ^{rs}	0.62 ^{f-i}	0.51 ^{l-p}	0.51 ^f	0.54 ^{i-l}	0.66 ^{d-g}	0.58 ^{i-l}	0.59 ^c
	M ₂	0.69 ^{bc}	0.69 ^{bc}	0.66 ^{c-e}	0.68 ^{c-e}	0.44 ^{p-r}	0.64 ^{e-g}	0.54 ^{j-n}	0.54 ^{d-f}	0.57 ^{i-l}	0.66 ^{d-g}	0.60 ^{h-j}	0.61 ^c
	M ₃	0.69 ^{bc}	0.69 ^{bc}	0.66 ^{c-e}	0.68 ^{c-e}	0.47 ^{n-q}	0.67 ^{d-f}	0.55 ^{j-m}	0.56 ^{de}	0.58 ^{i-l}	0.68 ^{c-f}	0.61 ^{g-j}	0.62 ^c
	M ₄	0.79 ^a	0.79 ^a	0.67 ^{cd}	0.75 ^a	0.55 ^{i-m}	0.98 ^a	0.60 ^{f-j}	0.71 ^a	0.67 ^{h-k}	0.88 ^a	0.63 ^{f-i}	0.73 ^a
S ₃	M ₁	0.74 ^{ab}	0.74 ^{ab}	0.63 ^{c-e}	0.70 ^{b-d}	0.33 ^s	0.65 ^{e-g}	0.41 ^{q-r}	0.46 ^g	0.59 ^{h-j}	0.64 ^{d-h}	0.57 ^{i-l}	0.60 ^c
	M ₂	0.74 ^{ab}	0.74 ^{ab}	0.64 ^{c-e}	0.71 ^{bc}	0.46 ^{o-r}	0.58 ^{g-l}	0.52 ^{k-o}	0.52 ^{ef}	0.60 ^{g-j}	0.66 ^{c-e}	0.58 ^{i-l}	0.61 ^c
	M ₃	0.75 ^{ab}	0.75 ^{ab}	0.65 ^{c-e}	0.72 ^{ab}	0.49 ^{m-p}	0.63 ^{f-h}	0.76 ^{b-c}	0.63 ^c	0.62 ^{c-e}	0.69 ^{c-e}	0.70 ^{b-d}	0.67 ^b
	M ₄	0.77 ^a	0.77 ^a	0.65 ^{c-e}	0.73 ^{ab}	0.62 ^{f-i}	0.75 ^{bc}	0.71 ^{c-e}	0.69 ^{ab}	0.69 ^{g-j}	0.76 ^{ab}	0.68 ^{c-f}	0.71 ^a
Variety		0.72 ^a	0.72 ^a	0.65 ^b		0.46 ^c	0.69 ^a	0.53 ^b		0.59 ^b	0.70 ^a	0.60 ^a	
		Variety x Seed rate			S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	0.68 ^b	0.68 ^b	0.65 ^{bc}	0.67 ^b	0.43 ^g	0.68 ^b	0.44 ^g	0.52 ^b	0.56 ^d	0.68 ^{bc}	0.55 ^e	0.60 ^b
	S ₂	0.72 ^a	0.72 ^a	0.66 ^{bc}	0.70 ^a	0.46 ^f	0.73 ^a	0.55 ^d	0.58 ^a	0.59 ^c	0.72 ^a	0.61 ^{bc}	0.64 ^a
	S ₃	0.75 ^a	0.75 ^a	0.64 ^e	0.71 ^a	0.50 ^e	0.62 ^c	0.63 ^c	0.58 ^a	0.63 ^{a-c}	0.69 ^{bc}	0.63 ^{bc}	0.65 ^a
		Variety x Micro			M	Variety x Micro			M	Variety x Micro			M
M	M ₁	0.70 ^b	0.70 ^b	0.68 ^{bc}	0.69 ^b	0.39 ^f	0.57 ^d	0.45 ^e	0.47 ^d	0.54 ^f	0.63 ^{cd}	0.56 ^{ef}	0.58 ^c
	M ₂	0.70 ^b	0.70 ^b	0.63 ^b	0.68 ^b	0.41 ^f	0.62 ^c	0.49 ^e	0.51 ^c	0.56 ^{ef}	0.66 ^c	0.56 ^{e-f}	0.59 ^c
	M ₃	0.71 ^b	0.71 ^b	0.64 ^d	0.69 ^b	0.49 ^e	0.68 ^b	0.58 ^d	0.58 ^b	0.60 ^e	0.69 ^b	0.61 ^{de}	0.63 ^b
	M ₄	0.75 ^a	0.75 ^a	0.65 ^{cd}	0.72 ^a	0.58 ^d	0.85 ^a	0.63 ^c	0.69 ^a	0.66 ^c	0.80 ^a	0.64 ^c	0.70 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.011				0.011				0.011			
Seed (S)		0.006				0.003				0.004			
Micro (M)		0.006				0.008				0.006			
V x S		0.010				0.005				0.006			
V x M		0.011				0.014				0.010			
S x M		0.011				0.014				0.010			
V x S x M		0.019				0.024				0.017			

Varieties : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient : M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

APPENDIX – I (contd...)

Effect of genotypes, seed rates and micro nutrients on phosphorus content (%) in rice straw under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled					
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M		
S ₁	M ₁	0.07 ^{d-g}	0.10 ^{a-d}	0.04 ^g	0.07 ^c	0.05 ^f	0.10 ^{b-e}	0.07 ^{d-f}	0.07 ^c	0.06 ^f	0.10 ^{b-d}	0.06 ^f	0.07 ^d		
	M ₂	0.08 ^{c-f}	0.10 ^{a-d}	0.05 ^{fg}	0.08 ^{bc}	0.05 ^f	0.14 ^{ab}	0.08 ^{c-f}	0.09 ^{a-c}	0.06 ^f	0.12 ^{ab}	0.07 ^{ef}	0.08 ^{cd}		
	M ₃	0.08 ^{c-f}	0.10 ^{a-d}	0.05 ^{e-g}	0.08 ^{bc}	0.06 ^{ef}	0.15 ^a	0.08 ^{c-f}	0.10 ^{ab}	0.07 ^{ef}	0.12 ^{ab}	0.07 ^{ef}	0.09 ^{bc}		
	M ₄	0.08 ^{c-f}	0.11 ^{a-c}	0.06 ^{d-g}	0.08 ^{bc}	0.07 ^{d-f}	0.15 ^a	0.09 ^{c-f}	0.10 ^{ab}	0.08 ^{d-f}	0.13 ^{a-c}	0.07 ^{ef}	0.09 ^{bc}		
S ₂	M ₁	0.09 ^{b-e}	0.13 ^a	0.07 ^{d-g}	0.10 ^a	0.05 ^f	0.10 ^{b-e}	0.07 ^{d-f}	0.07 ^c	0.07 ^{ef}	0.11 ^{ab}	0.07 ^{ef}	0.08 ^{cd}		
	M ₂	0.09 ^{b-e}	0.13 ^a	0.07 ^{e-g}	0.10 ^a	0.05 ^f	0.11 ^{a-d}	0.07 ^{d-f}	0.08 ^{bc}	0.07 ^{ef}	0.12 ^{ab}	0.07 ^{d-f}	0.09 ^{bc}		
	M ₃	0.09 ^{b-e}	0.11 ^{a-c}	0.06 ^{d-g}	0.09 ^a	0.05 ^f	0.11 ^{a-d}	0.09 ^{c-f}	0.08 ^{bc}	0.07 ^{d-f}	0.12 ^{ab}	0.08 ^{c-e}	0.09 ^{bc}		
	M ₄	0.10 ^{b-e}	0.13 ^a	0.07 ^{e-g}	0.10 ^{ab}	0.06 ^{ef}	0.12 ^{a-c}	0.10 ^{b-e}	0.09 ^{a-c}	0.08 ^{ef}	0.12 ^{ab}	0.09 ^{ef}	0.10 ^{ab}		
S ₃	M ₁	0.09 ^{b-e}	0.11 ^{a-c}	0.06 ^{e-g}	0.09 ^{ab}	0.05 ^f	0.08 ^{c-f}	0.08 ^{c-f}	0.07 ^c	0.07 ^{ef}	0.09 ^{a-c}	0.07 ^{d-f}	0.08 ^{cd}		
	M ₂	0.09 ^{b-e}	0.11 ^{a-c}	0.06 ^{e-g}	0.09 ^{ab}	0.05 ^f	0.11 ^{a-d}	0.09 ^{c-f}	0.08 ^{bc}	0.07 ^{ef}	0.11 ^{a-c}	0.08 ^{d-f}	0.09 ^{bc}		
	M ₃	0.09 ^{b-e}	0.11 ^{a-c}	0.06 ^{e-g}	0.09 ^{ab}	0.05 ^f	0.11 ^{a-d}	0.10 ^{b-e}	0.09 ^{a-c}	0.07 ^{ef}	0.11 ^{a-c}	0.08 ^{d-f}	0.09 ^{bc}		
	M ₄	0.09 ^{b-e}	0.12 ^{ab}	0.07 ^{d-g}	0.09 ^{ab}	0.12 ^{abc}	0.14 ^{ab}	0.08 ^{c-f}	0.11 ^a	0.11 ^{a-c}	0.13 ^a	0.08 ^{d-f}	0.11 ^a		
Variety		0.09 ^b	0.11 ^a	0.06 ^c		0.06 ^c	0.12 ^a	0.08 ^b		0.07 ^b	0.12 ^a	0.07 ^b			
	Variety x Seed rate				S	Variety x Seed rate				S	Variety x Seed rate				S
S	S ₁	0.08 ^{cd}	0.10 ^c	0.05 ^f	0.08 ^c	0.06 ^e	0.14 ^a	0.08 ^c	0.09 ^a	0.07 ^b	0.12 ^a	0.07 ^b	0.09 ^a		
	S ₂	0.09 ^c	0.13 ^b	0.07 ^{de}	0.10 ^b	0.05 ^d	0.11 ^b	0.08 ^c	0.08 ^a	0.07 ^b	0.12 ^a	0.08 ^b	0.09 ^a		
	S ₃	0.09 ^c	0.11 ^a	0.06 ^{ef}	0.09 ^a	0.07 ^{cd}	0.11 ^b	0.09 ^{bc}	0.09 ^a	0.08 ^b	0.11 ^{ab}	0.08 ^b	0.09 ^a		
	Variety x Micro				M	Variety x Micro				M	Variety x Micro				M
M	M ₁	0.08 ^d	0.11 ^a	0.06 ^c	0.08 ^a	0.05 ^d	0.09 ^b	0.07 ^{b-d}	0.07 ^c	0.07 ^{de}	0.10 ^b	0.06 ^e	0.08 ^c		
	M ₂	0.09 ^b	0.11 ^a	0.06 ^c	0.09 ^a	0.05 ^d	0.12 ^a	0.08 ^{bc}	0.08 ^{bc}	0.07 ^{de}	0.12 ^a	0.07 ^{de}	0.09 ^b		
	M ₃	0.09 ^b	0.11 ^a	0.06 ^c	0.09 ^a	0.06 ^{cd}	0.12 ^a	0.09 ^b	0.09 ^{ab}	0.07 ^{de}	0.12 ^a	0.08 ^{cd}	0.09 ^b		
	M ₄	0.09 ^b	0.12 ^a	0.07 ^c	0.09 ^a	0.08 ^{bc}	0.14 ^a	0.09 ^b	0.10 ^a	0.09 ^{bc}	0.13 ^a	0.08 ^{cd}	0.10 ^a		
Comparison		S.Em±				S.Em±				S.Em±					
Variety (V)		0.001				0.005				0.003					
Seed (S)		0.001				0.004				0.002					
Micro (M)		0.001				0.005				0.002					
V x S		0.002				0.007				0.004					
V x M		0.002				0.008				0.004					
S x M		0.002				0.008				0.004					
V x S x M		0.003				0.014				0.007					

Varieties : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204
 Seed Rate : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
 Micronutrient : M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)
 M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)
 M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

APPENDIX – I (contd...)

Effect of genotypes, seed rates and micro nutrients on potassium content (%) in rice straw direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	1.25 ^{f-j}	1.37 ^{b-f}	1.02 ⁿ	1.21 ^{d-e}	1.12 ^q	1.17 ^p	1.14 ^{pq}	1.14 ^f	1.19 ^{hi}	1.27 ^{f-h}	1.08 ^j	1.18 ^e
	M ₂	1.31 ^{c-h}	1.36 ^{b-g}	1.01 ⁿ	1.23 ^{b-e}	1.17 ^p	1.39 ^j	1.34 ^{lm}	1.30 ^e	1.24 ^{g-i}	1.38 ^{b-e}	1.17 ⁱ	1.26 ^d
	M ₃	1.28 ^{d-i}	1.35 ^{c-h}	1.05 ^{mn}	1.23 ^{b-e}	1.32 ^m	1.46 ^{gh}	1.34 ^{lm}	1.37 ^d	1.30 ^{d-g}	1.40 ^{a-c}	1.19 ^{hi}	1.30 ^d
	M ₄	1.19 ^{i-l}	1.32 ^{a-c}	1.14 ^{j-m}	1.22 ^{c-e}	1.36 ^{j-l}	1.61 ^c	1.69 ^b	1.55 ^b	1.28 ^{f-h}	1.47 ^{ab}	1.41 ^{a-l}	1.39 ^{bc}
S ₂	M ₁	1.02 ⁿ	1.42 ^a	1.42 ^{a-c}	1.29 ^{ab}	1.36 ^{j-l}	1.25 ⁿ	1.17 ^p	1.26 ^e	1.19 ^{h-i}	1.34 ^{c-f}	1.29 ^{e-g}	1.27 ^d
	M ₂	1.01 ⁿ	1.48 ^{g-j}	1.45 ⁿ	1.31 ^a	1.52 ^e	1.35 ^{k-m}	1.47 ^{f-h}	1.45 ^c	1.26 ^{fi}	1.42 ^{a-c}	1.46 ^{ab}	1.38 ^{bc}
	M ₃	1.09 ^{l-n}	1.24 ^{e-j}	1.35 ^{b-g}	1.23 ^{b-e}	1.68 ^b	1.57 ^d	1.50 ^{ef}	1.58 ^b	1.39 ^{b-d}	1.40 ^{a-c}	1.42 ^{a-c}	1.40 ^{bc}
	M ₄	1.09 ^{l-n}	1.26 ^{f-j}	1.46 ^{ab}	1.27 ^{a-d}	1.84 ^a	1.66 ^b	1.56 ^d	1.69 ^a	1.46 ^{ab}	1.46 ^{ab}	1.49 ^a	1.47 ^a
S ₃	M ₁	1.22 ^{h-k}	1.25 ^{e-i}	1.26 ^{e-i}	1.24 ^{b-e}	1.32 ^m	1.21 ^o	1.34 ^{lm}	1.29 ^e	1.27 ^{f-i}	1.23 ^{g-i}	1.30 ^{d-g}	1.27 ^d
	M ₂	1.11 ^{k-n}	1.26 ^{d-i}	1.21 ^{h-k}	1.19 ^e	1.33 ^{lm}	1.44 ^{hi}	1.38 ^{jk}	1.38 ^d	1.22 ^{g-i}	1.35 ^{c-f}	1.29 ^{e-i}	1.29 ^d
	M ₃	1.23 ^{h-j}	1.28 ^{a-d}	1.26 ^{e-i}	1.26 ^{a-d}	1.47 ^{f-h}	1.49 ^{e-g}	1.42 ^j	1.46 ^c	1.35 ^{c-f}	1.39 ^{b-d}	1.34 ^{c-f}	1.36 ^c
	M ₄	1.23 ^{a-e}	1.39 ^{a-d}	1.21 ^{h-k}	1.28 ^{a-c}	1.68 ^b	1.55 ^d	1.49 ^{e-g}	1.57 ^b	1.45 ^{ab}	1.47 ^{ab}	1.3 ^{c-f}	1.42 ^b
Variety		1.17 ^c	1.33 ^a	1.24 ^b		1.43 ^a	1.43 ^a	1.40 ^a		1.30 ^c	1.38 ^a	1.32 ^b	
Variety x Seed rate		S				S				S			
S	S ₁	1.26 ^{cd}	1.35 ^b	1.05 ^f	1.22 ^b	1.24 ^d	1.41 ^{bc}	1.38 ^c	1.34 ^c	1.25 ^f	1.38 ^{ac}	1.21 ^g	1.28 ^c
	S ₂	1.05 ^f	1.35 ^b	1.41 ^a	1.27 ^a	1.60 ^a	1.46 ^b	1.42 ^{bc}	1.49 ^a	1.33 ^{de}	1.40 ^{ab}	1.42 ^a	1.38 ^b
	S ₃	1.20 ^e	1.30 ^c	1.23 ^{de}	1.24 ^b	1.45 ^b	1.42 ^{bc}	1.41 ^{bc}	1.43 ^b	1.32 ^e	1.36 ^{cd}	1.32 ^e	1.33 ^a
Variety x Micro		M				M				M			
M	M ₁	1.16 ^{fg}	1.35 ^a	1.23 ^{de}	1.25 ^a	1.26 ^e	1.21 ^e	1.22 ^e	1.23 ^d	1.21 ^g	1.28 ^{ef}	1.22 ^{gf}	1.24 ^d
	M ₂	1.14 ^g	1.37 ^a	1.22 ^{d-f}	1.24 ^a	1.34 ^d	1.39 ^{cd}	1.39 ^{cd}	1.37 ^c	1.24 ^{fg}	1.38 ^{bc}	1.31 ^{de}	1.31 ^c
	M ₃	1.20 ^{d-g}	1.29 ^{bc}	1.22 ^{d-f}	1.24 ^a	1.49 ^b	1.51 ^b	1.42 ^c	1.47 ^b	1.35 ^{cd}	1.40 ^b	1.32 ^{de}	1.36 ^b
	M ₄	1.17 ^{e-g}	1.32 ^{ab}	1.26 ^{cd}	1.25 ^a	1.63 ^a	1.61 ^a	1.58 ^a	1.61 ^a	1.40	1.47 ^a	1.42 ^b	1.43 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.01				0.01				0.01			
Seed (S)		0.01				0.01				0.01			
Micro (M)		0.01				0.01				0.01			
V x S		0.01				0.02				0.02			
V x M		0.02				0.02				0.02			
S x M		0.02				0.02				0.03			
V x S x M		0.04				0.03				0.027			

Varieties : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204
Seed Rate : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
Micronutrient : M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)
M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)
M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

APPENDIX – I (contd...)

Effect of genotypes, seed rates and micro nutrients on iron content (mg kg⁻¹) in straw under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	184.7 ^{e-k}	218.5 ^{c-e}	89.4 ^o	164.2 ^{ef}	149.1 ^{c-f}	142.8 ^{d-g}	51.4 ^h	114.4 ^c	166.9 ^{f-k}	180.7 ^{d-j}	70.4 ⁿ	139.3 ^e
	M ₂	188.5 ^{d-j}	220.0 ^{cd}	116.0 ^{no}	174.8 ^e	153.2 ^{c-e}	148.8 ^{c-f}	70.4 ^{gh}	124.1 ^c	170.9 ^{f-k}	184.4 ^{d-j}	93.2 ^{mn}	149.5 ^{de}
	M ₃	194.6 ^{d-i}	2223.3 ^{cd}	133.7 ^{mn}	850.5 ^a	149.1 ^{c-f}	153.3 ^{c-e}	86.8 ^{e-h}	129.7 ^c	171.8 ^{f-k}	188.3 ^{c-i}	110.2 ^{l-n}	156.8 ^{c-e}
	M ₄	194.7 ^{d-i}	132.5 ^{mn}	135.6 ^{mn}	154.3 ^f	150.0 ^{c-f}	236.8 ^b	122.2 ^{d-h}	169.7 ^b	172.4 ^{f-k}	234.7 ^{bc}	128.9 ^{k-m}	178.7 ^{bc}
S ₂	M ₁	195.0 ^{d-i}	240.0 ^{bc}	143.6 ^{l-n}	192.9 ^d	157.4 ^{c-e}	131.6 ^{d-g}	75.3 ^{f-i}	121.4 ^c	176.2 ^{e-k}	185.8 ^{d-j}	109.5 ^{l-n}	157.2 ^{c-e}
	M ₂	196.3 ^{d-i}	252.5 ^b	155.1 ^{k-m}	201.3 ^{cd}	159.2 ^{c-e}	135.6 ^{d-g}	118.4 ^{d-h}	137.7 ^{bc}	178.0 ^{d-k}	194.1 ^{c-h}	136.7 ^{j-m}	169.6 ^{b-d}
	M ₃	200.0 ^{d-h}	289.6 ^a	157.7 ^{j-m}	215.8 ^{bc}	149.4 ^{c-f}	218.2 ^{bc}	143.1 ^{d-g}	170.2 ^b	174.7 ^{e-k}	253.9 ^b	150.4 ^{h-l}	193.0 ^{a-b}
	M ₄	203.7 ^{d-g}	290.7 ^a	160.0 ^{j-m}	218.1 ^{bc}	120.8 ^{d-h}	326.8 ^a	180.2 ^{b-d}	209.3 ^a	162.3 ^{f-k}	308.6 ^a	170.1 ^{f-k}	213.7 ^a
S ₃	M ₁	204.8 ^{d-f}	301.1 ^a	164.9 ^{i-m}	223.6 ^b	133.7 ^{d-g}	104.1 ^{d-h}	116.6 ^{d-h}	118.1 ^c	169.2 ^{f-k}	202.6 ^{c-g}	140.8 ^{i-l}	170.9 ^{b-d}
	M ₂	207.5 ^{d-f}	310.7 ^a	169.5 ^{h-l}	229.2 ^b	139.5 ^{d-g}	111.8 ^{d-h}	123.9 ^{d-h}	125.1 ^c	173.5 ^{e-k}	211.3 ^{b-f}	146.7 ^{h-l}	177.2 ^{bc}
	M ₃	211.4 ^{c-f}	310.0 ^a	171.0 ^{g-l}	230.8 ^b	119.1 ^{d-h}	135.7 ^{d-g}	133.7 ^{d-g}	129.5 ^c	165.2 ^{f-k}	222.8 ^{b-e}	152.3 ^{g-l}	180.1 ^{bc}
	M ₄	212.8 ^{c-f}	290.0 ^a	184.1 ^{f-k}	229.0 ^b	140.8 ^{d-g}	164.3 ^{cd}	133.8 ^{d-g}	146.3 ^{bc}	176.8 ^{e-k}	227.2 ^{b-d}	158.9 ^{g-k}	187.6 ^b
Variety		199.5 ^b	423.2 ^a	148.4 ^c		143.4 ^b	167.5 ^a	113.0 ^b		171.5 ^b	216.2 ^a	130.7 ^c	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	190.6 ^e	223.6 ^c	118.7 ^h	177.6 ^c	150.4 ^c	170.4 ^b	82.7 ^f	134.5 ^b	170.5 ^d	197.0 ^c	100.7 ^f	156.1 ^b
	S ₂	198.7 ^{de}	268.1 ^b	154.1 ^g	207.0 ^b	146.8 ^{cd}	203.1 ^a	129.2 ^e	159.7 ^a	172.8 ^d	235.6 ^a	141.7 ^e	183.4 ^a
	S ₃	209.1 ^d	302.9 ^a	172.4 ^f	228.1 ^a	133.3 ^{de}	129.0 ^e	127.0 ^e	129.8 ^b	171.2 ^d	216.0 ^b	149.7 ^e	179.0 ^a
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M	M ₁	194.8 ^c	253.2 ^b	132.7 ^e	193.6 ^b	146.7 ^{bc}	126.2 ^{cd}	81.1 ^e	118.0 ^c	170.8 ^{cd}	189.7 ^c	106.9 ^g	155.8 ^c
	M ₂	197.5 ^c	261.0 ^{ab}	146.8 ^{de}	201.8 ^{ab}	150.8 ^{bc}	132.1 ^{b-d}	104.2 ^{de}	129.0 ^{bc}	174.2 ^{cd}	196.6 ^c	125.5 ^{fg}	165.4 ^{bc}
	M ₃	202.0 ^c	274.3 ^a	154.1 ^d	210.1 ^a	139.2 ^{b-d}	169.1 ^b	121.2 ^{cd}	143.2 ^b	170.6 ^{cd}	221.7 ^b	137.7 ^{ef}	176.7 ^b
	M ₄	203.7 ^c	271.0 ^a	159.9 ^d	211.5 ^a	137.2 ^{b-d}	242.6 ^a	145.4 ^{b-d}	175.1 ^a	170.5 ^{cd}	256.8 ^a	152.6 ^{de}	193.3 ^a
Comparison		S.E.m±				S.E.m±				S.E.m±			
Variety (V)		2.8				5.6				6.9			
Seed (S)		2.8				2.8				2.8			
Micro (M)		4.8				7.4				4.9			
V x S		3.3				4.8				4.8			
V x M		5.7				12.7				8.5			
S x M		5.7				12.7				8.5			
V x S x M		10.0				22.1				14.8			

Varieties : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204

Seed Rate : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient : M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

APPENDIX – I (contd...)

Effect of genotypes, seed rates and micro nutrients on Zinc content (mg kg⁻¹) in straw under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	70.8 ^{j-n}	88.2 ^{c-f}	50.3 ^q	69.8 ^h	26.4 ^{e-i}	14.8 ^{k-n}	13.6 ^{mn}	18.3 ^c	48.6 ^{j-o}	51.5 ^{h-n}	32.0 ^q	44.0 ^g
	M ₂	71.9 ^{i-m}	89.8 ^{c-f}	53.7 ^{pq}	71.8 ^{gh}	33.5 ^{a-f}	32.0 ^{a-h}	14.4 ^{l-n}	26.6 ^b	52.7 ^{h-m}	60.9 ^{fg}	34.0 ^{pq}	49.2 ^f
	M ₃	76.5 ^{g-k}	90.7 ^{c-f}	56.3 ^{opq}	74.5 ^{f-h}	35.5 ^{a-d}	36.2 ^{a-d}	15.9 ^{j-m}	29.2 ^b	51.5 ^{h-n}	63.5 ^{d-f}	36.1 ^{pq}	50.4 ^{ef}
	M ₄	77.3 ^{g-j}	92.1 ^{b-e}	57.2 ^{opq}	75.5 ^{e-g}	37.6 ^{a-c}	32.1 ^{a-h}	31.6 ^{a-h}	33.8 ^a	57.4 ^{f-i}	62.1 ^{g-j}	44.4 ^{no}	54.6 ^{cd}
S ₂	M ₁	84.0 ^{e-h}	101.8 ^b	65.6 ^{l-o}	83.8 ^{bc}	21.9 ^{i-c}	7.7 ⁿ	26.3 ^{e-i}	18.6 ^c	53.0 ^{h-l}	54.8 ^{g-j}	46.0 ^{l-o}	51.3 ^{d-f}
	M ₂	84.9 ^{d-h}	117.3 ^a	66.5 ^{k-o}	89.6 ^a	22.5 ^{i-k}	26.3 ^{e-i}	28.0 ^{d-i}	25.6 ^b	53.7 ^{h-k}	71.8 ^{bc}	47.2 ^{k-o}	57.6 ^{bc}
	M ₃	75.1 ^{h-l}	118.7 ^a	67.5 ^{j-n}	87.1 ^{ab}	24.9 ^{f-i}	31.7 ^{a-h}	32.0 ^{a-h}	29.5 ^b	50.0 ^{j-n}	75.2 ^{ab}	49.7 ^{j-n}	58.3 ^{bc}
	M ₄	86.5 ^{d-g}	120.0 ^a	70.6 ^{j-n}	92.4 ^a	38.2 ^{ab}	37.5 ^{a-c}	37.0 ^{a-c}	37.6 ^a	62.3 ^{ef}	78.8 ^a	53.8 ^{h-k}	65.0 ^a
S ₃	M ₁	77.5 ^{g-j}	92.8 ^{b-d}	60.8 ^{n-p}	77.0 ^{e-g}	24.0 ^{g-i}	32.3 ^{a-g}	23.4 ^{h-j}	26.6 ^b	50.7 ⁱ⁻ⁿ	62.6 ^{ef}	42.1 ^{op}	51.8 ^{d-f}
	M ₂	77.8 ^{g-j}	94.3 ^{bc}	61.6 ^{m-p}	77.9 ^{d-f}	25.2 ^{f-i}	33.0 ^{a-f}	29.4 ^{c-i}	29.2 ^b	51.5 ^{h-n}	63.7 ^{d-f}	45.5 ^{m-o}	53.6 ^{de}
	M ₃	81.6 ^{f-i}	97.8 ^b	62.1 ^{m-p}	80.5 ^{c-e}	34.5 ^{a-e}	38.2 ^{ab}	29.8 ^{b-i}	34.2 ^a	58.1 ^{f-h}	68.0 ^{c-e}	46.0 ^{l-o}	57.4 ^{bc}
	M ₄	82.0 ^{e-i}	101.4 ^b	65.0 ^{l-o}	82.8 ^{b-d}	34.6 ^{a-e}	38.8 ^a	29.9 ^{b-i}	34.4 ^a	58.3 ^{f-h}	70.1 ^{b-d}	47.4 ^{k-o}	58.6 ^b
Variety		78.8 ^b	100.4 ^a	61.4 ^c		29.9 ^a	30.1 ^a	25.9 ^b		54.0 ^b	65.3 ^a	43.7 ^c	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	74.1 ^e	90.2 ^c	54.3 ^h	72.9 ^c	33.3 ^{ab}	28.8 ^{c-e}	18.9 ^f	27.0 ^b	53.7 ^d	59.5 ^c	36.6 ^g	49.9 ^c
	S ₂	82.6 ^d	114.5 ^a	67.5 ^f	88.2 ^a	26.8 ^{de}	25.8 ^c	30.8 ^{bc}	27.8 ^b	54.7 ^d	70.1 ^a	49.2 ^e	58.0 ^a
	S ₃	79.7 ^d	96.6 ^b	62.4 ^g	79.6 ^b	29.6 ^{cd}	35.6 ^a	28.1 ^{c-e}	31.1 ^a	54.6 ^d	66.1 ^b	45.2 ^f	55.3 ^b
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M	M ₁	77.4 ^c	94.3 ^b	58.9 ^d	76.9 ^c	24.1 ^{ef}	18.3 ^g	21.1 ^{fg}	21.2 ^d	50.8 ^{fg}	56.3 ^{cd}	40.0 ⁱ	49.0 ^d
	M ₂	78.2 ^c	100.5 ^a	60.6 ^d	79.8 ^{bc}	27.1 ^{de}	30.4 ^{cd}	23.9 ^{ef}	27.1 ^c	52.6 ^{ef}	65.4 ^b	42.3 ^{hi}	53.4 ^c
	M ₃	77.8 ^c	102.4 ^a	61.9 ^d	80.7 ^{ab}	31.6 ^{bc}	35.4 ^{ab}	25.9 ^e	31.0 ^b	54.7 ^{de}	68.9 ^{ab}	43.9 ^h	55.8 ^b
	M ₄	81.9 ^c	104.5 ^a	64.2 ^d	83.5 ^a	36.8 ^a	36.1 ^{ab}	32.8 ^{a-c}	35.2 ^a	59.3 ^c	70.3 ^a	48.5 ^g	59.4 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.3				0.6				0.3			
Seed (S)		0.8				0.6				0.3			
Micro (M)		1.0				0.8				0.7			
V x S		1.4				1.0				0.6			
V x M		1.8				1.5				1.2			
S x M		1.8				1.5				1.2			
V x S x M		3.1				2.5				2.1			

Varieties : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204
Seed Rate : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
Micronutrient : M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)
M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)
M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

APPENDIX – I (contd...)

Effect of genotypes, seed rates and micro nutrients on copper content (mg kg⁻¹) in straw under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	2.34 ^{b-k}	2.95 ^{de}	1.87 ⁿ	2.39 ^c	1.89 ^{j-n}	2.84 ^{d-h}	1.27 ^o	2.00 ^e	2.12 ^{i-l}	2.89 ^{ef}	1.57 ^o	2.19 ^g
	M ₂	2.34 ^{b-k}	2.95 ^{de}	1.96 ^{mn}	2.42 ^{bc}	2.46 ^{g-k}	3.36 ^{a-d}	1.37 ^o	2.40 ^d	2.40 ^{g-k}	3.16 ^{de}	1.66 ^{no}	2.41 ^f
	M ₃	2.36 ^{g-k}	2.95 ^{de}	1.96 ^{mn}	2.42 ^{bc}	2.69 ^{e-j}	3.37 ^{a-d}	1.62 ^{no}	2.56 ^{cd}	2.53 ^{f-i}	3.16 ^{de}	1.79 ^{no}	2.49 ^{ef}
	M ₄	2.36 ^{g-k}	3.04 ^{cd}	1.98 ⁱ⁻ⁿ	2.46 ^{bc}	3.00 ^{b-f}	3.48 ^{ab}	1.76 ⁿ	2.75 ^{bc}	2.68 ^{h-j}	3.26 ^{cd}	1.87 ^{no}	2.60 ^{de}
S ₂	M ₁	2.64 ^{e-i}	4.20 ^b	2.29 ^{j-m}	3.04 ^a	2.24 ^{i-m}	2.44 ^h	2.44 ^{h-k}	2.37 ^d	2.44 ^{g-k}	3.32 ^{cd}	2.26 ^{k-m}	2.67 ^d
	M ₂	2.67 ^{e-h}	4.60 ^a	2.29 ^{j-m}	3.19 ^a	2.44 ^{h-k}	3.09 ^{a-e}	2.43 ^{h-k}	2.65 ^{cd}	2.55 ^{f-j}	3.84 ^{ab}	2.36 ^{g-k}	2.92 ^{bc}
	M ₃	2.69 ^{e-g}	4.60 ^a	2.29 ^{j-m}	3.19 ^a	2.56 ^{f-k}	3.16 ^{a-e}	2.75 ^{e-i}	2.82 ^{bc}	2.62 ^{f-g}	3.88 ^{ab}	2.52 ^{f-j}	3.01 ^{ab}
	M ₄	2.75 ^{d-f}	4.60 ^a	2.32 ^{i-l}	3.22 ^a	2.95 ^{b-h}	3.39 ^{a-c}	2.98 ^{b-g}	3.11 ^a	2.85 ^{k-m}	4.00 ^a	2.65 ^{mn}	3.17 ^a
S ₃	M ₁	2.47 ^{f-i}	3.30 ^c	2.01 ^{k-n}	2.59 ^b	2.04 ^{k-n}	2.08 ^{k-n}	2.04 ^{k-n}	2.05 ^e	2.26 ^{j-k}	2.69 ^{f-i}	2.02 ^{lm}	2.32 ^{fg}
	M ₂	2.67 ^{e-h}	4.60 ^a	2.29 ^{j-m}	3.19 ^a	2.11 ^{k-n}	2.98 ^{b-g}	2.30 ^{i-l}	2.46 ^d	2.33 ^{j-m}	3.29 ^{cd}	2.18 ^{i-l}	2.60 ^{de}
	M ₃	2.69 ^{e-g}	4.60 ^a	2.29 ^{j-m}	3.19 ^a	2.21 ^{j-m}	3.28 ^{a-d}	2.46 ^{g-k}	2.65 ^{cd}	2.42 ^{i-l}	3.54 ^{bc}	2.35 ^{i-l}	2.77 ^{cd}
	M ₄	2.75 ^{d-f}	4.60 ^a	2.32 ^{i-l}	3.22 ^a	2.91 ^{c-h}	3.57 ^a	2.53 ^{f-k}	3.00 ^{ab}	2.77 ^{f-h}	3.80 ^{ab}	2.41 ^{i-l}	2.99 ^b
Variety		2.56 ^b	3.92 ^a	2.16 ^c		2.46 ^b	3.09 ^a	2.16 ^c		2.50 ^b	3.40 ^a	2.14 ^c	
Variety x Seed rate		S				S				S			
S	S ₁	2.35 ^e	2.97 ^c	1.94 ^g	2.42 ^c	2.51 ^c	3.26 ^a	1.51 ^d	2.43 ^b	2.43 ^e	3.12 ^c	1.72 ^g	2.42 ^c
	S ₂	2.69 ^d	4.50 ^a	2.30 ^e	3.16 ^a	2.54 ^c	3.02 ^b	2.60 ^c	2.72 ^a	2.62 ^d	3.76 ^a	2.45 ^e	2.94 ^a
	S ₃	2.57 ^d	3.69 ^b	2.15 ^f	2.80 ^b	2.32 ^c	2.98 ^b	2.33 ^c	2.54 ^b	2.44 ^e	3.33 ^b	2.24 ^f	2.67 ^b
Variety x Micro		M				M				M			
M	M ₁	2.48 ^c	3.48 ^b	2.06 ^d	2.67 ^c	2.06 ^{de}	2.45 ^c	1.85 ^c	2.12 ^d	2.27 ^{fg}	2.97 ^c	1.95 ⁱ	2.40 ^d
	M ₂	2.52 ^c	3.71 ^a	2.10 ^d	2.78 ^b	2.34 ^c	3.15 ^b	2.03 ^{de}	2.51 ^c	2.43 ^{ef}	3.43 ^b	2.07 ^{hi}	2.64 ^c
	M ₃	2.56 ^c	3.79 ^a	2.16 ^d	2.84 ^{ab}	2.48 ^c	3.27 ^b	2.28 ^{cd}	2.68 ^b	2.52 ^e	3.53 ^{ab}	2.22 ^{gh}	2.76 ^b
	M ₄	2.58 ^c	3.89 ^a	2.20 ^d	2.89 ^a	2.95 ^b	3.48 ^a	2.42 ^c	2.95 ^a	2.77 ^d	3.69 ^a	2.31 ^{fg}	2.92 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		0.03				0.05				0.01			
Seed (S)		0.03				0.04				0.03			
Micro (M)		0.03				0.05				0.03			
V x S		0.05				0.07				0.05			
V x M		0.06				0.09				0.06			
S x M		0.06				0.09				0.06			
V x S x M		0.10				0.16				0.10			

Varieties : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204
 Seed Rate : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
 Micronutrient : M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)
 M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)
 M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

APPENDIX – I (contd...)

Effect of genotypes, seed rates and micro nutrients on manganese content (mg kg⁻¹) in straw under direct seeded condition during rainy season

V x S x M		2014-15				2015-16				Pooled			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	477.5 ^{jk}	666.6 ^{ef}	378.0 ^m	507.4 ^f	313.7 ^j	350.3 ^{fj}	249.2 ^k	304.4 ^f	395.6 ^{lm}	508.4 ^h	313.6 ^o	405.9 ^h
	M ₂	500.6 ^{ij}	697.4 ^{de}	384.2 ^m	527.4 ^{ef}	362.3 ^{fj}	379.1 ^{e-j}	328.9 ^{ij}	356.8 ^{de}	431.5 ^j	538.3 ^f	356.6 ⁿ	442.1 ^g
	M ₃	505.3 ^{ij}	707.0 ^{de}	404.8 ^{lm}	539.0 ^{d-f}	409.9 ^{d-g}	403.1 ^{d-h}	334.0 ^{h-j}	382.3 ^{b-e}	457.6 ⁱ	555.0 ^{ef}	369.4 ⁿ	460.7 ^{fg}
	M ₄	509.5 ^{ij}	718.8 ^{de}	405.7 ^{lm}	544.7 ^{d-e}	421.6 ^{c-f}	413.9 ^{d-g}	341.3 ^{g-j}	392.3 ^{b-d}	465.6 ⁱ	566.3 ^{de}	373.5 ^{mn}	468.5 ^{ef}
S ₂	M ₁	560.9 ^{hi}	733.1 ^{cd}	413.8 ^{k-m}	569.3 ^d	331.7 ^{h-j}	473.8 ^{a-d}	321.2 ^{i-j}	375.6 ^{c-e}	446.3 ^{ij}	603.5 ^c	367.5 ⁿ	472.4 ^{ef}
	M ₂	576.1 ^{gh}	782.4 ^{bc}	449.0 ^{j-l}	602.5 ^c	347.7 ^{g-j}	505.8 ^{ab}	345.5 ^{g-j}	399.7 ^{bc}	461.9 ⁱ	644.1 ^b	397.2 ^{lm}	501.1 ^{cd}
	M ₃	636.6 ^{fg}	872.5 ^a	472.4 ^{jk}	660.5 ^a	390.7 ^{e-i}	516.7 ^a	346.6 ^{g-j}	418.0 ^{ab}	497.8 ^h	652.1 ^b	402.9 ^{kl}	517.6 ^{b-d}
	M ₄	605.9 ^{f-h}	789.7 ^{bc}	462.7 ^{j-l}	619.4 ^{bc}	466.6 ^{a-d}	529.5 ^a	343.7 ^{g-j}	446.6 ^a	536.2 ^{fg}	659.6 ^{ab}	403.2 ^{kl}	533.0 ^{ab}
S ₃	M ₁	612.8 ^{f-h}	816.3 ^{ab}	464.5 ^{j-l}	631.2 ^{a-c}	369.3 ^{e-j}	358.2 ^{f-j}	331.3 ^{h-j}	352.9 ^e	491.1 ^h	587.2 ^{cd}	397.9 ^{lm}	492.1 ^{de}
	M ₂	614.6 ^{f-h}	837.1 ^{ab}	471.8 ^{jk}	641.2 ^{ab}	410.6 ^{d-g}	435.2 ^{c-e}	370.7 ^{e-j}	405.5 ^{bc}	512.6 ^{gh}	636.2 ^b	421.2 ^{j-l}	523.3 ^{bc}
	M ₃	636.6 ^{fg}	872.5 ^a	472.4 ^{jk}	660.5 ^a	441.7 ^{b-e}	440.7 ^{b-e}	383.1 ^{e-j}	421.8 ^{ab}	539.2 ^{ef}	656.6 ^{ad}	427.7 ^{jk}	541.2 ^{ab}
	M ₄	638.2 ^{fg}	873.0 ^a	474.4 ^{jk}	661.9 ^a	470.7 ^{a-d}	485.5 ^{a-c}	383.1 ^{e-j}	446.4 ^a	554.4 ^f	679.3 ^a	428.7 ^{jk}	554.1 ^a
Variety		572.9 ^b	780.5 ^a	437.8 ^c		394.7	441.0 ^a	339.9 ^c		482.5 ^b	607.2 ^a	388.3 ^c	
	Variety x Seed rate				S	Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	498.3 ^f	697.4 ^c	393.2 ⁱ	529.6 ^c	376.9 ^c	386.6 ^c	313.4 ^d	359.0 ^b	437.6 ^e	542.0 ^b	353.3 ^h	444.3 ^c
	S ₂	586.9 ^e	773.2 ^b	446.2 ^g	602.1 ^b	384.2 ^c	506.4 ^a	339.2 ^d	409.9 ^a	485.5 ^d	639.8 ^a	392.7 ^g	506.0 ^b
	S ₃	625.5 ^d	849.7 ^a	470.8 ^h	648.7 ^a	423.1 ^b	429.9 ^b	367.0 ^c	406.7 ^a	524.3 ^c	639.8 ^a	418.9 ^f	527.7 ^a
	Variety x Micro				M	Variety x Micro			M	Variety x Micro			M
M	M ₁	550.4 ^c	738.7 ^b	418.8 ^d	569.3 ^b	338.2 ^e	394.1 ^{cd}	300.5 ^f	344.3 ^c	444.3 ^f	566.4 ^c	359.7 ^h	456.8 ^c
	M ₂	563.8 ^c	772.3 ^a	435.0 ^d	590.4 ^a	373.5 ^{de}	440.1 ^{ab}	348.4 ^e	387.3 ^b	468.6 ^e	606.2 ^b	391.7 ^g	488.8 ^b
	M ₃	582.3 ^c	789.0 ^a	445.4 ^d	605.6 ^a	414.1 ^{bc}	453.5 ^a	354.6 ^e	407.4 ^b	498.2 ^d	621.3 ^{ab}	400.0 ^g	506.5 ^a
	M ₄	584.5 ^c	793.8 ^a	447.6 ^d	608.6 ^a	453.0 ^a	476.3 ^a	356.0 ^e	428.4 ^a	518.7 ^d	635.1 ^a	401.8 ^g	518.5 ^a
Comparison		S.Em±				S.Em±				S.Em±			
Variety (V)		7.3				5.6				4.2			
Seed (S)		2.8				5.6				2.4			
Micro (M)		6.5				7.1				4.9			
V x S		4.8				9.6				4.2			
V x M		11.3				12.3				8.4			
S x M		11.3				12.3				8.4			
V x S x M		19.6				21.3				14.6			

Varieties : V₁- GGV 0501, V₂- MTU 1010 (rainy season), V₃- BPT 5204
Seed Rate : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
Micronutrient : M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)
M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)
M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

APPENDIX- I (contd...)

Effect of genotypes, seed rates and micro nutrients on nutrient content of nitrogen, phosphorous and potassium (%) in rice straw under direct seeded condition during summer

V x S x M		Nitrogen				Phosphorus				Potassium					
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M		
S ₁	M ₁	0.66 ^{ab}	0.59 ^{ab}	0.50 ^b	0.58 ^a	0.07 ^b	0.05 ^b	0.03 ^b	0.05 ^c	1.46 ^{ab}	1.36 ^{ab}	1.16 ^b	1.33 ^b		
	M ₂	0.66 ^{ab}	0.60 ^{ab}	0.52 ^{ab}	0.59 ^a	0.07 ^b	0.05 ^b	0.03 ^b	0.05 ^c	1.46 ^{ab}	1.36 ^{ab}	1.22 ^b	1.35 ^b		
	M ₃	0.66 ^{ab}	0.60 ^{ab}	0.53 ^{ab}	0.60 ^a	0.07 ^b	0.05 ^b	0.03 ^b	0.05 ^c	1.49 ^{ab}	1.39 ^{ab}	1.22 ^b	1.37 ^b		
	M ₄	0.68 ^{ab}	0.60 ^{ab}	0.56 ^{ab}	0.61 ^a	0.08 ^b	0.06 ^b	0.04 ^b	0.06 ^{bc}	1.51 ^{ab}	1.40 ^{ab}	1.29 ^{ab}	1.40 ^b		
S ₂	M ₁	0.72 ^{ab}	0.64 ^{ab}	0.56 ^{ab}	0.64 ^a	0.09 ^b	0.07 ^b	0.04 ^b	0.19 ^a	1.56 ^{ab}	1.43 ^{ab}	1.33 ^{ab}	1.44 ^b		
	M ₂	0.73 ^{ab}	0.64 ^{ab}	0.57 ^{ab}	0.65 ^a	0.09 ^b	0.07 ^b	0.04 ^b	0.07 ^{bc}	1.56 ^{ab}	1.44 ^{ab}	1.34 ^{ab}	1.45 ^b		
	M ₃	0.74 ^{ab}	0.65 ^{ab}	0.58 ^{ab}	0.66 ^a	0.10 ^b	0.07 ^b	0.04 ^b	0.07 ^{bc}	1.69 ^a	1.44 ^{ab}	1.35 ^{ab}	1.49 ^b		
	M ₄	0.76 ^a	0.66 ^{ab}	0.59 ^{ab}	0.67 ^a	0.11 ^a	0.07 ^b	0.05 ^b	0.08 ^b	1.72 ^a	1.44 ^{ab}	1.36 ^{ab}	1.51 ^b		
S ₃	M ₁	0.68 ^{ab}	0.61 ^{ab}	0.56 ^{ab}	0.62 ^a	0.08 ^b	0.06 ^b	0.04 ^b	0.06 ^{bc}	1.51 ^{ab}	1.40 ^{ab}	1.31 ^{ab}	1.41 ^b		
	M ₂	0.69 ^{ab}	0.62 ^{ab}	0.56 ^{ab}	0.62 ^a	0.08 ^b	0.06 ^b	0.04 ^b	0.06 ^{bc}	1.53 ^{ab}	1.41 ^{ab}	1.31 ^{ab}	1.42 ^b		
	M ₃	0.69 ^{ab}	0.63 ^{ab}	0.56 ^{ab}	0.63 ^a	0.08 ^b	0.06 ^b	0.04 ^b	0.06 ^{bc}	1.55 ^{abd}	1.42 ^{ab}	1.31 ^{ab}	1.43 ^b		
	M ₄	0.72 ^{ab}	0.64 ^{ab}	0.56 ^{ab}	0.64 ^a	0.09 ^b	0.07 ^b	0.04 ^b	0.07 ^{bc}	1.56 ^{ab}	1.43 ^{ab}	1.32 ^{ab}	1.44 ^b		
Variety		0.70 ^a	0.62 ^{ab}	0.55 ^b		0.08 ^a	0.06 ^a	0.07 ^a		1.55 ^a	1.41 ^b	1.29 ^c			
	Variety x Seed rate				S	Variety x Seed rate				S	Variety x Seed rate				S
S	S ₁	0.67 ^a	0.60 ^a	0.53 ^a	0.57 ^a	0.07 ^{bc}	0.05 ^{de}	0.04 ^e	0.05 ^b	1.48 ^{a-c}	1.38 ^{b-d}	1.22 ^d	1.30 ^a		
	S ₂	0.74 ^a	0.65 ^a	0.58 ^a	0.62 ^a	0.10 ^a	0.07 ^{bc}	0.05 ^{de}	0.06 ^a	1.64 ^a	1.44 ^{bc}	1.35 ^{b-d}	1.40 ^a		
	S ₃	0.69 ^a	0.63 ^a	0.56 ^a	0.60 ^a	0.08 ^b	0.06 ^{cd}	0.04 ^e	0.05 ^b	1.54 ^{ab}	1.42 ^{bc}	1.31 ^{cd}	1.37 ^a		
	Variety x Micro				M	Variety x Micro				M	Variety x Micro				M
M	M ₁	0.69 ^{a-c}	0.62 ^{a-d}	0.54 ^d	0.58 ^a	0.08 ^{ab}	0.06 ^{bc}	0.04 ^c	0.05 ^a	1.51 ^{ab}	1.40 ^{a-c}	1.26 ^c	1.33 ^a		
	M ₂	0.69 ^{a-c}	0.62 ^{a-d}	0.55 ^{cd}	0.59 ^a	0.08 ^{ab}	0.06 ^{bc}	0.04 ^c	0.05 ^a	1.52 ^{ab}	1.40 ^{a-c}	1.26 ^c	1.33 ^a		
	M ₃	0.70 ^{ad}	0.63 ^{a-d}	0.56 ^{b-d}	0.60 ^a	0.09 ^a	0.06 ^{bc}	0.04 ^c	0.05 ^a	1.58 ^a	1.42 ^{a-c}	1.30 ^{bc}	1.36 ^a		
	M ₄	0.72 ^a	0.63 ^{a-d}	0.57 ^{b-d}	0.60 ^a	0.09 ^a	0.06 ^{bc}	0.04 ^c	0.05 ^a	1.59 ^a	1.42 ^{a-c}	1.32 ^{bc}	1.37 ^a		
Comparison		S.Em±				S.Em±				S.Em±					
Variety (V)		0.02				0.006				0.02					
Seed (S)		0.04				0.003				0.03					
Micro (M)		0.02				0.004				0.04					
V x S		0.06				0.005				0.06					
V x M		0.04				0.007				0.07					
S x M		0.04				0.007				0.07					
V x S x M		0.07				0.012				0.13					

Varieties : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient : M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

APPENDIX – I (contd...)

Effect of genotypes, seed rates and micro nutrients on nutrient content of iron and zinc (mg kg⁻¹) in rice straw under direct seeded condition during summer

V x S x M		Iron				Zinc			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	129.8 ^{ab}	110.5 ^b	93.2 ^b	111.2 ^a	28.1 ^{a-g}	24.1 ^{a-g}	19.9 ^g	24.0 ^a
	M ₂	137.6 ^{ab}	114.3 ^b	100.8 ^b	117.6 ^a	28.9 ^{a-f}	24.3 ^{a-g}	21.0 ^{f-g}	24.7 ^a
	M ₃	137.1 ^{ab}	114.2 ^b	98.7 ^b	116.7 ^a	28.9 ^{a-f}	24.5 ^{a-g}	21.4 ^{e-g}	24.9 ^a
	M ₄	138.7 ^{ab}	116.0 ^b	101.0 ^b	118.6 ^a	29.1 ^{a-f}	25.8 ^{a-g}	21.8 ^{d-g}	25.6 ^a
S ₂	M ₁	154.7 ^{ab}	120.8 ^b	109.0 ^b	128.2 ^a	30.9 ^{a-c}	27.3 ^{a-g}	23.3 ^{b-g}	27.2 ^a
	M ₂	157.1 ^{ab}	123.7 ^b	109.8 ^b	130.2 ^a	31.7 ^{ab}	27.5 ^{a-g}	23.4 ^{b-g}	27.5 ^a
	M ₃	156.1 ^{ab}	122.2 ^b	109.1 ^b	129.1 ^a	31.9 ^a	27.5 ^{a-g}	23.6 ^{a-g}	27.7 ^a
	M ₄	151.6 ^{ab}	119.6 ^b	106.4 ^b	125.9 ^a	31.9 ^a	27.6 ^{a-g}	23.9 ^{a-g}	27.8 ^a
S ₃	M ₁	142.6 ^{ab}	116.0 ^b	103.0 ^b	120.5 ^a	29.5 ^{a-e}	26.3 ^{a-g}	22.2 ^{d-g}	26.0 ^a
	M ₂	148.2 ^{ab}	123.7 ^b	109.8 ^b	127.2 ^a	29.9 ^{a-d}	27.0 ^{a-g}	22.5 ^{c-g}	26.5 ^a
	M ₃	156.1 ^{ab}	122.2 ^b	109.1 ^b	132.6 ^a	29.9 ^{a-d}	27.2 ^{a-g}	22.9 ^{c-g}	26.7 ^a
	M ₄	192.8 ^a	124.2 ^b	110.1 ^b	142.4 ^a	30.0 ^{a-d}	27.2 ^{a-g}	23.0 ^{c-g}	26.7 ^a
Variety		150.2 ^a	118.7 ^a	105.0 ^a		30.1 ^a	26.4 ^{ab}	22.4 ^b	
		Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	135.8 ^{a-c}	113.7 ^{cd}	98.4 ^d	106.1 ^a	28.8 ^{a-c}	24.7 ^{b-d}	21.0 ^d	22.9 ^a
	S ₂	165.2 ^a	122.7 ^{b-d}	109.5 ^{cd}	116.1 ^a	31.6 ^a	27.5 ^{a-d}	23.6 ^{b-d}	25.6 ^a
	S ₃	147.4 ^{ab}	117.8 ^{b-d}	104.8 ^{cd}	111.3 ^a	29.8 ^{ab}	26.9 ^{a-d}	22.6 ^{cd}	24.8 ^a
		Variety x Micro			M	Variety x Micro			M
V	M ₁	142.4 ^a	115.8 ^a	101.7 ^a	108.8 ^a	29.5 ^a	25.9 ^{a-d}	21.8 ^d	23.9 ^a
	M ₂	147.6 ^a	119.0 ^a	105.3 ^a	112.2 ^a	30.2 ^a	26.3 ^{a-c}	22.3 ^{cd}	24.3 ^a
	M ₃	146.8 ^a	117.7 ^a	104.2 ^a	111.0 ^a	30.3 ^a	26.4 ^{a-c}	22.6 ^{b-d}	24.5 ^a
	M ₄	161.0 ^a	119.9 ^a	105.8 ^a	112.9 ^a	30.3 ^a	26.9 ^{ab}	22.9 ^{b-d}	24.9 ^a
Comparison		S.E.m±				S.E.m±			
Variety (V)		10.7				8.2			
Seed (S)		5.6				1.6			
Micro (M)		6.4				1.1			
V x S		9.7				0.8			
V x M		11.1				1.9			
S x M		11.1				1.4			
V x S x M		19.2				1.4			

Varieties : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient : M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)
M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹ + foliar @ 0.5% twice at 15 and 30 DAS)
M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

APPENDIX – I (contd...)

Effect of genotypes, seed rates and micro nutrients on nutrient content of copper and manganese (mg kg⁻¹) in rice straw direct seeded condition during summer

V x S x M		Iron				Zinc			
		V ₁	V ₂	V ₃	S x M	V ₁	V ₂	V ₃	S x M
S ₁	M ₁	2.94 ^{a-c}	2.46 ^{a-c}	1.86 ^c	2.42 ^a	398.2 ^{a-c}	360.0 ^{a-c}	292.6 ^c	350.3 ^a
	M ₂	2.96 ^{a-c}	2.47 ^{a-c}	1.97 ^{bc}	2.47 ^a	401.1 ^{a-c}	363.8 ^{a-c}	308.5 ^{bc}	357.8 ^a
	M ₃	2.98 ^{a-c}	2.48 ^{a-c}	2.05 ^{bc}	2.50 ^a	402.4 ^{a-c}	366.5 ^{a-c}	325.3 ^{a-c}	364.7 ^a
	M ₄	2.98 ^{a-c}	2.49 ^{a-c}	2.23 ^{bc}	2.57 ^a	402.6 ^{a-c}	375.8 ^{a-c}	329.0 ^{a-c}	369.1 ^a
S ₂	M ₁	3.11 ^{ab}	2.68 ^{a-c}	2.32 ^{bc}	2.70 ^a	441.5 ^{ab}	393.7 ^{a-c}	341.9 ^{a-c}	392.4 ^a
	M ₂	3.15 ^{ab}	2.75 ^{a-c}	2.42 ^{a-c}	2.77 ^a	442.7 ^{ab}	394.5 ^{a-c}	346.7 ^{a-c}	394.6 ^a
	M ₃	3.57 ^a	2.76 ^{a-c}	2.43 ^{a-c}	2.92 ^a	445.6 ^{ab}	395.1 ^{a-c}	347.9 ^{a-c}	396.2 ^a
	M ₄	3.57 ^a	2.79 ^{a-c}	2.43 ^{a-c}	2.93 ^a	451.6 ^a	397.9 ^{a-c}	354.1 ^{a-c}	401.2 ^a
S ₃	M ₁	3.02 ^{a-c}	2.63 ^{a-c}	2.24 ^{bc}	2.63 ^a	418.5 ^{a-c}	376.7 ^{a-c}	334.6 ^{a-c}	376.6 ^a
	M ₂	3.05 ^{a-c}	2.75 ^{a-c}	2.42 ^{a-c}	2.74 ^a	431.5 ^{a-c}	386.1 ^{a-c}	335.9 ^{a-c}	384.5 ^a
	M ₃	3.08 ^{ab}	2.64 ^{a-c}	2.30 ^{bc}	2.67 ^a	432.1 ^{ab}	387.7 ^{a-c}	347.9 ^{a-c}	389.2 ^a
	M ₄	3.10 ^{ab}	2.67 ^{a-c}	2.31 ^{bc}	2.69 ^a	433.7 ^{a-c}	392.4 ^{a-c}	340.5 ^{a-c}	388.9 ^a
Variety		3.13 ^a	2.63 ^b	2.25 ^c		425.1 ^a	382.5 ^b	333.7 ^c	
		Variety x Seed rate			S	Variety x Seed rate			S
S	S ₁	2.96 ^{a-c}	2.48 ^{d-e}	2.03 ^e	2.26 ^a	401.1 ^{a-c}	366.5 ^{c-e}	313.9 ^{de}	340.2 ^a
	S ₂	3.35 ^a	2.75 ^{b-d}	2.40 ^{c-e}	2.58 ^a	445.4 ^a	395.3 ^{a-d}	347.6 ^{c-e}	371.5 ^a
	S ₃	3.06 ^{ab}	2.65 ^{b-d}	2.28 ^{de}	2.47 ^a	428.9 ^{ab}	385.7 ^{b-e}	336.9 ^e	361.3 ^a
		Variety x Micro			M	Variety x Micro			M
V	M ₁	3.02 ^a	2.59 ^{ab}	2.14 ^b	2.37 ^a	419.4 ^a	376.8 ^{ab}	323.0 ^b	349.9 ^a
	M ₂	3.05 ^a	2.62 ^{ab}	2.22 ^b	2.42 ^a	425.1 ^a	381.5 ^{ab}	330.4 ^b	356.0 ^a
	M ₃	3.21 ^a	2.63 ^{ab}	2.26 ^b	2.45 ^a	426.7 ^a	383.1 ^{ab}	336.5 ^b	359.8 ^a
	M ₄	3.22 ^a	2.65 ^{ab}	2.32 ^d	2.49 ^a	429.3 ^a	388.7 ^{ab}	341.2 ^b	365.0 ^a
Comparison		S.E.m±				S.E.m±			
Variety (V)		0.07				10.3			
Seed (S)		0.10				9.8			
Micro (M)		0.12				13.2			
V x S		0.18				17.0			
V x M		0.20				22.9			
S x M		0.20				22.9			
V x S x M		0.35				39.7			

Varieties : V₁- GGV 0501, V₂- RNR15048 (summer), V₃- BPT 5204

Seed Rate : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹

Micronutrient : M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)

M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹+ foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

APPENDIX – I (contd...)

Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on nitrogen content (%) in rice straw under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	0.67 ^c	0.69 ^{bc}	0.74 ^{ab}	0.70 ^{bc}	0.33 ^a	0.47 ^a	0.53 ^a	0.44 ^c	0.50 ^f	0.58 ^d	0.64 ^{bc}	0.57 ^c
	M ₂	0.67 ^c	0.74 ^{ab}	0.75 ^a	0.72 ^b	0.39 ^a	0.53 ^a	0.55 ^a	0.49 ^b	0.53 ^e	0.63 ^c	0.65 ^{bc}	0.60 ^b
N ₂	M ₁	0.69 ^{bc}	0.69 ^{bc}	0.69 ^c	0.69 ^c	0.44 ^a	0.45 ^a	0.49 ^a	0.46 ^c	0.57 ^d	0.57 ^d	0.59 ^d	0.58 ^c
	M ₂	0.69 ^{bc}	0.77 ^a	0.79 ^a	0.75 ^a	0.46 ^a	0.56 ^a	0.62 ^a	0.54 ^a	0.57 ^d	0.66 ^b	0.70 ^a	0.65 ^a
Target		0.68 ^b	0.72 ^a	0.74 ^a		0.40 ^c	0.50 ^b	0.55 ^a		0.54 ^c	0.61 ^b	0.65 ^a	
Control		0.67				0.33				0.50			
Approach-N-(NE/ST) x Target (T)					N	N x T			N	N x T			N
N ₁		0.67 ^c	0.71 ^{ab}	0.75 ^{ab}	0.71 ^a	0.36 ^d	0.50 ^b	0.54 ^a	0.47 ^a	0.53 ^f	0.58 ^d	0.61 ^c	0.59 ^a
N ₂		0.69 ^{bc}	0.73 ^a	0.74 ^a	0.72 ^a	0.45 ^c	0.50 ^b	0.55 ^c	0.50 ^a	0.55 ^e	0.65 ^b	0.68 ^a	0.61 ^a
Approach-N-(NE/ST) x Target (T)					M	M x T			M	M x T			M
M ₁		0.68 ^d	0.69 ^{cd}	0.72 ^{bc}	0.70 ^a	0.38 ^d	0.46 ^b	0.51 ^a	0.45 ^a	0.51 ^d	0.61 ^b	0.64 ^a	0.57 ^b
M ₂		0.68 ^d	0.75 ^{ab}	0.77 ^a	0.74 ^a	0.42 ^c	0.54 ^a	0.59 ^a	0.52 ^a	0.57 ^c	0.62 ^b	0.65 ^a	0.63 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.03				0.03				0.02			
T		0.04				0.04				0.02			
M		0.03				0.03				0.02			
N x T		0.06				0.06				0.03			
M x T		0.06				0.06				0.03			
N x M		0.05				0.05				0.02			
N x T x M		0.08				0.08				0.04			
Control Vs Rest		0.02		0.05		0.03		0.09		0.008		0.023	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

APPENDIX – I (Contd...)

Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on phosphorus content (%) in rice straw under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	0.07 ^a	0.09 ^a	0.09 ^a	0.09 ^a	0.05 ^a	0.05 ^a	0.06 ^a	0.05 ^a	0.06 ^a	0.07 ^a	0.08 ^a	0.07 ^a
	M ₂	0.08 ^a	0.09 ^a	0.09 ^a	0.09 ^a	0.05 ^a	0.06 ^a	0.07 ^a	0.06 ^a	0.06 ^a	0.08 ^a	0.08 ^a	0.07 ^a
N ₂	M ₁	0.08 ^a	0.09 ^a	0.09 ^a	0.09 ^a	0.05 ^a	0.05 ^a	0.05 ^a	0.05 ^a	0.07 ^a	0.07 ^a	0.07 ^a	0.07 ^a
	M ₂	0.09 ^a	0.10 ^a	0.10 ^a	0.09 ^a	0.05 ^a	0.10 ^a	0.12 ^a	0.09 ^a	0.07 ^a	0.10 ^a	0.11 ^a	0.09 ^a
Target		0.08 ^a	0.09 ^a	0.09 ^a		0.05 ^a	0.07 ^a	0.08 ^a		0.07 ^a	0.08 ^a	0.09 ^a	
Control		0.08				0.05				0.06			
Approach-N-(NE/ST) x Target (T)					N	N x T			N	N x T			N
N ₁		0.08 ^a	0.09 ^a	0.09 ^a	0.09 ^a	0.05 ^a	0.06 ^a	0.07 ^a	0.06 ^a	0.06 ^a	0.07 ^a	0.08 ^a	0.07 ^a
N ₂		0.09 ^a	0.09 ^a	0.09 ^a	0.09 ^a	0.05 ^a	0.08 ^a	0.09 ^a	0.07 ^a	0.07 ^a	0.08 ^a	0.09 ^a	0.08 ^a
M (M) x Target (T)					M	M x T			M	M x T			M
M ₁		0.08 ^a	0.09 ^a	0.09 ^a	0.09 ^a	0.05 ^a	0.05 ^a	0.06 ^a	0.05 ^a	0.06 ^a	0.07 ^a	0.08 ^a	0.07 ^a
M ₂		0.08 ^a	0.09 ^a	0.10 ^a	0.09 ^a	0.05 ^a	0.08 ^a	0.10 ^a	0.08 ^a	0.07 ^a	0.09 ^a	0.10 ^a	0.08 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.003				0.003				0.002			
T		0.004				0.004				0.003			
M		0.003				0.003				0.002			
N x T		0.006				0.006				0.004			
M x T		0.006				0.006				0.004			
N x M		0.005				0.005				0.003			
N x T x M		0.008				0.008				0.005			
Control Vs Rest		0.002		0.005		0.002		0.005		0.001		0.003	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

APPENDIX – I (Contd...)

Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on potassium content (%) in rice straw under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	1.01 ^f	1.22 ^{cd}	1.25 ^{bc}	1.16 ^c	1.12 ^g	1.36 ^e	1.52 ^c	1.33 ^c	1.07 ^h	1.29 ^d	1.38 ^c	1.25 ^c
	M ₂	1.09 ^e	1.23 ^{b-d}	1.28 ^b	1.20 ^b	1.17 ^f	1.47 ^d	1.68 ^b	1.44 ^b	1.13 ^g	1.35 ^c	1.48 ^b	1.32 ^b
N ₂	M ₁	1.09 ^e	1.11 ^e	1.23 ^{b-d}	1.14 ^c	1.32 ^e	1.32 ^e	1.36 ^e	1.33 ^e	1.20 ^f	1.22 ^{ef}	1.30 ^d	1.24 ^c
	M ₂	1.19 ^d	1.31 ^f	1.37 ^a	1.29 ^a	1.33 ^e	1.68 ^b	1.84 ^a	1.62 ^a	1.26 ^{de}	1.50 ^b	1.61 ^a	1.45 ^a
Target		1.09 ^c	1.22 ^b	1.28 ^a		1.24 ^c	1.46 ^b	1.60 ^a		1.17 ^c	1.34 ^b	1.44 ^a	
Control		1.02				1.17				1.09			
Approach-N-(NE/ST) x Target (T)					N	N x T			N	N x T			N
N ₁		1.05 ^d	1.23 ^c	1.27 ^b	1.18 ^a	1.15 ^e	1.42 ^c	1.60 ^a	1.39 ^a	1.10 ^e	1.32 ^c	1.43 ^a	1.28 ^a
N ₂		1.14 ^c	1.21 ^b	1.30 ^a	1.22 ^a	1.33 ^d	1.50 ^b	1.60 ^a	1.48 ^a	1.23 ^d	1.36 ^b	1.45 ^a	1.35 ^a
M (M) x Target (T)					M	M x T			M	M x T			M
M ₁		1.05 ^c	1.17 ^b	1.24 ^b	1.15 ^b	1.22 ^e	1.34 ^d	1.44 ^c	1.33 ^b	1.13 ^f	1.25 ^d	1.34 ^c	1.24 ^b
M ₂		1.14 ^c	1.27 ^b	1.33 ^a	1.24 ^a	1.25 ^e	1.58 ^b	1.76 ^a	1.53 ^a	1.20 ^e	1.42 ^b	1.54 ^a	1.39 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.03				0.03				0.03			
T		0.04				0.04				0.04			
M		0.03				0.03				0.03			
N x T		0.06				0.06				0.06			
M x T		0.06				0.06				0.06			
N x M		0.05				0.05				0.05			
N x T x M		0.08				0.08				0.08			
Control Vs Rest		0.02		0.05		0.04		0.10		0.016		0.047	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

APPENDIX – I (Contd...)

Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on iron content (mg kg⁻¹) in rice straw under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	184.7 ^d	200.0 ^{bc}	207.5 ^{a-c}	197.4 ^b	477.5 ^g	604.8 ^c	614.6 ^c	565.7 ^c	331.1 ^g	402.4 ^c	411.1 ^c	381.5 ^c
	M ₂	194.6 ^{cd}	204.8 ^{bc}	211.4 ^{ab}	203.6 ^{ab}	505.3 ^f	612.8 ^c	636.6 ^b	584.9 ^b	349.9 ^f	408.8 ^c	424.0 ^b	394.2 ^b
N ₂	M ₁	194.7 ^{cd}	195.0 ^{cd}	203.7 ^{bc}	197.8 ^b	509.5 ^f	560.9 ^e	605.9 ^c	558.8 ^d	352.1 ^f	377.9 ^e	404.8 ^c	378.3 ^c
	M ₂	196.3 ^{cd}	212.8 ^{ab}	218.5 ^a	209.2 ^a	576.1 ^d	638.2 ^b	666.6 ^a	626.9 ^a	386.2 ^d	425.5 ^b	442.5 ^a	418.1 ^a
Target		192.6 ^c	203.1 ^b	210.3 ^a		517.1 ^b	604.2 ^a	603.9 ^a		354.8 ^c	403.7 ^b	420.6 ^a	
Control		188.5				500.6				344.6			
Approach-N-(NE/ST) x Target (T)					N	N x T			N	N x T			N
N ₁		189.6 ^c	202.4 ^{ab}	209.4 ^a	200.5 ^a	491.4 ^f	608.8 ^c	625.6 ^a	575.3 ^a	340.5 ^e	405.6 ^c	417.5 ^b	387.9 ^a
N ₂		195.5 ^{bc}	203.9 ^{ab}	211.1 ^a	203.5 ^a	542.8 ^e	599.6 ^d	636.2 ^b	592.9 ^a	369.2 ^d	401.7 ^c	423.7 ^a	398.2 ^a
M (M) x Target (T)					M	M x T			M	M x T			M
M ₁		189.7 ^d	197.5 ^{cd}	205.6 ^{bc}	197.6 ^b	493.5 ^f	582.9 ^d	610.3 ^c	562.2 ^b	341.6 ^f	390.2 ^{fd}	407.9 ^c	379.9 ^b
M ₂		195.4 ^d	208.8 ^{ab}	214.9 ^a	206.4 ^a	540.7 ^e	625.5 ^b	651.6 ^a	605.9 ^a	368.1 ^e	417.1 ^b	433.3 ^a	406.2 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		8.0				6.4				5.3			
T		9.8				7.8				6.5			
M		8.0				6.4				5.3			
N x T		13.8				11.1				9.2			
M x T		13.8				11.1				9.2			
N x M		11.3				9.0				7.5			
N x T x M		19.5				15.6				13.1			
Control Vs Rest		4.0		11.6		3.2		9.3		2.6		7.7	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

APPENDIX – I (Contd...)

Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on zinc content (mg kg⁻¹) in rice straw under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	70.76 ^f	81.62 ^d	84.86 ^c	79.08 ^c	14.78 ^h	33.53 ^c	34.60 ^b	27.64 ^c	42.77 ^j	57.58 ^e	59.73 ^{cd}	53.36 ^c
	M ₂	76.54 ^e	84.04 ^c	85.10 ^{bc}	81.89 ^b	22.45 ^g	34.52 ^b	35.52 ^b	30.83 ^b	49.50 ⁱ	59.28 ^d	60.31 ^c	56.36 ^b
N ₂	M ₁	77.26 ^e	77.46 ^e	82.00 ^d	78.90 ^c	23.97 ^f	25.21 ^e	24.85 ^{ef}	24.68 ^d	50.62 ^h	51.33 ^{gh}	53.43 ^f	51.79 ^d
	M ₂	77.79 ^e	86.46 ^b	88.20 ^a	84.15 ^a	26.44 ^d	37.56 ^a	38.21 ^a	34.07 ^a	52.11 ^g	62.01 ^b	63.21 ^a	59.11 ^a
Target		75.59 ^c	82.39 ^b	85.04 ^a		21.91 ^c	32.70 ^b	33.29 ^a		48.75 ^c	57.55 ^b	59.17 ^a	
Control		71.90				21.86				46.88			
Approach-N-(NE/ST) x Target (T)					N	N x T			N	N x T			N
N ₁		73.65 ^d	82.83 ^b	84.98 ^a	80.49 ^a	18.62 ^e	34.02 ^b	35.06 ^a	29.23 ^a	46.13 ^e	58.43 ^b	60.02 ^a	54.86 ^a
N ₂		77.52 ^c	81.96 ^b	85.10 ^a	81.53 ^a	25.20 ^d	31.39 ^c	31.53 ^c	29.37 ^a	51.36 ^d	56.67 ^c	58.32 ^b	55.45 ^a
M (M) x Target (T)					M	M x T			M	M x T			M
M ₁		74.01 ^f	79.54 ^b	83.43 ^c	78.99 ^b	19.38 ^e	29.37 ^c	29.73 ^c	26.16 ^b	46.69 ^e	54.46 ^d	56.58 ^c	52.58 ^b
M ₂		77.16 ^e	85.25 ^b	86.65 ^a	83.02 ^a	24.45 ^d	36.04 ^b	36.86 ^a	32.45 ^a	50.81 ^f	60.64 ^b	61.76 ^a	57.74 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.96				0.64				0.60			
T		1.17				0.78				0.73			
M		0.96				0.64				0.60			
N x T		1.66				1.11				1.04			
M x T		1.66				1.11				1.04			
N x M		1.35				0.90				0.85			
N x T x M		2.35				1.56				1.47			
Control Vs Rest		0.48		1.40		0.57		1.66		0.30		0.87	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

APPENDIX – I (Contd...)

Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on copper content (mg kg⁻¹) in rice straw under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	2.34 ^f	2.63 ^{cd}	2.67 ^{bc}	2.55 ^b	1.89 ^h	2.46 ^e	2.84 ^b	2.40 ^c	1.89 ^c	2.46 ^{a-c}	2.84 ^{ab}	2.40 ^{ab}
	M ₂	2.36 ^f	2.64 ^{cd}	2.69 ^{bc}	2.56 ^b	2.11 ^g	2.69 ^c	2.91 ^{ab}	2.57 ^b	2.11 ^{bc}	2.69 ^{a-c}	2.91 ^{b-c}	2.57 ^{ab}
N ₂	M ₁	2.36 ^f	2.47 ^e	2.64 ^{cd}	2.49 ^c	2.21 ^f	2.24 ^f	2.56 ^d	2.33 ^d	2.21 ^{a-c}	2.24 ^a	2.56 ^a	2.33 ^b
	M ₂	2.55 ^{de}	2.75 ^b	2.95 ^a	2.75 ^a	2.44 ^e	2.95 ^a	3.00 ^a	2.80 ^a	2.44 ^{a-c}	2.95 ^{ab}	3.00 ^a	2.80 ^a
Target		2.40 ^c	2.62 ^b	2.74 ^a		2.16 ^c	2.58 ^b	2.83 ^a		2.16 ^c	2.58 ^b	2.83 ^a	
Control		2.34				2.04				2.19			
Approach-N(NE/ST) x Target (T)					N	N x T			N	N x T			N
N ₁		2.35 ^d	2.63 ^b	2.68 ^b	2.55 ^a	2.00 ^e	2.58 ^c	2.88 ^a	2.48 ^a	2.00 ^e	2.58 ^c	2.88 ^a	2.48 ^a
N ₂		2.45 ^c	2.61 ^b	2.79 ^a	2.62 ^a	2.32 ^d	2.59 ^c	2.78 ^b	2.56 ^a	2.32 ^d	2.59 ^c	2.78 ^b	2.56 ^a
M (M) x Target (T)					M	M x T			M	M x T			M
M ₁		2.35 ^e	2.55 ^c	2.65 ^b	2.52 ^a	2.05 ^f	2.35 ^d	2.70 ^c	2.37 ^b	2.05 ^e	2.35 ^d	2.70 ^c	2.37 ^b
M ₂		2.45 ^d	2.69 ^b	2.82 ^a	2.66 ^a	2.28 ^e	2.82 ^b	2.96 ^a	2.68 ^a	2.28 ^e	2.82 ^b	2.96 ^a	2.68 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.06				0.06				0.06			
T		0.08				0.08				0.08			
M		0.06				0.06				0.06			
N x T		0.11				0.11				0.11			
M x T		0.11				0.11				0.11			
N x M		0.09				0.09				0.09			
N x T x M		0.16				0.16				0.16			
Control Vs Rest		0.03		0.09		0.03		0.09		0.03		0.09	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

APPENDIX – I (Contd...)

Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on manganese content (mg kg⁻¹) in rice straw under direct seeded condition during rainy season

N x T x M		2014-15				2015-16				Pooled			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	477.5 ⁱ	604.8 ^{eg}	614.6 ^d	565.7 ^c	313.67 ^j	331.6 ⁱ	369.3 ^f	338.2 ^d	395.6 ^j	468.3 ^g	492.0 ^{ce}	451.9 ^b
	M ₂	505.3 ^h	612.7 ^e	636.6 ^c	584.9 ^b	362.27 ^g	347.6 ^h	410.5 ^d	373.5 ^c	433.8 ⁱ	480.2 ^f	523.6 ^c	479.2 ^c
N ₂	M ₁	509.5 ^g	560.9 ^{ef}	605.8 ^c	558.8 ^d	409.95 ^d	390.7 ^e	441.6 ^b	414.1 ^b	459.7 ^h	475.8 ^f	523.8 ^c	486.5 ^b
	M ₂	576.0 ^d	638.1 ^b	666.5 ^a	626.9 ^a	421.62 ^c	466.5 ^a	470.7 ^a	452.9 ^a	498.9 ^d	552.4 ^b	568.6 ^a	540.0 ^a
Target		517.1 ^c	604.2 ^b	630.9 ^a		376.8 ^c	384.2 ^b	423.1 ^a		447.0 ^c	494.2 ^b	527.0 ^a	
Control		500.6				350.3				425.4			
Approach-N-(NE/ST) x Target (T)					N	N x T			N	N x T			N
N ₁		491.4 ^f	608.8 ^e	625.6 ^c	575.3 ^a	337.9 ^e	339.6 ^e	389.96 ^d	355.8 ^b	414.7 ^f	474.2 ^e	507.8 ^c	465.6 ^b
N ₂		542.8 ^d	599.6 ^b	636.2 ^a	592.9 ^a	415.7 ^c	428.6 ^b	456.19 ^a	433.5 ^a	479.3 ^d	514.1 ^b	546.2 ^a	513.2 ^a
M (M) x Target (T)					M	M x T			M	M x T			M
M ₁		493.5 ^f	582.9 ^d	610.3 ^c	562.2 ^b	361.1 ^d	361.2 ^d	405.5 ^b	376.1 ^b	427.7 ^f	472.0 ^d	507.9 ^c	469.2 ^b
M ₂		540.7 ^e	625.5 ^b	651.6 ^a	605.9 ^a	391.9c	407.1 ^b	440.6 ^a	413.2 ^a	466.3 ^e	516.3 ^b	546.1 ^a	509.6 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		6.4				4.30				3.60			
T		7.8				5.27				4.41			
M		6.4				4.30				3.60			
N x T		11.1				7.45				6.24			
M x T		11.1				7.45				6.24			
N x M		9.0				6.09				5.09			
N x T x M		15.6				10.54				8.82			
Control Vs Rest		3.20		9.34		2.16		6.23		1.82		5.31	

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

APPENDIX – I

Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on nitrogen, phosphorus and potassium content (%) in rice straw under direct seeded condition during summer season

N x T x M		Nitrogen				Phosphorus				Potassium			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	0.47 ^d	0.65 ^a	0.60 ^{a-c}	0.57 ^a	0.08 ^a	0.09 ^a	0.10 ^a	0.09 ^a	1.28 ^a	1.40 ^a	1.45 ^a	1.38 ^a
	M ₂	0.62 ^{ab}	0.60 ^{a-c}	0.57 ^{a-d}	0.59 ^a	0.08 ^a	0.09 ^a	0.10 ^a	0.09 ^a	1.36 ^a	1.44 ^a	1.48 ^a	1.43 ^a
N ₂	M ₁	0.57 ^{a-d}	0.52 ^{b-d}	0.54 ^{a-d}	0.55 ^a	0.08 ^a	0.08 ^a	0.09 ^a	0.08 ^a	1.37 ^a	1.39 ^a	1.44 ^a	1.40 ^a
	M ₂	0.57 ^{a-d}	0.50 ^{cd}	0.56 ^{a-d}	0.54 ^a	0.08 ^a	0.10 ^a	0.10a	0.09 ^a	1.39 ^a	1.55 ^a	1.56 ^a	1.50 ^a
Target		0.56 ^a	0.57 ^a	0.57 ^a		0.08 ^a	0.09 ^a	0.10 ^a		1.35 ^a	1.44 ^a	1.48 ^a	
Control		0.55				0.08				1.36			
Approach-N-(NE/ST) x Target (T)					N	N x T			N	N x T			N
N ₁		0.54 ^b	0.62 ^a	0.58 ^{ab}	0.58 ^a	0.08 ^a	0.09 ^a	0.10 ^a	0.09	1.32 ^a	1.42 ^a	1.46 ^a	1.40 ^a
N ₂		0.57 ^{ab}	0.51 ^b	0.55 ^{ab}	0.54 ^a	0.08 ^a	0.09 ^a	0.09 ^a	0.09	1.38 ^a	1.47 ^a	1.50 ^a	1.45 ^a
M (M) x Target (T)					M	M x T			M	M x T			M
M ₁		0.52 ^a	0.59 ^a	0.57 ^a	0.56 ^a	0.08 ^a	0.09 ^a	0.09 ^a	0.09	1.33 ^a	1.40 ^a	1.44 ^a	1.39 ^a
M ₂		0.59 ^a	0.55 ^a	0.57 ^a	0.57 ^a	0.08 ^a	0.10 ^a	0.10 ^a	0.09	1.38 ^a	1.49 ^a	1.52 ^a	1.46 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.07				0.03				0.21			
T		0.08				0.04				0.26			
M		0.07				0.03				0.21			
N x T		0.11				0.05				0.37			
M x T		0.11				0.05				0.37			
N x M		0.09				0.04				0.30			
N x T x M		0.16				0.07				0.52			
Control Vs Rest		0.05		NS		0.01		NS		0.11		NS	

NS – Not significant

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

APPENDIX – I (Contd...)

Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on iron and zinc (mg kg⁻¹) in rice straw under direct seeded condition during summer season

N x T x M		Iron				Zinc			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	116.3 ^d	136.8 ^{cd}	145.4 ^{b-d}	132.8 ^b	21.8 ^c	28.6 ^{a-c}	31.1 ^{ab}	27.2 ^b
	M ₂	126.4 ^{cd}	142.9 ^{b-d}	153.7 ^{bc}	141.0 ^b	23.4b ^c	30.4 ^{ab}	31.3 ^{ab}	28.4 ^{ab}
N ₂	M ₁	128.2 ^{cd}	133.3 ^{cd}	139.7 ^{b-d}	133.7 ^b	24.8b ^c	26.7 ^{a-c}	28.9 ^{a-c}	26.8 ^b
	M ₂	136.3b	186.0 ^a	167.6 ^{ab}	163.3a	27.7 ^{a-c}	33.3 ^a	33.8 ^a	31.6 ^a
Target		126.8 ^b	149.8 ^a	151.6 ^a		24.4 ^b	29.8 ^a	31.3 ^a	
Control		122.2				24.4			
Approach-N-(NE/ST) x Target (T)					N	N x T			N
N ₁		121.3 ^c	139.8 ^{a-c}	149.5 ^{ab}	136.9 ^a	22.6 ^a	29.5 ^a	31.2 ^a	27.8 ^a
N ₂		132.3 ^{bc}	159.7 ^a	153.6 ^a	148.5 ^a	26.2 ^a	30.0 ^a	31.4 ^a	29.2 ^a
M (M) x Target (T)					M	M x T			M
M ₁		122.2 ^b	135.0 ^b	142.5 ^b	133.3 ^a	23.3 ^c	27.7 ^{a-c}	30.0 ^{ab}	27.0 ^a
M ₂		131.4 ^b	164.5 ^a	160.7 ^a	152.2 ^a	25.6 ^{bc}	31.9 ^a	32.5 ^a	30.0 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		17.5				4.7			
T		21.4				5.7			
M		17.5				4.7			
N x T		30.3				8.1			
M x T		30.3				8.1			
N x M		24.7				6.6			
N x T x M		42.8				11.4			
Control Vs Rest		29.2		NS		2.7		NS	

NS – Not significant

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

APPENDIX – I (Contd...)

Effect of nutritional approaches, yield targets and supplementation of micronutrient and organics on copper and manganese (mg kg⁻¹) in rice straw under direct seeded condition during summer season

N x T x M		Copper (mg kg ⁻¹)				Manganese (mg kg ⁻¹)			
		T ₁	T ₂	T ₃	N x M	T ₁	T ₂	T ₃	N x M
N ₁	M ₁	2.29 ^a	2.62 ^a	2.69 ^a	2.54 ^a	337.0 ^a	395.9 ^a	411.4 ^a	381.4 ^a
	M ₂	2.44 ^a	2.66 ^a	2.74 ^a	2.61 ^a	368.9 ^a	402.7 ^a	413.6 ^a	395.1 ^a
N ₂	M ₁	2.46 ^a	2.49 ^a	2.64 ^a	2.53 ^a	380.5 ^a	381.7 ^a	398.5 ^a	386.9 ^a
	M ₂	2.53 ^a	2.80 ^a	2.86 ^a	2.73 ^a	394.7 ^a	417.2 ^a	445.7 ^a	419.2 ^a
Target		2.43 ^a	2.65 ^a	2.73 ^a		370.3 ^a	399.3 ^a	417.3 ^a	
Control		2.42				342.3			
Approach-N-(NE/ST) x Target (T)					N	N x T			N
N ₁		2.37 ^{ab}	2.64 ^a	2.72 ^a	2.58 ^a	352.9 ^a	399.3 ^a	412.5 ^a	388.2 ^a
N ₂		2.49 ^{ab}	2.65 ^a	2.75 ^b	2.63 ^a	387.6 ^a	399.4 ^a	422.1 ^a	403.0 ^a
M (M) x Target (T)					M	M x T			M
M ₁		2.37 ^a	2.56 ^a	2.67 ^a	2.53 ^a	358.7 ^a	388.8 ^a	405.0 ^a	384.2 ^a
M ₂		2.49 ^a	2.73 ^a	2.80 ^a	2.67 ^v	381.8 ^a	409.9 ^a	429.7 ^a	407.1 ^a
Comparison		S.Em±		LSD 0.05		S.Em±		LSD 0.05	
N		0.52				50.3			
T		0.63				61.6			
M		0.52				50.3			
N x T		0.90				87.1			
M x T		0.90				87.1			
N x M		0.73				71.1			
N x T x M		1.27				123.2			
Control Vs Rest		0.32		NS		25.3		NS	

NS – Not significant

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach

Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹

Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,

M₂ - With FeSO₄+ZnSO₄ + Organics

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different according to DMRT

APPENDIX – II

Prices of inputs and outputs

Sl. No.	Particulars	Cost (₹)	
I.	INPUTS		
A	Seeds (₹ kg ⁻¹): Gangavathi sona	37	
	MTU 1010	28	
	BPT 5204	37	
	RNR15048	38	
	Land preparation (₹ ha ⁻¹)	2500	
	Land leveling (₹ ha ⁻¹)	1000	
B	Fertilizers		
	Urea (₹ kg ⁻¹)	6	
	DAP (₹ kg ⁻¹)	26	
	MOP (₹ kg ⁻¹)	17	
	ZnSO ₄ (₹ kg ⁻¹)	25	
	FeSO ₄ (₹ kg ⁻¹)	30	
C	Labour		
	Men (₹ day ⁻¹)	250	
	Women (₹ day ⁻¹)	200	
	Bullock pair with men (₹ day ⁻¹)	500	
D	Chemicals		
	Bispyribac sodium 10% SL (₹ per 250 ml)	1625	
	Pendimethalin 30 EC (₹ per litre)	432	
E	Harvesting cost (₹ ha ⁻¹)	6000	
	Post harvest charges (₹ ha ⁻¹)	1000	
II.	OUTPUTS	2015	2016
	Paddy straw (₹ q ⁻¹)	200	200
	Grain (₹ q ⁻¹): Gangavathi sona	1800	1900
	MTU 1010	1650	1750
	BPT 5204	1950	2100
	RNR 15048 (Summer 2016)		2000

APPENDIX – III

Cost of cultivation of Experiment II 2015, 2016 and summer 2016

Cost of cultivation (₹ ha⁻¹)

Treatments	2014-15 Rainy season	2014-15 Rainy season	Pooled	Summer
N ₁ T ₁ M ₁	33,577	33,577	33,577	33,559
N ₁ T ₁ M ₂	49,952	49,952	49,952	49,934
N ₂ T ₁ M ₁	39,045	38,690	38,867	38,742
N ₂ T ₁ M ₂	55,420	55,065	55,242	55,117
N ₁ T ₂ M ₁	34,073	34,073	34,073	34,073
N ₁ T ₂ M ₂	50,448	50,448	50,448	50,448
N ₂ T ₂ M ₁	41,544	41,139	41,341	41,234
N ₂ T ₃ M ₂	57,919	57,514	57,716	57,609
N ₁ T ₃ M ₁	35,199	35,199	35,199	35,199
N ₁ T ₃ M ₂	51,574	51,574	51,574	51,574
N ₂ T ₃ M ₁	44,007	43,605	43,806	43,628
N ₂ T ₃ M ₂	60,382	59,980	60,181	60,003
Control	35,211	35,211	35,211	35,211

Nutrient approach (N) : N₁- Nutrient Expert, N₂- Soil Test Crop Response approach
Yield Targets (T) : T₁- 6 t ha⁻¹, T₂- 7 t ha⁻¹, T₃- 8 t ha⁻¹
Micronutrient & Organics (M) : M₁ - Without FeSO₄+ZnSO₄ + Organics,
M₂ - With FeSO₄+ZnSO₄ + Organics

APPENDIX – IV

Cost of cultivation (₹ ha⁻¹) of Experiment during rainy and summer seasons

	2014-15 Rainy season	2014-15 Rainy season	Pooled	Summer
V ₁ S ₁ M ₁	51136	52136	51636	52036
V ₁ S ₁ M ₂	51886	52886	52386	52786
V ₁ S ₁ M ₃	51761	52761	52261	52661
V ₁ S ₁ M ₄	52711	53711	53211	53611
V ₁ S ₂ M ₁	51321	52321	51821	52201
V ₁ S ₂ M ₂	52071	53071	52571	52951
V ₁ S ₂ M ₃	51946	52946	52446	52826
V ₁ S ₂ M ₄	52896	53896	53396	53776
V ₁ S ₃ M ₁	51506	52506	52006	52366
V ₁ S ₃ M ₂	52256	53256	52756	53116
V ₁ S ₃ M ₃	52131	53131	52631	52991
V ₁ S ₃ M ₄	53081	54081	53581	53941
V ₂ S ₁ M ₁	50911	51911	51411	52161
V ₂ S ₁ M ₂	51661	52661	52161	52911
V ₂ S ₁ M ₃	51536	52536	52036	52786
V ₂ S ₁ M ₄	52486	53486	52986	53736
V ₂ S ₂ M ₁	51051	52051	51551	52351
V ₂ S ₂ M ₂	51801	52801	52301	53101
V ₂ S ₂ M ₃	51676	52676	52176	52976
V ₂ S ₂ M ₄	52626	53626	53126	53926
V ₂ S ₃ M ₁	51191	52191	51691	52541
V ₂ S ₃ M ₂	51941	52941	52441	53291
V ₂ S ₃ M ₃	51816	52816	52316	53166
V ₂ S ₃ M ₄	52766	53766	53266	54116
V ₃ S ₁ M ₁	51136	52136	51636	52036
V ₃ S ₁ M ₂	51886	52886	52386	52786
V ₃ S ₁ M ₃	51761	52761	52261	52661
V ₃ S ₁ M ₄	52711	53711	53211	53611
V ₃ S ₂ M ₁	51321	52321	51821	52201
V ₃ S ₂ M ₂	52071	53071	52571	52951
V ₃ S ₂ M ₃	51946	52946	52446	52826
V ₃ S ₂ M ₄	52896	53896	53396	53776
V ₃ S ₃ M ₁	51506	52506	52006	52366
V ₃ S ₃ M ₂	52256	53256	52756	53116
V ₃ S ₃ M ₃	52131	53131	52631	52991
V ₃ S ₃ M ₄	53081	54081	53581	53941

Varieties : V₁- GGV 0501, V₂- MTU 1010 (rainy season)/ RNR15048 (summer), V₃- BPT 5204
 Seed Rate : S₁- 25 kg ha⁻¹, S₂- 30 kg ha⁻¹, S₃- 35 kg ha⁻¹
 Micronutrient : M₁- Control, M₂- FeSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)
 M₃- ZnSO₄ (Soil @ 25 kg ha⁻¹+ foliar @ 0.5% twice at 15 and 30 DAS)
 M₄- FeSO₄ + ZnSO₄ (each to soil @ 25 kg ha⁻¹ + foliar @ 0.5% at 15 and 30 DAS)