

**Effect of Organic and Inorganic Source of Nutrients on
Growth, Flowering, Fruiting, Yield and Quality of Mango
(*Mangifera indica* L.) cv. Amrapali under High Density
Planting**

THESIS

Submitted to the

Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur

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the Degree of

DOCTOR OF PHILOSOPHY

In

AGRICULTURE

(HORTICULTURE - FRUIT SCIENCE)

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2015

CERTIFICATE – I

*This is to certify that the thesis entitled “Effect of organic and inorganic source of nutrients on growth, flowering, fruiting, yield and quality of mango (*Mangifera indica* L.) cv. Amrapali under high density planting” submitted in partial fulfillment of the requirement for the degree of “**DOCTOR OF PHILOSOPHY IN AGRICULTURE HORTICULTURE (FRUIT SCIENCE)** of the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur is a research of the bonafide research work carried out by **Mrs. RAJNEE SHARMA** under my guidance and supervision. The subject of the thesis has been approved by the Student’s Advisory and the Director of Instruction.*

All the assistance and help received during the course of investigation has been duly acknowledged by her.

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List of Abbreviations

Abbreviation	Word	Abbreviation	Word
*	Significant at 5%	cm	Centimeter
/ or ⁻¹	per	g	Gram
ANOVA	Analysis of variance	ha	Hectare
d.f.	Degree of freedom	m ²	Per square meter
SS	Sum of squares	m ⁻³	Per cubic meter
MSS	Mean sum of square	ppm	Parts per million
Cal	Calculated	dSm ⁻¹	Desi Simon per mole
Tab	Tabulated	Mg	Megagram
R	Replication	No.	Number
S Em.±	Standard error mean	°C	Degree centigrade
S Ed.	Standard error difference	MT	Metric tonne
CD	Critical difference	mm	Millimeter
NS	Non significant	%	Per cent
Temp.	Temperature	°B	Degree Brix
Max.	Maximum	N	Nitrogen
Min.	Minimum	P	Phosphorous
RH	Relative humidity	K	Potassium
Mor	Morning	Zn	Zinc
Eve	Evening	Fe	Iron
<i>et. al.</i>	Co-workers'	Mn	Manganese
Fig.	Figure	Cu	copper
cv.	Cultivar	<i>i.e.</i>	That is
<i>etc.</i>	And the rest	RDF	Recommended dose of fertilizer
TSS	Total soluble solids	OC	Oil cake
BI	Bio-inoculants	VC	Vermicompost

INTRODUCTION

INTRODUCTION

Mango (*Mangifera indica* L.) has been cultivated for more than 5000 years ago and has a wide genetic diversity. It occupies a prominent place amongst the fruits grown in India and is acknowledged as “King of Fruits”. At present, mango covers 2.50 million hectares of area with a total production of 18.0 million tonnes, which works out to a low average productivity of 7.2 metric tonnes per hectare (Anonymous, 2013). India ranks first among world's mango producing countries. Despite India's share of 60% in world's mango production, its productivity is very low when compared to other mango producing countries. Indian share in world's fresh mango market is also meager with only 5.25% in term of quantity and 3.5% in value terms. In India, Uttar Pradesh and Andhra Pradesh both are having the largest area under mango each of around 25% of the total area, followed by Bihar, Karnataka, Kerala and Tamil Nadu (Anonymous, 2010). In Madhya Pradesh, total area under mango cultivation is 0.252 (million ha) with a total production of 3.76 million MT (Singh et al., 2014). Looking to the excellent taste, wide variability with respect to varieties, nutritive, therapeutic value and organic production mango will have immense scope in domestic and export market.

Mango is having wider adaptability with respect to soil, climate and altitude for its successful cultivation and it is universally considered as one of the most important fruit crops in tropical and subtropical areas of the world. Temperature, rainfall, wind velocity and altitude are the main climatic factors which influence its growth and fruiting. Globally, it has been identified that there are number of problems faced in mango production. These problems are largely associated with unavailability of quality scion and rootstock. The major constraints in mango cultivation are low productivity, prolonged juvenility, alternate bearing in most of the varieties and incidence of large numbers of pest and diseases. Beside these, traditional planting methods, poor orchard management, imbalance use of plant nutrients, improper or no irrigation, low yielding old varieties, problems of alternate bearing, etc are some of the important reasons of declining mango productivity in the country. Integrated nutrient management envisages the use of chemical fertilizers in conjunction with

organic manures, green manures, crop residues, legumes in a cropping system and locally available resources with the objectives of sustaining high yield and ensuring environmental safety.

The National productivity of India is stagnant since long time. Out of the new plantations, mango alone occupied major share. Now-a-days several operations involved in improving the yield and quality of mango. Regular bearer variety with small canopy is very important. Amrapali is a mango hybrid (Dashehari x Neelum) and gaining popularity for its dwarf stature and regular bearing in nature. Amrapali has already occupied a major area in newly planted mango orchard in high density planting and replacing the traditional cultivars. In general, compact and small trees canopy capturing and conversion of sunlight into the fruit biomass (dry matter content) is an important process in fruit production in a better way than the larger ones. The main controlling factors are the extent of incoming radiation and percentage radiation intercepted by tree canopies.

The fruit tree nutrition is concerned with the provision of plant with nutrients as well as nutrient uptake and plant nutrition is fertilizer or nutrient application. Fertilizer is one of the major inputs accounting for nearly one-third of the cost of cultivation and its production consumes a lot of energy used in agriculture. Consequent to the global energy crisis, efficient and judicious use of the fertilizers is imperative not only for obtaining more yields per unit area on a sustainable basis, but also to conserve the energy and to avoid the problem of environment quality (Lal and Dayal, 2014).

Therefore, integrated nutrient management is the most appropriate approach for managing the nutrient input. Integrated nutrient management refers to maintenance of the soil fertility and plant nutrient supply to an optimum level for sustaining the desired crop productivity through optimization of the benefits from all possible sources of plant nutrient. Therefore, it is a holistic approach, where we first know what exactly is required by the plant for an optimum level of production, in what different forms these nutrients should be applied in soil and at what different timings in the best possible method, and how best these forms should be integrated to obtain highest productive efficiency on the economically acceptable limits in an environment

friendly manner. Increased chemical fertilizer cost and awareness of environmental pollution have necessitated the use of organic fertilizers for the development of more efficient fertilizer management programme (Bhattarai and Tomar, 2009). Organic fertilizers are apparently environment and farmer friendly renewable source of non-bulky, low cost organic agricultural inputs for improving soil fertility status. Organic manures are fairly good source of nutrients which has direct influence on plant growth like other commercial fertilizers.

Moreover, factors like soil type, moisture regime in the root zone, climatic condition, plant age etc. also affect the absorption and assimilation of minerals. Any deviation from optimum i.e. insufficient or excess amounts of any nutrient in the soil results in deficiency or toxicity of the element in the plant which ultimately causes physiological maladies. These nutritional imbalance causes' disturbance in normal histological, physiological and biochemical activities which affect almost all parts of the plant, affecting yield, quality and post harvest storage life of horticultural crops. However, the integrated plant nutrient supply through the use of organic and inorganic fertilizers is the best means to provide nutrients to the plants in balanced and effective manner. Organic materials have major role in maintaining buffering capacity of soil and important for maintaining soil physical and biological properties. Among organic inputs, bio-fertilizers, more commonly known as microbial inoculants, are artificially multiplied cultures of certain soil organisms that can improve soil fertility and crop productivity. These are capable of mobilizing nutritive elements from non-available forms to available form through biological processes. They are less expensive, eco-friendly and sustainable for long term. Bio-fertilizers have various beneficial benefits, i.e. besides accessing nutrients, for current intake as well as residual, different bio-fertilizers also provide growth-promoting factors to plants and some have been successfully facilitating composting and effective recycling of solid wastes. By controlling soil-borne diseases, improving soil health and soil properties these organisms help not only in saving, but also in effectively utilizing chemical fertilizers, which result in higher yields besides maintaining the soil and plant health. Hence, it is necessary, to maintain the soil fertility and plant nutrient supply to an optimum level for sustaining the desired crop productivity through optimization of the

benefits from all possible sources of plant nutrients in an integrated manner (Chundawat, 2001). Biofertilizers are the living organism which add, conserve and mobilize the plant nutrients in the soil. Bio-fertilizer based on renewable energy source are cost effective supplement to chemical fertilizers and can help to economize on the high investment needed for fertilizer use (Motsara *et al.*, 1995). The beneficial effect of bio-fertilizers is now well established in fruit crops like papaya (Sukhade *et al.*, 1995) and banana (Gogoi *et al.*, 2004). However, very little work has been done on the use of bio-fertilizers in mango. It has realized that optimum yields from efficient use of nutrients under high density planting, high yielding varieties and better management of the orchards may result in higher mango productivity which can be considered to a revolution in mango production by avoiding the risk of soil and water pollution.

Keeping the above points in view, the present study entitled “Effect of organic and inorganic source of nutrients on growth, flowering, fruiting, yield and quality of mango (*Mangifera indica* L.) cv. Amrapali under high density planting” has been carried out with the following objectives;

1. To assess the impact of different sources of nutrient on yield and quality of mango cv. Amrapali,
2. To study the combined effect of vermicompost and fertilizer, on flowering, fruiting and quality of mango,
3. To determine the effect of organic and inorganic sources of nutrient on physico - chemical properties of soil and
4. To account out economics for nutrient management of mango cv. Amrapali under HDP.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

With the introduction of high-yielding varieties and adoption of multiple cropping system, the demand of chemical fertilizers especially that of nitrogenous, phosphetic and potashic have gone up many folds. Consequently, the production of these fertilizers may not be able to come up with the demand in the years to come. The gap between demand and supply is also partially compensated by organic manures, but its limited availability is a major constraint as a source of nutrients. Hence, the above said problem needs to be tackled largely through the use of organic resources of plant nutrients. Animal excreta, farm wastes, plant bio product like oil cake and bio-agents are excellent sources of nutrients. These can be applied directly or by converting in to quality compost by using earthworms with mineral fertilizers within a framework of integrated plant nutrient management system to improve and sustain fertility and productivity. The available literature on different aspects have been reviewed and presented under following sub-heads. The systematic research work on horticultural crops especially on mango in India and abroad is so limited; hence there is a paucity of information in this regard. Therefore, a few references of other fruit crops have also been included in the text.

2.1 Morphological character of mango

Availability of growth promoting substances and vitamins in vermicompost and bio-fertilizers and their subsequent effect on plant growth was reported by Subbiah (1994), Motsara *et al.* (1995) and Kumar *et al.* (1998).

The decomposition of organic residues produced several bio active humic substances (Nardi *et al.*, 1994 and Masciandaro *et al.*, 1999). These substances are endowed with hormone like activity that improves plant nutrition and growth (Chen and Aviad, 1990). Humic acid comprise one of the major fractions of humic substances which can display auxin like activities (Muscolo *et al.*, 1999).

Sharma *et al.* (2000) studied the effect of three levels of N (0, 400, 800 g) in combinations with three levels each of P₂O₅ (0, 200 400 g) and K₂O (0, 300, 600 g)

per plant were applied to 25 years old Dashehari mango. The experiment was started in 1989 and continued for eight years. They reported that 800 g N+ 200 g P₂O₅+ 300g K₂O was found to be the appropriate fertilizers combination in increasing the height, girth, spread and fruit yield of Dashehari mango.

Naik and Sri Hari (2007) conducted an investigation under semi-arid tropics of southern Andhra Pradesh, India to study the response of guava (*Psidium guajava* L.) cv. L-49 (Sardar) to different organic manures. The treatments consist of organics, viz. vermicompost(10 kg tree⁻¹), FYM (25 Kg tree⁻¹), pig, sheep, goat and poultry manures and guava leaf litter (each 20 Kg tree⁻¹), NPK (250:350:200g tree⁻¹) and control (without any treatment). The treatment with vermicompost resulted in maximum number of shoots plant⁻¹, more number of leaves shoot⁻¹ and highest fruit yield. Application of animal manures produced more number of fruits shoot⁻¹. Per cent fruit drop was nil with sheep, goat and leaf litter application, However it was higher with vermicompost and poultry manures. Heaviest fruits were borne under sheep and goat manures. The fruit yield was better with chemical fertilizers and good with poultry manures. Thus, investigation revealed that the vermicompost was superior over other organic sources and closely followed by poultry manure and leaf litter in improving vegetative growth, flowering, fruiting, yield and fruit attributes and fruit quality along with improvement in soil fertility and leaf nutrient status of the guava plant.

Patel et al.(2009) conducted a field experiment during 2004-2007 to find out the influence of microbial and inorganic fertilizers in combination with micronutrients (0.4% foliar spray) on growth, yield and leaf nutrient status of sweet orange cv. Mosambi, and resultant changes in rhizosphere soil microbial biomass. The treatment consisted of application of full dose of NPK, AMF (Nutrilink- mixed strains of IARI), Azospirillum, and micro-nutrients sprays in different combinations along with a control. The three years study reveal that the plant height, trunk diameter, canopy spread, fruit yield and fruit quality were significantly influenced by different microbial and inorganic fertilizers applications. Application of $\frac{3}{4}$ th N (300 g) + $\frac{3}{4}$ th P (250 g) + $\frac{3}{4}$ th K (300 g) + AMF (5 g) + AZO (5 g) + along with spray of 0.4 per cent micronutrients (Cu+Fe+B+Zn) resulted in the maximum plant height, trunk growth,

fruit yield , juice content and TSS: acid ratio. The use of AMF along with Azospirillum proved to be beneficial along with inorganic fertilizers and also indicated the beneficial effects of Azospirillum along with AMF strains. It also helped in lowering the applied dose of inorganic fertilizers and also improving the soil biological properties.

Pilania et al. (2010) conducted an experiment during 2007–08 to standardize the pruning intensity and integrated nutrient management in guava (*Psidium guajava* L.). They reported that the application of 50, 20, 50 g NPK + 5 kg vermicompost enriched with Azotobacter + Aspergillus niger resulted maximum canopy volume 0.69 m³, leaf area (57.19 cm²), flowers/shoot (49.12), fruit set (45.79%), fruit retention (44.76). Interaction effect of pruning and integrated nutrient management showed that 50, 20, 50 g NPK + 5 kg vermicompost enriched with Azotobacter + Aspergillus niger + 25% per cent pruning intensity resulted maximum canopy volume 0.96 m³, flowers/shoot (57.83), while 50, 20, 50 g NPK + 5 kg vermicompost enriched with Azotobacter + Aspergillus niger + 75% pruning intensity resulted maximum fruit diameter 5.20 cm (polar) and 5.31 cm (equatorial), average fruit weight (158.06 g), average pulp weight (154.19 g), pulp seed ratio 39.93 during both the years. However, highest leaf area (59.46 cm²) and fruit yield was obtained with 50, 20, 50 g NPK + 5 kg vermicompost enriched with Azotobacter + Aspergillus niger + 50% pruning intensity (F_{5I_2}) 6.68 kg plant⁻¹ and 33.43 tonnes / ha with B:C ratio of 4.33.

The experiment on Dashehari comprising 18 treatment combinations of FYM, vermicompost, NPK, Azotobacter, Trichoderma harzianum, phosphorus solubilizing micro- organisms and mulching was in the fifth year of progress at CISH, Lucknow. Anonymous (2011) Plant growth in terms of height, stem girth and canopy spread was maximum in treatment FYM + NPK + Azotobacter + PSM + Trichoderma harzianum + organic mulch (10 cm thick). Plant height and stem girth varied from 1.68 to 2.61 m and 18.5 to 31.0 cm, respectively in different treatments. Canopy spread in N-S direction ranged from 1.58 to 2.79 m, while in E-W direction it was between 1.68 and 2.68 m. There was no significant effect of different treatments on growth parameters. The flowering percentage ranged between 38.3 and 73.3 among different treatments.

Mishra et al. (2011) conducted an experiment to determine the effect of organic and inorganic sources of NPK and foliar spray of chemicals on plant growth, fruit yield and quality of ber cv. Gola. Different graded levels of FYM (37.5, 75 and 150 kg/plant) and Vermicompost (11, 22 and 45 kg plant⁻¹) were supplemented with different doses of inorganic fertilizers and foliar spray of chemicals (control, borax 0.4 per cent and thiourea 0.5 per cent) to balance fertilizer requirement of ber under semi-arid region of northern India. Experimental results revealed that application of 22 kg vermicompost + 0.82 kg urea + 1.15 kg SSP + 0.41 kg MOP per tree (F₅) and foliar spray of thiourea @ 0.5 per cent (T₂) significantly increased the plant height, plant spread, leaf area, average weight of fruit and fruit yield per tree and reduced the fruit drop.

Khan et al. (2013) examined the effect of plastic mulching, three soil metric potentials (SMP) treatments {I₁ (-20 kPa), I₂ (-40 kPa), and I₃ (-60 kPa)} and three fertigation levels {F₁ (100%), F₂ (80%), and F₃ (60%) recommended dose of fertilizer} under drip irrigation conditions for nutrient uptake, growth parameters and yield in guava plants during the year 2012-13. The investigation indicated that the plant canopy spread in (N-S and E-W) directions was greatly affected by different treatments. However, non-significant effects of interaction parameters were found on plant height, crop volume and plant girth. The maximum yield was obtained in MI₂F₂ (68.66 kg per plant and 22.86 t ha⁻¹) followed by NMI₂F₂ (66.50 kg plant⁻¹ and 22.14 t ha⁻¹) treatments. The maximum percentage of high quality (fruit levels A and B) were 48.2% and 50.1% in -40 k Pa irrigation treatment for mulch and no mulch conditions under 100% application of recommended dose of fertilizers.

Kundu et al. (2011) in an experiment found that all the inorganic and biofertilizers combination exhibited profound effect on growth, yield and fruit quality and leaf mineral composition than inorganic fertilizer alone. However, the efficiency of inorganic fertilizer at three levels was more when supplemented with both Azotobacter and VAM. Higher fruit yield was obtained when the plants were treated with 100% NPK + Azotobacter + VAM (98.1 kg plant⁻¹) or 75%NPK + Azotobacter + VAM (93.5 kg plant⁻¹) as compared to 100% NPK. It was shows that the treatment 100%NPK + Azotobacter + VAM and 75% NPK + Azotobacter + VAM was found

effective and may be adopted to improve the vegetative growth and productivity with quality fruits.

Raheel et al. (2011) observed that the fertilizer management particularly for mango trees is tedious on alkaline and calcareous soil. Mango (*Mangifera indica* L.) cv. Langra trees were supplied fertilizer through soil application under bimonthly nutrient application programme to ensure the continuous supply of nutrition to plants throughout the year. They observed that trees supplied with nutrients in February, April, June, August and October months, produced maximum number of flowers per panicle with highest percentage of perfect flowers (62.4%), maximum final fruit set (0.165%) and maximum nutrient use efficiency for nitrogen (25.57%), phosphorus (2%) and potassium (14.97%) over control. The results revealed the superiority of split application of nutrients in February, April, June, August and October over bulk application of fertilizer only in February and April (control).

Singh and Banik (2011) observed that the response of integrated nutrient management on the flowering, fruit setting, yield and fruit quality parameters were subjected to 100:50:50 g NPK tree⁻¹ (control) (T₁), T₁+ Zn (0.5%) + B (0.2%) + Mn (1%) + Ca (0.6%) as foliar application twice (Aug. and Oct.) (T₂), T₁ + organic mulching (10 cm thick of dry leaves) (T₃), T₂ + organic mulching (10 cm thick of dry leaves) (T₄), ½ T₁ + 50kg FYM + 250 g Trichoderma (T₅), ½ T₁+ 50 kg FYM + 250 g Azospirillum (T₆), ½ T₁+ Azotobacter (250 g) + 50 kg FYM (T₇) and ½ T₁ + Azotobacter (250 g) + 250 g Azospirillum (T₈). The observation revealed that the date of first and last flowering initiation was first recorded in T₄ on 12th February and T₇ on 2nd February. Highest ratio of hermaphrodite flower panicle⁻¹ was observed in T₄ (28.06%) and minimum in T₁ (21.40 %). Fruits panicle⁻¹ in pea stage and marble stage was highest in T₅ (13.24) and T₆ (8.53) and lowest in T₇ (10.80) and T₁ (5.16), respectively but the total number of fruits tree⁻¹ in harvest stage was recorded highest in T₆ (33.70) and lowest in control (176.0).

Yadav et al. (2011) carried out an experiment to evaluate the response of organic nutrients (FYM, Vermicompost and Biodynamic compost), inorganic manures (NPK), biofertilizers (Azotobacter and PSB), micronutrients (zinc and iron) and

paclobutrazol (Cultar) on flowering, fruiting, yield and quality of mango cv. Amrapali under high density orcharding. The maximum panicle length (23.92 and 23.96 cm), number of flowers per panicle (1710.67 and 1756.00), fruit set per panicle (194.67 and 201.33) and sex ratio (0.690 and 0.691) were recorded with T₈ (recommended NPK + vermicompost + Azotobacter + PSB + Zn + Fe + paclobutrazol) which was at par with T₁₂ (recommended NPK + biodynamic compost + Azotobacter + PSB + Zn + Fe + paclobutrazol).

Devi et al. (2012) an investigation was conducted under sub-tropical conditions of West Bengal, India at the Horticultural Research Station of the university to standardize the organic nutrient management protocol for guava. In this experiment, various organic sources (Farm yard manure (26 kg plant⁻¹ y⁻¹), poultry manure (10 kg plant⁻¹ y⁻¹), vermicompost (19 kg plant⁻¹ y⁻¹) and neem cake (9 kg plant⁻¹ y⁻¹) along with various biofertilizer combinations (Azotobacter, Azospirillum, phosphorous solubilizers and potash mobilizers each at 100 g plant⁻¹ y⁻¹) were tested on four-year-old guava cultivar 'Sardar' to study its effect on growth, fruiting and yield. The different doses of organic manures were calculated based on the 50% of potash requirement of the recommended dose of guava for the region. The calculated dose along with biofertilizer was applied in two splits in January and August. The results obtained showed higher fruit weight (230.5 and 224.8 g) by application of neem cake and vermicompost + Azotobacter + phosphorous solubilizers + potash mobilizers. Treatment combinations with poultry manure + Azospirillum + phosphorous solubilizers + potash mobilizers showed the highest total soluble solids (12 °Brix) and total sugar content of fruit (6.67%), whereas the vitamin C content (172.6 mg per 100 g pulp) was recorded maximum by application of neem cake.

Chandra et al. (2012) conducted a study during 2007 to 2010 on 15 year old guava orchards at Chandauli (U.P.) India. They reported that the rejuvenated guava tree received IPNM and VAM found to be most effective for promoting emergence of new shoots (3.76 fold).

Jain et al. (2012) carried out an investigation during 2008 to study the individual effect of Mycorrhiza and Vermicompost as well as their interaction on plant growth characteristics of Nagpur mandarin (*Citrus reticulata* Blanco) during pre bearing stage. The results revealed that treatment M₃ i.e. mycorrhiza @ 30 g/plant showed superior results with respect increase in plant height (42.94%), root stock girth (37.93%), scion girth (34.73%), canopy volume (41.86%), leaf area (46.73%), relative water content of leaves (69.38%) and plant spread E-W (30.32%) and N-S (25.91%) over control and lower doses and also an application of 6 kg Vermicompost per plant showed significantly better result with respect to most of the vegetative growth parameters as compared to their lower doses and control. Amongst various treatment combinations used, treatment M₃V₃ (mycorrhiza @ 30 g/plant+ Vermicompost 6 kg plant⁻¹) showed significantly superior over most of the treatment combinations including control in plant growth and development characters like root stock girth, scion girth, plant height, plant spread (E-W and N-S), canopy volume and relative water content of leaves.

Yadav et al. (2012) conducted an experiment to study the effect of nutrient management through organic sources on guava trees. Results showed that application of various organic substances increased growth of trees, fruit yield and fruit quality as compared to untreated ones(control).The highest values of these parameters were recorded for trees applied with poultry manure followed by the trees applied with FYM. Application of poultry manure on guava trees significantly increased number of fruits per plant and resultantly higher yield (kg tree⁻¹) was achieved as compared to control. The recorded values of total soluble solids and total sugar were also found significantly higher with the application of poultry manure.

Patil and Shinde (2013) Conducted a field experiment consisting of recommended dose of fertilizers alone and in combinations with organic manures and biofertilizers [Vesicular-arbuscular mycorrhiza (VAM), azotobacter and phosphate solubilising bacterial (PSB)] and found that the growth parameters in relation to plant height, stem girth, number of leaves per plant, leaf area and crop duration were influenced significantly due to different treatments. The maximum plant height (190.84 cm) and girth (81.34 cm) were recorded under 50% RDF + FYM +

Azotobacter (50 g/plant) + PSB (50 g/plant) + VAM *Glomus fasciculatum* (250 g/plant) where as the maximum leaves per plant (32.30) and leaf area (17.93 m²) were recorded in treatment T3. The minimum number of days (211.03) required for shooting after planting and number of days needed to harvest after shooting were recorded to be 117.46 with 50% RDF + FYM + Azotobacter (50 g plant⁻¹) + PSB (50 g/plant) + VAM *G. fasciculatum* (250 g plant⁻¹) and found beneficial for growth and yield of banana cv. Ardhapuri.

Halder (2013) conducted an experiment was conducted to investigate the effect of organic fertilizers on the growth, yield and yield contributing characters of BAU Kul-1 and Apple Kul in Randomized Complete Block Design at Germplasm Centre of Bangladesh Agricultural University, Mymensingh during the period from May, 2012 to February, 2013. The experiment consisted of two varieties of jujube viz. BAU Kul-1 and Apple Kul and eight doses of organic fertilizers viz., 50 kg cow dung plant⁻¹; 40 kg cow dung plant⁻¹; 30 kg cow dung plant⁻¹; 20 kg cow dung plant⁻¹; 10 kg paragon compost plant⁻¹; 5 kg paragon compost plant⁻¹; 2.5 kg paragon compost plant⁻¹ and a Control (no fertilizer). It was reported that the highest plant height (122.51 cm), number of branches (28.40) per plant, number of leaves (419.19) per plant, canopy volume (8.25 m³) and plant base girth (8.22 cm), were found under manuring with paragon compost 10 kg/plant whereas the lowest values of these characters were recorded in the control treatment.

Verma and Chauhan (2013) studied the effect of integrated nutrient application on apple productivity and soil fertility in temperate zone of Himachal Pradesh was investigated during the years 2007 and 2008. Plant growth parameters viz. terminal shoot growth, plant girth, height and spread; fruit characteristics viz. fruit weight, length, breadth and yield; fruit quality parameters viz. fruit pressure, total soluble solids, titrable acidity and total sugar; leaf nutrient content viz. nitrogen, phosphorus and potassium and soil properties viz. soil pH, OC content, available nitrogen, phosphorus and potassium were significantly affected by organic manures, bio-fertilizer and inorganic fertilizers treatments during both the years of experimentation. Maximum values of plant growth parameters, fruit characteristics, yield, leaf and soil nutrient contents were recorded under treatment (IFFCO mixture +

Urea + MOP + lime + FYM) followed by treatment (recommended doses) and minimum values were recorded under control treatment (without fertilizers, manures and biofertilizers). Better quality fruits were also recorded in treatment (1094g 12:32:16 IFFCO mixture + 1237g urea + 875 g MOP + 1 kg lime + FYM 100kg tree⁻¹).

Kumar et al. (2014) A field experiment was conducted to study the effect of seasonal variation on flowering and physiological parameters at State Horticultural Farm, Kanyakumari, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Periyakulam during the year 2010 to 2012. The result revealed that the number of inflorescence (32.10 and 26.40 m⁻²), hermaphrodite flower (37.95 and 33.25%), male flower (47.97 and 52.60%) and fruit set (0.67 and 0.63%) were found higher in cv. Neelum during main season and off-season respectively. With regard to physiological parameters, the highest soluble protein (12.55 and 11.94 mg100g⁻¹) and total phenols (3.51 and 3.25 mg 100g⁻¹) and the lowest of IAA oxidase activity (169. 85 and 178.20µg g⁻¹) and gibberellic acid content (1.05 and 1.06µg g⁻¹) were recorded in cv. Neelum during main season and off-season respectively.

Dwivedi et al (2014) studied the effect of organic and inorganic fertilizers on the performance of Cape gooseberry during 2013-14 at Horticulture Farm, Lucknow with twelve treatments replicated thrice was laid down in randomized block design. Biofertilizers used were *Azotobacter* (@ 1.5 kg ha⁻¹), PSB (each @ 1.5 kg ha⁻¹) and Vermicompost (@ 1kg/plant) (alone and in combination) along with NPK doses, the vegetative performance with respect to number of buds (2.44, 5.22 and 31.66 after 45, 75 and 105 days of transplanting, respectively), number of flowers (2.44, 6.24 and 13.22 after 75, 90 and 105 days of transplanting, respectively).

Kumar et al (2014) studied to evaluate the effect of Vermicompost, Urea and *Azotobacter* on growth and quality attributes of Sweet Charlie cultivar of strawberry (*Fragaria x ananassa* Duch.) during 2013-2014. Vermicompost, Urea and *Azotobacter* were applied separately (100% each) and in combination with each other (25%, 50% and 75% each) at 100 q ha⁻¹, 100 kg ha⁻¹ and 30 ml litre⁻¹ water, respectively. Different treatment combinations revealed significantly positive effect on most of the

parameters studied under the experiment. Maximum height of the plant (13.39 cm), plant spreading (29.56 cm), number of leaves (17.33), leaf length (6.133 cm), leaf width (4.90 cm), leaf area (50.33 cm²) number of flowers (18.93) and number of runners (4.33) were found in treatment with 50% vermicompost, 25% *Azotobactor* and 25% urea.

Manjusha and Parthiban (2014) conducted experiment to study the 'Effect of organic and inorganic source of nutrients and crop density on growth and yield of acid lime cv. PKM-1' during 2012-2013 at Horticultural College and Research Institute, Periyakulam. The treatment combinations includes three levels of spacing (6×6, 6×5, and 6×4 m) and three nutrient NPK levels of (100, 75 and 50% RDF) with and without vermicompost were assessed. The result of study revealed that application of 100% RDF fertilizer in the spacing of 6 x 5 m showed a superior performance with the respect to vegetative parameters such as tree height (5.42 m), canopy spread (North-South and East-West) (4.95 and 5.58 m) and stem girth (49.90 cm). The least time of 33.79 days taken for 50% bloom and reproductive characters viz., number of fruits per tree (383.33), fruit yield per tree (20.17 kg), fruit weight (51.74 g) juice content (24%) and yield 6.7 t ha⁻¹ were ultimately results in maximum.

2.2 Physico- chemical composition of fruits

Hossain et al. (2001) conducted an experiment in which three varieties of mango were selected to find out the physio-morphological and chemical compositional differences in the fruits. Amrapali possessed highest pulp with skin (87.12%) and lowest stone (11.88%) but the fresh fruit weight was minimum (221.33 g). The variety "Bishawanath" had the highest fresh weight (256.0 g) and stone (18.67%) and lowest in pulp with skin (81.33%), pulp stone ratio (4.4:1) and keeping quality (8.75 days). Keeping quality was higher in Amrapali (12.5 days). Total sugar (26.85%), TSS (23.50%) and pH of pulp (6.0) were higher in Amrapali, but Bishawanath showed maximum titrable acidity (0.87%) and Vitamin C (14.20 mg 100 g⁻¹). So, Amrapali was superior in respect of all characters to other varieties.

Estrada (2004) conducted a study to test the effect of the application of the biofertilizer Maya Magic (MM), clearing and bagging on some quality characteristics

of mango 'Kent' at fruit set, leaving 1 or 2 fruits per panicle, performing 4 to 5 intermittent shakings per branch and eliminating the fruitless inflorescence axes. It was found that fruits with MM, registered the highest total soluble solids content (10.4° brix); the highest resistant to penetration (8.3 pounds) occurred with mere bagging and the highest weight per fruit (452 g), whereas the lowest weight (397 g) per fruit was registered in the conventional control.

Naik and Sri Hari (2007) conducted an investigation under semi-arid tropics of southern Andhra Pradesh, India to study the response of guava (*Psidium guajava* L.) cv. L-49 (Sardar) to different organic manures. The treatments consist of organics, viz. vermicompost (10 kg tree⁻¹), FYM (25 Kg tree⁻¹), pig, sheep, goat and poultry manures and guava leaf litter (each 20 Kg tree⁻¹), NPK (250:350:200g tree⁻¹) and control (without any treatment). The results reveals that treatment with vermicompost resulted in maximum number of shoots plant⁻¹, more number of leaves shoot⁻¹ and highest yield. Further they reported that the TSS was highest with animal manures and least in control. Acidity was highest under FYM treatment closely followed by vermin-compost. Ascorbic acid content was highest in pig manure treatment whereas total sugars and reducing sugars were maximal with goat manure. Thus, the investigation revealed that the performance of vermicompost was superior over other organic sources and closely followed by poultry manure and leaf litter in improving vegetative growth, flowering, fruiting, yield and fruit attributes and fruit quality along with improvement in soil fertility and leaf nutrient status of the guava plant.

Katiyar et al. (2008) conducted an that integrated nutrition trial on guava cv. Sardar with two levels, each of N (400 g and 600 g), Zinc (0 and 20 g) and FYM (0 and 60 kg) during two consecutive years of 2005-06 and 2006-07. Observations recorded revealed that N @ 600 g, FYM 60 kg and Zinc 20 g per plant applied individually caused significant improvement in vegetative growth and weight of fruit. These attributes along with the quality traits e.g. T.S.S., vitamin C and yield per plant improved further in association with either zinc or FYM. The combination of 400g N + 60kg FYM + 20g zinc brought about significant improvement in the weight of individual fruit over 400g N alone.

Singh et al. (2010) conducted a study during 2006-08 on 20-year-old 'New Castle' apricot (*Prunus armeniaca* L.) trees to investigate the conjoint efficacy of bio-organics used along with chemical fertilizers on cropping behaviour, soil properties and quality attributes. They found that application of biofertilizers @ 60 g tree⁻¹, vermicompost 30 kg tree⁻¹, cow urine 12.5% and 50% NPK resulted in significantly maximum bloom density (25.08%), fruit set (62.38%), yield (29.85 kg tree⁻¹), fruit firmness (7.06 kg per cm²), total soluble solids (17.04 °Brix), reducing sugars (3.97%), ascorbic acid (7.29 mg 100 g⁻¹) and total carotenoids (0.96 mg 100 g⁻¹).

Baviskar et al. (2011) study the effect of different combinations of organic, inorganic manures and biofertilizers on yield and quality of sapota at Department of Horticulture, Panjabrao Deshmukh Krishi Vidyapeeth, Akola during 2010-11. The superior fruit quality traits evaluated in terms of fruit weight, fruit size, fruit volume, pulp and peel weight, total soluble solids and total sugar was maximum and lower acidity was recorded in plants which were treated with (1125:750:375 g NPK + 15 kg vermicompost + 250 g Azotobacter + 250 g PSB plant⁻¹).

Mishra et al. (2011) conducted an experiment to determine the effect of organic and inorganic sources of NPK and foliar spray of chemicals on plant growth, fruit yield and quality of ber cv. Gola. Different graded levels of FYM (37.5, 75 and 150 kg plant⁻¹) and Vermicompost (11, 22 and 45 kg plant⁻¹) were supplemented with different doses of inorganic fertilizers and foliar spray of chemicals (control, borax 0.4 per cent and thiourea 0.5 per cent) to balance fertilizer requirement of ber under semi-arid region of northern India. Experimental results revealed that application of 22 kg vermicompost + 0.82 kg urea + 1.15 kg SSP + 0.41 kg MOP per tree (F₅) and foliar spray of thiourea @ 0.5 per cent (T₂) significantly increased the ascorbic acid and iron content of fruits and NPK uptake by fruits were enhanced alongwith improvement in relative leaf water content (RLWC) and chlorophyll content in leaves under treatment F₅ and T₂. All these parameters were appeared to be dose and source dependent and best results were achieved with the combined application of 22 kg vermicompost + 0.82 kg urea + 1.15 kg SSP + 0.41 kg MOP per tree + foliar spray of thiourea @ 0.5 per cent under integrated nutrient management systems of ber orchard.

Yadav et al. (2011) carried out an experiment to evaluate the response of organic nutrients (FYM, Vermicompost and Biodynamic compost), inorganic manures (NPK), biofertilizers (Azotobacter and PSB), micronutrients (zinc and iron) and paclobutrazol (Cultar) on flowering, fruiting, yield and quality of mango cv. Amrapali under high density orcharding. The fruit physical parameters viz., maximum fruit length (9.88 and 10.08 cm), width (6.62 and 6.48 cm), weight (151.25 and 153.00 g), pulp weight (97.06 and 97.08 g), stone weight (26.45 and 26.62 g), pulp: stone ratio (3.693 and 3.694), number of fruits per tree (163.33 and 184.67) and fruit yield (25.00 and 26.72 q/ha) was recorded with T₈ (recommended NPK + vermicompost + Azotobacter + PSB + Zn + Fe + paclobutrazol) closely followed by T₁₂ (recommended NPK + biodynamic compost + Azotobacter + PSB + Zn + Fe + paclobutrazol). However, the chemical composition of fruit viz., maximum TSS (23.72 and 23.91⁰Brix), TSS: acid ratio (191.60 and 197.76), ascorbic acid content (44.13 and 45.63 mg 100 g⁻¹), carotenoids (18.91 and 18.63 mg 100 g⁻¹), reducing sugars (8.35 and 8.39%), non reducing sugar (9.94 and 9.95%), total sugars (18.29 and 18.34%) and minimum acidity content (0.120 and 0.121%) were recorded with the application of T₈ (recommended NPK + vermicompost + Azotobacter + PSB + Zn + Fe + paclobutrazol) which was at par with T₁₂ (recommended NPK + biodynamic compost + Azotobacter + PSB + Zn + Fe + paclobutrazol) during both the years of experimentation.

Devi et al. (2012) an investigation was conducted under sub-tropical conditions of West Bengal, India at the Horticultural Research Station of the university to standardize the organic nutrient management protocol for guava. In this experiment, various organic sources (Farm yard manure (26 kg plant⁻¹y⁻¹), poultry manure (10 kg plant⁻¹y⁻¹), vermicompost (19 kg plant⁻¹y⁻¹) and neem cake (9 kg plant⁻¹y⁻¹) along with various biofertilizer combinations (Azotobacter, Azospirillum, phosphorous solubilizers and potash mobilizers each at 100 g plant⁻¹y⁻¹) were tested on four-year-old guava cultivar 'Sardar' to study its effect on growth, fruiting and yield. The different doses of organic manures were calculated based on the 50% of potash requirement of the recommended dose of guava for the region. The calculated dose along with biofertilizer was applied in two splits in January and August. The results obtained showed higher fruit weight (230.5 and 224.8 g) by application of neem cake

and vermicompost + Azotobacter + phosphorous solubilizers + potash mobilizers. They reported that the treatment combinations with poultry manure + Azospirillum + phosphorous solubilizers + potash mobilizers showed the highest total soluble solids (12°Brix) and total sugar content of fruit (6.67%), whereas the vitamin C content (172.6 mg 100 g⁻¹ pulp) was recorded maximum by application of neem cake.

Chandra et al. (2012) conducted a study during 2007 to 2010 on 15 year old guava orchards at Chandauli (U.P.) India. They reported that the rejuvenated guava tree received IPNM and VAM found to be most effective for promoting fruit weight (1.89 fold) and TSS (1.11fold). The fruit yield was 140.55% higher in under IPNM and VAM followed by IPNM and VAM over the yield of control.

Alila and Azungla (2012) conducted an experiment with 13 INM treatments viz. 100% NPK (T₀), 75% NPK + Azospirillum (T₁), 75% NPK + Azotobacter (T₂), 75% NPK+ Phosphotica (T₃), 50% NPK+ Azospirillum (T₄), 50%NPK + Azotobacter (T₅), 50% NPK+Phosphotica (T₆), 25% NPK+ Azospirillum (T₇), 25% NPK + Azotobacter (T₈), 25% NPK + Phosphotica (T₉), Azospirillum + Phosphotica (T₁₀), Azotobacter + Phosphotica (T₁₁), Azospirillum + Azotobacter + Phosphotica (T₁₂) and evaluated for their effect on yield of the Kaveri variety of in Passion fruit, perennial climber of Passiflora and changes in soil fertility on manure-treated Alfisol. They reported that the highest fruit yield per plant was observed with T₇ (10.0 t ha⁻¹ with fruit weight of 94 g fruit⁻¹), followed by T₆ (9.5 t ha⁻¹ with fruit weight of 100 g fruit⁻¹) and T₁₂ (8.14 t ha⁻¹ with fruit weight of 81 g fruit⁻¹) compared to T₀ (2.7 t ha⁻¹ with fruit weight of 54 g fruit⁻¹). Further they reported that the studies provided strong evidence that a starter dose of inorganic fertilizers is necessary to harness the efficacy of microbial transformations vis-a-vis nutrient availability for improved fruit yield.

Bhowmick et al. (2012) studied the influence of foliar application of zinc sulphate and borax on fruit retention, yield and physico-chemical properties of mango cv. Amrapali at Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya under the new alluvial zone of West Bengal, India. The chemicals, i.e., zinc sulphate (0.5, 1.0 and 1.5%) and borax (0.25, 0.5 and 0.75%) were sprayed at pea and marble stages of fruit growth and development. The

consecutive two years data reveals that the maximum fruit set at marble stage (40.95%), and retained at harvest stage (7.66%), maximum number of fruits per plant (170), and maximum yield per tree (36.00 kg) was obtained with spray of borax (0.5%) whereas, average maximum fruit length (10.33 cm), breadth (6.33 cm), were recorded with borax 0.25% and maximum pulp content (73.57%) was obtained from the treatment with borax 0.75%. Further they reported that maximum TSS (20.75°brix), total sugars (17.08%), non reducing sugar (12.32%), ascorbic acid (41.62 mg 100 g⁻¹ fruit pulp), TSS : acid ratio (115.11) and lowest acidity (0.18%) were recorded with application of 1.0% zinc sulphate.

Singh and Banik (2011) observed that the response of integrated nutrient management on the flowering, fruit setting, yield and fruit quality parameters were subjected to 100:50:50 g NPK/tree (control) (T₁), T₁+ Zn (0.5%) + B (0.2%) + Mn (1%) + Ca (0.6%) as foliar application twice (Aug. and Oct.) (T₂), T₁+organic mulching (10 cm thick of dry leaves) (T₃), T₂ + organic mulching (10 cm thick of dry leaves) (T₄), ½ T₁ + 50kg FYM + 250g Trichoderma (T₅), ½ T₁+ 50 kg FYM + 250g Azospirillum (T₆), ½ T₁+ Azotobacter (250 g) + 50 kg FYM (T₇) and ½ T₁ + Azotobacter (250 g) + 250g Azospirillum (T₈). The observation revealed that the average fruit weight was highest in T₆ (24.2 g) and lowest in T₈ (216.28 g). However, fruit length and breadth was recorded maximum in T₄ (6.8cm) and T₂ (5.80 cm) and minimum in control (6.2 cm) and (5.04 cm), respectively. Seed weight and peel weight was observed highest in T₈ (38.30 g) and T₅ (3.10 g) but lowest in T₆ (26.18 g) and T₄ (24.50 g), respectively but pulp weight was noted maximum in T₆ (189.86g) and minimum T₁ and T₈ (151.48 g). The quality parameters viz., total soluble solid, reducing sugar and total sugar were observed maximum in T₆ (19.24 ° Brix), (4.4 %) and (15.48 %), respectively but minimum in T₂ (17.50 °Brix), T₂ and T₅ (3.6 %) and T₇ (14.04 %), respectively. Acidity was found highest in T₅ (0.21 %) and lowest in T₆ (0.14 %).

Sarker and Rahim (2012) carried out the experiment to investigate the effects of fertilizer and its installment of application on harvesting time, yield and quality of fruits of 8 years old mango plant cv. Amrapali at the Germplasm Centre of Bangladesh Agricultural University, Mymensingh during the fruiting season of 2005-

06. They reported that the plants receiving 150% of the fertilizer dose in three installments, the fruit quality with regard to TSS, pH, titratable acidity, vitamin C, moisture content, dry matter content, reducing sugar, non reducing sugar and total sugar content when plant received higher dose of fertilizer over control in three split doses.

Banepal et al. (2013) conducted an experiment on seven year old guava tree cv. L-49 to study the effect of integrated nutrient management on physico -chemical parameters. They reported that significantly higher fruit diameter (7.91 cm), fruit length (7.52 cm), volume of fruit (217.41 ml), pulp weight (211.61 g), specific gravity (1.02), total soluble solids (11.67 °Brix), total sugars (8.06 %), non-reducing sugar (3.89 %), reducing sugar (4.17 %) and minimum acidity (0.20 %) were recorded with application of 100% N and P₂O₅ + Azospirillum + PSB + 10 kg Vermicompost whereas, highest pulp percentage of 96.0 was obtained under the application of 75% N and P₂O₅ + Azospirillum + PSB + 10 kg vermicompost.

Halder (2013) conducted an experiment to investigate the effect of organic fertilizers on the growth, yield and yield contributing characters of BAU Kul-1 and Apple Kul in Randomized Complete Block Design at Germplasm Centre of Bangladesh Agricultural University, Mymensingh during the period from May, 2012 to February, 2013. The experiment consisted of two varieties of jujube viz. BAU Kul-1 and Apple Kul and eight doses of organic fertilizers viz., 50 kg cow dung plant⁻¹; 40 kg cow dung plant⁻¹; 30 kg cow dung plant⁻¹; 20 kg cow dung plant⁻¹; 10 kg paragon compost plant⁻¹; 5 kg paragon compost plant⁻¹; 2.5 kg paragon compost plant⁻¹ and a Control (no fertilizer). Findings revealed that significant higher number of flowers (117.70) per plant, number of fruits (20.41) per plant, number of harvested fruits (17.36) per plant, individual fruit weight (43.46 g), length (3.83 cm) and breadth (2.88 cm) of fruit, individual seed weight (3.40 g), length (0.80 cm) and breadth (0.45 cm) of seed, total soluble solids (20.09%), pulp thickness (5.74), percent edible portion (91.80) and yield per plant (0.83 kg) were found from manuring with paragon compost 10 kg plant⁻¹ the lowest values of these characters were recorded in the control treatment.

Khayat and Rehiem (2013) studied the effect of using two sources of nitrogen and phosphorous; the first is the mineral fertilizers ammonium nitrate and calcium super phosphate, and the second is the bio-fertilizers Nitrobin and Phosphorin, applied either alone or in combinations to different mandarin trees cultivars; Balady, Clementine and Chinese (Emperor). on the tree growth, leaf mineral contents and fruit quality. Results indicated that, the Balady fruits had the highest leaf potassium and acidity content and higher leaf nitrogen as compared with Clementine, Furthermore. Clementine had the highest total soluble solids content. Meanwhile, the highest vitamin C content occurred in the Chinese variety. Additionally, leaf phosphorous, potassium, as well as fruit acidity contents in the three mandarin varieties increased only by applying 500 g mineral P plus 100 g Phosphorin. In addition, a significant increase in fruit total soluble solids was obtained by applying 300g Nitrobin. Furthermore, the treatment; 500 g mineral P plus 100 g Phosphorin and 250g mineral P + 200g Phosphorin increased fruit diameter. 750 mineral N plus 200g Nitrobin increased fruit length. Moreover, 750 mineral N plus 200g Nitrobin and 300g Nitrobin showed an increase in leaf nitrogen as compared with 1500 g mineral N plus 100g Nitrobin in the first season.

Sharma et al. (2013) conducted an experiment to find out the effect of organic and inorganic sources of fertilizers on yield, quality and nutrient status of winter season guava. The two years pooled data indicates that 25% of N tree⁻¹ through FYM + 75% of N tree⁻¹ through inorganic fertilizer showed highest fruit yield (41.14 kg plant⁻¹) maximum fruit length (8.39 cm), breadth (7.94 cm), weight (244.24 g) and pectin (0.81%), while, Azotobacter + 50% of N tree⁻¹ through FYM + 50% of N tree⁻¹ through inorganic fertilizer showed highest TSS (12.95 °Brix), total sugars (8.61%) and minimum physiological loss in weight (14.29%) after ten days under ambient conditions

Lembisana et al. (2014) conducted a experiment under subtropical conditions of West Bengal, India at the Horticultural Research Station of the University with an aim to standardize the organic nutrient management protocol for litchi. Various organic sources viz., farm yard manure at 60 kg tree⁻¹ year⁻¹, poultry manure at 21.4 kg tree⁻¹ year⁻¹, vermicompost at 42.86 kg tree⁻¹ year⁻¹ and neem cake at 20.28 kg tree⁻¹ year⁻¹

along with combinations biofertilizer (*Azotobacter*, *Azospirillum*, phosphorous solubilizers and potash mobilizers each at 100 g/tree/ year) were tested on 32-year-old litchi cultivar 'Bombai'. These trees were not fertilized with any nutrients for five years prior to the experiment. The different doses of nutrients were calculated based on the 50% of the potassium requirement of the crop in this region and were applied in two split doses in January (after fruit set) and July (after fruit harvest). Application of farm yard manure + *Azotobacter* + phosphorous solubilizers + potash mobilizers resulted in greater fruit weight (24.73 g). The number of fruits (2556) and fruit yield (61.59 kg compared to 23.94 kg in control) per tree were greater with vermicompost + *Azotobacter* + phosphorous solubilizers + potash mobilizers. Treatment combinations with farm yard manure + *Azotobacter* + phosphorous solubilizers + potash mobilizers showed higher total soluble solids (17.79 °Brix) and total sugar content (17.57%), whereas vitamin C content (53.48 mg 100 g⁻¹ pulp) was higher where a combination of neem cake + *Azospirillum* + phosphorous solubilizers + potash mobilizers was applied. Addition of biofertilizers along with organic manure was more effective in enhancing fruit growth parameters in litchi than the use of organic manure alone. Application of vermicompost at (42.86 kg tree⁻¹year⁻¹) + *Azotobacter* + phosphorous solubilizers + potash mobilizers each at 100 g/tree/year in two split doses (January and July) is recommended for the organic production of the 'Bombai' litchi.

Dwivedi et al (2014) studied the effect of organic and inorganic fertilizers on the performance of Cape gooseberry during 2013-14 at Horticulture Farm, Lucknow with twelve treatments replicated thrice was laid down in randomized block design. Biofertilizers used were *Azotobacter* (@ 1.5 kg ha⁻¹), PSB (each @ 1.5 kg ha⁻¹) and Vermicompost (@ 1kg/plant) (alone and in combination) along with NPK doses. They reported that the higher fruit weight (10.46 g) and fruit yield (224.07 g) was found maximum under *Azotobacter* @ 1.5 kg ha⁻¹. Average number of fruits (5.44, 13.22 and 16.55 after 90, 105 and 120 days of transplanting, respectively), fruit size in polar diameter (26.97 mm) and fruit size in equatorial diameter (33.73 mm) were recorded better under treatment PSB + Vermicompost. The maximum fruit specific gravity 1.04 was observed in 100% NPK) and maximum TSS (15.44%) with application of PSB + Vermicompost.

Kishore et al (2014) carried out an investigation to find out the effect of intercropping along with organic and inorganic fertilizers on yield and quality of apple. Apple trees were intercropped with pea and cauliflower along with four different treatment combinations comprising FYM + Inorganic (Recommended dose), FYM + Vermicompost + Inorganic, FYM + Vermicompost + Bio-fertilizers + Inorganic and FYM + Inorganic (half of the recommended doses). Physico-chemical characteristics of fruits i.e. length, diameter, fruit weight, firmness, total soluble solids (TSS), total acidity, ascorbic acid, reducing, total sugars and yield per tree were determined. Treatment comprising Pea as intercrop+FYM+Vermicompost+Bio-fertilizer+ Inorganic registered highest average yield per tree (19.9 kg) as compared to other treatments. This treatment also significantly improved the fruit qualities like TSS (13.7 °B).

Kumar et al (2014) studied the effect of Vermicompost, Urea and *Azotobacter* on growth and quality attributes of Sweet Charlie cultivar of strawberry (*Fragaria x ananassa* Duch.) during 2013-2014. Vermicompost, Urea and *Azotobacter* were applied separately (100% each) and in combination with each other (25%, 50% and 75% each) at 100 q ha⁻¹, 100 kg ha⁻¹ and 30 ml litre⁻¹ water, respectively. Different treatment combinations revealed significantly positive effect on most of the parameters studied under the experiment. The maximum T.S.S (10.29 °B), Vitamin-C (72.267 mg 100 g⁻¹.pulp), reducing sugars (4.60%) and total sugars (5.549%) were also found same treatment. Maximum titrable acidity (0.79%) was recorded in control. Vermicompost with higher concentration along with urea and *Azotobacter* resulted in increased vegetative growth and quality of fruits. Conclusively, treatment with 50% vermicompost, 25% *Azotobacter* and 25% urea was found to be the most effective among all other treatments to improve growth and quality traits of strawberry cv- Sweet Charlie.

Lal and Dayal (2014) carried out an investigation on integrated nutrient management in acid lime (*Citrus aurantifolia* Swingle) with nine treatments, T₁- Control (500 : 300 : 300 g NPK per tree through fertilizers), T₂- 2/3 RDF + 1/3 through Goat manure, T₃- 2/3 RDF + 1/3 through Neem Cake, T₄- 1/3 RDF + 2/3 through Goat manure, T₅- 1/3 RDF + 2/3 through Neem Cake, T₆- 50% RDF + 50% through Goat manure, T₇- 50% RDF + 50% through Neem Cake, T₈- 100% RDF as Goat manure,

T₉- 100% RDF as Neem Cake. The reported that the highest fruit length (4.43 cm), fruit diameter (3.99 cm) and fruit weight (35.71 g) as well as maximum juice (43.37%), TSS (10.42%) and Ascorbic acid (86.33 mg/100 g juice) content was recorded under 50% RDF + 50% through goat manure.

Masalkar et al (2014) conducted an experiment consisting of 11INM treatments with an object to study the influence by integrated nutrient management treatments and its impact on physico-chemical characteristics of pomegranate. They reported that the quality parameters were found to be statistically non-significant. The range of rind thickness (38.10 to 40 mm), seed hardness (2.42-2.99 kg cm⁻²), total soluble solids (15.87 to 16.82 °Brix), acidity (0.35 to 0.38%), total sugars (15.00 to 16.55%), aril per cent (57to 62%), rind per cent (38 to 43%), juice per cent (59 to 63%) were recorded. Furthermore, the maximum average weight of fruit (370 g) was recorded in the treatment 50% N through chemical fertilizers and 50% N through FYM with biofertilizers.

2.3 Fruit yield

Chowdhury and Rahim (2007) studied different fertilizers on the control of anthracnose disease, yield and quality of mango cv Amrapali. Results of investigation reveals that application of combined fertilizers gave the highest fruit set, fruit retention and fresh fruits, therefore, produced the highest yield per plant and per hectare. The highest number of healthy fruits was found from 2nd year crop and the lowest was obtained from 1st year. The highest (8.47 t ha⁻¹) yield was obtained from 2nd year and the lowest (4.58 t ha⁻¹) was obtained from 1st year crop. Among the treatments, combined application of NPK, ZnSo₄, Gypsum and Cowdung gave the highest (50.67) number of healthy fruits and the lowest (16) was obtained from untreated plant. The highest (12.41 t ha⁻¹) yield was obtained from combined application of NPK, ZnSo₄, Gypsum and Cowdung and the lowest (3.88 t ha⁻¹) was obtained from untreated plant. In respect of combined effect, the highest (15.22t ha⁻¹) yield was obtained from 2nd year x T₉ treated plant and the lowest (2.95 t ha⁻¹) was found in untreated 1st year plant.

Kundu et al. (2011) carried out experiment to find out the effect of biofertilizers and inorganic fertilizer in Amrapali mango trees of 10 years old which were planted in the year 1995 at 5m x 5m spacing and subsequently pruned during January 2004 at 2.5m height. Three levels of inorganic fertilizers (100% NPK, 75% NPK and 50% NPK) were applied alone and also in combinations with different biofertilizers (Azotobacter, Azospirillum and VAM. Among sixteen treatments, all the inorganic and biofertilizers combinations exhibited profound effect on growth, yield and fruit quality and leaf mineral composition than inorganic fertilizer alone. However, the efficiency of inorganic fertilizer at three levels was more when supplemented with both Azotobacter and VAM. Higher fruit yield was obtained when the plants were treated with 100% NPK + Azotobacter + VAM (98.1kg/plant) or 75% NPK + Azotobacter + VAM (93.3 kg plant⁻¹) as compared to much lesser yield (60 kg plant⁻¹) with 100% NPK. It was concluded that the treatments 100% NPK + Azotobacter + VAM and 75% NPK + Azotobacter + VAM were effective and may be adopted to improve the vegetative growth and productivity with quality fruits

Mitra et al (2012) conducted an investigation under sub-tropical condition of West Bengal, India to standardize the organic nutrient management protocol of 'Sardar' guava under high density (625 plants ha⁻¹) planting. Different organic sources of nutrients (neem cake, vermicompost, farm yard manure and poultry manure) and biofertilizers (azotobacter and azospirillum) and found that application of neem cake along with azotobacter significantly increased yield, fruit size and improve quality of fruit. The treatment also showed the maximum cost benefit ratio of 3.18 compared with 1.48 in control. Application of organic manures along with bio-fertilizers substantially increased soil microbial population which improved soil health and thereby the growth and productivity of guava trees.

Sarker and Rahim (2012) carried out the experiment to investigate the effects of fertilizer and its installment of application on harvesting time, yield and quality of fruits of 8 years old mango plant cv. Amrapali during the fruiting season of 2005-06. They reported that the plants receiving 150% of the fertilizer dose in three installments caused delayed harvest by 11 days than that of the control. Plants treated with 150% of fertilizer dose in combination with three installments produced

the highest number of fruits (96 plant^{-1}) as well as the highest yield ($19.55 \text{ kg plant}^{-1}$) as compared to control (23 plant^{-1} and $3.48 \text{ kg plant}^{-1}$).

Yadav et al. (2012) conducted investigation to study the effect of nutrient management through organic sources on guava trees and they reported that application of various organic substances increased growth of trees, fruit yield and quality as compared to untreated ones (control). The highest values of these parameters were recorded for trees applied with poultry manure followed by the trees applied with FYM. Application of poultry manure on guava trees significantly increased number of fruits per plant and resultantly higher yield (kg tree^{-1}) was achieved as compared to control. The recorded values of total soluble solids and total sugar were also found significantly higher with the application of poultry manure.

Dhomane and Kadam (2013) conducted an investigation in order to estimate the influence of organic and inorganic sources of nitrogen, the present experiment was conducted on 5 years old Sardar guava trees growing at Instructional - cum Research Farm, Department of Horticulture, College of Agriculture, Latur during 2009 to 2010. For the investigation, different sources of nitrogen namely; urea, vermicompost, neem cake, farmyard manure (FYM), poultry manure and green manure in combination were used. The results of the experiment revealed that integration of organic manures and inorganic fertilizers was more effective in increasing yield and quality of guava trees than the inorganic fertilizers alone. Among the various combinations, 75% of nitrogen through urea along with 25% nitrogen through neem cake was found the best over most of the treatments in respect of yield parameters like weight of fruit (243.80 g), yield per tree (58.1 kg) and yield per hectare (23.26 tonnes), gross returns (2, 32, 700 Rs. ha^{-1}), net returns (2, 06, 690 Rs. ha^{-1}) and highest B: C ratio (8.94).

Muthu and Ponnuswami (2013) observe the combined effect of 100% crop water requirement through drip irrigation + 50% farmyard manure + 50% vermicompost recorded the highest scores for pulp recovery (47.12%), juice recovery (34.32%), TSS (11.26 °Brix), ascorbic acid ($197.82 \text{ mg } 100 \text{ g}^{-1}$), titrable

acidity (0.392%), fruit firmness (3.26 kg per cm²), total carbohydrate (584.39 mg 100 g⁻¹), total phenol (374.26 mg 100 g⁻¹), total carotenoids (0.177 mg 100 g⁻¹), protein (412.95 mg 100 g⁻¹) and total flavonoids (128.53 mg 100 g⁻¹) content of noni fruits.

Sarker and Rahim (2012) carried out an experiment at the Germplasm Centre of Bangladesh Agricultural University, Mymensingh during 2005-06 to investigate the effects of fertilizer and its installment of application on harvesting time, yield and quality of fruits of 8 years old mango plant cv. Amrapali. Four fertilizer doses i.e. T₁ : 50% of the fertilizer dose (cowdung 12.5 kg, urea 375 g, TSP 200g, MoP125 g, gypsum 125 g and zinc sulphate 7.5 g plant⁻¹), T₂ : 100% of the fertilizer dose (cowdung 25 kg, urea 750 g, TSP 400 g, MoP 250 g, gypsum 250 g and zinc sulphate 15 g per plant), T₃ : 150% of the fertilizer dose (cowdung 37.5 kg, urea 1125 g, TSP 600 g, MoP 375 g, gypsum 375 g and zinc sulphate 22.5 g per plant), and T₄ : control (no fertilizer) and three splits of application i.e. A₁ : One installment (whole fertilizer applied on 15 September), A₂ : Two installments (15 September and 15 March) and A₃ : Three installments (15 September, 15 March and 15 May) were included as treatments. Plants receiving 150% of the fertilizer dose in three installments caused delayed harvest by 11 days compared to control than that of the control. Plants treated with 150% of fertilizer dose in combination with three installments produced the highest number of fruits (96/plant) as well as the highest yield (19.55 kg plant⁻¹) as compared to control (23/plant and 3.48kg plant⁻¹).

Dwivedi (2013) conducted an experiment during 2009-10 to evaluate the effect of integrated nutrient management on yield, quality and economics of guava. Application of 50% RDF (250:100:250 g NPK) + 25kg FYM + 5kg vermicompost tree⁻¹ and 100% RDF (500:200:500 g NPK) + Zn, B, Mn foliar spray + organic mulching 10 cm thick /tree were found significantly superior than other INM treatments with respect to yield attributes, yield and economics from guava cv. Allahabad Safeda . Under these treatments, fruit yield ranged from 89.07 to 90.0 q ha⁻¹ and economics from Rs.53204 to Rs.53439 ha⁻¹. Only total soluble solids were found in the higher range (12.23 to 12.43 °Brix) in treatment (500:200:500 g NPK tree⁻¹ as control) and treatment (500:200:500 g NPK tree⁻¹ + organic mulching@10cm thick). Other fruit qualities as well as fruit size were not influenced significantly due to INM treatments.

Sarker and Rahim (2013) conducted a study on nine year old tree of mango (*Mangifera indica* L.) cv. Amrapali to determine the effects of KNO₃ and urea in manipulating the harvesting time and increasing yield as well as quality. They reported that the foliar spraying of urea at 4% exhibited better performance in relation to terminal shoot length, number of leaves and leaf area and potassium nitrate at 4% gave superior results with respect to length and breadth of panicle and number of secondary branches per panicle compared to control. The plants sprayed with KNO₃ at 4% expressed earlier panicle appearance by 17 days as compared to delayed appearance of panicle in untreated control plants. Further they reported that the 4% spray of KNO₃ produced higher number of panicles (220.67), fruits (136.67) and yield (23.14) plant⁻¹. Whereas the control plants had the least number of panicles (107.67) fruits (62.67) and yield (9.12 Kg). Regardless of concentration, KNO₃ and urea manifested slightly earlier harvest (5 days) compared to control. The spray of urea (4%) resulted higher fruit weight (202.83 g) and exhibited the lower fruit weight (175.00 g) control plants.

Lal and Dayal (2014) carried out an investigation on integrated nutrient management in acid lime (*Citrus aurantifolia* Swingle) with nine treatments, T₁- Control (500 : 300 : 300 g NPK per tree through fertilizers), T₂- 2/3 RDF + 1/3 through Goat manure, T₃- 2/3 RDF + 1/3 through Neem Cake, T₄- 1/3 RDF + 2/3 through Goat manure, T₅- 1/3 RDF + 2/3 through Neem Cake, T₆- 50% RDF + 50% through Goat manure, T₇- 50% RDF + 50% through Neem Cake, T₈- 100% RDF as Goat manure, T₉- 100% RDF as Neem Cake. They reported that the maximum vegetative growth and yield (7.58 kg tree⁻¹) of fruits was recorded under 50% RDF + 50% through goat manure.

2.4 Nutrient content in leaves

Srivastava et al. (2002) reported that the Mycorrhizae found to be highly effective in low fertility coarse textured soils. Mycorrhizal-treated trees had better plant growth and uptake of nutrients like P, Ca, Zn, Cu, and Fe compared to non-mycorrhizal trees. Inoculation of soil with mycorrhizae helped in regulating the water relations and carbohydrate metabolism of citrus trees. Phosphorus nutrition of

mycorrhizal-treated citrus trees was best improved by using rock phosphate as a source of P as opposed to other sources.

Naik and Sri Hari (2007) conducted an investigation under semi-arid tropics of southern Andhra Pradesh, India, to study the response of guava (*Psidium guajava* L.) cv. L-49 (Sardar) to different organic manures. The treatments consist of organics, viz. vermicompost(10 kg tree⁻¹), FYM (25 Kg tree⁻¹), pig, sheep, goat and poultry manures and guava leaf litter (each 20 Kg tree⁻¹), NPK (250:350:200g tree⁻¹) and control (without any treatment). Results showed that the irrespective of the treatment, leaf N remained almost the same before and after the trial. On the other hand, the leaf P and K showed an increase after the termination of the trial due to various treatments except control. The present investigation also revealed that the vermicompost was superior over other organic sources and closely followed by poultry manure and leaf litter in improving vegetative growth, flowering, fruiting, yield and fruit attributes and fruit quality along with improvement in soil fertility and leaf nutrient status of the guava plant.

Boshra et al. (2011) study the influence of biofertilization with nitrobiene at 50, 100 and 200 g/tree, phosphorene at 5, 10 and 20 g tree⁻¹ and potassimne at 250, 500 and 1000 ppm on leaf mineral content, yield, physical and chemical properties of Ewaise mango fruits were studied during 2009 and 2010 seasons. They reported that all biofertilizers were very effective in enhancing the nutritional status of the trees, yield, physical and chemical characters of the fruits. The best results with regard to nutritional status of the trees, yield and fruit quality were obtained when Ewaise mango trees were bio-fertilized twice with nitrobiene at 200 g tree⁻¹ or phosphorene at 20 g tree⁻¹ and once or three times with potassine at 1000 ppm.

Khan et al. (2013) examined the effect of plastic mulching, three soil metric potentials (SMP) treatments {I₁(-20 kPa), I₂(-40 kPa), and I₃(-60 kPa)} and three fertigation levels {F₁(100%), F₂(80%), and F₃(60%) recommended dose of fertilizer} under drip irrigation conditions for nutrient uptake, growth parameters and yield in guava plants during the year 2012-13. The investigation indicated that the varying range of leaf nutrients under different treatments of irrigation, fertigation and mulch is

1.26-1.74% N, 0.14-0.26% P, 0.44-0.88% K, 36.33-74.23 ppm Zn, 11.33-32.76 ppm Cu, 415.6- 557.3 ppm Fe, 26.80- 39.06 ppm Mn, 0.533-0.762 % Mg and 3.42-5.06% Ca.

2.5 Effect on soil environment

Minhas and Mehta (1984) reported a decrease in pH to the extent of 0.3 to 0.6 units over the initial value of 7.5 due to NPK fertilizer application. Similar results have also been reported by Gattani *et al.* (1976) who stated that removal of cations increased due to higher production of these ions under well fertilized plots which might have contributed indirectly towards the lowering of soil pH.

Bhandari et al. (1992) found that organic carbon content of soil increased significantly with application of 100 per cent RDF(NPK). The conjunctive use of organic manures such as FYM or green manure with fertilizer further increased the organic carbon content of soil.

Hapse (1993) reported that vermicompost application enhanced the organic carbon content of soil as compared to fertilizer alone.

Krishnamurthy (1995) found that application of organic manures recorded significantly higher organic carbon content of the soil. Further, he stated that combined application of vermicompost and Azospirillum also recorded higher organic carbon in the soil (0.61)

Vasanthi and Kumaraswamy (1999) revealed that the application of poultry manure or sheep/goat manure @10 t t/ha along with 50 per cent RDF significantly increased organic carbon content soil as compared to only inorganic fertilizers in red clay loam soil.

Hangarge et al. (2002) in a field experiment at Marathwada Agricultural University in Parbhani showed that application of vermicompost at 5 t per ha + organic booster at 1 lit per m² enhanced the availability of N, P₂O₅, K₂O and organic carbon in soil then also concluded that recommended dose of N, P₂O₅, K₂O and organic sources each alone couldn't perform significantly. The combined effect of

organic + inorganic sources proved to be better either organic alone or combination of organic +inorganic fertilizer.

A field experiment was conducted by Kannan et al. (2005) during December - May (2003-2004) with tomato (*Lycopersiconesculentum*. Mill) Var, PKM 1 as a test crop in Agricultural College and Research Institute, Madurai to study the influence of different organic N sources viz, FYM, Vermicompost and coir pith compost with biofertilizers on the soil physical properties, nutrient availability and biological properties. Based on N content of the organic N sources on dry weight basis, the quantity required for the substitution of recommended doses at 50, 75 and 100 per cent level worked out and applied along with 2 kg azospirillum. Application of different organics with azospirillum favorably influenced the soil physical, chemical and biological environment such as bulk density, water holding capacity, organic carbon, available nitrogen, beneficial bacterial and fungal population over the inorganic alone applied plot. Among different organic N sources, the application 75 per cent Vermicompost with azospirillum was found to be superior in improving soil health over the other treatments. The above finding revealed that organic farming would able to sustain the soil fertility for a longer period by meeting the demands of present and future generation.

Govindan and Thirumurugan (2005) noticed that application of organic manures markedly improved soil available nitrogen status. Among them application of vermicompost equivalent to 100 per cent N, 75 per cent N and composted coirpith equivalent to 75 per cent RDN recorded higher soil available N status (110.3) kg ha⁻¹, 133 kg ha⁻¹ respectively after soybean) over 100 % inorganic NPK (92.4 kg ha⁻¹) treatment.

Pandey et al. (2006) reported that application of manures recorded significantly higher soil organic, available N, P₂O₅ and K₂O as compared to control. Higher content of organic carbon in soil may be due to increased yield of roots and plant residues, and external application of organic manures.

Naik and Sri Hari (2007) conducted an investigation under semi-arid tropics of southern Andhra Pradesh, India, to study the response of guava (*Psidium guajava* L.)

cv. L-49 (Sardar) to different organic manures. The treatments consist of organics, viz. vermicompost (10 kg tree^{-1}), FYM (25 Kg tree^{-1}), pig, sheep, goat and poultry manures and guava leaf litter (each 20 Kg tree^{-1}), NPK ($250:350:200 \text{g tree}^{-1}$) and control (without any treatment). The treatment with vermicompost resulted in maximum number of shoots plant^{-1} , more number of leaves shoot^{-1} and highest yield. They noted that the soil pH decreased in all treatments, whereas EC increased in all the treatments. Similarly organic carbon content increased in all manurial treatments. This trend was almost similar with soil NPK. Thus, the present investigation revealed that the performance of vermicompost was superior over other organic sources and closely followed by poultry manure and leaf litter in improving vegetative growth, flowering, fruiting, yield and fruit attributes and fruit quality along with improvement in soil fertility and leaf nutrient status of the guava plant.

Marathe et al. (2009) conducted a field experiment to study the effect of integrated supply of organic manures, inorganic fertilizers and biofertilizers on soil properties and yield of sweet orange (*Citrus sinensis*) grown on Vertisol. The treatments consist of farmyard manure, vermicompost, wheat straw and green manuring with sunnhemp alone or with inorganic or biofertilizers. The organic manurial matter showed to be highly effective to improve the physical properties of soil, farmyard manure to meet 100% N being the best. Application of wheat straw along with inorganic fertilizer was equally effective, especially for infiltration characteristics of soil. Combined application of various organic manures to meet 50% N along with 50% of NPK and biofertilizers recorded significant increase in available N, P and K content in the soil with maximum fruit yields. Considerable increase of available Zn and Mn was observed with farmyard manure application and of Fe with vermicompost application alone or in combinations with inorganic fertilizers.

Gunjan et al. (2010) reported on soybean that the uptake of NPK was significantly increased with increased levels of FYM. Application of RDF with organics i.e. FYM 5 t ha^{-1} recorded significantly higher uptake of N, P and K (218 , 28.48 and $125.51 \text{ kg ha}^{-1}$) over the control (135.84 , 14.66 and 82.68 kg ha^{-1}). Increasing the soil fertility status (available NPK) upto of $50 \text{ kg N} + 75 \text{ kg P}_2\text{O}_5 + 50 \text{ kg K}_2\text{O} + 5 \text{ t FYM}$. (N 237.32 , P 26.30 and K $337.03 \text{ kg ha}^{-1}$).

The experiment on Dashehari comprising 18 treatment combinations of FYM, vermicompost, NPK, Azotobacter, Trichoderma harzianum, phosphorus solubilizing micro-organisms and mulching was in the fifth year of progress at CISH, Lucknow. Anonymous (2011) the results of this study reveals that there was an increase of 37.5 per cent in organic carbon content over the initial level (0.32%) by the application of substrate treatments. Maximum organic carbon build up (0.44 %) was recorded in treatment FYM + NPK+ Azotobacter + PSM + Trichoderma harzianum + organic mulch (10 cm thick) as against 0.32 per cent where no FYM or vermicompost was applied. Available N, P and K were minimum (61.3, 18.2 and 62.7 ppm) in the treatments receiving no N, P or K fertilizers. In general, status of available N was low and available P and K was high in all the treatments. DTPA extractable Fe, Mn, Zn and Cu contents ranged from 6.22 to 10.97, 7.02 to 12.05, 1.25 to 3.55 and 1.34 to 6.49 ppm, respectively. These nutrients were in lower amounts in the treatments where organic matter was not added to the soil. Both macro as well as micro-nutrient contents increased in the treatments comprising FYM and or vermicompost and NPK with mulching; however, there was no significant difference due to treatments.

Raina et al. (2011) carried out an investigation at Progeny-cum-Demonstration Orchard Charna, Distt. Sirmour (HP) for two years to evaluate the effect of conjoint application of chemical fertilizers and organic manures on soil nutrient status, tree growth, yield and quality of apple fruits. Conjoint applications of organic fertilizers did not influence the soil pH, EC and bulk density however; its application has improved the organic carbon, N, P, K, Zn and Fe status of soils.

Vidyavathi et al. (2011) conducted a field experiment at UAS, Dharwad, Karnataka and found that integrated application of manure and fertilizers resulted in significantly higher available N, P_2O_5 , K_2O and S than chemical fertilizers alone. Significantly higher uptake of N, P and K was recorded in integrated nutrient management practice compared to inorganic nutrient management

Sharma et al. (2013) conducted an experiment to find out the effect of organic and inorganic sources of fertilizers on yield, quality and nutrient status of winter season guava. The two years pooled data revealed that highest soil nitrogen and

phosphorous (269.97 and 19.77 kg ha⁻¹), Ca & Mg (7.03 and 2.76 mg 100 g⁻¹ soil), leaf nitrogen and phosphorous (1.76 and 0.26%) and leaf Ca and Mg (2.01 and 0.86%) contents, respectively, was obtained with the treatment comprising Azotobacter + 25% of N tree⁻¹ through FYM + 75% of N tree⁻¹ through inorganic fertilizer, whereas, the highest soil potassium (148.23 kg ha⁻¹) and leaf potassium (1.25%) contents was obtained with the application of Azotobacter + 50% of N tree⁻¹ through FYM + 50% of N tree⁻¹ through inorganic fertilizer.

Adak et al. (2014) changes in soil organic carbon, dehydrogenase activity, nutrient availability and leaf nutrient concentrations in a mango orchard soil was evaluated from four years (2007-2011) field experiment on a Typic Ustocrepts of subtropical region in Lucknow, India. Organic (FYM, vermicompost, mulching, Azotobacter, PSM and Trichoderma harzianum) and inorganic (N,P,K) substrates were applied each year within the tree basin. It was observed that soil and leaf nutrients concentrations significantly increased in organic and inorganic amended soils as compared to control. Vermicompost, organic mulching and microbial inoculation significantly enhanced soil organic carbon content, available nutrients, dehydrogenase activity and leaf nutrient concentrations. Dehydrogenase activity was the highest (1.85 µg TPF g⁻¹ h⁻¹) in organically treated soils. Surface soil (0-10 cm depth) showed higher dehydrogenase activity (1.29 to 1.85 µg TPF g⁻¹ h⁻¹) as compared to lower soil depths in all the treatments.

Lembisana et al. (2014) conducted an experiment to standardize the organic nutrient management protocol for litchi. Various organic sources viz., farm yard manure at 60 kg tree⁻¹ year⁻¹, poultry manure at 21.4 kg tree⁻¹ year⁻¹, vermicompost at 42.86 kg tree⁻¹ year⁻¹ and neem cake at 20.28 kg tree⁻¹ year⁻¹ along with combinations biofertilizer (*Azotobacter*, *Azospirillum*, phosphorous solubilizers and potash mobilizers each at 100 g tree⁻¹ year⁻¹) were tested on 32-year-old litchi cultivar 'Bombai'. These trees were not fertilized with any nutrients for five years prior to the experiment. The different doses of nutrients were calculated based on the 50% of the potassium requirement of the crop in this region and were applied in two split doses in January (after fruit set) and July (after fruit harvest). They reported that application of nutrients through organic source along with biofertilizers improved soil health by

increasing the microbial population in the rhizosphere. Application of vermicompost at $(42.86 \text{ kg tree}^{-1}\text{year}^{-1}) + \text{Azotobacter} + \text{phosphorous solubilizers} + \text{potash mobilizers}$ each at $100 \text{ g tree}^{-1} \text{ year}^{-1}$ in two split doses (January and July) is recommended for the organic production of the 'Bombai' litchi.

2.6 Malformation with respect to nutrient content in leaves

Pandey et al. (1977) studied the changes in carbohydrate reserves and total nitrogen and the anatomy of healthy and malformed shoots of mango cultivars Dashehari and Chausa both before and after the fruit-bud differentiation. Acid hydrolysable polysaccharides and total carbohydrates remained at higher levels in leaves, stems and panicles of malformed shoots as compared to healthy ones in both the cultivars. The total nitrogen did not show much change. Marked anatomical differences were noted in rachis of both types of panicles. The floral malformation was observed to be associated with the accumulation of excessive amounts of acid hydrolysable polysaccharides.

Dashhan (1987) reported that the activities of endogenous auxin and gibberellins were considerably increased in malformed panicle and the accumulation of hormones in malformed panicle which is closely associated with an ineffective translocation of hormones from the panicle of the shoot.

Singh and Dhillon (1989 a) analysed the healthy and malformed panicles and shoots for total nitrogen, protein content and amino acid at different stages of panicle viz. (I) fully swollen buds, (II) bud inception, (III) full grown panicles prior to full bloom and (IV) full grown panicles at full bloom. Malformed buds at stage (I & II) had the higher nitrogen, protein content and total amino acids than healthy ones, whereas the trend was reverse in stages III and IV. Nitrogen and protein content was higher in shoots bearing healthy panicles than those bearing malformed panicles in stages I and II, whereas, nitrogen and protein content was higher in shoots bearing malformed panicles in stages III and IV than healthy ones.

Singh and Dhillon (1989b) reported that the malformed seedlings possessed higher concentration of total nitrogen, protein and amino acids than healthy seedlings. Likewise, the contents of basic, acidic, neutral, and aromatic and sulphur -

containing amino acids were also higher in malformed seedlings as compared to the healthy ones. Further infected plant contains higher percentage of ammonia.

Singh et al. (1991) collected the samples of malformed and healthy panicles of mango (*Mangifera indica* L.) as well as leaves and shoots bearing them at different stages of development (fully swollen buds, bud inception, fully grown panicles prior to full bloom and at full bloom) over two consecutive years and were analysed for their macro and micronutrient status. In addition, malformed and healthy seedlings were collected and analysed. Malformed panicles were found to be significantly higher in N at all the developmental stages except at bud inception. Phosphorus and K also tended to accumulate in malformed panicles at later stages of their development. In general, malformed panicles exhibited lower levels of P, K and Ca than healthy panicles. The differences in levels of Mg and S in malformed and healthy panicles were not significant. All micronutrients were in much lower concentrations in malformed panicles except for Mn which appears to accumulate in malformed panicles particularly at the early stages of development. The leaves on the shoots bearing malformed panicles also showed a tendency to accumulate N, while P, Mg and S were always higher in leaves on shoots bearing healthy panicles. The leaves on shoots bearing healthy panicles had lower levels of Fe, Cu and Mn, whereas levels of Zn and B tended to be higher in leaves on shoots bearing malformed panicles. The nutrient concentration differences between the two kinds of shoots were generally non-significant ($P=0.05$), except for K and S which were significantly lower in shoots bearing malformed panicles. The shoots bearing malformed panicles showed significantly ($P=0.05$) higher levels of almost all nutrients compared with shoots bearing healthy panicles. Vegetative malformation was found to be associated significantly ($P=0.05$) with higher amounts of all nutrients except Ca which was significantly higher in healthy seedlings. The present study, therefore, seems to point to lower Ca as one of the pre-disposing factors causing malformation in mango.

Singh et al. (1994) analyzed the contents of Fe, Zn, Mn, Cu and Co in malformed and healthy panicles of mango leaves and shoots bearing fully swollen bud, bud inception, fully grown panicles prior to full bloom and at full bloom. They found that the concentrations of Fe, Zn, Cu, Mn and Co varied in malformed and

healthy tissues at various developmental stages. Malformed panicles exhibited lower level of Fe, Zn, Cu and higher Mn than healthy ones. The leaves on the shoots bearing malformed panicles showed higher levels of Fe, Mn, Cu and higher Zn than the leaves on the shoots bearing healthy panicles. The shoots bearing malformed panicles revealed higher levels of Fe, Zn, Mn and. Cu than shoots bearing healthy panicles. The levels of Co in healthy and malformed organs did not differ much. They reported that, malformation in mango is not caused by the deficiency of these micronutrients.

MATERIAL AND METHODS

MATERIAL AND METHODS

The investigation deals with the “**Effect of organic and inorganic source of nutrients on growth, flowering, fruiting, yield and quality of mango (*Mangifera indica* L.) cv. Amrapali under high density planting**”. For this a field experiment was conducted at Horticulture Complex, Department of Horticulture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during the year 2012-13 and 2013-14. The details of the experiments and methods followed during the course of present investigation are described under following heads;

3.1 Experimental Site

The experiment was carried out at Horticulture Complex, Department of Horticulture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) which is situated at 22°49' and 20°80' North latitude and 78°21' and 80°58' East longitude at an attitude of 411.78 meter above the mean sea level. The tropic cancer passes through middle of the district.

3.2 Soil characteristics

Physico-chemical composition of the soil was determined and results are given in Table 3.1. The soil of experimental site was clay loam in texture (58.4% clay, 21.5% silt and 20.1% sand) with good drainage having pH 7.4, electric conductivity (0.25 dSm⁻¹), bulk density (1.48 Mg m⁻³) available N (230.7 kg ha⁻¹), P (12.6 kg ha⁻¹) and K (340.2 kg ha⁻¹) and with low organic carbon (0.47%).

Table 3.1 Physico-chemical composition of soils of the experimental field.

Constituent	Value	Interpretation	Method
A. Physical properties			
1. Sand (%)	20.1	Clay loam in texture	International pipette method (Piper, 1967)
2. Silt (%)	21.5		
3. Clay (%)	58.4		

Constituent	Value	Interpretation	Method
B. Chemical properties			
1. Organic carbon (%)	0.47	Low	Walkey and Black (Black, 1965)
2. Available N kg ha ⁻¹	230.7	Medium	Alkaline permanganate method (Subbiah and Asija, 1956)
3. Available P kg ha ⁻¹	12.6	Low	Colorimetric method Jackson, 1965
4. Available K kg ha ⁻¹	340.2	Medium	Flame photometer Jackson, 1965
5. pH (1:2)	7.46	Normal	pH meter (Piper, 1967)
6. Electrical Conductivity (dSm ⁻¹)	0.25	Normal	Solubridge method (Black, 1965)

3.3 Climate

The climate of the region location was characterized by the long hot summer and cool winter. Dry and warm weather usually persists during the month of March to June and temperature may go as high as 44°C during these months.

Rainfall is mainly concentrated in four months, starting from mid June to mid October. The average rainfall ranges from 1350 mm, winter rains are also received usually. There is a probability of low rainfall after each four and five years. The mean weekly meteorological data were recorded during the period of investigation presented Table 3.2 and depicted in Fig.3.1.

Table 3.2 Weekly Meteorological data of Jabalpur during the course of investigation (2012, 2013 and 2014).

Meteor- ological weeks	Temp max.	Temp min.	Sun Shine hrs.	Rainfall (mm)	RH Mor	RH Eve	Wind Speed (Kmh ^{r⁻¹})	Vapor Pressure (mm)		Evapo (mm)	Rainy days
								Mor	Eve		
2012-13											
22	44.1	22.9	6.5	8.8	31	13	7.0	11.2	8.7	11.9	1
23	40.0	27.4	8.1	0.0	45	23	8.5	14.8	11.7	10.6	0
24	40.2	26.7	4.9	58.2	64	30	8.5	19.1	15.7	7.7	2
25	33.2	23.2	3.3	63.4	78	53	9.0	20.4	18.3	4.7	2
26	37.7	27.0	6.4	0.0	64	42	8.8	19.4	17.2	8.6	0
27	34.5	24.4	5.6	296.8	85	62	6.9	22.2	20.4	5.7	3
28	31.3	23.9	4.7	116.0	88	77	6.3	22.7	23.2	3.6	4
29	32.3	24.1	3.1	117.5	90	76	6.6	23.4	24.5	3.2	3
30	28.2	22.8	3.0	119.9	95	88	6.9	21.9	23.1	1.8	5
31	26.3	22.0	0.0	32.4	94	87	7.6	21.2	22.4	1.8	4
32	27.7	22.7	1.2	145.8	96	88	6.0	22.7	22.6	1.7	5
33	28.2	23.0	3.3	101.8	89	81	5.9	21.0	21.5	2.3	5
34	30.2	22.9	4.9	84.4	92	77	6.3	22.3	22.1	2.8	4
35	31.9	24.2	4.8	3.0	92	69	3.0	24.1	23.4	3.4	0
36	30.8	23.9	2.8	52.2	93	79	5.4	23.8	23.4	3.0	3
37	30.7	23.4	2.8	87.4	91	79	5.1	22.1	22.6	3.1	2
38	30.8	23.1	4.6	11.0	89	69	3.9	20.9	20.7	2.6	1
39	31.9	22.6	8.7	0.0	88	51	3.1	20.0	16.3	3.6	0
40	33.4	21.9	7.3	2.3	91	44	3.3	20.1	16.2	3.4	0
41	32.4	18.5	9.0	0.0	83	35	2.9	14.8	12.9	4.0	0
42	32.5	18.6	9.4	0.0	79	32	2.4	14.2	11.3	3.4	0
43	31.6	15.2	8.4	0.0	82	35	1.9	13.7	11.8	3.2	0
44	27.9	15.6	6.7	0.0	91	51	3.6	13.5	12.9	2.7	0
45	28.2	14.6	7.7	0.0	88	30	3.0	11.7	9.5	2.8	0
46	28.6	10.0	8.4	0.0	85	28	2.7	10.0	7.8	3.0	0
47	27.9	10.6	7.6	0.0	88	29	2.2	9.3	8.2	2.4	0
48	28.4	11.5	8.4	0.0	83	33	2.1	9.7	9.1	2.3	0
49	28.7	10.6	9.0	0.0	85	26	2.1	9.4	7.8	2.4	0
50	29.0	14.0	7.2	3.2	92	41	2.2	12.3	11.8	2.7	1
51	25.3	7.1	8.6	0.0	88	29	2.3	7.3	6.7	2.4	0
52	23.8	5.0	9.1	0.0	90	30	2.2	6.8	7.4	2.3	0
1	23.3	7.2	5.9	0.0	87	42	3.6	7.7	8.7	2.2	0
2	23.0	5.2	9.2	0.0	87	32	2.6	6.7	7.3	2.6	0

Meteor- ological weeks	Temp max.	Temp min.	Sun Shine hrs.	Rainfall (mm)	RH Mor	RH Eve	Wind Speed (Kmh ^{r-1})	Vapor Pressure (mm)		Evapo (mm)	Rainy days
								Mor	Eve		
3	26.7	10.1	8.1	0.0	84	36	4.0	9.0	9.1	3.1	0
4	21.4	5.0	7.6	0.0	86	36	2.9	6.6	7.0	2.5	0
5	24.6	7.4	7.4	0.0	91	36	2.3	7.9	8.8	2.5	0
6	25.9	11.3	6.2	0.0	88	49	4.4	10.1	12.0	3.0	0
7	25.2	13.0	4.1	55.4	91	60	4.4	11.5	12.7	3.1	3
8	25.0	11.0	9.3	4.8	93	49	3.2	10.4	11.5	2.7	1
9	28.0	9.2	9.8	0.0	87	37	3.1	9.3	10.6	3.6	0
10	30.7	9.9	9.6	0.0	83	28	2.6	9.0	9.2	4.1	0
11	31.6	14.7	7.4	26.1	84	39	4.6	12.2	12.7	4.6	2
12	33.4	16.2	8.2	0.0	77	28	3.6	12.6	10.6	4.5	0
13	33.8	16.2	7.8	7.2	76	30	3.7	13.3	11.2	4.9	1
14	35.3	15.2	8.9	3.2	68	20	4.2	12.1	8.1	6.1	1
15	39.5	19.9	8.7	0.0	57	14	4.5	12.6	7.1	10.7	0
16	36.5	20.1	8.6	10.6	51	22	5.2	11.3	8.8	6.9	1
17	37.6	20.6	9.0	0.0	64	21	4.0	15.5	10.2	5.8	0
18	42.1	21.4	10.8	0.0	42	12	4.5	11.7	7.4	8.5	0
19	42.1	24.1	10.6	0.0	31	12	7.1	10.1	7.0	11.5	0
20	42.7	23.4	10.6	0.0	36	9	6.4	11.3	6.2	11.4	0
21	44.1	26.8	10.0	0.0	27	15	8.6	9.6	9.8	13.3	0
2013-14											
22	41.8	26.3	8.2	0.0	44	17	6.9	14.7	9.8	11.3	0
23	39.7	25.0	8.5	30.4	68	38	7.8	18.8	18.3	7.4	3
24	32.8	23.7	3.8	84.0	89	63	7.3	22.2	21.8	4.7	4
25	32.1	23.6	6.3	138.3	89	67	7.4	22.2	22.2	4.5	4
26	29.3	23.3	2.0	232.4	92	88	9.2	21.6	22.4	3.8	5
27	29.2	23.5	3.9	42.2	89	75	5.9	21.9	22.5	3.0	3
28	30.5	24.0	2.9	214.1	93	81	6.3	23.6	23.7	3.2	6
29	31.1	24.3	3.0	150.7	95	79	5.8	23.6	25.4	3.3	5
30	29.2	23.6	3.0	122.1	93	84	7.6	22.8	23.9	2.7	6
31	30.0	23.9	3.5	38.9	93	78	7.0	22.7	24.0	3.3	5
32	28.7	23.6	3.1	210.2	95	80	6.7	22.7	23.1	2.1	4
33	29.4	23.2	3.0	687.6	95	80	4.2	23.0	23.0	3.2	5
34	27.9	23.3	3.1	184.3	96	83	6.8	22.3	23.7	2.4	5
35	28.5	23.2	4.1	57.2	94	81	5.9	22.1	22.9	2.7	3
36	31.4	23.1	7.2	86.8	92	64	4.4	21.6	21.2	4.0	2
37	32.6	23.7	7.9	0.0	89	63	2.8	22.4	23.0	3.9	0

Meteorological weeks	Temp max.	Temp min.	Sun Shine hrs.	Rainfall (mm)	RH Mor	RH Eve	Wind Speed (Kmh ^{r-1})	Vapor Pressure (mm)		Evapo (mm)	Rainy days
								Mor	Eve		
38	26.6	20.0	3.5	46.2	80	62	3.6	19.4	18.8	2.5	3
39	31.8	23.4	5.9	6.0	90	57	3.5	21.6	20.0	3.6	2
40	28.9	22.9	6.6	69.0	95	77	4.3	21.9	22.5	2.1	3
41	29.7	21.8	5.5	18.4	93	72	3.9	20.7	20.4	2.4	2
42	30.1	18.4	8.3	0.0	95	50	2.1	18.0	15.9	2.7	0
43	29.4	18.8	6.8	16.4	94	60	4.2	17.6	17.5	2.6	1
44	30.7	15.4	8.3	0.0	91	36	2.1	14.6	12.1	2.8	0
45	28.9	12.7	7.8	0.0	93	36	1.9	11.8	10.4	2.3	0
46	26.0	8.9	7.8	0.0	93	35	2.1	9.4	8.8	2.5	0
47	27.9	9.2	8.8	0.0	86	30	2.1	9.6	9.0	2.7	0
48	27.8	9.1	8.3	0.0	88	30	2.3	9.4	8.3	2.8	0
49	26.3	8.5	7.7	0.0	91	33	2.0	8.8	8.2	2.1	0
50	25.9	7.1	8.6	0.0	89	30	1.9	8.4	7.4	2.2	0
51	26.0	7.5	8.0	0.0	91	34	2.0	9.5	8.2	2.1	0
52	24.5	11.0	5.4	0.0	90	44	3.0	10.2	9.9	2.0	0
1	23.5	11.1	4.7	0.0	90	56.7	3.1	11.5	11.6	1.7	0
2	22.2	10.2	5.3	18.0	94.3	58.1	2.9	10.1	12.0	1.8	1
3	22.2	12.3	3.6	6.8	94.9	67.6	4.4	11.8	13.6	1.7	1
4	22.3	10.6	4.7	0.0	91.0	60.7	3.9	10.7	11.6	1.8	0
5	23.7	5.6	9.6	0.0	92.6	34.1	1.8	7.2	7.8	2.2	0
6	28.0	10.0	9.4	0.0	90.9	39.1	2.5	9.8	10.3	2.8	0
7	23.9	9.5	7.7	12.0	88.0	40.9	3.8	9.4	8.9	3.0	2
8	25.5	12.2	6.5	17.0	93.1	55.4	3.3	11.5	12.6	2.3	1
9	25.5	14.3	6.3	47.0	92.2	58.2	5.9	13.7	12.8	2.4	3
10	26.6	11.9	7.5	1.8	87.4	41.9	2.2	12.1	12.4	2.9	0
11	30.5	12.6	7.9	2.6	84.1	44.6	2.9	14.6	14.7	1.5	1
12	34.0	13.4	8.5	0.0	78.7	27.4	3.2	13.8	10.5	4.3	0
13	36.4	17.6	8.6	0.0	76.7	20.3	2.9	14.5	9.2	6.0	0
14	37.4	18.5	9.3	0.0	55.0	15.9	3.9	11.2	7.4	6.9	0
15	37.4	17.8	9.3	0.0	56.9	16.6	3.9	11.4	8.0	6.4	0
16	37.7	20.6	9.0	0.0	60.9	26.0	5.1	13.9	10.8	6.6	0
17	39.7	19.9	9.5	0.0	50.3	12.9	3.5	12.4	7.1	8.1	0.0
18	40.6	24.2	9.6	0.0	37.4	19.0	6.1	11.3	9.7	9.8	0.0
19	38.5	24.5	7.6	0.0	48.0	23.9	6.4	13.7	11.4	7.8	0.0
20	39.5	22.3	8.6	10.6	51.7	19.0	4.0	14.1	10.2	7.4	1.0
21	41.2	24.8	10.2	0.0	47.3	19.0	5.5	14.7	10.3	8.9	0.0

3.4 Experiment details

The field experiment was carried out at Horticulture Complex, during 2012-13 and 2013-14. The five year old Amrapali plants under high density with a spacing of 2.5 x 2.5 m were used in the study. Investigations related to bio-chemical parameters were carried out in the Department of Horticulture, Soil Science and Agricultural Chemistry and Food Science of College of Agriculture, Jabalpur. The factorial experiment was laid out in Factorial Randomized Block Design with three replications. The experiment consisting four levels of chemical fertilizer and six organic sources and its combinations were applied in 39th and 44th meteorological week of 2012 and 2013, respectively. The last rains (11 mm and 69 mm) received on the 37th and 40th meteorological weeks of 2012 and 2013, respectively. After that plants were fertilized as per the treatment and its combinations the experimental details are given below;

Location	:	Horticulture Complex, Department of Horticulture, J.N.K.V.V., Jabalpur (M.P.)
Crop and Variety	:	Mango var. Amrapali
Statistical Design	:	Factorial Randomized Block Design
Replications	:	Three
Treatments	:	24
A. Inorganic source of fertilizers	:	F ₁ Without chemical fertilizers (Control) F ₂ 310:100:270g NPK plant ⁻¹ (75% of RDF) F ₃ 415:130:360g NPK plant ⁻¹ (100% of RDF) F ₄ 520:160:450g NPK plant ⁻¹ (125% of RDF)
B. Organic source of nutrients	:	O ₁ Oil cake 2.5 kg plant ⁻¹ O ₂ Azotobacter + VAM + Trichoderma viridi + PSB (100g plant ⁻¹ each) O ₃ Vermicompost (25 kg plant ⁻¹) O ₄ Vermicompost (25 kg plant ⁻¹) + Oil cake (2.5 kg plant ⁻¹) O ₅ Vermicompost (25 kg/plant) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant ⁻¹ each) O ₆ Vermicompost (25 kg plant ⁻¹) + Oil cake (2.5 kg plant ⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant ⁻¹ each)
Total plants	:	72

Treatment Combinations

T ₁	(Control)+ Oil cake (2.5 kg plant ⁻¹)
T ₂	(Control)+ Azotobacter + VAM + Trichoderma viridi + PSB (100g plant ⁻¹ each)
T ₃	(Control)+ Vermicompost (25 kg plant ⁻¹)
T ₄	(Control)+ Vermicompost (25 kg plant ⁻¹) + Oil cake (2.5 kg plant ⁻¹)
T ₅	(Control)+ Vermicompost (25 kg plant ⁻¹)+Azotobacter+VAM+Trichoderma viridi + PSB (100g plant ⁻¹ each)
T ₆	(Control) + Vermicompost (25 kg plant ⁻¹) + Oil cake (2.5 kg plant ⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant ⁻¹ each)
T ₇	75% of RDF + Oil cake (2.5 kg plant ⁻¹)
T ₈	75% of RDF + Azotobacter + VAM + Trichoderma viridi + PSB (each 100g plant ⁻¹)
T ₉	75% of RDF + Vermicompost (25 kg plant ⁻¹)
T ₁₀	75% of RDF + Vermicompost (25 kg plant ⁻¹) + Oil cake (2.5 kg plant ⁻¹)
T ₁₁	75% of RDF + Vermicompost (25 kg plant ⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant ⁻¹ each)
T ₁₂	75% of RDF + Vermicompost (25 kg plant ⁻¹) + Oil cake (2.5 kg plant ⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant ⁻¹ each)
T ₁₃	100% of RDF + Oil cake (2.5 kg plant ⁻¹)
T ₁₄	100% of RDF + Azotobacter+VAM+Trichoderma viridi +PSB (100g plant ⁻¹ each)
T ₁₅	100% of RDF + Vermicompost (25 kg plant ⁻¹)
T ₁₆	100% of RDF + Vermicompost (25 kg plant ⁻¹) + Oil cake (2.5 kg plant ⁻¹)
T ₁₇	100% of RDF+ Vermicompost (25 kg plant ⁻¹)+Azotobacter+VAM+ Trichoderma viridi + PSB (100g plant ⁻¹ each)
T ₁₈	100% of RDF + Vermicompost (25 kg plant ⁻¹)+Oil cake (2.5 kg plant ⁻¹)+ Azotobacter + VAM + Trichoderma viridi + PSB (100g plant ⁻¹ each)
T ₁₉	125% RDF + Oil cake (2.5 kg plant ⁻¹)
T ₂₀	125% RDF+Azotobacter+VAM +Trichoderma viridi+PSB (100g plant ⁻¹ each)
T ₂₁	125% RDF + Vermicompost (25 kg plant ⁻¹)
T ₂₂	125% RDF + Vermicompost (25 kg plant ⁻¹) + Oil cake (2.5 kg plant ⁻¹)
T ₂₃	125% RDF + Vermicompost (25 kg plant ⁻¹)+ Azotobacter + VAM + Trichoderma viridi + PSB (each 100g plant ⁻¹)
T ₂₄	125% RDF + Vermicompost (25 kg plant ⁻¹) + Oil cake (2.5 kg plant ⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant ⁻¹ each)

3.5 Observations recorded

For the study, seventy two plants of mango var. Amrapali under high density planting were randomly selected and replicated thrice. The observations were recorded from seventy two plants which were selected randomly and tagged in each replication. The observations on growth and morphological characters, physical composition of the fruits, biochemical parameters and physico-chemical analysis of soil were determined and economics of each treatment were computed and statistically analyzed.

3.5.1 Growth and morphological characters

3.5.1.1 Crown height (cm)

Crown height is measured vertically from the ground level to the point half way between the lowest green branches forming green crown all around and lowest green branch of the bole. Randomly tagged plants were used for measuring the crown height with the help of scale and average height was computed.

3.5.1.2 Crown length (cm)

Crown length is vertical measurement of the crown of a tree from the tip to the point half way between the lowest green branch forming green crown all around and the lowest green branch on the bole. Randomly selected plants were measured and recorded the length with the help of measuring tape and recorded data were computed and statistically analysed for interpretation.

3.5.1.3 Crown spread (cm)

Randomly tagged plants were used for measuring the crown width with the help of scale in east –west and south – north direction of tree and average width was computed.

3.5.1.4 Shoot length (cm)

Ten shoots from each treatment were randomly selected and tagged for the measurement of shoot length and average length was computed. Furthermore, these tagged shoots were also used for the other parameters under study.

3.5.1.5 Number of leaves per shoot

Randomly tagged shoots were selected to assess the leaves shoot⁻¹ bearing panicles and average leaves shoot⁻¹ was computed.

3.5.1.6 Days to bud emergence

Tagged shoots selected and data pertaining to bud emergence was recorded as date of bud emergence and number of days were also counted from the application of nutrients.

3.5.1.7 Day to first panicle emergence

Tagged shoots selected and data pertaining to panicles emergence were recorded and number of days computed of panicle emergence from date of nutrient application.

3.5.1.8 Days of 50% Flowering

Tagged shoots selected and data pertaining to panicles having 50 per cent flowering were recorded and number of days computed of 50% flowered panicles from date of nutrient application.

3.5.1.9 Panicle length (cm)

Tagged shoots selected after the emergence of panicles, the length was measured with the help of scale and average length was computed.

3.5.1.10 Number of panicle lets

Tagged shoots selected the total number of paniclets panicle⁻¹ was counted in all treatment of each replication.

3.5.1.11 Number of healthy and malformed panicles (m²)

Number of healthy and malformed panicles was counted with the help of quadrat and average value of healthy and malformed panicles were computed.

3.5.1.12 Percentage of healthy and malformed panicles (%)

Ten panicles were selected and tagged randomly and observations pertaining to healthy and malformed panicles were recorded and depicted in percentage.

3.5.1.13 Fresh and dry weight of healthy and malformed panicle (g)

Healthy and malformed panicles were randomly detached from the node and recorded the fresh weight on electronic balance, these panicles were chopped and oven dried at $60 \pm 2^{\circ}\text{C}$ temperatures till get the constant weight. The weight was taken with the help of electronic balance and average fresh and dry weight of healthy and malformed panicle was computed.

3.5.1.14 Fruit set at pea stage

The number of fruit was counted at pea stage from tagged panicles and average value of fruit set per panicle was computed.

3.5.1.15 Fruit drop (%)

The percentage of fruit drop was calculated from the tagged ten panicles which were used for fruit set counting. The percentage of fruit drop was worked out by using the following formula.

$$\text{Fruit drop (\%)} = \frac{\text{Fruit set} - \text{Fruit retained}}{\text{Total fruit set}} \times 100$$

3.5.1.16 Fruit retention (%)

The number of fruits was counted and percentage of fruit retention was calculated by the following equation.

$$\text{Fruit retention (\%)} = \frac{\text{No of fruits}}{\text{Total No of fruit set at pea stage}} \times 100$$

3.5.1.17 Number of fruits / per tree

The total number of fruits from each plants were counted and average fruit plant⁻¹ were computed.

3.5.2 Chemical analysis of healthy and malformed panicle

The chemical analysis was done to determine the content of nitrogen, phosphorus and potassium in leaves of shoot bearing healthy and malformed panicle separately.

3.5.2.1 Nitrogen content (%)

The Nitrogen content in healthy and malformed panicle was estimated by using methods given by Mc Donald (1978). Ten gram of oven dried material was digested in corning test tube with 12 drops of concentrate H_2SO_4 and a pinch of digestion mixture of 5g, which consists of chemicals Potassium sulphate (2.0g), Sodium thiosulphate (1.5g), Salicylic acid (1.5g), and Selenium (1.0 g).

After cooling of the digestion mixture few drops of hydrogen peroxide was added and heated for few minutes. Finally, the colourless digested fluid was make up by distilled water to 10 ml volume. Then 0.2 ml of sodium silicate (10%) and sodium hydroxide (10%) was added and shaken thoroughly. The final volume was made upto 10 ml with distilled water. The 2 ml of diluted (1:2) Nessler's reagent was mixed and shaken. After 10 minutes, the absorbance of yellow colour was read at 425 nm. The amount of nitrogen was calculated with the help of standard curve, prepared from ammonium sulphate. The results are expressed in percentage.

3.5.2.2 Phosphorus (%) and Potassium content (ppm)

Oven dried samples were ground for determination of phosphorus and potassium content in leaves of shoot bearing healthy and malformed panicle, oven dried sample were used and one gram of material was taken in 100 ml of flask separately. Fifteen milliliter mixture of ternary acid (10:4:1 of A.R. grade HNO_3 : $HClO_4$: H_2SO_4 , respectively) was added to each flask and mass was digested on hot plate till colourless solution was obtained. The solution was transferred into the 50 ml volumetric flask and volume was made

up to the mark with distilled water (Jackson, 1965). The extract was used for determination of phosphorus and potassium content.

Phosphorus concentration in leaves of shoot bearing healthy and malformed panicle was determined by vanadomolybdate yellow colour methods as suggested by Koeing and Jhonson (1942), on spectrophotometer at 420 nm and recorded data are expressed in percentage.

Potassium concentration in leaves of shoot bearing healthy and malformed panicle was determined by flame photometer methods (Hanway and Heidal, 1952) and presented in ppm.

3.5.2.3 Micro nutrients content in plants by atomic absorption spectrophotometer

Micronutrients content in leaves of shoot bearing healthy and malformed panicle were determined by using Atomic Absorption Spectrometer. The concentration of zinc, copper, iron and manganese in the sample was calculated by multiplying the displayed reading of AAS and the dilution factor. The amount of the given micronutrient in plant was then calculated as per the given equation below; (Weight of plant taken = 1.0 g, Volume of sample made up=100ml, Dilution=100times)

$$\frac{\text{Concentration of micronutrient in micro g g}^{-1}}{\text{Weight of plant (g)}} \quad \text{OR} \quad \frac{\text{Concentration} \times 100}{100}$$

3.5.2 Physical composition of fruits

Five healthy fruits were plucked randomly as per treatments tree per replication and subjected to physical observations.

3.5.2.1 Fruit size (cm)

Five fruits from each replication under each treatment were collected at randomly and their length and diameter were measured in centimeter with the help of Vernier Calipers and average and width determined and presented.

3.5.2.2 Fruit weight (g)

Five fruits were randomly picked up from the harvested bulk and fruit weight recorded on electronic balance and average fruit weight was determined and presented.

3.5.2.4 Pulp percentage

Pulp percentage in fruit was determined by using following formula;

$$\text{Pulp percentage} = \frac{\text{Weight of pulp}}{\text{Weight of fruit}} \times 100$$

3.5.2.5 Peel percentage

The ripe fruit were peeled with the help of peeler and weighed on single pan mettler balance. Percentage was calculated by the following equation;

$$\text{Peel percentage} = \frac{\text{Weight of peel}}{\text{Weight of fruit}} \times 100$$

3.5.2.6 Stone percentage

The pulp of the fruit was removed with the help of stainless steel knife from the stone. Both pulp and stones were weighed separately on electronic balance and determine the percentage by using following formula;

$$\text{Stone percentage} = \frac{\text{Weight of stone}}{\text{Weight of fruit}} \times 100$$

3.5.2.7 Pulp: Stone ratio

The pulp and stone ratio of the fruit was calculated by dividing the pulp weight by the stone weight.

$$\text{Pulp-stone ratio} = \frac{\text{Weight of pulp}}{\text{Weight of stone}}$$

3.5.2.8 Pulp: Peel ratio

The pulp and peel ratio of the fruit was calculated by dividing the pulp weight by the peel weight.

$$\text{Pulp-peel ratio} = \frac{\text{Weight of pulp}}{\text{Weight of peel}}$$

3.5.2.9 Fruits yield (kg tree⁻¹)

Fresh fruits were picked out from the tree as per treatment and weighed with the use of physical balance and expressed yield in kg plant⁻¹.

3.5.3 Chemical composition of fruits

For analysis of biochemical parameter, five healthy fruits were plucked randomly as per treatment from each replication and wiped with tissue paper and kept for ripening at room condition.

3.5.3.1 TSS (°Brix)

The homogenized fruit sample was crushed and juice was extracted through muslin cloth. The extract was used for determination of °Brix by hand Refractometer. Few drops of juice were placed on the surface of prism. The hinged part was placed back. The refractometer was then placed against the sun and the reading was taken by revolving the eye pieces, at room temperature (AOAC, 1995)

3.5.3.2 Acidity (%)

Titrate acidity content of samples was determined by simple acid-alkaline titration method as described in AOAC (1995). The samples were homogenized with 100ml distilled water. Now 25ml of diluted sample was transferred into a 250ml beaker. Three drops of phenolphthalein indicator was added to the solution. N/10 NaOH solution was taken in burette and titrated with alkali solution drop by drop with constant stirring till the pink end point is reached. End point readings were recorded and the percentage acidity was calculated in terms of citric acid by the following formula.

Calculation

$$\text{Titrate acidity (\%)} = \frac{\text{Reading} \times \text{Normality of NaOH} \times \text{Eq. weight of Citric acid}}{\text{Volume of sample taken} \times 1000}$$

3.5.3.3 TSS: Acid ratio

The TSS and acid ratio of the fruit was calculated by dividing the TSS by the acid (%).

$$\text{TSS- Acid ratio} = \frac{\text{Percentage total soluble solid}}{\text{Percentage of acid}}$$

3.5.3.4 Ascorbic acid (mg 100g⁻¹ pulp)

Ascorbic acid content in fruit pulp was determined by colorimetric procedure described by Ranganna (1991). The direct colorimetric method is based on measurement of the extent to which A 2, 6-dichlorophenol-indophenol solution is decolorized by ascorbic acid in sample extracted and in standard ascorbic acid solution. Since interfering substances reduce the dye solution slowly, rapid determination at 520nm wave length would be measured mainly ascorbic acid.

3.5.3.5 Total sugars (%)

The sugars content of the sample was determined by the procedure as described by Ranganna (1991).

Reagents:

1. Fehling's solution A.
2. Fehling's solution B.
3. Methylene blue indicator.
4. 45% Neutral Lead Acetate solution: 225g of neutral lead acetate were dissolved in distilled water and diluted to 500ml.
5. 22% Potassium Oxalate solution: 110 g of potassium oxalate ($\text{K}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$) were dissolved in distilled water and make up to 500ml.
6. Standard invert sugar solution. Weighed 9.5g of AR grade sucrose into 1 litre volumetric flask. Then added 100ml water and 5ml concentrated HCl. Allowed it to stand for 3 days at 20-25°C for inversion to take place and then make up to mark with water and its stable for several days. Pipette

25ml of standard invert sugar solution into 100ml volumetric flask and added 50ml water. Added few drops of phenolphthalein indicator and neutralized with 20% NaOH until pink. Then it was acidified with 1N HCl by adding it drop wise until 1 drop causes the pink to disappear. Make upto mark with water (1ml=2.5mg of invert sugar).

7. Standardization of Fehling's solution: Mix 50ml solutions of Fehling A and 50ml of Fehling B. Pipette 10ml of mixed solution into 250ml conical flask and added 25ml water. Take invert sugar solution prepared by inversion of sucrose in 50ml burette. Add to the mixed Fehling solution almost the whole of the standard invert sugar solution (18-19ml) required to effect the reduction of copper, so that not more than 1ml will required to complete titration. The flask was heat over a hot plate. When liquid began to boil, keep in moderate ebullition for 2min. On flame, added three drop of methylene blue and completed titration in 1min, over all 3 min and no interruption. End point were noted which was indicated by the discoloration of indicator (i.e. brick red).

$$\text{Factor for Fehling's solution (g of invert sugar)} = \frac{\text{Titer value} \times 2.5}{1000}$$

Preparation of sample:

25g of sample powder was taken and transferred to 250ml flask. Added 100ml water and neutralized with 1N/NaOH and then filtered. 2ml of lead acetate solution was added, shaken well and allowed it to stand for 10 min. added 2ml of potassium oxalate solution to remove excess lead and make up the volume with water and filtered.

3.5.3.6 Reducing sugars

Pipette 10ml of mixed Fehling solution into 250ml conical flask (5A and 5B). The burette was filled with the sample solution prepared. Then run into the flask almost the whole volume(15-50ml) of solution required to reduce the Fehling solution so that 0.5-1.0ml is require to later complete titration. Mixed

the content and was heated to boiling and boiled moderately for 2min. Then added 3 drops of methylene blue and by not touching the sides. Titration was completed within 1min by adding 2-3 drops of sugar solution at 5-10sec intervals, until the indicator is completely decolorized from blue to brick red of cuprous oxide. Noted the volume of the solution required.

Note: End point was determined within 1 drop of sugar and not interrupting the boiling more than few seconds as the indicator undergoes back oxidation rapidly when air has free excess into the flask.

Calculation

$$\text{Reducing sugar (\%)} = \frac{\text{Factor} \times \text{Dilution} \times 100}{\text{Titer value} \times \text{Weight of sample}}$$

3.5.3.7 Total sugars (%)

50ml of the clarified solution was pipette into 250ml flask and added 5g of citric acid and 50ml of water. It was boiled gently for 10 min to complete inversion of sucrose, and then cooled. Transferred it to 250ml flask and neutralized with 1N NaOH using phenolphthalein and make up volume and was titrated with Fehling solution.

Calculation:

$$\text{Total sugar (\%)} = \frac{\text{Factor} \times \text{Dilution} \times 100}{\text{Titer value} \times \text{Weight of sample}}$$

$$\text{Non reducing sugar \%} = \text{Total sugar} - \text{Reducing sugar}$$

3.5.3.8 Total phenols

The total phenol content of samples was determined by procedure as described by Sadasivam and Manickam (1991).

Reagents:

1. 80% ethanol: (80ml ethanol + 20ml distilled water).
2. Folin - ciocalteau reagent.

3. 20% sodium carbonate (Na_2CO_3).
4. Standard - (100mg catechol in 100ml distilled water), dilute 10 times for a working standard.
5. Blank - (3ml distilled water + 0.5ml Folin reagent + 2ml Na_2CO_3).

Procedure

The sample (0.5 to 1.0g) was grind in pestle and mortar in 10 time volume of 80% ethanol. The aliquot was centrifuge and homogenized at 10,000 RPM for 20 min. The supernatant collected and residue was re-extracted five times with 80% ethanol. The supernatant was pooled and evaporated to dryness. The dried residue was further dissolved in a known volume of distilled water (5 to 10 ml). Form the above solution pipette out aliquots, 0.2ml into 20ml test tube. Now make up the volume in each test tube upto 3ml with distilled water (add 2.8ml distilled water). 3ml of Folin reagent was taken and its volume was makeup to 9ml. From this solution add 0.5ml of Folin reagent in to the test tube. After a period of 3 min, add 2ml of 20% Na_2CO_3 solution to each tube. Mix it thoroughly and place the tubes in boiling water for exactly 1 min. Cool it and measure the absorbance at 650 nm against a reagent blank. Also prepare a standard curve simultaneously using different concentration of catechol.

The phenol content was calculated from the standard curve prepared by catechol and express as mg of phenol/100g sample.

Calculation

$$\frac{\text{Concentration of std.}}{\text{Absorbance of std.}} \times \frac{\text{Abs. of sample}}{\text{Vol. of assay}} \times \frac{\text{Vol. make up}}{\text{Wt. of sample}} \times 100$$

3.5.4 Physico-chemical analysis of soil

The representative soil samples from all plants were collected from 0-20 cm depth. Before analysis, these samples were air dried, crushed by wooden

pestle and mortar and passed through 2 mm size sieve. These samples were used for the following determinations.

3.5.4.1 Soil pH

The glass electrode pH meter was standardized for pH 4 to 9 buffer solutions. After standardization of electrode was washed with distilled water and immersed in to the suspension of 1:5 (Soil: Water) and keep for four hours. The pH was determined by methods suggested by Govindrajan (1970).

3.5.4.2 Organic carbon (%)

Organic carbon content was determined by rapid titration method given by Walkey and Black as described by Jackson (1965).

3.5.4.3 Bulk density (Mg m^{-3})

Bulk density was determined by core sampler methods (Black and Hartge, 1986). Soil sample were drawn at the end of experiment with the help of core sampler (4.8 cm diameter and 10cm length). Soil samples were oven dried at 105°C until a constant weight was sustained. The dried sample was transferred to measuring cylinder and volume was noted. The weight of the soil was calculated to determine the density of the soil.

$$\text{Soil density (Mg m}^{-3}\text{)} = \frac{\text{Weight of soil (g)}}{\text{Volume of soil (ml)}}$$

3.5.4.4 Available nitrogen (kg ha^{-1})

It was determined by alkaline permanganate method (Subbiah and Asija, 1956). Twenty grams of soil sample was taken in one liter distillation flask, added 20 ml of distilled water followed by 100 ml of KMnO_4 (0.32 %) solution. Then 100 ml of 2.5% NaOH was added and fixed the distillation assembly quickly possible and start distillation. The liberated ammonia was collected in 250 ml conical flask containing 20 ml boric acid and the collected ammonia was titrated with standard 0.02 N H_2SO_4 solutions. Results were calculated in kilogram of nitrogen ha^{-1} .

3.5.4.5 Available phosphorus (kg ha^{-1})

The available phosphorus in the soil was determined through the Olsen's method (Olsen et al., 1954). Soil sample 2.5g was taken in 100 ml conical flask and 1 g Darco G 60 and 50 ml 0.5 % NaHCO_3 solution was added. After shaking the flask for 30 minutes, filtered the content through whatman No. 40 filter paper. Then 5 ml extract was transferred by pipette into 25 ml volumetric flask and 5 ml ammonium molybdate solution was added. After adding 1ml of diluted stannous chloride (SnCl_2) solution, the volume was made up upto 25 ml and shaken well. The intensity of blue colour so developed was read after 10 minutes on spectrophotometer at 660 as suggested by Dikman and Bray, 1940. The phosphorus content was computed and expressed in kg ha^{-1} .

3.5.4.6 Available potassium (kg ha^{-1})

To determine the available potassium in soil, 5g soil sample was taken into 100 ml conical flask and 25 ml neutral normal ammonium acetate was added, shaken the content for 5 minutes and then filtered through whatman filter paper no 1. The potassium concentration in extract was determined by flame photometer after (Black, 1965). Potassium was computed in kilogram ha^{-1} .

3.5.4.7 Electrical conductivity (dSm^{-1})

Electrical conductivity was measured in the supernatant liquid of 1:2 soil water suspensions by solu-bridge (as per the method suggested by Jackson, 1965).

3.5.5 Economics of treatments

The total cost involved in different input under particular treatment was worked out on the basis of existing price the calculation was made.

3.5.5.1 Monetary advantage

The estimate value of total produce as per the existing market rate i.e. gross monitoring return was computed treatment wise on per hectare basis. The net monitoring return under particular treatment was determined by subtracting cost of treatment input the gross monitoring return of the particular treatment.

3.5.5.2 Benefit cost ratio

It is the ratio which gives an indication of the monitoring gain over every rupee invested on a particular treatment. This study facilitates the feasibility of the treatment to be adopted by different categories of the farmers based on their economic status. The ratio was worked out by dividing gross return with cost of treatments.

3.6.1 Statistical analysis

Various characters under study was statistically analysed by using analysis of variance techniques appropriate for Factorial Randomized Block Design (FRBD) as described by Panse and Sukhatme (1967). The treatment differences were tested for significance by “F” test. For the data in which treatment effect were significant, the appropriate standard error of mean ($SEm\pm$) and critical differences (CD) were worked out at 5 per cent level of significance. The skeleton analysis of variance of design is given in Table 3.3.

Table 3.3 Skeleton of analysis of variance (ANOVA)

Source of variation	DF	SS	MS	F calculated	Table F value
Replication	2		RSS/2	RMSS/EMSS	
Fertilizer (F)	3		FSS/3	FMSS/EMSS	
Organic sources (O)	5		OSS/5	OMSS/EMSS	
F x O	15		OXFSS/15	OFSS/EMSS	
Error	46		ESS/46		
Total	71				

3.6.2 Estimation of standard error and critical differences

The standard error and critical differences were calculated with the use of following formula

Difference between the inorganic sources

$$SEd = \frac{\sqrt{EMSS}}{R \times O}$$

Difference between the organic sources

$$SEd = \frac{\sqrt{EMSS}}{R \times F}$$

Difference between the inorganic and organic sources

$$SEd = \frac{\sqrt{EMSS}}{R}$$

Test was applied for judging the significance of treatment. The significant difference between means was determined by using CD at 5 per cent level of significance.

$$\begin{array}{l} \text{CD for comparison} \\ \text{between inorganic sources (F)} \end{array} = \frac{\sqrt{MSE}}{RXO} \times \sqrt{2} \times t_{5\%} \text{ (at error degree freedom)}$$

$$\begin{array}{l} \text{CD for comparison} \\ \text{between organic sources (O)} \end{array} = \frac{\sqrt{MSE}}{RXF} \times \sqrt{2} \times t_{5\%} \text{ (at error degree freedom)}$$

$$\begin{array}{l} \text{CD for comparison} \\ \text{between interaction(F x O)} \end{array} = \frac{\sqrt{MSE}}{R} \times \sqrt{2} \times t_{5\%} \text{ (at error degree freedom)}$$

EXPERIMENTAL RESULTS

EXPERIMENTAL RESULTS

The observations pertaining to crown height, crown length, width, shoot length, number of leaves, days to first bud emergence, panicle emergence, days to 50% flowering, number of paniclelets, panicle length, severity, intensity, fresh and dry weight of healthy and malformed panicles, initial fruit set (at pea stage), fruit drop, fruit set at maturity, number of fruits per tree under the influence of different organic and chemical fertilizers and the subsequent effect on nutrient content in leaves of shoot bearing healthy and malformed panicle, physico – chemical composition of fruits and effect on soil environment are presented and described in this chapter under the appropriate heads;

4.1 Growth and development

Progressive growth and development in terms of plant spread, shoot length, number of leaves and panicle length and number of fruits affected by various sources of nutrient have been described individually;

4.1.1 Crown height (cm)

The length of the crown height is an important character growth which was recorded and absolute value of crown height is presented in Table 4.1. In general, gradual increase in plant height was recorded with the advancement of crop growth period.

The application of recommended dose of chemical fertilizers significantly promotes the crown height both years. It was observed that the all doses of chemical fertilizers significantly differ with each other and maximum height of 68.8 cm was noted with the application of 520:160:450 g NPK plant⁻¹ (125% of RDF) followed by recommended dose of fertilizer (67.0 cm). The minimum crown height of 60.6 cm was recorded with unfertilized plant i.e. control. The increasing level of chemical fertilizer significantly increased the plant height over their preceding fertilizer level.

Table 4.1: Influence of organic and inorganic sources of nutrients on crown height (cm)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	47.7	45.0	57.7	58.0	61.7	62.7	55.4
310:100:270g NPK (75%RDF)	(F ₂)	58.0	51.3	60.0	60.7	61.0	64.7	59.3
415:130:360g NPK (100%RDF)	(F ₃)	58.3	55.0	63.3	63.7	64.3	68.3	62.2
520:160:450g NPK (125%RDF)	(F ₄)	60.0	55.3	65.0	66.7	67.0	69.0	63.8
Mean		56.0	51.7	61.5	62.3	63.5	66.2	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.84		1.03		2.06		
CD at 5%		2.40		2.95		5.89		
2013-14								
Without fertilizer (Control)	(F ₁)	59.3	55.0	67.7	67.7	71.0	71.0	65.7
310:100:270g NPK (75%RDF)	(F ₂)	66.3	60.3	68.0	68.7	71.3	73.0	67.6
415:130:360g NPK (100%RDF)	(F ₃)	68.0	65.3	71.0	71.7	74.7	80.0	71.8
520:160:450g NPK (125%RDF)	(F ₄)	70.0	66.3	72.0	75.0	77.7	82.0	73.8
Mean		66.5	61.8	69.3	70.6	73.7	76.5	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.86		1.05		2.10		
CD at 5%		2.44		2.99		5.99		
Pooled data								
Without fertilizer (Control)	(F ₁)	53.5	50.0	62.7	62.8	66.3	66.8	60.6
310:100:270g NPK (75%RDF)	(F ₂)	62.2	55.8	64.0	64.7	66.2	68.8	63.4
415:130:360g NPK (100%RDF)	(F ₃)	63.2	60.2	67.2	67.7	69.5	74.2	67.0
520:160:450g NPK (125%RDF)	(F ₄)	65.0	60.8	68.5	70.8	72.3	75.5	68.8
Mean		61.3	56.7	65.4	66.4	68.6	71.3	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.67		0.83		1.65		
CD at 5%		1.92		2.36		4.71		

Addition of organic sources of nutrients had significantly increased the plant length in both the years. The maximum plant length of 71.3 cm was recorded with the application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) whereas, plant received nutrients through Vermicompost (25 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and Vermicompost (25 kg/plant) + Oil cake (2.5 kg plant⁻¹) was found at par with each other. The lowest plant length of 56.7 cm was recorded with the application of Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each).

Sources of nutrients in term of organic and inorganic interact with each other and height of 75.5 cm was recorded with the application of chemical fertilizer 520:160:450g NPK plant⁻¹ (125% of RDF) in combination with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) ,followed by recommended dose of fertilizer alongwith Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and 125% of recommended dose of fertilizer with Vermicompost (25 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each). The lowest plant length of 50.0 cm was recorded with Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) applied without chemical fertilizer.

4.1.2 Crown length (cm)

Data presented in Table 4.2 revealed that the increasing trend of crown length was noted with various levels of fertilizers and had a significant effect. The average maximum crown length (193.7 cm) was recorded with 125 % recommended dose NPK which was found significantly superior over control (178.6 cm). While all the fertility levels were also showed significant effect with each other in all the years as well as pooled data.

Table 4.2: Influence of organic and inorganic sources of nutrients on crown length (cm)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	175.0	173.0	177.0	178.0	179.3	180.0	177.1
310:100:270g NPK (75%RDF)	(F ₂)	179.7	180.0	181.7	182.3	183.7	186.0	182.2
415:130:360g NPK (100%RDF)	(F ₃)	183.3	182.0	187.3	193.7	194.3	196.3	189.5
520:160:450g NPK (125%RDF)	(F ₄)	184.0	183.0	185.7	194.7	195.0	198.7	190.2
Mean		180.5	179.5	182.9	187.2	188.1	190.3	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.20		1.47		2.94		
CD at 5%		3.43		4.20		8.40		
2013-14								
Without fertilizer (Control)	(F ₁)	177.0	176.0	180.0	182.3	181.0	184.0	180.1
310:100:270g NPK (75%RDF)	(F ₂)	183.0	182.7	185.0	185.0	186.0	191.0	185.5
415:130:360g NPK (100%RDF)	(F ₃)	187.0	185.3	189.0	191.0	194.7	198.7	190.9
520:160:450g NPK (125%RDF)	(F ₄)	196.0	192.7	196.0	196.7	198.7	203.3	197.2
Mean		185.8	184.2	187.5	188.8	190.1	194.3	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.94		1.16		3.21		
CD at 5%		2.70		3.30		6.61		
Pooled data								
Without fertilizer (Control)	(F ₁)	176.0	174.5	178.5	180.2	180.2	182.0	178.6
310:100:270g NPK (75%RDF)	(F ₂)	181.4	181.4	183.4	183.7	184.9	188.5	183.8
415:130:360g NPK (100%RDF)	(F ₃)	185.2	183.7	188.2	192.4	194.5	197.5	190.2
520:160:450g NPK (125%RDF)	(F ₄)	190.0	187.9	190.9	195.7	196.8	201.0	193.7
Mean		183.1	181.8	185.2	188.0	189.1	192.3	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.46		0.56		1.12		
CD at 5%		1.31		1.60		3.20		

An addition of organic sources of nutrient also had significant effect on crown length. The application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) recorded the highest crown length (192.3 cm) whereas, the lowest crown length (181.8 cm) was recorded with application of bio inoculants alone (F₂).

An application of chemical fertilizer alongwith the organic sources also had significant effect on crown length and maximum crown length (201.0 cm) was recorded with application of 125% chemical fertilizer (520:160:450g NPK plant⁻¹) alongwith Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and showed superiority over rest of the treatments .Whereas, minimum crown length (174.5 cm) was recorded under no chemical fertilizer + bio-inoculants (F₁O₂). Moreover, all the sources of inorganic and organic interact with each other and showed superiority over preceding levels.

4.1.3 Canopy spread (cm)

Plant canopy with respect to spread of crown in east- west (Table 4.3) and north-south (Table 4.4) direction are recorded. Data revealed that an application of inorganic nutrient increased the spread of tree canopy in all directions. The maximum crown width in east – west (229.3 cm) and south – north (225.0 cm) direction was recorded with application of 520:160:450g NPK plant⁻¹ (125% of RDF) and showed superiority over rest of the treatments. Whereas, the minimum spread of canopy in east–west (196.9cm) and south–north direction (202.3cm) was recorded with control.

As regards to nutrients applied through organic sources had also showed significant effect on tree canopy The maximum canopy (239.0 cm) in east - west and (233.3 cm) in south – north direction was recorded with application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and showed superiority over rest of the treatments. The minimum canopy spread in east – west (191.3 cm) and south – north (196.9 cm) directions, respectively was recorded with the application of bio-inoculants applied alone.

Table 4.3: Influence of organic and inorganic sources of nutrients on crown width east-west direction (cm)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	170.0	166.7	189.3	193.3	200.0	226.7	191.0
310:100:270g NPK (75%RDF)	(F ₂)	176.7	170.0	196.7	198.3	210.0	230.0	197.0
415:130:360g NPK (100%RDF)	(F ₃)	206.7	200.0	210.0	216.7	236.7	235.0	217.5
520:160:450g NPK (125%RDF)	(F ₄)	210.0	208.3	218.3	220.0	240.0	246.7	223.9
Mean		190.8	186.3	203.6	207.1	221.7	234.6	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.22		1.50		3.00		
CD at 5%		3.50		4.28		8.56		
2013-14								
Without fertilizer (Control)	(F ₁)	180.0	176.7	203.3	209.0	210.0	238.3	202.9
310:100:270g NPK (75%RDF)	(F ₂)	186.7	180.0	206.7	208.3	210.0	230.0	203.6
415:130:360g NPK (100%RDF)	(F ₃)	216.7	210.0	220.0	226.7	240.0	248.3	227.0
520:160:450g NPK (125%RDF)	(F ₄)	226.7	218.3	226.7	230.0	250.0	256.7	234.7
Mean		202.5	196.3	214.2	218.5	227.5	243.3	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.11		1.36		2.71		
CD at 5%		3.16		3.88		7.55		
Pool data								
Without fertilizer (Control)	(F ₁)	175.0	171.7	196.3	201.2	205.0	232.5	196.9
310:100:270g NPK (75%RDF)	(F ₂)	181.7	175.0	201.7	203.3	210.0	230.0	200.3
415:130:360g NPK (100%RDF)	(F ₃)	211.7	205.0	215.0	221.7	238.3	241.7	222.2
520:160:450g NPK (125%RDF)	(F ₄)	218.4	213.3	222.5	225.0	245.0	251.7	229.3
Mean		196.7	191.3	208.9	212.8	224.6	239.0	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.81		1.00		1.99		
CD at 5%		2.32		2.85		5.69		

Table 4.4: Influence of organic and inorganic sources of nutrients on crown width south-north direction (cm)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	187.0	183.3	200.0	201.7	211.7	213.3	199.5
310:100:270g NPK (75%RDF)	(F ₂)	194.3	191.7	198.3	200.0	210.0	226.7	203.5
415:130:360g NPK (100%RDF)	(F ₃)	198.4	196.7	200.0	216.7	223.3	233.3	211.4
520:160:450g NPK (125%RDF)	(F ₄)	210.0	201.7	210.0	225.0	226.7	245.0	219.7
Mean		197.4	193.3	202.1	210.8	217.9	229.6	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.13		1.39		2.78		
CD at 5%		3.24		3.97		7.94		
2013-14								
Without fertilizer (Control)	(F ₁)	193.7	188.3	206.7	206.7	216.7	218.3	205.1
310:100:270g NPK (75%RDF)	(F ₂)	198.3	198.3	206.7	216.7	233.3	238.3	215.3
415:130:360g NPK (100%RDF)	(F ₃)	205.0	203.3	206.7	223.3	230.0	240.0	218.1
520:160:450g NPK (125%RDF)	(F ₄)	223.0	211.7	223.4	230.0	241.7	251.7	230.2
Mean		205.0	200.4	210.8	219.2	230.4	237.1	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.01		1.24		2.48		
CD at 5%		2.89		3.54		7.07		
Pooled data								
Without fertilizer (Control)	(F ₁)	190.3	185.8	203.3	204.2	214.2	215.8	202.3
310:100:270g NPK (75%RDF)	(F ₂)	196.3	195.0	202.5	208.4	221.7	232.5	209.4
415:130:360g NPK (100%RDF)	(F ₃)	201.7	200.0	203.4	220.0	226.7	236.7	214.7
520:160:450g NPK (125%RDF)	(F ₄)	216.5	206.7	216.7	227.5	234.2	248.3	225.0
Mean		201.2	196.9	206.5	215.0	224.2	233.3	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.62		0.76		1.51		
CD at 5%		1.77		2.16		4.32		

The interaction effect of inorganic and organic sources of nutrient had significant effect on spread of crown in all the directions and the maximum crown spread of east - west (251.7cm) and south – north (248.3 cm) was recorded with chemical fertilizer applied @ 520:160:450g NPK plant⁻¹ (125% of RDF) alongwith Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and showed superiority over rest of the treatments whereas, the minimum crown spread of east-west (171.7cm) and south-north (185.8 cm) direction was recorded with no chemical fertilizer application + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each). Moreover, all the sources of inorganic and organic interact with each other and showed superiority over preceding level of nutrient.

4.1.4 Shoot length (cm)

The observations recorded on shoot length presented are in Table 4.5. Results revealed that all the sources of nutrient had significant effect on shoot length. Increasing dose of fertilizer increased the shoot length significantly. The highest shoot length (14.6 cm) was noted with the application of 520:160:450g NPK plant⁻¹ (125% of RDF) and proved superior over rest of the fertilizer doses except 415:130:360g NPK plant⁻¹ (100% of RDF). The lowest shoot length (13.2 cm) was recorded with unfertilized plant i.e. control.

The shoot length significantly influenced with addition of organic source of nutrients and the significant higher shoot length (15.3 cm) was noted with application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹each) followed by Vermicompost (25kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) with the shoot length (14.6 cm). The treatments O₁, O₃ and O₄ were statistically at par with each other whereas the minimum shoot length (12.9 cm)was noted under application of bio- inoculants alone (O₂).

The interaction of fertilizers and organic sources of nutrients did not exhibit any significant effect with respect to shoot length during first year as well as in pooled data. The maximum shoot length (16.6 cm) was noted with 125% recommended

dose of fertilizer in combination with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) which was significantly higher over the treatments. The minimum shoot length (12.4 cm) was recorded without chemical fertilizer application in combination with bio-inoculants during second year.

4.1.5 Number of leaves per shoot

Data pertaining to number of leaves per shoot were record and presented in Table 4.6. All the fertility levels significantly influenced the number of leaves per shoots. The higher number of leaves (10.7 shoot⁻¹) was recorded with 125 % recommended dose of fertilizer (520:160:450g NPK plant⁻¹) and showed superiority over rest of the levels, while the minimum number of leaves (8.1 shoots⁻¹) was recorded with unfertilized (control).

The various sources of organic nutrients application significantly influenced the leaves per shoot during both the years of study and pooled data. The higher number of leaves (10.5 shoot⁻¹) was noted with application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) whereas, the minimum number of 8.5 leaves shoot⁻¹ was noted with treatment where plant received bio inoculants alone (O₂). Moreover, treatment O₄ and O₅ comprising Vermicompost (25 kg/plant) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and Vermicompost (25 kg/plant) + Oil cake (2.5 kg plant⁻¹), O₁ and O₃ (Vermicompost (25 kg/plant) and Oil cake (2.5 kg plant⁻¹) statistically at par with each other with respect to number of leaves shoot⁻¹ in both the year of study.

The interaction between inorganic and organic sources found non significant in both the year of study as well as in the pooled data.

Table 4.5: Influence of organic and inorganic sources of nutrients on shoot length (cm)

Treatments		OC		VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	12.2	12.0	12.2	12.4	13.4	14.5	12.8
310:100:270g NPK (75%RDF)	(F ₂)	12.7	12.4	13.3	13.5	13.7	14.6	13.4
415:130:360g NPK (100%RDF)	(F ₃)	13.7	12.7	13.7	13.7	14.1	14.8	13.8
520:160:450g NPK (125%RDF)	(F ₄)	13.5	13.0	13.8	14.2	15.2	15.6	14.2
Mean		13.0	12.5	13.3	13.4	14.1	14.9	
		Inorganic sources		Organic sources		Interaction		
S Em ±		0.13		0.16		0.32		
CD at 5%		0.36		0.45		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	12.8	12.4	13.2	13.4	14.4	15.5	13.7
310:100:270g NPK (75%RDF)	(F ₂)	13.7	13.3	14.3	14.4	14.4	15.6	14.3
415:130:360g NPK (100%RDF)	(F ₃)	13.8	13.8	14.3	14.7	15.1	15.2	14.5
520:160:450g NPK (125%RDF)	(F ₄)	14.2	13.6	14.5	14.8	16.2	16.6	15.0
Mean		13.6	13.4	14.1	14.3	15.0	15.7	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.11		0.13		0.26		
CD at 5%		0.31		0.37		0.75		
Pooled data								
Without fertilizer (Control)	(F ₁)	12.5	12.4	12.7	12.9	13.9	15.0	13.2
310:100:270g NPK (75%RDF)	(F ₂)	13.2	12.8	13.8	13.9	14.0	15.1	13.8
415:130:360g NPK (100%RDF)	(F ₃)	13.7	13.3	14.0	14.2	14.6	15.0	14.1
520:160:450g NPK (125%RDF)	(F ₄)	13.8	13.3	14.2	14.5	15.7	16.1	14.6
Mean		13.3	12.9	13.7	13.9	14.6	15.3	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.17		0.21		0.43		
CD at 5%		0.50		0.61		NS		

Table 4.6: Influence of organic and inorganic sources of nutrients on number of leaves per shoot

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	7.4	6.7	7.7	8.0	8.0	8.7	7.7
310:100:270g NPK (75%RDF)	(F ₂)	8.1	8.1	8.4	8.8	9.1	9.4	8.6
415:130:360g NPK (100%RDF)	(F ₃)	8.8	8.5	9.1	9.8	10.1	10.7	9.5
520:160:450g NPK (125%RDF)	(F ₄)	9.5	9.1	9.8	10.1	10.4	11.1	10.0
Mean		8.4	8.1	8.7	9.2	9.4	10.0	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.09		0.11		0.23		
CD at 5%		0.26		0.32		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	8.0	7.3	8.4	8.7	8.7	9.4	8.4
310:100:270g NPK (75%RDF)	(F ₂)	9.1	8.4	9.1	9.7	10.1	10.4	9.5
415:130:360g NPK (100%RDF)	(F ₃)	10.1	9.8	10.1	11.4	11.4	12.0	10.8
520:160:450g NPK (125%RDF)	(F ₄)	11.1	10.4	11.1	11.4	11.8	12.4	11.4
Mean		9.6	9.0	9.7	10.3	10.5	11.1	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.14		0.17		0.34		
CD at 5%		0.39		0.48		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	7.7	7.0	8.0	8.4	8.4	9.0	8.1
310:100:270g NPK (75%RDF)	(F ₂)	8.6	8.2	8.7	9.3	9.6	9.9	9.0
415:130:360g NPK (100%RDF)	(F ₃)	9.5	9.1	9.6	10.6	10.7	11.4	10.1
520:160:450g NPK (125%RDF)	(F ₄)	10.3	9.8	10.4	10.8	11.1	11.7	10.7
Mean		9.0	8.5	9.2	9.7	9.9	10.5	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.08		0.09		0.19		
CD at 5%		0.23		0.28		NS		

4.1.6 Days to bud emergence

Plants were fertilized as per the treatment in the 37th and 40th meteorological weeks of 2012 and 2013, respectively. The different sources of nutrient had significant effect on bud emergence from the date of nutrient application. The plants higher received nutrient delayed the bud initiation (Table 4.7). The pooled data showed that more number of days (97.25) were taken by the plants for bud emergence with 520:160:450g NPK plant⁻¹ (125% of RDF) whereas, the least day (71.2) were taken plants for bud emergence under control. Moreover, it was noted the incremental dose of chemical fertilizer delayed the bud initiation.

The higher content of nutrient through organic sources significantly influenced the bud initiations. The maximum number of days (87.6) was taken by plants which received Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and minimum days (79.9) for bud emergence was recorded under plants received bio-inoculants alone. Moreover, treatment comprising Vermicompost (25 kg/plant) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and Vermicompost (25 kg/plant) + Oil cake (2.5 kg plant⁻¹), and Vermicompost (25 kg/plant) and Oil cake (2.5 kg plant⁻¹) statistically at par with each other with respect to number of days taken for bud emergence.

The interaction of chemical fertilizers and organic sources showed significant delayed the bud initiation. The maximum number of days (101.3) was taken with the application of chemical fertilizer @ 520:160:450g NPK plant⁻¹ (125% of RDF) alongwith the Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) whereas, the minimum days for bud initiation (68.0) was taken under F₁ O₂.

Table 4.7: Influence of organic and inorganic sources of nutrients on bud emergence (days)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	64.0	64.7	66.3	68.0	68.0	68.3	66.6
310:100:270g NPK (75%RDF)	(F ₂)	69.7	69.3	70.3	72.7	75.3	76.0	72.2
415:130:360g NPK (100%RDF)	(F ₃)	77.7	75.7	78.0	81.7	86.3	88.7	81.3
520:160:450g NPK (125%RDF)	(F ₄)	90.7	89.7	92.7	93.0	95.3	95.7	92.8
Mean		75.5	74.8	76.8	78.8	81.3	82.2	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.51		0.63		1.26		
CD at 5%		1.46		1.79		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	74.3	70.7	74.3	77.0	77.3	78.7	75.4
310:100:270g NPK (75%RDF)	(F ₂)	81.0	79.7	83.0	85.3	86.3	85.7	83.5
415:130:360g NPK (100%RDF)	(F ₃)	89.7	88.7	90.7	92.7	97.7	98.7	93.0
520:160:450g NPK (125%RDF)	(F ₄)	100.7	99.0	101.0	101.7	101.7	106.0	101.7
Mean		86.4	84.5	87.3	89.2	90.8	92.3	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.29		0.35		0.70		
CD at 5%		0.81		0.99		1.99		
Pooled data								
Without fertilizer (Control)	(F ₁)	69.3	68.0	70.7	72.7	73.0	73.7	71.2
310:100:270g NPK (75%RDF)	(F ₂)	75.7	74.7	77.0	79.3	81.0	81.3	78.2
415:130:360g NPK (100%RDF)	(F ₃)	83.7	82.3	84.3	87.3	92.3	94.0	87.3
520:160:450g NPK (125%RDF)	(F ₄)	95.7	94.7	97.0	97.7	98.7	101.3	97.5
Mean		81.1	79.9	82.3	84.3	86.3	87.6	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.31		0.38		0.75		
CD at 5%		0.86		1.07		2.14		

4.1.7 Days to first panicle emergence

The different sources of nutrient had significant effect on panicle emergence from the date of nutrient application Table 4.8. The number of days of panicle emergence increased from 86.8 to 113.2 days with the application of chemical fertilizer @ 520:160:450g NPK plant⁻¹ (125% of RDF) over no fertilizer application. Further, it was noted that the increasing dose of chemical fertilizer significantly delayed the panicle emergence over preceding level of fertilizer.

The application of nutrient through organic sources also significantly delayed the panicle emergence. The maximum average number of days (102.9) was taken for panicle emergence when plants applied Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) followed by 101.3 days when plants applied Vermicompost (25 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each). The minimum average days (95.8) was taken when plants applied bio-inoculants alone which was statistically at par with Vermicompost 25 kg plant⁻¹ (O₁) and Oil cake 2.5 kg plant⁻¹ (O₃).

The interaction of organic and inorganic sources of nutrient significantly delayed the panicle emergence. The maximum number of days (116.7) was taken with application of chemical fertilizer @ 520:160:450g NPK plant⁻¹ (125% of RDF) alongwith the Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each), followed by 114.7 days when applied same level of fertilizer in combination with Vermicompost (25 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each). The minimum average number of 84.0 days for panicle emergence was noted with F₁O₂ (bio inoculants + no chemical fertilizer).

Table 4.8: Influence of organic and inorganic sources of nutrients on panicle emergence (days)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	79.3	79.7	81.0	81.7	81.3	82.3	80.9
310:100:270g NPK (75%RDF)	(F ₂)	85.7	84.7	86.3	90.3	90.3	90.7	88.0
415:130:360g NPK (100%RDF)	(F ₃)	93.0	90.7	93.7	95.7	104.0	104.7	96.9
520:160:450g NPK (125%RDF)	(F ₄)	106.7	105.0	107.0	109.0	109.0	111.7	108.1
Mean		91.2	90.0	92.0	94.2	96.2	97.3	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.50		0.61		1.22		
CD at 5%		1.42		1.74		3.48		
2013-14								
Without fertilizer (Control)	(F ₁)	91.7	88.0	92.0	93.7	94.7	94.7	92.4
310:100:270g NPK (75%RDF)	(F ₂)	96.7	96.0	97.7	98.7	100.3	101.3	98.4
415:130:360g NPK (100%RDF)	(F ₃)	105.0	104.7	105.7	109.0	110.0	114.7	108.2
520:160:450g NPK (125%RDF)	(F ₄)	115.7	115.3	117.0	117.7	119.3	121.3	117.7
Mean		102.3	101.0	103.1	104.8	106.1	108.0	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.38		0.46		0.92		
CD at 5%		1.09		1.32		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	85.7	84.0	86.7	88.0	88.0	88.7	86.8
310:100:270g NPK (75%RDF)	(F ₂)	91.3	90.7	92.3	94.7	95.3	96.3	93.4
415:130:360g NPK (100%RDF)	(F ₃)	99.0	98.0	100.0	102.7	107.3	110.0	102.8
520:160:450g NPK (125%RDF)	(F ₄)	111.3	110.3	112.3	113.7	114.7	116.7	113.2
Mean		96.8	95.8	97.8	99.8	101.3	102.9	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.36		0.44		0.88		
CD at 5%		1.03		1.26		2.53		

4.1.8 Days to 50% Flowering

Data in relation to days to 50% flowering were recorded, analysed and presented in Table 4.9. The analysis of data revealed that the different sources of nutrient showed significant effect on days taken for 50% flowering from the date of nutrient application. The average more number (131.3 days) was taken to attained 50% flowering with application of 125 % recommended dose of chemical fertilizer (520:160:450g NPK plant⁻¹) ,which was significantly higher than the preceding level of fertilizer. However, lesser days was taken to reach 50% flowering when plants were not fertilized chemically (104.9 days) which was significantly less than the other treatments.

The application of nutrient through organic sources delayed the flowering significantly. The higher number of days (127.2) was taken to reach plant up to fifty per cent flowering when plants applied Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) followed by Vermicompost (25 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each). Whereas, the minimum average days (122.6) taken when applied bio-inoculants alone which was statistically at par with application of oil cake (O₁,) and vermicompost (O₃) alone.

The interaction of organic and inorganic sources of nutrient delayed the flowering whereas the effect on flowering was statistically non significant to reach upto fifty per cent flowering.

Table 4.9: Influence of organic sources and chemical fertilizer on fifty per cent flowering (days)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	101.3	100.0	103.3	103.7	103.7	106.3	103.1
310:100:270g NPK (75%RDF)	(F ₂)	109.3	108.3	112.3	112.7	113.3	113.3	111.6
415:130:360g NPK (100%RDF)	(F ₃)	114.7	114.0	117.3	118.3	125.0	126.3	119.3
520:160:450g NPK (125%RDF)	(F ₄)	129.3	128.3	130.7	131.0	131.3	136.0	131.1
Mean		113.7	112.7	115.9	116.4	118.3	120.5	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.56		0.68		1.37		
CD at 5%		1.60		1.96		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	104.7	103.7	105.7	107.0	107.7	109.0	106.3
310:100:270g NPK (75%RDF)	(F ₂)	110.3	109.3	112.7	113.3	113.7	113.7	112.2
415:130:360g NPK (100%RDF)	(F ₃)	119.3	118.7	119.3	122.7	124.0	126.7	121.8
520:160:450g NPK (125%RDF)	(F ₄)	130.0	127.7	130.3	131.7	132.3	135.0	131.2
Mean		116.1	114.8	117.0	118.7	119.4	121.1	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.20		1.47		1.47		
CD at 5%		3.43		4.20		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	103.3	102.0	104.7	105.7	106.0	108.0	104.9
310:100:270g NPK (75%RDF)	(F ₂)	110.0	109.0	112.7	113.3	113.7	114.0	112.1
415:130:360g NPK (100%RDF)	(F ₃)	117.3	116.7	118.3	120.7	124.7	127.0	120.8
520:160:450g NPK (125%RDF)	(F ₄)	129.7	128.3	130.7	131.7	132.0	135.7	131.3
Mean		123.1	122.6	122.4	125.0	125.0	127.2	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.67		0.82		1.63		
CD at 5%		1.90		2.33		NS		

4.1.9: Panicle length (cm)

Panicle length was measured in both the year of study and average length is presented in Table 4.10. The statistical analysis revealed that length of panicle significantly influenced by application of organic and inorganic source of nutrient during both the years as well in pooled data. Further, it was noted that increasing the levels of nutrient either through inorganic or organic significantly increased the length of panicles. The increasing level of NPK showed increasing trend in length of panicle. The longest panicle length of 37.2 cm was recorded with application of 520:160:450g NPK plant⁻¹ (125% of RDF) whereas, the shortest panicle (30.8 cm) was observed with unfertilized plants (control).

The data also indicated that each incremental dose of nutrients through organic sources significantly increased the panicle length. The average higher length of 35.7 cm was noted with application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and proved significantly superior over remaining source of nutrient whereas, the shortest panicle length of 31.7cm was noted with application of bio-inoculants alone.

The interaction effect of organic and inorganic sources was significant in both the years as well as in the pooled data. The higher panicle length of 39.7cm was noted with the application of 125% of recommended dose of fertilizer (520:160:450g NPK plant⁻¹) in combination with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) ,followed by same level of chemical fertilizer alongwith Vermicompost (25 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and showed superiority over rest of the combinations under study. However, the minimum length of panicle (29.1cm) was recorded with the application of bio-inoculants alone without chemical fertilizer.

Table 4.10: Influence of organic sources and chemical fertilizer on length of panicle (cm)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	27.7	27.7	30.0	30.0	30.0	30.3	29.3
310:100:270g NPK (75%RDF)	(F ₂)	28.0	27.0	30.7	31.7	32.4	33.4	30.5
415:130:360g NPK (100%RDF)	(F ₃)	31.4	31.4	32.0	33.3	33.7	34.7	32.8
520:160:450g NPK (125%RDF)	(F ₄)	34.0	33.0	33.7	34.7	37.0	38.0	35.1
Mean		30.3	29.8	31.6	32.4	33.3	34.1	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.09		0.11		0.22		
CD at 5%		0.26		0.32		0.64		
2013-14								
Without fertilizer (Control)	(F ₁)	30.7	30.4	33.4	32.0	32.4	34.7	32.3
310:100:270g NPK (75%RDF)	(F ₂)	34.1	33.7	34.4	35.4	35.4	36.1	34.8
415:130:360g NPK (100%RDF)	(F ₃)	35.0	33.7	35.4	36.4	37.0	37.4	35.8
520:160:450g NPK (125%RDF)	(F ₄)	38.7	36.7	38.7	39.4	41.3	41.3	39.3
Mean		34.6	33.6	35.5	35.8	36.5	37.4	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.14		0.17		0.35		
CD at 5%		0.41		0.50		1.01		
Pooled data								
Without fertilizer (Control)	(F ₁)	29.2	29.1	31.7	31.0	31.2	32.5	30.8
310:100:270g NPK (75%RDF)	(F ₂)	31.1	30.4	32.6	33.6	33.9	34.8	32.7
415:130:360g NPK (100%RDF)	(F ₃)	33.2	32.6	33.7	34.9	35.4	36.1	34.3
520:160:450g NPK (125%RDF)	(F ₄)	36.4	34.9	36.2	37.1	39.2	39.7	37.2
Mean		32.5	31.7	33.5	34.1	34.9	35.7	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.09		0.11		0.22		
CD at 5%		0.26		0.32		0.64		

4.1.10: Number of paniclelets (panicle⁻¹)

Number of paniclelets per panicle were recorded and presented in Table 4.11. Data revealed that the both the source of nutrient in application significantly affected the number of paniclelets significantly. The number of paniclelets per panicle increased from 30 to 37 with the application of chemical fertilizer @ 415:130:360g NPK plant⁻¹ (100% of RDF). Further, it was noted that the increasing dose of chemical fertilizer significantly increased the paniclelets per panicle over preceding level of fertilizer. Moreover, the minimum number of 30 paniclelets panicle⁻¹ was noted with control.

The application of nutrient through organic sources had significant effect on number of paniclelets per panicle. The higher number of 35 paniclelets panicle⁻¹ with the application of both Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and Vermicompost (25 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) was recorded which showed superiority over rest of the combination of organic sources. The minimum number of 31 paniclelets panicle⁻¹ was noted when applied bio-agents alone i.e. Azotobacter + VAM + Trichoderma viridae + PSB (100 g plant⁻¹ each).

The interaction effect of organic and inorganic sources had significantly effect on number of paniclelets / panicle in both the years as well as in the pooled data. The higher number of 40 paniclelets panicle⁻¹ was noted under the application of recommended dose of fertilizer (415:130:360g NPK plant⁻¹) in combination with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) ,followed by same level of fertilizer in combination with Vermicompost (25 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and showed superiority over rest of the combinations under study. Further, it was noted that increasing the levels of nutrient either through inorganic or organic increased the number of paniclelets per panicle significantly. However, less number of 28 paniclelets panicle⁻¹ was recorded with the application of bio-inoculants and oil cake without chemical fertilizer.

Table 4.11: Influence of organic sources and chemical fertilizer on number of paniclelets panicle⁻¹

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	28	28	30	30	30	30	29
310:100:270g NPK (75%RDF)	(F ₂)	27	28	31	32	32	33	31
415:130:360g NPK (100%RDF)	(F ₃)	33	34	34	35	37	38	35
520:160:450g NPK (125%RDF)	(F ₄)	31	31	32	33	34	35	33
Mean		30	30	32	32	33	34	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.09		0.11		0.23		
CD at 5%		0.27		0.33		0.67		
2013-14								
Without fertilizer (Control)	(F ₁)	28	28	31	30	31	33	30
310:100:270g NPK (75%RDF)	(F ₂)	32	31	32	34	34	34	33
415:130:360g NPK (100%RDF)	(F ₃)	39	37	39	40	41	42	39
520:160:450g NPK (125%RDF)	(F ₄)	35	34	35	36	37	37	36
Mean		33	32	34	35	36	37	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.10		0.12		0.24		
CD at 5%		0.29		0.35		0.71		
Pooled data								
Without fertilizer (Control)	(F ₁)	28	28	31	30	31	32	30
310:100:270g NPK (75%RDF)	(F ₂)	30	30	32	33	33	34	32
415:130:360g NPK (100%RDF)	(F ₃)	36	36	37	38	39	40	37
520:160:450g NPK (125%RDF)	(F ₄)	33	33	34	35	36	36	35
Mean		32	31	33	34	35	35	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.08		0.09		0.19		
CD at 5%		0.23		0.28		0.56		

4.1.11 Number of healthy panicles (m^2)

In general, the number of healthy panicles was higher than that of the malformed panicles in all the treatments under study. The incremental dose of nutrient either through chemical fertilizer or organic increased the number of healthy panicles during both the years and pooled data Table 4.12. The highest number of healthy panicle (17.3 per m^2) was recorded with the application of $415:130:360 \text{ g NPK plant}^{-1}$ (100% of RDF) and found significantly superior over rest of doses. Whereas, the lowest number of healthy panicles (11.4 per m^2) was recorded with unfertilized plant.

Application of organic sources of nutrients proved able to bring out the significant changes in number of healthy panicles during both the years and pooled data. The significantly higher number of healthy panicles (15.9 per m^2) were recorded when applied nutrient through Vermicompost (25 kg plant^{-1}) + Oil cake ($2.5 \text{ kg plant}^{-1}$) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant^{-1} each). However, the lower number of healthy panicles was noted with application of microbes alone (11.7 m^2).

The interaction of organic and inorganic sources of nutrient also showed significant effect on number of healthy panicles. The maximum number of healthy panicles (20.4 per m^2) was recorded with application of recommended dose of chemical fertilizer ($415:130:360\text{g NPK plant}^{-1}$) in combination of Vermicompost (25 kg plant^{-1}) + Oil cake ($2.5 \text{ kg plant}^{-1}$) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant^{-1} each) whereas, the lowest number of healthy panicles (9.9 per m^2) was recorded with no chemical fertilizer in combination of bio-inoculants.

Table 4.12: Influence of organic sources and chemical fertilizer on number of healthy panicle (m²)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	8.7	8.3	9.7	9.0	10.0	10.4	9.3
310:100:270g NPK (75%RDF)	(F ₂)	10.0	9.4	10.7	11.3	11.4	12.7	10.9
415:130:360g NPK (100%RDF)	(F ₃)	15.7	13.3	15.4	18.7	17.7	20.7	16.9
520:160:450g NPK (125%RDF)	(F ₄)	12.0	11.4	13.4	12.0	14.0	14.0	12.8
Mean		11.6	10.6	12.3	12.8	13.3	14.4	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.11		0.13		0.27		
CD at 5%		0.32		0.39		0.79		
2013-14								
Without fertilizer (Control)	(F ₁)	13.4	11.4	12.4	13.0	15.0	15.0	13.4
310:100:270g NPK (75%RDF)	(F ₂)	12.4	10.7	13.4	14.1	15.1	15.7	13.6
415:130:360g NPK (100%RDF)	(F ₃)	16.4	14.4	17.3	18.0	19.3	20.0	17.6
520:160:450g NPK (125%RDF)	(F ₄)	16.1	14.4	14.7	16.7	16.4	18.4	16.1
Mean		14.5	12.7	14.5	15.5	16.5	17.3	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.10		0.13		0.26		
CD at 5%		0.30		0.37		0.74		
Pooled data								
Without fertilizer (Control)	(F ₁)	11.1	9.9	11.1	11.0	12.5	12.7	11.4
310:100:270g NPK (75%RDF)	(F ₂)	11.2	10.1	12.1	12.7	13.3	14.2	12.3
415:130:360g NPK (100%RDF)	(F ₃)	16.1	13.9	16.4	18.4	18.5	20.4	17.3
520:160:450g NPK (125%RDF)	(F ₄)	14.1	12.9	14.1	14.4	15.2	16.2	14.5
Mean		13.1	11.7	13.4	14.1	14.9	15.9	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.08		0.09		0.19		
CD at 5%		0.22		0.28		0.56		

4.1.12 Healthy panicles (%)

Total healthy and malformed panicles in a quadrat were counted and percentage of healthy panicle was computed. The data presented in Table 4.13 revealed that the highest percentage of healthy panicles, (90.56 %) were recorded with application of chemical fertilizer @ 415:130:360g NPK plant⁻¹ (100% of RDF) and found significantly superior over rest doses of chemical fertilizer whereas, the least number of healthy panicles (74.03 %) was recorded with control plant. Further, it was also noted that the incremental dose of chemical fertilizer significantly increased the number of healthy panicles during both the year of study.

The significantly higher percentage of healthy panicles (87.85%) were recorded under Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and found significantly superior to produced higher percentage of healthy panicles. The lower percentage of healthy panicles was noted under microbes alone (76.47%). Moreover, nutrient content increased by the application of organic sources increased the percentage of healthy panicles.

The interaction of organic and inorganic sources of nutrient had significant effect on percentage of healthy panicles. The maximum percentage of healthy panicles (94.44 %) was recorded with application of 415:130:360g NPK plant⁻¹ (100% of RDF) in combination of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each). However, the lowest percentage of healthy panicles (65.56 %) was recorded without chemical fertilizer in combination of bio-inoculants alone (F₁O₂). Moreover, incremental dose of nutrient produce higher percentage of healthy panicles.

Table 4.13: Influence of organic sources and chemical fertilizer on percentage of healthy panicle

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	64.93	61.03	72.39	70.87	76.92	79.39	70.99
310:100:270g NPK (75%RDF)	(F ₂)	78.74	73.44	77.54	80.71	82.61	85.81	80.15
415:130:360g NPK (100%RDF)	(F ₃)	90.23	84.71	86.52	89.90	91.24	93.67	89.42
520:160:450g NPK (125%RDF)	(F ₄)	81.63	77.03	83.23	81.63	87.50	87.50	83.12
Mean		79.45	74.65	80.39	82.05	85.26	87.80	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.05		0.06		0.13		
CD at 5%		0.16		0.19		0.39		
2013-14								
Without fertilizer (Control)	(F ₁)	75.28	69.51	75.15	74.71	79.79	81.08	76.14
310:100:270g NPK (75%RDF)	(F ₂)	76.54	72.30	77.91	80.11	82.97	83.07	79.07
415:130:360g NPK (100%RDF)	(F ₃)	88.65	87.27	90.58	92.78	93.24	95.24	91.67
520:160:450g NPK (125%RDF)	(F ₄)	83.85	82.29	85.47	86.98	86.77	91.09	86.10
Mean		81.01	77.91	82.86	84.24	85.94	87.82	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.28		0.34		0.69		
CD at 5%		0.81		0.99		1.98		
Pooled data								
Without fertilizer (Control)	(F ₁)	70.70	65.56	74.00	72.85	78.62	80.38	74.03
310:100:270g NPK (75%RDF)	(F ₂)	77.24	72.66	77.56	80.38	82.61	84.02	79.35
415:130:360g NPK (100%RDF)	(F ₃)	89.44	85.80	88.65	91.09	92.04	94.44	90.58
520:160:450g NPK (125%RDF)	(F ₄)	82.94	79.63	84.43	84.71	86.86	89.50	84.80
Mean		80.37	76.47	81.71	82.94	85.63	87.85	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.14		0.17		0.34		
CD at 5%		0.39		0.48		0.97		

4.1.13 Fresh weight of healthy and malformed panicle (g)

In general it was observed that the fresh weight of healthy panicles was less than that of recorded for malformed panicles in both year of study. The incremental dose of nutrient either through chemical fertilizer or through organic sources increased the fresh weight of healthy Table 4.14 and malformed panicles Table 4.15 during both the year and pooled. Data revealed the highest fresh weight of healthy (48.5g) with recommended dose of chemical fertilizer (415:130:360g NPK plant⁻¹) whereas higher fresh weight of malformed panicles (102.1g) was recorded with the 125% recommended dose of fertilizer (520:160:450g NPK plant⁻¹) and it was significantly higher than the rest of treatments. Whereas, the lowest fresh weight (35.7 and 85.2 g) of healthy and malformed panicles was noted with unfertilized plant, respectively.

Organic sources of nutrient also increased the fresh weight of healthy and malformed panicles during both the year and pooled data. The significantly higher fresh weight of healthy and malformed panicles (48.4 and 104.7g) was recorded when plant received nutrients through Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) whereas, the lower fresh weight of healthy and malformed panicles (34.5 and 82.2 g) was noted when microbes applied alone (O₂), respectively. Moreover, the incremental content of nutrient through organic sources increased the fresh weight of healthy and malformed panicles.

The interaction of organic and inorganic sources of nutrient had significant effect on fresh weight of healthy and malformed panicles. The higher fresh weight of healthy (55.0 g) and malformed panicles (115.2 g) were recorded with application of RDF (415:130:360g NPK plant⁻¹) and 125 % recommended dose fertilizer (520:160:450g NPK plant⁻¹) in combination of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each). However, the lowest weight (30.9 and 76.5 g) of healthy and malformed panicles was recorded with no fertilizer in combination of bio-inoculants alone (F₁O₂), respectively.

Table 4.14: Influence of organic sources and chemical fertilizer on fresh weight of healthy panicle (g)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	26.3	26.0	27.0	32.3	32.3	33.0	29.5
310:100:270g NPK (75%RDF)	(F ₂)	34.0	28.4	37.0	34.0	37.0	40.0	35.1
415:130:360g NPK (100%RDF)	(F ₃)	37.7	35.0	40.0	43.0	45.7	48.0	41.6
520:160:450g NPK (125%RDF)	(F ₄)	34.0	27.7	34.4	35.7	42.0	42.3	36.0
Mean		33.0	29.3	34.6	36.3	39.3	40.8	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.08		0.10		0.21		
CD at 5%		0.24		0.30		0.60		
2013-14								
Without fertilizer (Control)	(F ₁)	36.0	35.7	45.7	37.7	47.7	48.7	41.9
310:100:270g NPK (75%RDF)	(F ₂)	38.7	36.4	41.4	42.3	47.4	50.3	42.8
415:130:360g NPK (100%RDF)	(F ₃)	52.0	48.0	53.0	60.7	56.3	62.0	55.3
520:160:450g NPK (125%RDF)	(F ₄)	44.0	38.7	49.4	53.0	54.0	63.0	50.3
Mean		42.7	39.7	47.4	48.4	51.4	56.0	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.10		0.13		0.26		
CD at 5%		0.30		0.37		0.75		
Pooled data								
Without fertilizer (Control)	(F ₁)	31.2	30.9	36.4	35.0	40.0	40.9	35.7
310:100:270g NPK (75%RDF)	(F ₂)	36.4	32.4	39.2	38.2	42.2	45.2	39.0
415:130:360g NPK (100%RDF)	(F ₃)	44.9	41.5	46.5	51.9	51.0	55.0	48.5
520:160:450g NPK (125%RDF)	(F ₄)	39.0	33.2	41.9	44.4	48.0	52.7	43.2
Mean		37.8	34.5	41.0	42.3	45.3	48.4	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.07		0.09		0.19		
CD at 5%		0.22		0.27		0.54		

Table 4.15: Influence of organic sources and chemical fertilizer on fresh weight of malformed panicle (g)

Treatments		OC		VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	66.3	64.7	66.7	78.0	79.7	81.7	72.8
310:100:270g NPK (75%RDF)	(F ₂)	75.3	68.0	77.3	88.0	94.0	88.7	81.9
415:130:360g NPK (100%RDF)	(F ₃)	72.7	68.7	88.3	83.7	87.7	103.3	84.1
520:160:450g NPK (125%RDF)	(F ₄)	84.0	82.3	91.0	102.3	104.7	112.0	96.1
Mean		74.6	70.9	80.8	88.0	91.5	96.4	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.30		0.37		0.74		
CD at 5%		0.87		1.06		2.12		
2013-14								
Without fertilizer (Control)	(F ₁)	89.7	88.3	92.7	103.3	104.4	107.3	97.6
310:100:270g NPK (75%RDF)	(F ₂)	94.4	93.4	97.3	108.4	109.7	112.7	102.6
415:130:360g NPK (100%RDF)	(F ₃)	94.7	94.3	98.3	108.0	109.7	113.7	103.1
520:160:450g NPK (125%RDF)	(F ₄)	99.7	98.0	103.7	114.3	114.7	118.3	108.1
Mean		94.6	93.5	98.0	108.5	109.6	113.0	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.06		0.08		0.16		
CD at 5%		0.19		0.23		0.47		
Pooled data								
Without fertilizer (Control)	(F ₁)	78.0	76.5	79.7	90.7	92.1	94.5	85.2
310:100:270g NPK (75%RDF)	(F ₂)	84.9	80.7	87.3	98.2	101.9	100.7	92.3
415:130:360g NPK (100%RDF)	(F ₃)	83.7	81.5	93.3	95.9	98.7	108.5	93.6
520:160:450g NPK (125%RDF)	(F ₄)	91.9	90.2	97.4	108.3	109.7	115.2	102.1
Mean		84.6	82.2	89.4	98.3	100.6	104.7	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.16		0.19		0.39		
CD at 5%		0.46		0.55		1.11		

4.1.14: Dry weight of healthy and malformed panicles (g)

In general it was observed that the dry weight of malformed panicles was more than the healthy panicles. The incremental dose of nutrient either through chemical fertilizer or organic sources increased the accumulation of dry matter in panicles. Data pertaining healthy Table 4.16 and malformed panicles Table 4.17 revealed that significantly higher dry weight of 30.8 g healthy and 41.5 g malformed panicles was recorded with recommended dose of fertilizer (415:130:360 g NPK plant⁻¹), and 125 % recommended dose of fertilizer (520:160:450g NPK plant⁻¹), respectively. Whereas, the lowest dry weight (22.6 and 36.3 g) of healthy and malformed panicles, was recorded under unfertilized plant. Further, it was noted that the incremental dose of chemical fertilizer increased the dry matter accumulation in term of dry weight of healthy and malformed panicles significantly.

Application of nutrient through organic sources also increased the dry weight of healthy and malformed panicles during both the year and pooled data. The significantly higher dry weight of healthy and malformed panicles (29.4 and 41.0 g) was recorded when plant received nutrients through Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each).Whereas, the lower dry weight of healthy and malformed panicle (23.4 and 36.8 g) was noted when plants received microbes alone (O₂) followed by oilcake (2.5 kg plant⁻¹. Moreover, the higher doses of nutrient through organic sources increased the weight of healthy and malformed panicle.

The interaction of organic and inorganic sources of nutrient had showed significant effect on dry weight of healthy and malformed panicles. The higher dry weight of healthy (33.5 g) and malformed panicles (43.9 g) was recorded with 415:130:360 g NPK plant⁻¹ (RDF) and 520:160:450g NPK plant⁻¹ (125% of RDF) alongwith Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each), respectively. However, the lowest dry weight (21.0 and 34.9 g) of healthy and malformed panicle, respectively was recorded under without chemical fertilizer in combination of bio-inoculants alone (F₁O₂).

Table 4.16: Influence of organic sources and chemical fertilizer on dry matter accumulation in healthy panicle (g)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	18.0	16.3	16.3	21.0	17.0	21.3	18.3
310:100:270g NPK (75%RDF)	(F ₂)	18.3	17.7	24.0	21.7	24.4	22.0	21.4
415:130:360g NPK (100%RDF)	(F ₃)	23.0	25.0	27.7	27.4	28.0	30.0	26.9
520:160:450g NPK (125%RDF)	(F ₄)	24.0	17.0	24.0	26.7	27.0	27.0	24.3
Mean		20.8	19.0	23.0	24.2	24.6	24.6	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.08		0.10		0.21		
CD at 5%		0.25		0.31		0.62		
2013-14								
Without fertilizer (Control)	(F ₁)	24.4	25.7	26.0	25.7	27.7	32.0	26.9
310:100:270g NPK (75%RDF)	(F ₂)	24.7	26.0	28.7	27.0	30.3	33.0	28.3
415:130:360g NPK (100%RDF)	(F ₃)	33.7	31.0	34.7	36.3	36.0	37.0	34.8
520:160:450g NPK (125%RDF)	(F ₄)	32.7	28.7	34.0	34.7	35.7	35.0	33.5
Mean		28.9	27.9	30.9	30.9	32.4	34.3	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.10		0.12		0.25		
CD at 5%		0.29		0.36		0.72		
Pooled data								
Without fertilizer (Control)	(F ₁)	21.2	21.0	21.2	23.4	22.4	26.7	22.6
310:100:270g NPK (75%RDF)	(F ₂)	21.5	21.9	26.4	24.4	27.4	27.5	24.8
415:130:360g NPK (100%RDF)	(F ₃)	28.4	28.0	31.2	31.9	32.0	33.5	30.8
520:160:450g NPK (125%RDF)	(F ₄)	28.4	22.9	29.0	30.7	31.4	31.0	28.9
Mean		24.8	23.4	26.9	27.6	28.5	29.4	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.06		0.07		0.15		
CD at 5%		0.18		0.22		0.44		

Table 4.17: Influence of organic sources and chemical fertilizer on dry matter accumulation in malformed panicle (g)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	32.1	31.5	32.9	33.4	32.2	34.0	32.7
310:100:270g NPK (75%RDF)	(F ₂)	35.1	32.7	35.9	37.6	35.8	38.0	35.8
415:130:360g NPK (100%RDF)	(F ₃)	34.2	32.9	34.6	35.8	39.4	40.4	36.2
520:160:450g NPK (125%RDF)	(F ₄)	38.0	37.4	40.1	40.8	40.3	42.9	39.9
Mean		34.9	33.6	35.9	36.9	36.9	38.8	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.095		0.117		0.234		
CD at 5%		0.272		0.333		0.667		
2013-14								
Without fertilizer (Control)	(F ₁)	38.7	38.3	39.8	40.4	40.7	41.6	39.9
310:100:270g NPK (75%RDF)	(F ₂)	40.5	40.1	41.4	41.8	42.2	43.4	41.6
415:130:360g NPK (100%RDF)	(F ₃)	40.4	39.9	41.5	41.9	42.3	43.1	41.5
520:160:450g NPK (125%RDF)	(F ₄)	41.8	41.5	42.9	43.6	43.7	44.8	43.1
Mean		40.3	39.9	41.4	41.9	42.2	43.2	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.080		0.099		0.197		
CD at 5%		0.230		0.281		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	35.4	34.9	36.4	36.9	36.5	37.8	36.3
310:100:270g NPK (75%RDF)	(F ₂)	37.8	36.4	38.7	39.7	39.0	40.7	38.7
415:130:360g NPK (100%RDF)	(F ₃)	37.3	36.4	38.1	38.9	40.9	41.8	38.9
520:160:450g NPK (125%RDF)	(F ₄)	39.9	39.5	41.5	42.2	42.0	43.9	41.5
Mean		37.6	36.8	38.6	39.4	39.6	41.0	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.070		0.085		0.171		
CD at 5%		0.199		0.244		0.487		

4.1.15 Intensity (m^2) and severity (%) of malformed panicles

Total number of healthy and malformed panicles in a quadrat was counted and number of infected panicles in a quadrat expressed as intensity (m^2) and percentage of malformed panicles articulated as severity (%). The data pertaining intensity (Table 4.18) and severity (Table 4.19) revealed that the minimum intensity (1.8 m^2) and severity (9.42%) of malformed panicles was recorded under recommended dose of chemical fertilizers (415:130:360g NPK plant^{-1}). All the treatment of fertilizer differs significantly with each other and the maximum intensity (4.0 m^2) of malformed panicles and severity (25.97%) was recorded with no chemical fertilizer.

Organic sources of nutrient also showed significant effect on intensity and severity of malformed panicle. The significantly lower intensity (2.2 m^2) and severity (12.15%) of malformed panicle was noted with Vermicompost (25 kg plant^{-1}) + Oil cake ($2.5 \text{ kg plant}^{-1}$) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant^{-1} each) followed by Vermicompost (25 kg plant^{-1}) + Oil cake ($2.5 \text{ kg plant}^{-1}$) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant^{-1} each). Whereas, the higher intensity (3.6 m^2) and severity (23.53%) was noted with application of bio-inoculants alone.

The interaction of organic and inorganic sources of nutrient had show significant effect on intensity and severity of malformed panicle in both the year as well as in pooled data. The least intensity (1.2 m^2) and severity (5.56 %) of malformation were recorded with application of recommended dose of fertilizer (415:130:360g NPK plant^{-1}) in combination of Vermicompost (25 kg plant^{-1}) + Oil cake ($2.5 \text{ kg plant}^{-1}$) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant^{-1} each). However, the higher malformed intensity (5.2 m^2) and severity (34.44 %) was recorded under without chemical fertilizer in combination of bio-inoculants alone (F_1O_2).

Table 4.18: Influence of organic sources and chemical fertilizer on intensity of malformed panicle (m²)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	4.7	5.3	3.7	3.7	3.0	2.7	3.8
310:100:270g NPK (75%RDF)	(F ₂)	2.7	3.4	3.1	2.7	2.4	2.1	2.7
415:130:360g NPK (100%RDF)	(F ₃)	1.7	2.4	2.4	2.1	1.7	1.4	2.0
520:160:450g NPK (125%RDF)	(F ₄)	2.7	3.4	2.7	2.7	2.0	2.0	2.6
Mean		3.0	3.6	3.0	2.8	2.3	2.0	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.10		0.12		0.25		
CD at 5%		0.29		0.36		0.73		
2013-14								
Without fertilizer	(F ₁)	4.4	5.0	4.1	4.4	3.8	3.5	4.2
310:100:270g NPK (75%RDF)	(F ₂)	3.8	4.1	3.8	3.5	3.1	3.2	3.6
415:130:360g NPK (100%RDF)	(F ₃)	2.1	2.1	1.8	1.4	1.4	1.0	1.6
520:160:450g NPK (125%RDF)	(F ₄)	3.1	3.1	2.5	2.5	2.5	1.8	2.6
Mean		3.4	3.6	3.0	2.9	2.7	2.4	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.01		0.13		0.25		
CD at 5%		0.30		0.30		NS		
Pooled data								
Without fertilizer	(F ₁)	4.6	5.2	3.9	4.1	3.4	3.1	4.0
310:100:270g NPK (75%RDF)	(F ₂)	3.3	3.8	3.5	3.1	2.8	2.7	3.2
415:130:360g NPK (100%RDF)	(F ₃)	1.9	2.3	2.1	1.8	1.6	1.2	1.8
520:160:450g NPK (125%RDF)	(F ₄)	2.9	3.3	2.6	2.6	2.3	1.9	2.6
Mean		3.2	3.6	3.0	2.9	2.5	2.2	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.07		0.09		0.19		
CD at 5%		0.22		0.27		0.54		

Table 4.19: Influence of organic sources and chemical fertilizer on severity of malformed panicle (%)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	35.07	38.97	27.61	29.13	23.08	20.61	29.01
310:100:270g NPK (75%RDF)	(F ₂)	21.26	26.56	22.46	19.29	17.39	14.19	19.85
415:130:360g NPK (100%RDF)	(F ₃)	9.77	15.29	13.48	10.10	8.76	6.33	10.58
520:160:450g NPK (125%RDF)	(F ₄)	18.37	22.97	16.77	18.37	12.50	12.50	16.88
Mean		20.55	25.35	19.61	17.95	14.74	12.20	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.04		0.05		0.11		
CD at 5%		0.13		0.16		0.33		
2013-14								
Without fertilizer (Control)	(F ₁)	24.72	30.49	24.85	25.29	20.21	18.92	23.86
310:100:270g NPK (75%RDF)	(F ₂)	23.46	27.70	22.09	19.89	17.03	16.93	20.93
415:130:360g NPK (100%RDF)	(F ₃)	11.35	12.73	9.42	7.22	6.76	4.76	8.33
520:160:450g NPK (125%RDF)	(F ₄)	16.15	17.71	14.53	13.02	13.23	8.91	13.90
Mean		18.99	22.09	17.14	15.76	14.06	12.18	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.02		0.03		0.06		
CD at 5%		0.07		0.09		0.17		
Pooled data								
Without fertilizer (Control)	(F ₁)	29.30	34.44	26.00	27.15	21.38	19.62	25.97
310:100:270g NPK (75%RDF)	(F ₂)	22.76	27.34	22.44	19.62	17.39	15.98	20.65
415:130:360g NPK (100%RDF)	(F ₃)	10.56	14.20	11.35	8.91	7.96	5.56	9.42
520:160:450g NPK (125%RDF)	(F ₄)	17.06	20.37	15.57	15.29	13.14	10.50	15.20
Mean		19.63	23.53	18.29	17.06	14.37	12.15	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.02		0.02		0.05		
CD at 5%		0.07		0.08		0.16		

4.1.16 Fruit set (%)

Fruits per plant were counted at pea stage in both the years and presented in Table 4.20. Data revealed that the incremental dose of nutrients either in the form of inorganic fertilizer or in the form of organic increased the fruit set per par panicle. The maximum average number of fruit set at pea stage ($21.8 \text{ panicle}^{-1}$) was recorded with recommended dose of chemical fertilizer ($415:130:360 \text{ g NPK plant}^{-1}$) and 125% of RDF ($520:160:450 \text{ g NPK plant}^{-1}$) registered $20.6 \text{ fruit panicle}^{-1}$ and showed superiority over rest of the treatment. Whereas, the minimum average number of $16.1 \text{ fruits panicle}^{-1}$ at pea stage was noted with unfertilized plants.

As regards, to the application of nutrients through organic sources had the significant effect on pea stage fruit set in both the years as well as in pooled data. The maximum average number of $21.8 \text{ fruits panicle}^{-1}$ was noted with the application of Vermicompost (25 kg plant^{-1}) + Oil cake ($2.5 \text{ kg plant}^{-1}$) + Azotobacter + VAM + Trichoderma viridi + PSB (100 g plant^{-1} each) and proved significantly superior over remaining organic source of nutrients whereas, the minimum average number of $15.8 \text{ fruits panicle}^{-1}$ at pea stage was noted with application of bio-inoculants alone.

The interaction of organic and inorganic source of nutrient had show significant effect on fruit set in both the years as well as in the pooled data at pea stage whereas, the maximum average number of fruits set at pea stage ($24.9 \text{ panicle}^{-1}$) was recorded with the application of fertilizer $415:130:360 \text{ g NPK plant}^{-1}$ RDF in combination with Vermicompost (25 kg plant^{-1}) + Oil cake ($2.5 \text{ kg plant}^{-1}$) + Azotobacter + VAM + Trichoderma viridi + PSB (100 g plant^{-1} each) and showed superiority over rest of the treatment combination of organic and inorganic sources. However, the minimum average number of $13.2 \text{ fruits panicle}^{-1}$ was noted with the application of bio-inoculants without chemical fertilizer.

Table 4.20: Effect of organic and inorganic sources on fruit set at pea stage panicle⁻¹

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	12.0	11.0	12.7	14.3	15.3	16.0	13.6
310:100:270g NPK (75%RDF)	(F ₂)	14.0	13.0	14.4	16.4	17.4	17.7	15.5
415:130:360g NPK (100%RDF)	(F ₃)	17.7	17.4	18.0	20.7	21.0	21.4	19.4
520:160:450g NPK (125%RDF)	(F ₄)	16.3	15.3	18.0	18.7	19.7	21.7	18.3
Mean		15.0	14.2	15.8	17.5	18.4	19.2	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.11		0.13		0.27		
CD at 5%		0.32		0.38		0.77		
2013-14								
Without fertilizer (Control)	(F ₁)	17.4	15.4	18.4	18.4	20.4	21.4	18.6
310:100:270g NPK (75%RDF)	(F ₂)	17.4	14.0	18.4	19.0	22.4	23.4	19.1
415:130:360g NPK (100%RDF)	(F ₃)	21.7	21.7	23.0	24.7	24.7	28.0	24.3
520:160:450g NPK (125%RDF)	(F ₄)	21.7	18.4	23.0	23.4	26.7	25.0	22.7
Mean		19.5	17.4	20.7	21.4	23.5	24.4	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.12		0.15		0.31		
CD at 5%		0.36		0.44		0.89		
Pooled data								
Without fertilizer (Control)	(F ₁)	14.7	13.2	15.6	16.4	17.9	18.7	16.1
310:100:270g NPK (75%RDF)	(F ₂)	15.7	13.5	16.4	17.7	19.9	20.6	17.3
415:130:360g NPK (100%RDF)	(F ₃)	19.7	19.6	20.5	22.7	23.2	24.9	21.8
520:160:450g NPK (125%RDF)	(F ₄)	19.0	16.9	20.5	21.1	22.9	23.2	20.6
Mean		17.3	15.8	18.2	19.5	21.0	21.8	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.08		0.10		0.21		
CD at 5%		0.24		0.30		0.60		

4.1.17 Fruit drop (%)

Fruits drop percentage were computed on the basis of fruit set at pea stage and fruits retained. Data presented in Table 4.21 revealed that the incremental dose of nutrients either in the form of inorganic or organic fertilizer application decreased the fruit drop percentage over preceding level of nutrition. The minimum fruit of drop (84.5%) was recorded with the recommended dose of chemical fertilizer (415:130:360 g NPK plant⁻¹) and showed superiority over rest of the doses. Whereas, the maximum percentage of fruit drop (87.7%) was noted with unfertilized plants. Further it was noted that the fruit drop was decreased either applied 75 or 125% of recommended dose of chemical fertilizer.

The minimum percentage of fruit drop (85.0 %) was noted with application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and proved superiority over rest of the organic sources of nutrient whereas, maximum percentage of fruit drop (87.0 %) was noted when applied bio-inoculants alone i.e. Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each).

The interaction of organic and inorganic sources of nutrient application had significant effect on percentage of fruit drop during both the years as well as in the pooled data. The minimum percentage of fruit drop (82.2 %) was recorded with recommended of chemical fertilizer (415:130:360 g NPK plant⁻¹) in combination with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and showed superiority over rest of the treatment combination of organic and inorganic sources. Almost similar fruit drop (88.4, 88.3 and 88.0 %) was noted with the application of oil cake, bio-inoculants and vermicompost when applied without chemical fertilizer which registered as maximum percentage of fruit drop respectively.

Table 4.21: Effect of organic sources and chemical fertilizer on fruit drop (%)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	89.1	88.4	87.8	88.0	87.7	87.5	88.1
310:100:270g NPK (75%RDF)	(F ₂)	88.2	88.3	87.1	87.0	86.6	87.0	87.4
415:130:360g NPK (100%RDF)	(F ₃)	86.6	86.0	86.0	85.3	84.8	83.4	85.4
520:160:450g NPK (125%RDF)	(F ₄)	87.1	87.1	86.5	87.0	86.3	85.6	86.6
Mean		87.8	87.4	86.9	86.8	86.4	85.9	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.12		0.15		0.30		
CD at 5%		0.35		0.43		0.85		
2013-14								
Without fertilizer (Control)	(F ₁)	87.6	88.2	88.2	87.1	86.6	86.3	87.3
310:100:270g NPK (75%RDF)	(F ₂)	86.1	86.1	86.3	85.8	85.9	85.3	85.9
415:130:360g NPK (100%RDF)	(F ₃)	84.6	84.9	84.2	83.7	82.8	81.0	83.5
520:160:450g NPK (125%RDF)	(F ₄)	85.6	86.6	85.0	84.9	85.4	84.1	85.3
Mean		86.0	86.5	85.9	85.4	85.2	84.2	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.11		0.14		0.28		
CD at 5%		0.33		0.41		0.81		
Pooled data								
Without fertilizer (Control)	(F ₁)	88.4	88.3	88.0	87.6	87.2	86.9	87.7
310:100:270g NPK (75%RDF)	(F ₂)	87.2	87.2	86.7	86.4	86.3	86.2	86.7
415:130:360g NPK (100%RDF)	(F ₃)	85.6	85.5	85.1	84.5	83.8	82.2	84.5
520:160:450g NPK (125%RDF)	(F ₄)	86.4	86.9	85.8	86.0	85.9	84.9	86.0
Mean		86.9	87.0	86.4	86.1	85.8	85.0	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.06		0.08		0.16		
CD at 5%		0.19		0.23		0.47		

4.1.18 Fruit retention (%)

Fruits retention percentage was computed over fruit set at pea stage to fruits retained till maturity in the years as well as the pooled data and presented in Table 4.22. Data revealed that the incremental dose of nutrients either in the form of inorganic fertilizer or organic sources of nutrient increased the fruit retention. The maximum percentage of fruit retained (14.6, 16.5 and 15.6 %) with the application of chemical fertilizer at the rate of 415:130:360g NPK plant⁻¹ (RDF) during first, second and pooled data and showed superiority over rest of the doses, whereas the minimum fruit retained (11.9, 12.7 and 12.3 %) with unfertilized plants during first, second and pool data, respectively.

The application of nutrients through organic sources had show the significant effect on fruit retention till maturity. The maximum fruit retained (14.0, 15.9 and 15 %) with application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and proved significantly superior over remaining sources of nutrient during first, second and pooled data, respectively. Whereas, the minimum fruit retained during first (12.2 %), second (13.6 %) and pool data (12.9%) with the application of bio inoculants (Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) applied alone.

The interaction of inorganic and organic sources of nutrient had show significant effect on percentage of fruit set in both the years as well as in the pooled data. The maximum fruit retained till the maturity during first (16.6 %), second (19.0 %) and pool data (17.8%) was recorded with the application of 415:130:360g NPK plant⁻¹ (RDF) in combination with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and showed superiority over rest of the treatment combination of organic and inorganic sources. However, the minimum fruit retained (11.3, 11.8 and 11.3 %) was noted with the application of bio-inoculants without chemical fertilizer during first, second and pooled data, respectively.

Table 4.22: Influence of organic sources and chemical fertilizer on fruit retention (%)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	11.6	10.8	12.0	12.2	12.3	12.5	11.9
310:100:270g NPK (75%RDF)	(F ₂)	11.7	11.8	13.1	12.9	13.4	13.0	12.6
415:130:360g NPK (100%RDF)	(F ₃)	14.0	13.4	14.7	14.0	15.2	16.6	14.6
520:160:450g NPK (125%RDF)	(F ₄)	12.9	13.0	13.0	13.5	13.7	14.0	13.4
Mean		12.6	12.2	13.2	13.2	13.6	14.0	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.11		0.13		0.27		
CD at 5%		0.31		0.38		0.76		
2013-14								
Without fertilizer (Control)	(F ₁)	11.8	11.8	12.9	12.4	13.4	13.8	12.7
310:100:270g NPK (75%RDF)	(F ₂)	13.7	13.9	14.2	13.9	14.1	14.8	14.1
415:130:360g NPK (100%RDF)	(F ₃)	15.9	15.1	16.3	15.4	17.2	19.0	16.5
520:160:450g NPK (125%RDF)	(F ₄)	15.0	13.4	15.1	14.4	14.6	15.9	14.7
Mean		14.1	13.6	14.6	14.0	14.8	15.9	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.12		0.15		0.29		
CD at 5%		0.35		0.42		0.85		
Pooled data								
Without fertilizer (Control)	(F ₁)	11.7	11.3	12.5	12.3	12.9	13.2	12.3
310:100:270g NPK (75%RDF)	(F ₂)	12.7	12.9	13.7	13.4	13.8	13.9	13.4
415:130:360g NPK (100%RDF)	(F ₃)	15.0	14.3	15.5	14.7	16.2	17.8	15.6
520:160:450g NPK (125%RDF)	(F ₄)	14.0	13.2	14.1	14.0	14.2	15.0	14.1
Mean		13.3	12.9	13.9	13.6	14.2	15.0	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.08		0.09		0.19		
CD at 5%		0.23		0.28		0.57		

4.1.19 Number of fruits

Mango crop is highly responsive to nutrient applications. The data revealed that the increasing level of nutrient application either chemical or organic sources increased the number of fruits plant⁻¹. The data pertaining to fruit yield plant⁻¹ was recorded from different treatments and statistically analyzed. Data presented in Table 4.23 indicated that the fertilizer application had significant effect on production of fruits during both the years as well as in pooled data. Each incremental level of fertility significantly increases the number of fruits and recorded the higher number of 68, 71 and 70 fruits plant⁻¹ with recommended dose of chemical fertilizer (415:130:360 g NPK plant⁻¹) during first, second year and in pooled data respectively. Whereas, the lowest number of 50, 52 and 51 fruit plant⁻¹ was recorded without application of fertilizer during first, second year as well as pooled over the year respectively.

Nutrient applied through organic sources showed significant response in terms of number of fruits per plant. The higher number of 66, 69 and 68 fruits plant⁻¹ were recorded with application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and showed superiority over rest of the treatments of organics whereas, the minimum number of 51, 54 and 53 fruits plant⁻¹ were noted with application of bio-inoculants alone i.e. Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) during first, second year and in pooled, respectively.

The interaction between doses of fertilizer and organic sources found to be significant in both the years as well as in pooled data. The maximum number of 73, 78 and 76 fruits plant⁻¹ were noted with recommended dose of chemical (415:130:360 g NPK plant⁻¹) in combination with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) whereas, the minimum number of 42, 44 and 43 fruits plant⁻¹ were obtained without chemical fertilizer in combination of bio-inoculants during first and second year and in pooled, respectively.

Table 4.23: Influence of organic sources and chemical fertilizer on number of fruit plant⁻¹.

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	50	42	51	52	52	54	50
310:100:270g NPK (75%RDF)	(F ₂)	50	45	58	59	65	68	58
415:130:360g NPK (100%RDF)	(F ₃)	64	59	67	70	73	73	68
520:160:450g NPK (125%RDF)	(F ₄)	61	57	61	63	65	69	63
Mean		56	51	59	61	64	66	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.42		0.52		1.05		
CD at 5%		1.22		1.50		3.00		
2013-14								
Without fertilizer (Control)	(F ₁)	52	44	53	53	54	56	52
310:100:270g NPK (75%RDF)	(F ₂)	54	48	61	62	69	71	61
415:130:360g NPK (100%RDF)	(F ₃)	69	64	69	72	77	78	71
520:160:450g NPK (125%RDF)	(F ₄)	64	61	64	66	69	73	66
Mean		60	54	62	63	67	69	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.15		0.19		0.38		
CD at 5%		0.45		0.55		1.09		
Pooled data								
Without fertilizer (Control)	(F ₁)	51	43	52	53	53	55	51
310:100:270g NPK (75%RDF)	(F ₂)	52	47	60	61	67	70	60
415:130:360g NPK (100%RDF)	(F ₃)	67	62	68	71	75	76	70
520:160:450g NPK (125%RDF)	(F ₄)	63	59	63	65	67	71	65
Mean		58	53	61	62	66	68	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.25		0.30		0.61		
CD at 5%		0.75		0.86		1.75		

4.1.20 Fruit yield (kg)

Fruit yield was recorded at harvest of crop during 2013, 2014 and pooled data were analysed and presented in Table 4.24. Data revealed that various treatments of organic sources and chemical fertilizer had significant effect on fruit yield. The maximum fruit yield (12.19, 12.89 and 12.53 kg plant⁻¹) was obtained with the application of recommended dose of fertilizer (415:130:360 g NPK plant⁻¹) followed by 125 % recommended dose of chemical fertilizer (520:160:450 g NPK plant⁻¹) with 11.01, 11.48 and 11.24 fruit plant⁻¹ during first, second year as well as pooled data, respectively and both were found significantly superior over 75% of RDF and control. Whereas, the unfertilized plant possessed significantly lowest fruit yield (7.57, 7.96 and 7.77 kg plant⁻¹) during first, second year as well as pooled data, respectively.

As regards, the application of organic sources had significant effect on fruit yield and the maximum fruit yield (11.67, 12.40 and 12.03 kg plant⁻¹) was recorded under Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and found at par with the application of Vermicompost (25 kg/plant) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) whereas, the minimum fruit yield (8.06, 8.76 and 8.41 kg plant⁻¹) during 1st, 2nd year and pooled data, respectively with the application of bioinoculants alone.

The interaction effect of organic sources and chemical fertilizer was also showed significant with respect to fruit yield. The application of chemical fertilizer @ 415:130:360 g NPK plant⁻¹ (RDF) in combination with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) recorded higher fruit yield (14.58, 15.48 and 15.00 kg plant⁻¹) and found at par with F₃O₅ (13.29, 14.14 and 13.73 kg), F₃O₄ (13.02, 13.58 and 13.27 kg), F₃O₃ (12.80, 13.56 and 13.20 kg), F₄O₆ (12.19, 13.03 and 12.60 kg) and F₂O₆ (11.49, 12.19 and 11.87 kg) F₄O₅ (11.46, 12.27 and 11.87 kg) whereas, unfertilized with bioinoculants possessed the minimum fruit yield (6.14, 6.53 and 6.33 kg plant⁻¹) during first, second and pooled data, respectively.

Table 4.24: Influence of organic sources and chemical fertilizer on fruit yield (kg plant⁻¹)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	7.16	6.14	7.87	7.77	8.05	8.44	7.57
310:100:270g NPK (75%RDF)	(F ₂)	7.71	6.92	9.46	9.64	10.54	11.49	9.29
415:130:360g NPK (100%RDF)	(F ₃)	9.90	9.56	12.80	13.02	13.29	14.58	12.19
520:160:450g NPK (125%RDF)	(F ₄)	10.19	9.64	11.43	11.18	11.46	12.19	11.01
Mean		8.74	8.06	10.39	10.40	10.83	11.67	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.22		0.28		0.58		
CD at 5%		0.68		0.56		1.68		
2013-14								
Without fertilizer (Control)	(F ₁)	7.49	6.53	8.10	8.15	8.60	8.91	7.96
310:100:270g NPK (75%RDF)	(F ₂)	8.32	7.54	9.74	10.11	11.31	12.19	9.87
415:130:360g NPK (100%RDF)	(F ₃)	9.97	10.60	13.56	13.58	14.14	15.48	12.89
520:160:450g NPK (125%RDF)	(F ₄)	10.55	10.39	11.40	11.22	12.27	13.03	11.48
Mean		9.08	8.76	10.70	10.77	11.58	12.40	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.34		0.42		0.84		
CD at 5%		0.98		1.22		1.68		
Pooled data								
Without fertilizer (Control)	(F ₁)	7.30	6.33	8.00	7.97	8.33	8.67	7.77
310:100:270g NPK (75%RDF)	(F ₂)	8.03	7.20	9.63	9.87	10.90	11.87	9.58
415:130:360g NPK (100%RDF)	(F ₃)	9.93	10.07	13.20	13.27	13.73	15.00	12.53
520:160:450g NPK (125%RDF)	(F ₄)	10.37	10.03	11.40	11.20	11.87	12.60	11.24
Mean		8.91	8.41	10.56	10.58	11.21	12.03	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.21		0.27		0.56		
CD at 5%		0.64		0.54		1.60		

4.2 Physical composition of fruit as influenced with application of organic sources and chemical fertilizer

Physical composition of fruit in term of fruit weight, length, diameter and composition of pulp, skin and stone affected by various sources of nutrient have been determined and presented individually;

4.2.1 Fruit weight (g)

Fruit weight was recorded and presented in Table 4.25. Results revealed that various treatments of organic sources and chemical fertilizers had significant effect on fruit weight. The doses of NPK as per the recommended dose brought about the significant changes in the weight of fruit. It is evident from the table that application of 520:160:450g NPK plant⁻¹ (125% of RDF) recorded on an average higher fruit weight (171.7, 174.3 and 173.0 g fruit⁻¹) and proved significantly superior over rest of the fertilizer doses whereas, the no application of fertilizer possessed significantly lower fruit weight (150.2, 153.0 and 151.6g) during 1st, 2nd and pooled data, respectively.

The application of organic sources had significant effect on fruit weight and the maximum fruit weight (168.3, 171.8 and 170.0 g) was recorded with application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and found at par with Vermicompost (25 kg/plant) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) while, the minimum fruit weight (157.1,153.9 and 158.2 g) with the application of bioinoculants during 1st, 2nd and pooled data, respectively.

The significant interaction effect of organic sources and chemical fertilizer was recorded for fruit weight. The application of chemical fertilizer @ 520:160:450g NPK plant⁻¹ (125% of RDF) in combination with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) recorded fruit weight (175.7, 179.3 and 177.5 g) whereas, unfertilized with bio-inoculants posses the minimum fruit weight (143.3,145.0 and 144.2 g) during 1st, 2nd year and pooled data respectively.

Table 4.25: Influence of organic sources and chemical fertilizer on weight of fruit (g)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	145.0	143.3	151.3	152.3	153.7	155.3	150.2
310:100:270g NPK (75%RDF)	(F ₂)	153.7	153.3	155.7	161.3	161.3	169.0	159.1
415:130:360g NPK (100%RDF)	(F ₃)	163.0	163.7	166.0	167.7	170.0	173.0	167.2
520:160:450g NPK (125%RDF)	(F ₄)	168.0	168.0	170.7	172.3	175.3	175.7	171.7
Mean		157.4	157.1	160.9	163.4	165.1	168.3	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.84		1.03		2.06		
CD at 5%		2.41		2.95		5.91		
2013-14								
Without fertilizer (Control)	(F ₁)	148.3	145.0	151.7	154.7	159.3	159.0	153.0
310:100:270g NPK (75%RDF)	(F ₂)	156.0	155.0	160.7	163.0	164.7	171.0	161.7
415:130:360g NPK (100%RDF)	(F ₃)	166.3	167.0	168.3	172.7	173.3	177.7	170.9
520:160:450g NPK (125%RDF)	(F ₄)	171.3	170.0	172.0	174.7	178.7	179.3	174.3
Mean		160.5	159.3	163.2	166.3	169.0	171.8	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.08		1.33		2.66		
CD at 5%		3.01		3.81		7.63		
Pooled data								
Without fertilizer (Control)	(F ₁)	146.7	144.2	151.5	153.5	156.5	157.2	151.6
310:100:270g NPK (75%RDF)	(F ₂)	154.8	154.2	158.2	162.2	163.0	170.0	160.4
415:130:360g NPK (100%RDF)	(F ₃)	164.7	165.3	167.2	170.2	171.7	175.3	169.1
520:160:450g NPK (125%RDF)	(F ₄)	169.7	169.0	171.3	173.5	177.0	177.5	173.0
Mean		159.0	158.2	162.0	164.8	167.0	170.0	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.81		0.99		1.97		
CD at 5%		2.30		2.82		5.65		

4.2.2 Fruit length and width (cm)

Fruit length and width was recorded at harvest of fruit and subject to statistical analysis. Data pertaining fruit length Table 4.26 and width Table 4.27 revealed that the increasing level of chemical fertilizer increased the fruit length and width significantly over preceding level of fertilizer during both the year and pool data. The maximum length (93.9 cm) and width (71.1 cm) was recorded with the application of 125% of RDF (520: 160: 450g NPK plant⁻¹) whereas, the minimum length (71.7 and 52.8 cm) was recorded with no chemical fertilizer (control) when data pooled over the year, respectively.

The application of organic sources had significant effect on fruit length and width and the maximum fruit length and width (87.9 and 69.2 cm) was recorded with application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and found at par with Vermicompost (25 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100 g plant⁻¹ each) and posses the fruit length(87.5 cm) and width (67.75 cm) while, the minimum fruit length and width (79.8 and 54.6 cm) was recorded in pooled data with application of bioinoculants alone.

The interaction effect of organic sources and chemical fertilizer was also showed significant on fruit weight. The incremental dose of nutrient increases the fruit length and width during both the year and pooled data and maximum length (96.7 cm) and width (76.8 cm) was recorded with the application of chemical fertilizer @ 520:160:450g NPK plant⁻¹ (125% of RDF) in combination with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) whereas, unfertilized with bio-inoculants posses the minimum fruit length (69.3 cm) and width (44.8 cm) when data pooled over the year, respectively.

Table 4.26: Influence of organic sources and chemical fertilizer on fruit length (cm)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	68.3	67.7	69.3	68.3	71.0	72.0	69.4
310:100:270g NPK (75%RDF)	(F ₂)	74.0	71.7	80.0	76.0	80.3	81.0	77.2
415:130:360g NPK (100%RDF)	(F ₃)	90.3	85.7	91.0	90.7	94.7	95.0	91.2
520:160:450g NPK (125%RDF)	(F ₄)	90.7	86.7	91.7	91.0	95.0	95.7	91.8
Mean		80.8	77.9	83.0	81.5	85.3	85.9	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.47		1.81		3.61		
CD at 5%		4.22		5.16		10.36		
2013-14								
Without fertilizer (Control)	(F ₁)	71.7	71.0	74.3	73.3	76.0	77.0	73.9
310:100:270g NPK (75%RDF)	(F ₂)	74.0	71.7	86.7	82.7	87.0	87.7	81.6
415:130:360g NPK (100%RDF)	(F ₃)	94.0	90.0	95.0	94.3	96.7	97.3	94.6
520:160:450g NPK (125%RDF)	(F ₄)	95.3	94.0	95.3	95.7	99.0	97.7	96.2
Mean		83.8	81.7	87.8	86.5	89.7	89.9	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.63		1.99		3.98		
CD at 5%		4.64		5.68		11.42		
Pooled data								
Without fertilizer (Control)	(F ₁)	70.0	69.3	71.8	70.8	73.5	74.5	71.7
310:100:270g NPK (75%RDF)	(F ₂)	74.0	71.7	83.3	79.3	83.7	84.3	79.4
415:130:360g NPK (100%RDF)	(F ₃)	92.2	87.8	93.0	92.5	95.7	96.2	92.9
520:160:450g NPK (125%RDF)	(F ₄)	93.0	90.3	93.5	93.3	97.0	96.7	93.9
Mean		82.3	79.8	85.4	84.0	87.5	87.9	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.29		1.57		3.15		
CD at 5%		3.67		4.49		9.04		

Table 4.27: Influence of organic sources and chemical fertilizer on fruit width (cm)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	51.7	44.0	53.3	52.7	54.0	56.0	51.9
310:100:270g NPK (75%RDF)	(F ₂)	52.0	46.7	59.3	60.3	67.0	69.7	59.2
415:130:360g NPK (100%RDF)	(F ₃)	64.0	60.7	66.3	64.3	68.7	71.0	65.8
520:160:450g NPK (125%RDF)	(F ₄)	74.3	60.3	68.7	65.3	72.0	74.3	69.2
Mean		60.5	52.9	61.9	60.7	65.4	67.8	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.47		1.80		3.61		
CD at 5%		4.21		5.15		10.36		
2013-14								
Without fertilizer (Control)	(F ₁)	53.3	45.7	55.0	54.3	55.7	57.7	53.6
310:100:270g NPK (75%RDF)	(F ₂)	55.3	50.0	62.7	63.7	70.3	71.3	62.2
415:130:360g NPK (100%RDF)	(F ₃)	67.3	64.0	69.7	68.3	72.7	74.3	69.4
520:160:450g NPK (125%RDF)	(F ₄)	79.3	65.3	70.3	70.7	73.7	79.3	73.1
Mean		63.8	56.3	64.4	64.3	68.1	70.7	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.28		1.56		3.13		
CD at 5%		3.65		4.46		8.98		
Pooled data								
Without fertilizer (Control)	(F ₁)	52.5	44.8	54.2	53.5	54.8	56.8	52.8
310:100:270g NPK (75%RDF)	(F ₂)	53.7	48.3	61.0	62.0	68.7	70.5	60.7
415:130:360g NPK (100%RDF)	(F ₃)	65.7	62.3	68.0	66.3	70.7	72.7	67.6
520:160:450g NPK (125%RDF)	(F ₄)	76.8	62.8	69.5	68.0	72.8	76.8	71.1
Mean		62.2	54.6	63.2	62.5	66.75	69.2	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.28		1.56		3.12		
CD at 5%		3.64		4.47		8.95		

4.2.3 Pulp (%)

Pulp weight of fruit was recorded after ripening of fruit during 2013, 2014 and pooled data were analysed and computed in percentage. The data presented in Table 4.28 revealed that various treatments of organic sources and chemical fertilizer had significant effect on pulp weight. The doses of NPK as per the recommended dose brought about the significant changes in the weight of pulp. It is evident from the table that application of 520:160:450g NPK plant⁻¹ (125% of RDF) recorded higher pulp percentage (60.68, 61.51 and 61.09 %) and proved significantly superior over rest of the fertilizer doses whereas, the without application of fertilizer possessed significantly lower percentage of pulp (57.55, 58.17 and 57.86 %) during 1st, 2nd and pooled data, respectively.

As regards, the application of organic sources had significant effect on pulp weight of fruit and maximum pulp percentage (62.11, 62.86 and 62.48%) was recorded with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and proved significantly superior over rest of the organic treatment whereas, the minimum percentage of pulp (55.65, 57.00 and 56.32%) was noted with the application of bio-inoculants alone during 1st, 2nd and pooled data, respectively.

The interaction effect of organic sources and chemical fertilizer was found non significant during both the year as well as pool over the year.

Table 4.28: Influence of organic sources and chemical fertilizer on pulp (%)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	57.72	54.41	57.65	57.88	58.59	59.06	57.55
310:100:270g NPK (75%RDF)	(F ₂)	58.30	54.78	57.93	56.76	59.79	62.53	58.35
415:130:360g NPK (100%RDF)	(F ₃)	58.06	54.77	59.08	60.99	62.40	64.06	59.90
520:160:450g NPK (125%RDF)	(F ₄)	58.87	58.64	59.72	61.44	62.62	62.80	60.68
Mean		58.24	55.65	58.59	59.27	60.85	62.11	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.46		0.56		1.23		
CD at 5%		1.31		1.61		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	58.41	55.10	58.27	58.40	59.29	59.56	58.17
310:100:270g NPK (75%RDF)	(F ₂)	58.88	54.97	59.05	59.10	60.22	63.28	59.25
415:130:360g NPK (100%RDF)	(F ₃)	59.67	59.39	60.30	61.91	62.26	62.88	61.07
520:160:450g NPK (125%RDF)	(F ₄)	58.89	58.52	61.53	61.53	62.86	65.70	61.51
Mean		58.96	57.00	59.79	60.24	61.16	62.86	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.39		0.48		0.96		
CD at 5%		1.12		1.37		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	58.07	54.76	57.96	58.14	58.94	59.31	57.86
310:100:270g NPK (75%RDF)	(F ₂)	58.59	54.88	58.49	57.93	60.01	62.91	58.80
415:130:360g NPK (100%RDF)	(F ₃)	58.87	57.08	59.69	61.45	62.33	63.47	60.48
520:160:450g NPK (125%RDF)	(F ₄)	58.88	58.58	60.63	61.49	62.74	64.25	61.09
Mean		58.60	56.32	59.19	59.75	61.01	62.48	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.33		0.41		0.82		
CD at 5%		0.95		1.67		NS		

4.2.4 Peel (%)

In general it was observed that the peel percentage was decreased with the increase fertility level either through organic or inorganic sources in both the year of study. Peel weight of fruit was recorded after ripening of fruit during 2013, 2014 and pooled data were analysed and computed in percentage. Data presented in Table 4.29 revealed that various treatments of organic sources and chemical fertilizers had significant effect on percentage of peel. The doses of NPK as per the recommended dose brought about the significant changes in the percentage of peel. The minimum peel percentage of 19.52, and 19.66 % during first and pooled data under 520:160:450g NPK plant⁻¹ (125% of RDF) whereas, peel percentage (19.26%) under 415:130:360g NPK plant⁻¹ (125% of RDF) was recorded during the second year. The higher percentage of peel (22.67, 22.73 and 22.70%) was recorded under unfertilized plant during 1st, 2nd and pooled data, respectively.

As regards, the application of organic sources had significant effect on peel percentage and the minimum peel percentage (19.13, 19.03 and 19.08%) was recorded with application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) whereas, maximum percentage of peel (23.33, 22.73 and 23.04%) was noted with application of bioinoculants alone during 1st, 2nd and pooled data, respectively.

The interaction effect of organic sources and chemical fertilizer was found non significant during both the year as well as pool over the year.

4.2.5 Stone (%)

Stone weight of fruit was recorded after ripening of fruit during 2013, 2014 and pooled data were analysed and computed in percentage in Table 4.30. Data revealed that the effect of various treatment of chemical fertilizer and organic sources of nutrient applied either alone or in combination had not show any significant effect on stone percentage during both the year as well as in pool over the year.

Table 4.29: Influence of organic sources and chemical fertilizer on peel (%)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	21.80	24.97	22.90	21.57	22.53	22.27	22.67
310:100:270g NPK (75%RDF)	(F ₂)	21.37	24.23	23.40	23.13	21.53	18.90	22.09
415:130:360g NPK (100%RDF)	(F ₃)	21.13	23.87	21.83	20.07	18.17	16.83	20.32
520:160:450g NPK (125%RDF)	(F ₄)	20.77	20.27	21.43	18.17	17.97	18.53	19.52
Mean		21.27	23.33	22.39	20.73	20.05	19.13	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.56		0.68		1.37		
CD at 5%		1.60		1.95		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	21.80	24.93	22.93	21.73	22.47	22.50	22.73
310:100:270g NPK (75%RDF)	(F ₂)	21.47	24.87	22.90	21.73	21.77	18.80	21.92
415:130:360g NPK (100%RDF)	(F ₃)	21.00	20.90	20.03	20.17	17.67	15.80	19.26
520:160:450g NPK (125%RDF)	(F ₄)	20.60	20.23	21.53	18.37	19.00	19.03	19.79
Mean		21.22	22.73	21.85	20.50	20.23	19.03	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.46		0.57		1.13		
CD at 5%		1.32		1.61		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	21.81	24.95	22.92	21.65	22.49	22.36	22.70
310:100:270g NPK (75%RDF)	(F ₂)	21.41	24.56	23.16	22.42	21.66	18.86	22.01
415:130:360g NPK (100%RDF)	(F ₃)	21.08	22.39	20.93	20.11	17.93	16.31	19.79
520:160:450g NPK (125%RDF)	(F ₄)	20.70	20.25	21.50	18.27	18.46	18.80	19.66
Mean		21.25	23.04	22.13	20.61	20.14	19.08	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.43		0.53		1.06		
CD at 5%		1.24		1.52		NS		

Table 4.30: Influence of organic sources and chemical fertilizer on stone (%)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	20.45	20.63	19.45	20.56	18.90	18.70	19.78
310:100:270g NPK (75%RDF)	(F ₂)	20.33	20.96	18.67	20.13	18.66	18.57	19.56
415:130:360g NPK (100%RDF)	(F ₃)	20.78	21.37	19.09	18.95	19.42	19.12	19.79
520:160:450g NPK (125%RDF)	(F ₄)	20.37	21.11	18.81	20.39	19.45	18.68	19.80
Mean		20.48	21.02	19.01	20.01	19.11	18.77	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.37		0.45		0.90		
CD at 5%		NS		NS		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	19.79	19.97	18.79	19.86	18.23	17.97	19.10
310:100:270g NPK (75%RDF)	(F ₂)	19.67	20.17	18.03	19.17	18.00	17.90	18.82
415:130:360g NPK (100%RDF)	(F ₃)	20.12	20.56	18.43	18.30	19.45	18.50	19.23
520:160:450g NPK (125%RDF)	(F ₄)	19.70	20.37	18.17	19.71	18.75	18.05	19.12
Mean		19.82	20.27	18.36	19.26	18.61	18.10	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.34		0.41		0.83		
CD at 5%		NS		NS		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	20.12	20.30	19.12	20.21	18.57	18.33	19.44
310:100:270g NPK (75%RDF)	(F ₂)	20.00	20.57	18.35	19.65	18.33	18.24	19.19
415:130:360g NPK (100%RDF)	(F ₃)	20.45	20.97	18.76	18.63	19.44	18.81	19.51
520:160:450g NPK (125%RDF)	(F ₄)	20.03	20.74	18.49	20.05	19.10	18.36	19.46
Mean		20.15	20.64	18.68	19.63	18.86	18.44	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.35		0.43		0.86		
CD at 5%		NS		NS		NS		

4.2.6 Pulp: Peel ratio

Analysis of data presented in Table 4.31 revealed that the pulp peel ratio markedly increased significantly with the increase dose of chemical fertilizers. The significantly high pulp stone ratio of 3.15, 3.25 and 3.20 was recorded with the application of 125% recommended dose of fertilizer (520:160:450g NPK plant⁻¹) and found statistically at par with recommended dose of chemical fertilizer (415:130:360g NPK plant⁻¹) during first, second and pooled over the year. The lower pulp peel ratio (2.59) was noted under control (F₁) during both the years as well as pool over the year. However, the variation between 125% and recommended dose of fertilizer were at par during both the year and pooled data and pulp peel ratio (3.04, 3.13 and 3.08) was recorded.

The organic sources had significant variation in pulp peel ratio during both the years and pooled data. The maximum pulp peel ratio (3.30, 3.38 and 3.34) was noted with O₆ which contain Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and found at par with Vermicompost (25 kg plant⁻¹) + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) whereas, the minimum pulp peel ratio (2.44, 2.55 and 2.50) was noted under Azotobacter + VAM + Trichoderma viridi + PSB (O₂) and found to be at par with Vermicompost (25 kg plant⁻¹) during both the years of study and in pooled data.

The interaction of chemical fertilizers and organic were found to be non significant during both the years and pooled data.

Table 4.31: Influence of organic and inorganic sources on pulp : peel ratio

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	2.71	2.18	2.54	2.78	2.63	2.67	2.59
310:100:270g NPK (75%RDF)	(F ₂)	2.74	2.29	2.50	2.48	2.81	3.32	2.69
415:130:360g NPK (100%RDF)	(F ₃)	2.76	2.34	2.75	3.04	3.50	3.81	3.04
520:160:450g NPK (125%RDF)	(F ₄)	2.85	2.95	2.78	3.42	3.53	3.39	3.15
Mean		2.76	2.44	2.65	2.93	3.12	3.30	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.08		0.19		0.22		
CD at 5%		0.25		0.32		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	2.69	2.22	2.56	2.75	2.65	2.65	2.59
310:100:270g NPK (75%RDF)	(F ₂)	2.78	2.23	2.60	2.72	2.78	3.38	2.75
415:130:360g NPK (100%RDF)	(F ₃)	2.96	2.94	2.85	3.40	3.34	3.30	3.13
520:160:450g NPK (125%RDF)	(F ₄)	2.83	2.81	3.08	3.05	3.57	4.17	3.25
Mean		2.82	2.55	2.77	2.98	3.08	3.38	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.08		0.09		0.19		
CD at 5%		0.24		0.27		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	2.70	2.20	2.55	2.77	2.64	2.66	2.59
310:100:270g NPK (75%RDF)	(F ₂)	2.76	2.26	2.55	2.60	2.79	3.35	2.72
415:130:360g NPK (100%RDF)	(F ₃)	2.86	2.64	2.80	3.22	3.42	3.56	3.08
520:160:450g NPK (125%RDF)	(F ₄)	2.84	2.88	2.93	3.23	3.55	3.78	3.20
Mean		2.79	2.50	2.71	2.95	3.10	3.34	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.07		0.08		0.17		
CD at 5%		0.20		0.24		NS		

4.2.7 Pulp: Stone ratio

Analysis of data presented in Table 4.32 revealed that the pulp: stone ratio markedly increased with the increase in dose of chemical fertilizers. The significantly high pulp stone ratio of 3.08, 3.24 and 3.16 was recorded with application of 520:160:450g NPK plant⁻¹ (125% of RDF) whereas, lower pulp: stone ratio of 2.92, 3.06 and 2.99 was noted with control (F₁) during 2012, 2013 and pooled over the year. However, all the fertilizer doses showed superiority over control during both the years and pooled data.

The organic sources also had the significant variation in pulp : stone ratio. The maximum pulp: stone ratio (3.32, 3.48 and 3.40) was noted with O₆ which contain Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and proved significantly superior over rest of the treatment whereas, the minimum pulp : stone ratio (2.66, 2.82 and 2.74) was noted with (O₂) However, Oil cake (O₁) and Azotobacter + VAM + Trichoderma viridi + PSB (O₂) found to be at par to each other during both the years of study and in pooled data.

The interaction of chemical fertilizers and organic sources of nutrients were found to be non significant during both the years as well as in the pooled data.

4.2.8 Peel: Stone ratio

The data presented in Table 4.33 revealed significant differences due to different levels of chemical fertilizers. The increasing level of chemical fertilizer reduces the peel: stone ratio. The minimum peel stone ratio (0.99, 1.02 and 1.01) was noted under application of 125% of recommended dose of fertilizer (520:160:450g NPK plant⁻¹) whereas, the maximum peel: stone ratio (1.16, 1.20 and 1.18) was noted under unfertilized control (F₁) during 2012, 2013 and pooled over the years.

The organic sources of nutrients either applied alone or in combination with chemical fertilizer did not show any significant effect on peel: stone ratio.

Table 4.32: Influence of organic and inorganic sources on pulp : stone ratio

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	2.82	2.64	2.98	2.84	3.10	3.17	2.92
310:100:270g NPK (75%RDF)	(F ₂)	2.88	2.63	3.11	2.87	3.20	3.39	3.01
415:130:360g NPK (100%RDF)	(F ₃)	2.82	2.59	3.13	3.24	3.28	3.37	3.07
520:160:450g NPK (125%RDF)	(F ₄)	2.90	2.79	3.18	3.01	3.25	3.37	3.08
Mean		2.85	2.66	3.10	2.99	3.21	3.32	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.044		0.054		0.108		
CD at 5%		0.125		0.154		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	2.95	2.77	3.13	2.96	3.25	3.31	3.06
310:100:270g NPK (75%RDF)	(F ₂)	3.00	2.73	3.28	3.13	3.36	3.55	3.18
415:130:360g NPK (100%RDF)	(F ₃)	3.04	2.92	3.33	3.14	3.33	3.49	3.21
520:160:450g NPK (125%RDF)	(F ₄)	2.95	2.87	3.41	3.39	3.27	3.56	3.24
Mean		2.99	2.82	3.29	3.16	3.31	3.48	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.03		0.04		0.95		
CD at 5%		0.11		0.13		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	2.89	2.71	3.06	2.90	3.18	3.24	2.99
310:100:270g NPK (75%RDF)	(F ₂)	2.94	2.68	3.20	3.00	3.28	3.47	3.09
415:130:360g NPK (100%RDF)	(F ₃)	2.93	2.75	3.23	3.19	3.31	3.43	3.14
520:160:450g NPK (125%RDF)	(F ₄)	2.93	2.83	3.30	3.20	3.26	3.47	3.16
Mean		2.92	2.74	3.19	3.07	3.26	3.40	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.04		0.05		0.10		
CD at 5%		0.11		0.13		NS		

Table 4.33: Influence of organic and inorganic sources on peel : stone ratio

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	1.07	1.21	1.19	1.08	1.20	1.19	1.16
310:100:270g NPK (75%RDF)	(F ₂)	1.06	1.16	1.26	1.17	1.16	1.03	1.14
415:130:360g NPK (100%RDF)	(F ₃)	1.03	1.11	1.17	1.07	0.98	0.88	1.04
520:160:450g NPK (125%RDF)	(F ₄)	1.02	0.97	1.15	0.90	0.94	0.99	0.99
Mean		1.05	1.11	1.19	1.05	1.07	1.02	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.04		0.05		0.11		
CD at 5%		0.13		NS		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	1.10	1.25	1.24	1.12	1.24	1.25	1.20
310:100:270g NPK (75%RDF)	(F ₂)	1.11	1.24	1.27	1.15	1.22	1.06	1.18
415:130:360g NPK (100%RDF)	(F ₃)	1.06	1.00	1.19	0.94	1.03	1.06	1.04
520:160:450g NPK (125%RDF)	(F ₄)	1.06	1.02	1.11	1.11	0.92	0.86	1.02
Mean		1.08	1.13	1.20	1.08	1.10	1.06	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.03		0.04		0.09		
CD at 5%		0.11		NS		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	1.09	1.23	1.21	1.10	1.22	1.22	1.18
310:100:270g NPK (75%RDF)	(F ₂)	1.08	1.20	1.27	1.16	1.19	1.04	1.16
415:130:360g NPK (100%RDF)	(F ₃)	1.04	1.05	1.18	1.00	1.00	0.97	1.04
520:160:450g NPK (125%RDF)	(F ₄)	1.04	0.99	1.13	1.01	0.93	0.93	1.01
Mean		1.06	1.12	1.20	1.07	1.09	1.04	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.04		0.05		0.10		
CD at 5%		0.11		NS		NS		

4.3 Chemical composition of fruit influenced by organic and inorganic sources of nutrients

The data on the effect of organic and inorganic sources and their combinations on the chemical composition of the fruits in terms of TSS, total sugar, reducing and non reducing sugar, ascorbic acid, acidity, phenols and TSS acid ratio were determined and presented under sub heads;

4.3.1 Total Soluble Solid ($^{\circ}\text{B}$)

The content of total soluble solid was determined after fruits ripening in both the years (Table 4.34). Statistical analyses of pooled data revealed that the higher total soluble solid of 21.86, 22.98 and 22.48 $^{\circ}\text{B}$ was recorded with the application of 415:130:360 g NPK plant⁻¹ (F_3), followed by 520:160:450g NPK plant⁻¹ (125% RDF). However, the lowest total soluble solid (19.84, 21.02 and 20.43 $^{\circ}\text{B}$) content recorded with no application of chemical fertilizer during first and second year and in pooled data, respectively.

Addition of organic source of nutrients showed significantly effect with regard to total soluble solid content in pulp of fruit. The data analyses revealed that the maximum content of total soluble solid (21.31, 22.28 and 21.80 $^{\circ}\text{B}$) was recorded under O_6 i.e. Vermicompost (25 kg) + Oil cake (2.5 kg) + Azotobacter + VAM + *Trichoderma viridi* + PSB (100g each) which was statistically at par with O_5 containing Vermicompost (25 kg) + Azotobacter + VAM + *Trichoderma viridi* + PSB (100g each), O_4 i.e. Vermicompost (25 kg) + oil cake(2.5kg) whereas, the minimum total soluble solid of 20.75, 21.76 and 21.25 $^{\circ}\text{B}$ was noted with the application of Azotobacter + VAM + *Trichoderma viridi* + PSB (100g each) alone during first,second year and in pooled data. The application of oil cake and vermicompost alone or in combinations showed improvement in total soluble solid content and found to be change significantly over bio inoculants alone.

The interaction effect of organic sources and chemical fertilizer was also showed significant with respect to total soluble solid. The application of chemical fertilizer @ 415:130:360g NPK (100% RDF) in combination with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + *Trichoderma viridi* + PSB (100g plant⁻¹ each) recorded higher TSS (22.60 $^{\circ}\text{B}$) whereas, unfertilized with bio-inoculants possessed the minimum value of TSS (22.02 $^{\circ}\text{B}$).

Table 4.34: Effect of organic sources and chemical fertilizer on total soluble solid (⁰B)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
1012-13								
Without fertilizer (Control)	(F ₁)	19.57	19.53	19.73	19.90	20.07	20.23	19.84
310:100:270g NPK (75%RDF)	(F ₂)	20.37	20.23	20.80	21.17	21.20	21.30	20.84
415:130:360g NPK (100%RDF)	(F ₃)	21.77	21.77	21.73	21.90	21.97	22.00	21.86
520:160:450g NPK (125%RDF)	(F ₄)	21.40	21.47	21.50	21.63	21.63	21.70	21.56
Mean		20.78	20.75	20.94	21.15	21.22	21.31	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.11		0.13		0.27		
CD at 5%		0.31		0.38		0.77		
1013-14								
Without fertilizer (Control)	(F ₁)	20.93	20.50	21.07	21.20	21.20	21.20	21.02
310:100:270g NPK (75%RDF)	(F ₂)	21.60	21.60	21.70	21.90	22.10	22.10	21.83
415:130:360g NPK (100%RDF)	(F ₃)	22.70	22.67	23.03	23.10	23.17	23.20	22.98
520:160:450g NPK (125%RDF)	(F ₄)	22.17	22.27	22.53	22.57	22.63	22.63	22.47
Mean		21.85	21.76	22.08	22.19	22.28	22.28	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.10		0.13		0.25		
CD at 5%		0.30		0.36		0.71		
Pooled data								
Without fertilizer (Control)	(F ₁)	20.25	20.02	20.40	20.55	20.63	20.72	20.43
310:100:270g NPK (75%RDF)	(F ₂)	20.98	20.92	21.25	21.53	21.65	21.70	21.34
415:130:360g NPK (100%RDF)	(F ₃)	22.23	22.22	22.38	22.50	22.57	22.60	22.42
520:160:450g NPK (125%RDF)	(F ₄)	21.78	21.87	22.02	22.10	22.13	22.17	22.01
Mean		21.31	21.25	21.51	21.67	21.75	21.80	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.07		0.08		0.17		
CD at 5%		0.93		0.24		0.49		

4.3.2 Total sugar (%)

Total sugar was determined from ripe fruits during both years (Table 4.35). The statistical analysis revealed significant improvement in total sugar content with application of chemical fertilizer and it has been observed that the significantly maximum total sugar 18.11, 18.71 and 18.41 % was recorded during the first and second year of experimentation as well as in pooled data, respectively with recommended doses of chemical fertilizer @ 415:130:360 g NPK plant⁻¹. However, lower dose of fertilizer registered the lower value of total sugar 15.12, 16.34 and 15.73% during the first and second year of experimentation as well as in pooled data.

As regards, the application of nutrient through organic sources significantly improved total sugar content in fruit pulp. The maximum total sugar content of 17.22, 18.28 and 17.75% was recorded with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each), followed with value of 17.09, 18.13 and 17.31 % with Vermicompost (25 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100 g plant⁻¹ each) and value of 16.62, 17.67 and 17.14 % with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) during first and second year as well as in pooled data applied alone, respectively. However, the minimum total sugar 15.91, 16.83 and 16.37 % was recorded with Azotobacter + VAM + Trichoderma viridi + PSB (100 g plant⁻¹ each) alone and found at par with Oil cake (2.5 kg plant⁻¹) and Vermicompost (25 kg plant⁻¹) applied alone.

The interaction between organic sources and chemical fertilizer was found significant in both the crop seasons as well as in pooled data whereas, the maximum total sugar of 18.49, 19.25 and 18.87 % was noted with the recommended dose of fertilizer (415:130:360g NPK plant⁻¹) when applied in combination of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and whereas unfertilized with bioinoculant possessed the minimum total sugar (14.49, 15.73 and 15.11%) in the pooled data.

Table 4.35: Effect of organic sources and chemical fertilizer on total sugar (%)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
1012-13								
Without fertilizer (Control)	(F ₁)	14.92	14.49	15.06	14.77	15.59	15.87	15.12
310:100:270g NPK (75%RDF)	(F ₂)	15.60	15.12	15.81	15.99	16.56	16.61	15.94
415:130:360g NPK (100%RDF)	(F ₃)	17.77	17.35	18.34	18.29	18.44	18.49	18.11
520:160:450g NPK (125%RDF)	(F ₄)	17.12	16.66	17.49	17.42	17.78	17.91	17.40
Mean		16.35	15.91	16.68	16.62	17.09	17.22	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.11		0.13		0.26		
CD at 5%		0.31		0.38		0.75		
1013-14								
Without fertilizer (Control)	(F ₁)	16.12	15.73	16.00	16.79	16.47	16.94	16.34
310:100:270g NPK (75%RDF)	(F ₂)	16.72	16.20	16.75	17.07	18.05	17.95	17.12
415:130:360g NPK (100%RDF)	(F ₃)	18.60	17.72	18.60	18.87	19.20	19.25	18.71
520:160:450g NPK (125%RDF)	(F ₄)	17.20	17.63	17.98	17.96	18.80	18.97	18.10
Mean		17.16	16.83	17.34	17.67	18.13	18.28	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.11		0.14		0.28		
CD at 5%		0.33		0.40		0.81		
Pooled data								
Without fertilizer (Control)	(F ₁)	15.52	15.11	15.53	15.78	16.03	16.41	15.73
310:100:270g NPK (75%RDF)	(F ₂)	16.16	15.66	16.28	16.53	17.31	17.28	16.53
415:130:360g NPK (100%RDF)	(F ₃)	18.19	17.54	18.47	18.58	18.82	18.87	18.41
520:160:450g NPK (125%RDF)	(F ₄)	17.16	17.15	17.74	17.69	18.29	18.44	17.75
Mean		16.76	16.37	17.01	17.14	17.61	17.75	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.08		0.09		0.19		
CD at 5%		0.22		0.27		0.55		

4.3.3 Non reducing sugar (%)

The non reducing sugar was computed by subtracting reducing sugar from the total sugar value obtained during both the year as well as in pooled data (Table 4.36). The data indicated that the chemically fertilized plants showed increasing trend in terms of non reducing sugar with the application of chemical fertilizer over unfertilized plant. The higher non reducing sugar (13.45, 13.99 and 13.72 %) was noted with recommended dose of chemical fertilizer (415:130:360g NPK plant⁻¹) which showed superiority over rest of treatments. Whereas, the lower non reducing sugar content (11.62, 12.16 and 11.89 %) was recorded during first, second as well as in pooled data, respectively under fruits of unfertilized plant (control).

The nutrients application through organic sources increased the nonreducing sugar in pulp. The maximum non reducing sugar content (12.72, 13.41 and 13.06 %) was recorded with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and to be found superior over rest of treatment during both the year and pooled over the year. Whereas, the minimum non reducing sugar content of 12.12, 12.68 and 12.40 was noted with bio inoculants (Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each).

The interaction effect of organic and inorganic sources of nutrient had significant effect on non reducing sugar content in the pulp. However, maximum non reducing sugar content (13.94%) was recorded in pooled over the year with recommended dose of chemical fertilizer (415:130:360g NPK plant⁻¹) in combination of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and the minimum value of non reducing sugar (11.57%) was noted with F₁O₂.

Table 4.36: Effect of organic sources and chemical fertilizer on non reducing sugar (%)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
1012-13								
Without fertilizer (Control)	(F ₁)	11.53	11.20	11.63	11.33	12.00	12.00	11.62
310:100:270g NPK (75%RDF)	(F ₂)	11.83	11.67	11.90	11.90	12.27	12.27	11.97
415:130:360g NPK (100%RDF)	(F ₃)	13.30	13.13	13.57	13.50	13.60	13.60	13.45
520:160:450g NPK (125%RDF)	(F ₄)	12.63	12.47	12.90	12.90	12.93	13.00	12.81
Mean		12.32	12.12	12.50	12.41	12.70	12.72	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.13		0.16		0.32		
CD at 5%		0.37		NS		0.92		
1013-14								
Without fertilizer (Control)	(F ₁)	12.20	11.93	12.07	12.37	12.00	12.37	12.16
310:100:270g NPK (75%RDF)	(F ₂)	12.50	12.00	12.23	12.37	13.27	13.00	12.56
415:130:360g NPK (100%RDF)	(F ₃)	13.97	13.47	13.90	14.07	14.27	14.27	13.99
520:160:450g NPK (125%RDF)	(F ₄)	12.80	13.30	13.23	13.23	13.93	14.00	13.42
Mean		12.87	12.68	12.86	13.01	13.37	13.41	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.13		0.16		0.33		
CD at 5%		0.38		0.47		0.94		
Pooled data								
Without fertilizer (Control)	(F ₁)	11.87	11.57	11.85	11.85	12.00	12.19	11.89
310:100:270g NPK (75%RDF)	(F ₂)	12.17	11.84	12.07	12.14	12.77	12.64	12.27
415:130:360g NPK (100%RDF)	(F ₃)	13.64	13.30	13.74	13.79	13.94	13.94	13.72
520:160:450g NPK (125%RDF)	(F ₄)	12.72	12.89	13.07	13.07	13.43	13.50	13.12
Mean		12.60	12.40	12.68	12.71	13.03	13.06	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.12		0.15		0.30		
CD at 5%		0.35		0.42		0.86		

4.3.4 Reducing sugar (%)

The reducing sugar was determined from ripe fruits during each year and statistically analysis and presented in Table 4.37. Data revealed significant improvement in reducing sugar content with application of chemical fertilizer. The maximum reducing sugar content of 4.66, 4.72 and 4.69 % was recorded with application of recommended dose of chemical fertilizer (415:130:360g NPK plant⁻¹) and found to be at par with 125% of recommended dose of chemical fertilizer, though lower reducing sugar content (3.50, 4.18 and 3.84%) was noted with unfertilized plant (F₁) which was significantly lower than other level of fertilizer during first, second as well as in pooled data, respectively.

Addition of nutrient through organic sources increases the reducing sugar content in pulp. The maximum reducing sugar content (4.50, 4.87 and 4.69 %) was recorded with application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and found significantly superior over rest of treatments during first, second and pooled over the year, respectively followed by vermicompost applied alone on mixed with other organic sources of nutrient under study. The minimum content of reducing sugar (3.79, 4.15 and 3.97%) was noted with application of microbes alone i.e. Azotobacter + VAM + *Trichoderma viridi* + PSB (each 100g) which was at par with microbes, oil cake and vermicompost applied alone.

The interaction between organic sources and chemical fertilizer was found significant in both the crop seasons as well as in pooled data whereas, the maximum reducing sugar of 4.91, 4.97 and 4.94 % was noted with the recommended dose of fertilizer when applied in combination of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and minimum reducing sugar (3.29, 3.80 and 3.55%) was recorded in the fruit of unfertilized with bio- unfertilized with bio-inoculants.

Table 4.37: Effect of organic sources and chemical fertilizer on reducing sugar (%)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
1012-13								
Without fertilizer (Control)	(F ₁)	3.39	3.29	3.43	3.44	3.59	3.87	3.5
310:100:270g NPK (75%RDF)	(F ₂)	3.77	3.45	3.91	4.09	4.29	4.34	3.97
415:130:360g NPK (100%RDF)	(F ₃)	4.47	4.22	4.77	4.79	4.84	4.91	4.66
520:160:450g NPK (125%RDF)	(F ₄)	4.49	4.19	4.59	4.52	4.85	4.89	4.59
Mean		4.03	3.79	4.18	4.21	4.39	4.50	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.12		0.15		0.29		
CD at 5%		0.34		0.41		0.83		
1013-14								
Without fertilizer (Control)	(F ₁)	3.92	3.80	3.93	4.42	4.47	4.57	4.18
310:100:270g NPK (75%RDF)	(F ₂)	4.22	4.20	4.52	4.70	4.78	4.95	4.56
415:130:360g NPK (100%RDF)	(F ₃)	4.63	4.25	4.70	4.80	4.93	4.98	4.72
520:160:450g NPK (125%RDF)	(F ₄)	4.40	4.33	4.75	4.73	4.87	4.97	4.68
Mean		4.29	4.15	4.48	4.66	4.76	4.87	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.14		0.17		0.34		
CD at 5%		0.39		0.50		0.78		
Pooled data								
Without fertilizer (Control)	(F ₁)	3.66	3.55	3.68	3.93	4.03	4.22	3.84
310:100:270g NPK (75%RDF)	(F ₂)	4.00	3.83	4.22	4.40	4.54	4.65	4.27
415:130:360g NPK (100%RDF)	(F ₃)	4.55	4.24	4.74	4.80	4.89	4.94	4.69
520:160:450g NPK (125%RDF)	(F ₄)	4.45	4.26	4.67	4.63	4.86	4.94	4.64
Mean		4.16	3.97	4.33	4.44	4.58	4.69	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.08		0.11		0.22		
CD at 5%		0.25		0.31		0.63		

4.3.5 Acidity (%)

The acidity of fruit pulp was determined during both the years and statistically analyzed. The data presented in Table 4.38 revealed that the increasing dose of chemical fertilizer reduces the acidity content in pulp. The minimum acidity content (0.354, 0.348 and 0.351 %) was recorded during first, second and pooled over the year, respectively with higher dose of chemical fertilizer (520:160:450g NPK plant⁻¹) which was found at par with preceding level of chemical fertilizer but showed superiority over 75 % recommended dose of fertilizer and unfertilized control plant. The maximum acidity content (0.370, 0.364 and 0.367 %) was recorded with no application of chemical fertilizer (F₁) during first, second and pooled over the year, respectively.

As regards to the addition of organic sources, the minimum acidity content of 0.348, 0.340 and 0.344 % was recorded with the application Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) whereas, the maximum value of acidity (0.386, 0.380 and 0.383%) was observed with bio-inoculants during first, second and pooled over the year, respectively.

Interaction of organic and inorganic sources did not showed significant effect on acidity content in pulp of the fruit. However, the minimum acidity content of 0.340, 0.333 and 0.337 was noted with application of chemical fertilizer @ 520:160:450g NPK plant⁻¹ (125 %RDF) in combination of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) during first, second as well as pooled over the year, respectively.

Table 4.38: Effect of organic sources and chemical fertilizer on acidity (%)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
1012-13								
Without fertilizer (Control)	(F ₁)	0.377	0.396	0.373	0.364	0.355	0.357	0.370
310:100:270g NPK (75%RDF)	(F ₂)	0.370	0.387	0.367	0.360	0.350	0.350	0.364
415:130:360g NPK (100%RDF)	(F ₃)	0.363	0.383	0.360	0.353	0.343	0.343	0.358
520:160:450g NPK (125%RDF)	(F ₄)	0.360	0.380	0.357	0.350	0.340	0.340	0.354
Mean		0.368	0.386	0.364	0.357	0.347	0.348	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.003		0.004		0.008		
CD at 5%		0.009		0.011		NS		
1013-14								
Without fertilizer (Control)	(F ₁)	0.370	0.389	0.367	0.357	0.349	0.350	0.364
310:100:270g NPK (75%RDF)	(F ₂)	0.363	0.383	0.360	0.353	0.343	0.343	0.358
415:130:360g NPK (100%RDF)	(F ₃)	0.353	0.373	0.350	0.343	0.333	0.333	0.348
520:160:450g NPK (125%RDF)	(F ₄)	0.353	0.373	0.350	0.343	0.333	0.333	0.348
Mean		0.360	0.380	0.357	0.349	0.340	0.340	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.004		0.005		0.010		
CD at 5%		0.012		0.015		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	0.373	0.392	0.370	0.361	0.352	0.353	0.367
310:100:270g NPK (75%RDF)	(F ₂)	0.367	0.385	0.363	0.357	0.347	0.347	0.361
415:130:360g NPK (100%RDF)	(F ₃)	0.358	0.378	0.355	0.348	0.338	0.338	0.353
520:160:450g NPK (125%RDF)	(F ₄)	0.357	0.377	0.353	0.347	0.337	0.337	0.351
Mean		0.364	0.383	0.360	0.353	0.343	0.344	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.011		0.013		0.026		
CD at 5%		NS		0.037		NS		

4.3.6 Ascorbic acid (mg 100 pulp⁻¹)

The ascorbic acid was determined from ripe fruits during each year and statistically analyzed and data are presented in Table 4.39. Results revealed that significant improvement in ascorbic acid content with application of chemical fertilizer. The higher ascorbic content (56.93, 56.74 and 56.84 mg 100g pulp⁻¹) was recorded with recommended dose of chemical fertilizer (415:130:360g NPK plant⁻¹) which was found statistically at par with 125% recommended dose of chemical fertilizer whereas, the lowest ascorbic acid content (49.60, 49.49 and 49.55 mg 100 g pulp⁻¹) was noted with no fertilizer (F₁) during first, second year and in pooled data, respectively.

As regards to the addition of organic sources, the maximum ascorbic acid content (57.59, 57.33 and 57.46 mg 100 g pulp⁻¹) was recorded with the application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and found to be at par with other organic source of nutrient except bio-inoculants alone and registered lowest value of ascorbic acid content (49.31, 47.64 and 48.48 mg 100g pulp⁻¹) during first, second and pool data, respectively.

The interaction effect of organic and inorganic sources of nutrient had significant effect on ascorbic acid content in the pulp. However, maximum ascorbic acid content (60.08 mg / 100 g pulp) was recorded in pooled with recommended dose of chemical fertilizer (415:130:360g NPK plant⁻¹) in combination with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and the minimum value of ascorbic acid (44.33 mg / 100 g pulp) was noted under F₁O₂.

**Table 4.39: Effect of organic sources and chemical fertilizer on ascorbic acid
(mg 100g pulp⁻¹)**

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
1012-13								
Without fertilizer (Control)	(F ₁)	47.92	44.81	50.13	47.98	51.92	54.84	49.60
310:100:270g NPK (75%RDF)	(F ₂)	50.61	47.76	53.29	50.49	56.04	56.30	52.41
415:130:360g NPK (100%RDF)	(F ₃)	55.46	52.66	58.07	55.10	60.09	60.22	56.93
520:160:450g NPK (125%RDF)	(F ₄)	55.17	52.01	57.14	54.96	58.63	59.03	56.15
Mean		52.29	49.31	54.65	52.13	56.67	57.59	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.91		1.11		2.24		
CD at 5%		2.61		3.19		6.42		
1013-14								
Without fertilizer (Control)	(F ₁)	47.37	43.84	50.62	48.84	51.96	54.32	49.49
310:100:270g NPK (75%RDF)	(F ₂)	50.00	46.42	53.87	51.07	55.76	55.99	52.18
415:130:360g NPK (100%RDF)	(F ₃)	55.41	51.27	58.03	56.25	59.56	59.95	56.74
520:160:450g NPK (125%RDF)	(F ₄)	53.73	49.05	57.02	55.04	59.12	59.05	55.50
Mean		51.63	47.64	54.88	52.80	56.60	57.33	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.22		1.50		3.01		
CD at 5%		3.41		4.31		8.63		
Pooled data								
Without fertilizer (Control)	(F ₁)	47.64	44.33	50.37	48.41	51.94	54.58	49.55
310:100:270g NPK (75%RDF)	(F ₂)	50.31	47.09	53.58	50.78	55.90	56.14	52.30
415:130:360g NPK (100%RDF)	(F ₃)	55.43	51.96	58.05	55.67	59.83	60.08	56.84
520:160:450g NPK (125%RDF)	(F ₄)	54.45	50.53	57.08	55.00	58.88	59.04	55.83
Mean		51.96	48.48	54.77	52.47	56.63	57.46	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.17		1.44		2.88		
CD at 5%		2.20		2.70		8.26		

4.3.7 Total soluble solid : acid ratio

The total soluble solid: acid was computed during each year as well as in pooled data and presented in Table 4.40. The data indicate that the chemically fertilized plants showed the increasing trend in terms of total soluble solid acid ratio with the application of chemical fertilizer over unfertilized plant. The higher total soluble solid: acid ratio (61.06, 66.03 and 63.51) was noted with recommended dose of chemical fertilizer (415:130:360g NPK plant⁻¹) followed by 125% recommended dose of fertilizer (520:160:450g NPK plant⁻¹) whereas, the lower total soluble solid: acid ratio (53.62, 57.75 and 55.67) was recorded during first, second as well as pooled data, respectively with unfertilized plant (control).

The nutrients application through organic sources increased the total soluble solid acid ratio in pulp. The maximum total soluble solid: acid ratio (61.24, 65.53 and 63.37) was recorded with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and found at par with Vermicompost (25 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) whereas, the minimum total soluble solid: acid ratio (53.76, 57.26 and 55.48) was noted with application of bio inoculants alone (Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) during first, second as well as in pooled data, respectively.

The interaction effect of organic sources and chemical fertilizer was showed non significant for total soluble solid: acid ratio of the pulp. However, the maximum total soluble solid: acid ratio (64.14, 69.67 and 66.86) was recorded during first, second and pooled over the year with recommended dose of chemical fertilizer (415:130:360g NPK plant⁻¹) in combination with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and the minimum total soluble solid: acid ratio was noted under F₁O₂.

Table 4.40: Influence of organic sources and chemical fertilizer on TSS: acid ratio

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
1012-13								
Without fertilizer (Control)	(F ₁)	51.91	49.32	52.90	54.67	56.54	56.67	53.62
310:100:270g NPK (75%RDF)	(F ₂)	55.05	52.27	56.68	58.81	60.57	60.86	57.25
415:130:360g NPK (100%RDF)	(F ₃)	59.97	56.84	60.36	62.04	64.05	64.14	61.06
520:160:450g NPK (125%RDF)	(F ₄)	59.44	56.50	60.22	61.80	63.62	63.82	60.90
Mean		56.47	53.76	57.53	59.24	61.15	61.24	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.73		0.89		1.78		
CD at 5%		2.08		2.55		NS		
1013-14								
Without fertilizer (Control)	(F ₁)	56.57	52.70	57.41	59.38	60.74	60.57	57.75
310:100:270g NPK (75%RDF)	(F ₂)	59.50	56.40	60.28	62.04	64.43	64.43	60.98
415:130:360g NPK (100%RDF)	(F ₃)	64.31	60.78	65.80	67.35	69.58	69.67	66.03
520:160:450g NPK (125%RDF)	(F ₄)	62.80	59.71	64.37	65.80	67.96	67.96	64.57
Mean		60.69	57.26	61.85	63.58	65.53	65.53	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.02		1.25		2.50		
CD at 5%		2.92		3.57		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	54.29	51.07	55.14	56.93	58.61	58.70	55.67
310:100:270g NPK (75%RDF)	(F ₂)	57.17	54.34	58.54	60.31	62.39	62.54	59.11
415:130:360g NPK (100%RDF)	(F ₃)	62.09	58.78	63.04	64.66	66.78	66.86	63.51
520:160:450g NPK (125%RDF)	(F ₄)	61.01	58.01	62.38	63.69	65.67	65.79	62.71
Mean		58.54	55.48	59.75	61.39	63.41	63.37	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.72		0.89		1.77		
CD at 5%		2.06		2.53		NS		

4.3.8 Phenol content (mg litter⁻¹)

The total phenol content was determined in fruits and its value was computed as mg Gallic acid equivalent (GAE) the data are presented in Table 4.41. The results indicated that the chemically fertilized plants showed the increasing trend in GAE with the application of chemical fertilizer over unfertilized plant. The higher GAE (40.39, 44.66 and 42.53 mg litter⁻¹) was noted with recommended dose of chemical fertilizer (415:130:360g NPK plant⁻¹) which showed superiority over rest of treatments. Whereas, the lowest GAE of 30.87, 35.09 and 32.98 mg litter⁻¹ was recorded during first, second as well as in pooled data, respectively under fruits of unfertilized plant (control).

The nutrients application through organic sources and interaction of chemical fertilizer with organic sources did not show any significant effect on Gallic acid equivalent.

Table 4.41: Influence of organic sources and chemical fertilizer on total phenols

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
1012-13								
Without fertilizer (Control)	(F ₁)	30.37	30.11	30.63	30.95	31.53	31.63	30.87
310:100:270g NPK (75%RDF)	(F ₂)	31.89	31.84	31.95	32.74	33.26	33.58	32.54
415:130:360g NPK (100%RDF)	(F ₃)	38.84	38.37	40.63	40.68	40.68	43.16	40.39
520:160:450g NPK (125%RDF)	(F ₄)	34.10	34.05	35.25	35.37	37.11	37.37	35.54
Mean		33.80	33.59	34.62	34.93	35.65	36.43	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.66		0.81		1.62		
CD at 5%		1.89		NS		NS		
1013-14								
Without fertilizer (Control)	(F ₁)	34.63	34.37	34.90	35.21	35.79	35.63	35.09
310:100:270g NPK (75%RDF)	(F ₂)	36.16	36.10	36.26	37.00	37.53	38.16	36.87
415:130:360g NPK (100%RDF)	(F ₃)	43.11	42.63	44.89	44.95	44.95	47.42	44.66
520:160:450g NPK (125%RDF)	(F ₄)	38.32	38.37	39.52	39.63	41.37	42.16	39.89
Mean		38.05	37.87	38.89	39.20	39.91	40.84	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.99		1.21		2.42		
CD at 5%		2.82		NS		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	32.50	32.24	32.77	33.08	33.66	33.63	32.98
310:100:270g NPK (75%RDF)	(F ₂)	34.02	33.97	34.10	34.87	35.39	35.87	34.71
415:130:360g NPK (100%RDF)	(F ₃)	40.97	40.50	42.76	42.82	42.82	45.29	42.53
520:160:450g NPK (125%RDF)	(F ₄)	36.21	36.21	37.38	37.50	39.24	39.77	37.72
Mean		35.93	35.73	36.75	37.07	37.78	38.64	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.75		0.92		1.83		
CD at 5%		2.13		NS		NS		

4.4 Influence of organic and inorganic sources of nutrients on macro and micro nutrient content in leaves of shoot bearing healthy and malformed panicles

Leaves from shoots bearing healthy and malformed panicles, were collected separately from each treatment under study for determination of nitrogen, phosphorus, potassium, zinc, copper, iron and manganese content. The results are presented in following heads.

4.4.1 Nitrogen content in leaves of shoot bearing healthy and malformed panicles

Data presented in Table 4.42 and 4.43 indicated that, nitrogen content in leaves of shoot bearing healthy and malformed panicles was almost similar. However, the values were slightly low in leaves of shoot bearing healthy panicles. Further, it was also noted that the increasing dose of fertilizer increased the content of nitrogen in leaves. Application of fertilizers significantly increased the N content in leaves over control (F_0). The maximum content of N in leaves (2.33 and 2.58%) and was recorded in the leaves of shoot bearing healthy and malformed panicles with the application the 520:160:450g NPK plant⁻¹ (125% RDF), respectively which showed superiority over rest of the treatment. Whereas, lowest nitrogen content (2.08 and 2.33 %) was noted with control in leaves of shoot bearing healthy and malformed panicles, respectively.

Pooled data revealed significantly higher nitrogen content (2.52 and 2.73%) in the leaves of shoot bearing healthy and malformed panicles when plant received the nutrient through Vermicompost (25 kg) + Oil cake (2.5 kg) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) followed by Vermicompost (25 kg) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹) and Vermicompost (25 kg) + Oil cake (2.5 kg). Whereas, the minimum nitrogen content of (1.92 and 2.11 %) was noted in leaves of shoot bearing healthy and malformed panicles with application of microbes (O_2) alone.

The interaction effect of organic and inorganic source of nutrient was non significant for nitrogen content in the leaves of shoot bearing healthy and malformed panicles.

Table 4.42: Influence of organic sources and chemical fertilizer on nitrogen content (%) in leaves of shoot bearing healthy panicle

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	1.86	1.81	1.93	2.08	2.14	2.40	2.04
310:100:270g NPK (75%RDF)	(F ₂)	1.92	1.83	1.97	2.09	2.46	2.48	2.13
415:130:360g NPK (100%RDF)	(F ₃)	2.05	1.85	2.30	2.23	2.48	2.49	2.23
520:160:450g NPK (125%RDF)	(F ₄)	2.07	2.01	2.35	2.28	2.48	2.55	2.29
Mean		1.98	1.88	2.10	2.20	2.39	2.48	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.10		0.13		0.26		
CD at 5%		0.30		0.37		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	1.94	1.96	2.01	2.17	2.22	2.46	2.13
310:100:270g NPK (75%RDF)	(F ₂)	2.01	1.98	2.06	2.18	2.55	2.57	2.22
415:130:360g NPK (100%RDF)	(F ₃)	2.10	1.98	2.32	2.42	2.56	2.57	2.33
520:160:450g NPK (125%RDF)	(F ₄)	2.12	2.09	2.35	2.43	2.57	2.62	2.36
Mean		2.04	2.00	2.19	2.30	2.48	2.56	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.14		0.18		0.35		
CD at 5%		0.41		0.50		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	1.90	1.89	1.97	2.12	2.18	2.43	2.08
310:100:270g NPK (75%RDF)	(F ₂)	1.96	1.91	2.02	2.13	2.50	2.53	2.17
415:130:360g NPK (100%RDF)	(F ₃)	2.08	1.91	2.28	2.36	2.52	2.53	2.28
520:160:450g NPK (125%RDF)	(F ₄)	2.10	2.05	2.32	2.39	2.52	2.59	2.33
Mean		2.01	1.94	2.15	2.25	2.43	2.52	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.10		0.12		0.24		
CD at 5%		0.28		0.34		NS		

Table 4.43: Influence of organic sources and chemical fertilizer on nitrogen content (%) in leaves of shoot bearing malformed panicle

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	2.04	1.96	2.21	2.42	2.48	2.59	2.28
310:100:270g NPK (75%RDF)	(F ₂)	2.22	1.98	2.30	2.47	2.67	2.71	2.39
415:130:360g NPK (100%RDF)	(F ₃)	2.28	2.04	2.46	2.51	2.71	2.73	2.46
520:160:450g NPK (125%RDF)	(F ₄)	2.39	2.30	2.49	2.59	2.70	2.74	2.54
Mean		2.23	2.07	2.36	2.50	2.64	2.69	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.14		0.17		0.35		
CD at 5%		0.40		0.49		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	2.13	2.04	2.30	2.51	2.56	2.67	2.37
310:100:270g NPK (75%RDF)	(F ₂)	2.31	2.06	2.39	2.55	2.76	2.79	2.48
415:130:360g NPK (100%RDF)	(F ₃)	2.36	2.12	2.55	2.59	2.80	2.82	2.54
520:160:450g NPK (125%RDF)	(F ₄)	2.48	2.39	2.57	2.67	2.82	2.82	2.62
Mean		2.32	2.15	2.45	2.58	2.73	2.77	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.16		0.19		0.38		
CD at 5%		0.45		0.55		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	2.08	2.00	2.26	2.47	2.52	2.63	2.33
310:100:270g NPK (75%RDF)	(F ₂)	2.27	2.02	2.35	2.51	2.72	2.75	2.44
415:130:360g NPK (100%RDF)	(F ₃)	2.32	2.08	2.51	2.55	2.76	2.78	2.50
520:160:450g NPK (125%RDF)	(F ₄)	2.44	2.35	2.53	2.63	2.77	2.78	2.58
Mean		2.28	2.11	2.41	2.54	2.69	2.73	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.12		0.15		0.29		
CD at 5%		0.34		0.42		NS		

4.4.2 Phosphorous content in leaves of shoot bearing healthy and malformed panicles

Data presented in Table 4.44 and 4.45 revealed that the incremental dose of nutrient application increased the phosphorous content in the leaves of shoot bearing healthy and malformed panicles. The content of phosphorous in leaves of shoot bearing healthy and malformed panicles was almost similar. However, there were slight reductions in phosphorous content of leaves of shoot bearing malformed panicles. The maximum content of P (0.35 and 0.32 %) was recorded with 125 per cent recommended dose of chemical fertilizer (520:160:450g NPK plant⁻¹) whereas, it was minimum (0.31 and 0.28%) with no fertilizer in the leaves of shoot bearing healthy and malformed panicles, respectively.

As regards, the organic sources of nutrient the highest value of phosphorous content (0.36 and 0.33 %) was recorded with application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each), followed by Vermicompost (25 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and the lowest value of P (0.29 and 0.25 %) was recorded with microbes applied alone. Overall, phosphorus content in the leaves of shoot bearing healthy panicle was higher as compared to malformed panicle.

The interaction effect of organic and inorganic source of nutrient did not show significant effect on the concentration of phosphorous in the leaves of shoot bearing healthy and malformed panicles. However, the maximum phosphorus content (0.37 and 0.34%) was recorded with 520:160:450g NPK plant⁻¹ (125 % of RDF) alongwith Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and the minimum (0.25 and 0.24 %) with no chemical fertilizer with combination of Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) in the leaves of shoot bearing healthy and malformed panicles, respectively.

Table 4.44: Influence of organic sources and chemical fertilizer on phosphorous content (%) in leaves of shoot bearing healthy panicle

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	0.28	0.23	0.30	0.29	0.32	0.33	0.29
310:100:270g NPK (75%RDF)	(F ₂)	0.29	0.23	0.30	0.30	0.33	0.34	0.30
415:130:360g NPK (100%RDF)	(F ₃)	0.30	0.28	0.32	0.32	0.34	0.35	0.32
520:160:450g NPK (125%RDF)	(F ₄)	0.31	0.30	0.32	0.32	0.34	0.35	0.32
Mean		0.29	0.26	0.31	0.31	0.33	0.34	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.007		0.009		0.017		
CD at 5%		0.02		0.024		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	0.33	0.27	0.34	0.34	0.36	0.37	0.33
310:100:270g NPK (75%RDF)	(F ₂)	0.33	0.31	0.34	0.34	0.38	0.38	0.35
415:130:360g NPK (100%RDF)	(F ₃)	0.34	0.32	0.36	0.36	0.38	0.39	0.36
520:160:450g NPK (125%RDF)	(F ₄)	0.35	0.34	0.36	0.36	0.38	0.40	0.37
Mean		0.34	0.31	0.35	0.35	0.37	0.38	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.007		0.008		0.016		
CD at 5%		0.019		0.023		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	0.31	0.25	0.32	0.32	0.34	0.35	0.31
310:100:270g NPK (75%RDF)	(F ₂)	0.31	0.27	0.32	0.32	0.35	0.36	0.32
415:130:360g NPK (100%RDF)	(F ₃)	0.32	0.30	0.34	0.34	0.36	0.37	0.34
520:160:450g NPK (125%RDF)	(F ₄)	0.33	0.32	0.34	0.34	0.36	0.37	0.35
Mean		0.32	0.29	0.33	0.33	0.35	0.36	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.006		0.007		0.014		
CD at 5%		0.017		0.020		NS		

Table 4.45: Influence of organic sources and chemical fertilizer on phosphorous content (%) in leaves of shoot bearing malformed panicle

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	0.24	0.22	0.25	0.28	0.29	0.30	0.26
310:100:270g NPK (75%RDF)	(F ₂)	0.24	0.22	0.25	0.28	0.30	0.31	0.27
415:130:360g NPK (100%RDF)	(F ₃)	0.24	0.23	0.29	0.30	0.31	0.31	0.28
520:160:450g NPK (125%RDF)	(F ₄)	0.29	0.26	0.30	0.31	0.32	0.32	0.30
Mean		0.25	0.23	0.27	0.29	0.30	0.31	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.012		0.015		0.029		
CD at 5%		NS		0.042		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	0.28	0.26	0.28	0.32	0.33	0.34	0.30
310:100:270g NPK (75%RDF)	(F ₂)	0.28	0.26	0.30	0.33	0.34	0.35	0.31
415:130:360g NPK (100%RDF)	(F ₃)	0.28	0.27	0.34	0.34	0.35	0.35	0.32
520:160:450g NPK (125%RDF)	(F ₄)	0.33	0.30	0.34	0.35	0.36	0.36	0.34
Mean		0.29	0.27	0.31	0.33	0.35	0.35	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.012		0.014		0.029		
CD at 5%		NS		0.041		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	0.26	0.24	0.27	0.30	0.31	0.32	0.28
310:100:270g NPK (75%RDF)	(F ₂)	0.26	0.24	0.28	0.31	0.32	0.33	0.29
415:130:360g NPK (100%RDF)	(F ₃)	0.26	0.24	0.32	0.32	0.33	0.33	0.30
520:160:450g NPK (125%RDF)	(F ₄)	0.31	0.28	0.32	0.33	0.34	0.34	0.32
Mean		0.27	0.25	0.30	0.31	0.32	0.33	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.011		0.014		0.027		
CD at 5%		NS		0.039		NS		

4.4.3 Potassium content in leaves of shoot bearing healthy and malformed panicles

Data presented in table 4.46 and 4.47 indicated that the fertilizer dose had significant effect on the potassium content in leaves of shoot bearing healthy and malformed panicles. The maximum potassium content in leaves of shoot bearing healthy and malformed panicles (58.39 and 71.46 mg kg⁻¹) were recorded when plants received 125 per cent recommended dose of fertilizer 520:160:450g NPK plant⁻¹, respectively and found significantly superior over rest of the fertilizer doses. Whereas, the minimum potassium content (51.01 and 61.19 mg kg⁻¹) in leaves of shoot bearing healthy and malformed panicles, respectively with unfertilized plant.

Organic sources of nutrient also showed significant effect in terms of potassium content in leaves of shoot bearing healthy and malformed panicles. The maximum potassium content of (61.31 and 75.89 mg kg⁻¹) in leaves of shoot bearing healthy and malformed panicles was recorded with application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each), respectively followed by (59.44 and 73.18 mg kg⁻¹) with Vermicompost (25 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) and the lowest value (46.59 and 55.12 mg kg⁻¹) was noted with the treatment where microbes were applied alone.

The interaction effect of organic and inorganic source of nutrient also showed significant effect on the content of potassium in the leaves of shoot bearing healthy and malformed panicles. The maximum potassium content of 62.90 and 77.82 mg kg⁻¹ was noted with 520:160:450g NPK plant⁻¹ (125 % of RDF) along with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) in leaves of shoot bearing healthy and malformed panicles which was statistically at par with F₃O₆, F₂O₆, F₂O₅, F₃O₅ and F₄O₅. The minimum content of potassium (43.74 and 47.43 mg kg⁻¹) was noted with without chemical fertilizer with combination of Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) in the leaves of shoot bearing healthy and malformed panicles, respectively.

Table 4.46: Influence of organic sources and chemical fertilizer on potassium content (mg kg^{-1}) in leaves of shoot bearing healthy panicle

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	44.37	42.94	48.66	52.24	55.46	57.96	50.27
310:100:270g NPK (75%RDF)	(F ₂)	45.80	44.01	49.23	51.88	59.04	60.83	51.80
415:130:360g NPK (100%RDF)	(F ₃)	46.51	44.37	56.39	58.32	59.75	61.18	54.42
520:160:450g NPK (125%RDF)	(F ₄)	53.67	51.88	57.85	58.68	59.75	62.11	57.32
Mean		47.59	45.80	53.03	55.28	58.50	60.52	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.76		0.93		1.86		
CD at 5%		2.16		2.65		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	45.97	44.54	50.26	53.17	57.06	59.56	51.76
310:100:270g NPK (75%RDF)	(F ₂)	47.40	45.61	50.81	53.46	60.62	62.41	53.39
415:130:360g NPK (100%RDF)	(F ₃)	48.09	45.92	57.97	59.90	61.33	62.76	55.99
520:160:450g NPK (125%RDF)	(F ₄)	55.25	53.46	59.43	61.33	63.59	63.69	59.46
Mean		49.18	47.38	54.62	56.97	60.65	62.11	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.31		0.39		0.77		
CD at 5%		0.90		1.10		2.20		
Pooled data								
Without fertilizer (Control)	(F ₁)	45.17	43.74	49.46	52.70	56.26	58.76	51.01
310:100:270g NPK (75%RDF)	(F ₂)	46.60	44.81	50.02	52.67	59.83	61.62	52.59
415:130:360g NPK (100%RDF)	(F ₃)	47.30	45.14	57.18	59.11	60.54	61.97	55.20
520:160:450g NPK (125%RDF)	(F ₄)	54.46	52.67	58.64	60.54	61.13	62.90	58.39
Mean		48.38	46.59	53.82	56.25	59.44	61.31	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.40		0.49		0.97		
CD at 5%		1.14		1.39		2.78		

Table 4.47: Influence of organic sources and chemical fertilizer on potassium content (mg kg^{-1}) in leaves of shoot bearing malformed panicle

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	53.67	46.51	60.83	62.38	67.37	70.87	60.27
310:100:270g NPK (75%RDF)	(F ₂)	57.25	50.09	64.40	67.06	74.37	75.86	64.84
415:130:360g NPK (100%RDF)	(F ₃)	60.83	57.25	65.78	67.69	75.00	76.27	67.14
520:160:450g NPK (125%RDF)	(F ₄)	67.98	62.99	69.60	71.82	75.67	76.91	70.83
Mean		59.93	54.21	65.15	67.24	73.10	74.98	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.77		0.94		1.87		
CD at 5%		2.20		2.69		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	55.50	48.34	62.66	64.21	69.20	72.70	62.10
310:100:270g NPK (75%RDF)	(F ₂)	59.08	51.92	66.21	68.87	76.18	77.67	66.66
415:130:360g NPK (100%RDF)	(F ₃)	62.64	59.06	67.59	69.50	73.48	78.08	68.39
520:160:450g NPK (125%RDF)	(F ₄)	69.79	64.80	71.41	73.63	74.15	78.72	72.08
Mean		61.76	56.03	66.97	69.06	73.25	76.80	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.43		0.52		1.04		
CD at 5%		1.22		1.49		2.98		
Pooled data								
Without fertilizer (Control)	(F ₁)	54.59	47.43	61.75	63.30	68.29	71.79	61.19
310:100:270g NPK (75%RDF)	(F ₂)	58.17	51.01	65.31	67.97	75.28	76.77	65.75
415:130:360g NPK (100%RDF)	(F ₃)	61.74	58.16	66.69	68.60	74.24	77.18	67.76
520:160:450g NPK (125%RDF)	(F ₄)	68.89	63.90	70.51	72.73	74.91	77.82	71.46
Mean		60.85	55.12	66.06	68.15	73.18	75.89	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.39		0.48		0.95		
CD at 5%		1.11		1.36		2.72		

4.4.4 Copper content in leaves of shoot bearing healthy and malformed panicles

The copper content in leaves of shoot bearing healthy and malformed panicles was determined and presented in Table 4.48 and 4.49 the inorganic sources of nutrients application had significant effect on the Cu content in leaves of shoot bearing healthy and malformed panicles. In general, higher copper content in the leaves of shoot bearing malformed panicle was observed than the leaves of shoot bearing healthy panicle. Data indicated that, the maximum Cu content (8.77 mg kg^{-1}) in leaves of shoot bearing healthy panicle and (9.75 mg kg^{-1}) in leaves of shoot bearing malformed panicle was observed when plants were fertilized with @ 520:160:450g NPK plant^{-1} (125% of RDF). Whereas, minimum Cu content (7.98 and 9.00 mg kg^{-1}) was recorded in leaves of shoot bearing healthy and malformed panicles with control i.e. no chemical fertilizer, respectively.

The organic sources of nutrient also exerted significant effect on content of Cu. Significantly higher content (9.25 and 10.29 mg kg^{-1}) was noted with application of Vermicompost (25 kg plant^{-1}) + Oil cake ($2.5 \text{ kg plant}^{-1}$) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant^{-1} each) whereas, the lowest content of Cu was recorded with microbe applied alone (i.e. 7.18 and 8.37 mg kg^{-1}) in the leaves of shoot bearing healthy and malformed panicles, respectively.

The combined effect of organic and inorganic sources of nutrient found non significant with respect to content of Cu in the leaves of shoot bearing healthy and malformed panicles. The 125 per cent recommended dose of fertilizer (520:160:450g NPK plant^{-1}) along with Vermicompost (25 kg plant^{-1}) + Oil cake ($2.5 \text{ kg plant}^{-1}$) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant^{-1} each) recorded higher value of copper content (9.53 and 10.5 mg kg^{-1}) in the leaves of healthy and malformed panicles, respectively. Similar trends were noted during both the year of investigation.

Table 4.48: Influence of organic sources and chemical fertilizer on copper content (mg kg^{-1}) in leaves of shoot bearing healthy panicle

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	7.12	6.58	7.52	8.12	8.23	8.74	7.72
310:100:270g NPK (75%RDF)	(F ₂)	7.37	6.45	7.83	8.38	8.62	8.76	7.90
415:130:360g NPK (100%RDF)	(F ₃)	7.89	7.18	8.25	8.70	8.71	9.17	8.32
520:160:450g NPK (125%RDF)	(F ₄)	8.08	7.45	8.36	8.89	8.96	9.26	8.50
Mean		7.62	6.92	7.99	8.52	8.63	8.98	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.06		0.08		0.15		
CD at 5%		0.18		0.22		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	7.65	7.11	8.05	8.65	8.76	9.27	8.25
310:100:270g NPK (75%RDF)	(F ₂)	7.90	6.98	8.36	8.91	9.15	9.29	8.43
415:130:360g NPK (100%RDF)	(F ₃)	8.42	7.71	8.78	9.23	9.24	9.70	8.85
520:160:450g NPK (125%RDF)	(F ₄)	8.61	7.98	8.89	9.42	9.49	9.79	9.03
Mean		8.15	7.45	8.52	9.05	9.16	9.51	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.10		0.12		0.24		
CD at 5%		0.28		0.34		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	7.39	6.85	7.79	8.39	8.50	9.01	7.98
310:100:270g NPK (75%RDF)	(F ₂)	7.64	6.72	8.10	8.65	8.88	9.02	8.17
415:130:360g NPK (100%RDF)	(F ₃)	8.16	7.45	8.52	8.97	8.98	9.44	8.58
520:160:450g NPK (125%RDF)	(F ₄)	8.35	7.72	8.63	9.16	9.23	9.53	8.77
Mean		7.88	7.18	8.26	8.79	8.89	9.25	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.07		0.09		0.17		
CD at 5%		0.20		0.24		NS		

Table 4.49: Influence of organic sources and chemical fertilizer on copper content (mg kg⁻¹) in leaves of shoot bearing malformed panicle

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	8.07	7.53	8.47	9.07	9.18	9.69	8.67
310:100:270g NPK (75%RDF)	(F ₂)	8.32	7.73	8.78	9.33	9.71	9.90	8.96
415:130:360g NPK (100%RDF)	(F ₃)	8.84	7.80	9.20	9.65	9.66	10.12	9.21
520:160:450g NPK (125%RDF)	(F ₄)	9.31	9.03	8.40	9.84	9.91	10.21	9.45
Mean		8.64	8.02	8.71	9.47	9.61	9.98	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.13		0.16		0.33		
CD at 5%		0.38		0.47		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	8.69	8.17	9.26	9.69	9.80	10.31	9.32
310:100:270g NPK (75%RDF)	(F ₂)	8.99	8.35	9.37	9.93	10.30	10.49	9.57
415:130:360g NPK (100%RDF)	(F ₃)	9.46	8.68	9.85	10.31	10.35	10.78	9.91
520:160:450g NPK (125%RDF)	(F ₄)	9.93	9.63	8.99	10.43	10.50	10.80	10.05
Mean		9.27	8.71	9.37	10.09	10.24	10.60	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.17		0.20		0.41		
CD at 5%		0.47		0.58		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	8.38	7.85	8.87	9.38	9.49	10.00	9.00
310:100:270g NPK (75%RDF)	(F ₂)	8.66	8.04	9.08	9.63	10.00	10.20	9.27
415:130:360g NPK (100%RDF)	(F ₃)	9.15	8.24	9.52	9.98	10.01	10.45	9.56
520:160:450g NPK (125%RDF)	(F ₄)	9.62	9.33	8.70	10.14	10.21	10.51	9.75
Mean		8.95	8.37	9.04	9.78	9.93	10.29	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.13		0.16		0.31		
CD at 5%		0.36		0.44		NS		

4.4.5 Zinc content in leaves of shoot bearing healthy and malformed panicles

. It is revealed by the data presented in Table 4.50 and 4.51 that significant variations in content of Zn in leaves of shoot bearing healthy and malformed panicles during both the years as well as in pooled data. The inorganic and organic source of nutrient had significant effect on the Zn content in shoot bearing healthy and malformed panicles. However, the slight reduction in zinc content in the leaves of shoot of healthy panicle as compared to malformed was recorded. The maximum Zn content of 25.85 and 27.15 mg kg⁻¹ in leaves of shoot bearing healthy and malformed panicles was recorded when plants were fertilized with 520:160:450g NPK plant⁻¹ (125% of RDF) ,respectively. Whereas, the minimum Zn content (23.65 and 24.79 mg kg⁻¹) Zn in leaves of shoot bearing healthy and malformed panicles was recorded with unfertilized plant i.e. control, respectively.

As regards, to the organic sources, the higher Zn content (26.84 and 29.40 mg kg⁻¹) in leaves of shoot bearing healthy and malformed panicles was recorded with application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each), respectively. Whereas the minimum Zn content (21.96 and 23.04 mg kg⁻¹) in leaves of shoots bearing healthy and malformed panicles was noted with application of microbes applied alone (Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each), respectively

The interaction of organic and inorganic sources of nutrient did not showed significant effect on Zn content in leaves of shoot bearing healthy as well as in malformed panicles. However, higher content of Zn (27.33 and 30.03 mg kg⁻¹) in the leaves of healthy and malformed panicles was recorded with 125 per cent of recommended dose fertilizer (520:160:450g NPK plant⁻¹) in combination with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100 g plant⁻¹ each), respectively.

Table 4.50: Influence of organic sources and chemical fertilizer on zinc content (mg kg^{-1}) in leaves of shoot bearing healthy panicle

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	21.65	20.83	22.63	24.02	25.45	25.74	23.39
310:100:270g NPK (75%RDF)	(F ₂)	22.85	21.23	23.19	24.72	26.17	26.84	24.17
415:130:360g NPK (100%RDF)	(F ₃)	22.90	22.19	25.64	25.97	26.36	26.99	25.01
520:160:450g NPK (125%RDF)	(F ₄)	24.52	22.99	26.17	26.28	27.16	27.22	25.72
Mean		22.98	21.81	24.41	25.25	26.29	26.70	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.17		0.21		0.42		
CD at 5%		0.49		0.60		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	22.13	21.19	23.05	24.96	26.00	26.16	23.92
310:100:270g NPK (75%RDF)	(F ₂)	23.27	21.53	23.47	25.06	26.45	27.12	24.48
415:130:360g NPK (100%RDF)	(F ₃)	23.18	22.47	26.07	26.24	26.62	27.25	25.31
520:160:450g NPK (125%RDF)	(F ₄)	24.78	23.30	26.43	26.51	27.42	27.45	25.98
Mean		23.34	22.12	24.76	25.69	26.62	27.00	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.16		0.19		0.39		
CD at 5%		0.46		0.56		1.12		
Pooled data								
Without fertilizer (Control)	(F ₁)	21.89	21.01	22.84	24.49	25.72	25.95	23.65
310:100:270g NPK (75%RDF)	(F ₂)	23.06	21.38	23.33	24.89	26.31	26.98	24.32
415:130:360g NPK (100%RDF)	(F ₃)	23.04	22.33	25.85	26.10	26.49	27.12	25.16
520:160:450g NPK (125%RDF)	(F ₄)	24.65	23.15	26.30	26.39	27.29	27.33	25.85
Mean		23.16	21.96	24.58	25.47	26.45	26.84	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.14		0.17		0.34		
CD at 5%		0.40		0.49		0.98		

Table 4.51: Influence of organic sources and chemical fertilizer on zinc content (mg kg⁻¹) in leaves of shoot bearing malformed panicle

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	23.10	22.23	23.65	25.22	26.15	27.38	24.62
310:100:270g NPK (75%RDF)	(F ₂)	23.63	22.83	24.49	25.96	28.06	29.85	25.80
415:130:360g NPK (100%RDF)	(F ₃)	23.85	22.90	26.37	27.28	28.67	29.85	26.49
520:160:450g NPK (125%RDF)	(F ₄)	25.62	23.59	26.41	27.57	28.97	29.89	27.01
Mean		24.05	22.89	25.23	26.51	27.96	29.24	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.29		0.36		0.72		
CD at 5%		0.84		1.03		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	23.43	22.56	23.98	25.55	26.48	27.71	24.95
310:100:270g NPK (75%RDF)	(F ₂)	23.96	23.16	24.80	26.27	28.37	30.16	26.12
415:130:360g NPK (100%RDF)	(F ₃)	24.16	23.21	26.68	27.59	28.96	30.15	26.79
520:160:450g NPK (125%RDF)	(F ₄)	25.91	23.88	26.70	27.86	29.26	30.18	27.30
Mean		24.36	23.20	25.54	26.82	28.27	29.55	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.09		0.11		0.21		
CD at 5%		0.25		0.30		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	23.26	22.39	23.81	25.38	26.31	27.54	24.79
310:100:270g NPK (75%RDF)	(F ₂)	23.79	22.99	24.64	26.11	28.21	30.00	25.96
415:130:360g NPK (100%RDF)	(F ₃)	24.00	23.05	26.52	27.43	28.82	30.00	26.64
520:160:450g NPK (125%RDF)	(F ₄)	25.77	23.74	26.56	27.72	29.12	30.03	27.15
Mean		24.21	23.04	25.38	26.66	28.12	29.40	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.18		0.22		0.45		
CD at 5%		0.53		0.64		NS		

4.4.6 Iron content in leaves of shoot bearing healthy and malformed panicles

Inorganic and organic sources of nutrient had significant effect on the Fe content in leaves of shoot bearing healthy and malformed panicles. The Fe content was higher in leaves of shoot bearing malformed panicle as compared to healthy one. Data presented in Table 4.52 and 4.53 indicated that the maximum Fe content ($181.43 \text{ mg kg}^{-1}$) in leaves of shoot bearing healthy panicle and ($196.55 \text{ mg kg}^{-1}$) in leaves of shoot bearing malformed panicle was observed when plants were received 520:160:450g NPK plant^{-1} (125% of RDF) and proved significantly superior over rest of the fertilizer doses. Whereas, the minimum Fe content (163.88 and $180.25 \text{ mg kg}^{-1}$) in the leaves of shoot bearing healthy and malformed panicles was recorded with control, respectively. Moreover, the recommended dose ($415:130:360 \text{ g NPK plant}^{-1}$) and 75% of RDF ($310:100:270 \text{ g NPK plant}^{-1}$) statistically at par with each other in the leaves of shoot bearing healthy panicles while all the chemical fertilizer doses showed significant effect on concentration of Fe in leaves of shoot bearing malformed panicle.

As regards the organic sources significant effect on the content of Fe in the leaves of shoot bearing healthy and malformed panicles was recorded. The maximum Fe content (192.59 and $207.87 \text{ mg kg}^{-1}$) in leaves of shoot bearing healthy and malformed panicles was recorded with Vermicompost (25 kg plant^{-1}) + Oil cake ($2.5 \text{ kg plant}^{-1}$) + Azotobacter + VAM + Trichoderma viridi + PSB (100 g plant^{-1} each) respectively. Whereas, the lowest content of Fe was noted with Azotobacter + VAM + Trichoderma viridae + PSB (100 g plant^{-1} each) applied alone (i.e. 145.48 and $160.13 \text{ mg kg}^{-1}$) in the leaves of shoot bearing healthy and malformed panicles, respectively.

The interaction effect of organic and inorganic source of nutrients showed significant effect and the maximum Fe content (196.33 and $213.10 \text{ mg kg}^{-1}$) was recorded with application of 125% of RDF in combination with Vermicompost (25 kg plant^{-1}) + Oil cake ($2.5 \text{ kg plant}^{-1}$) + Azotobacter + VAM + Trichoderma viridi + PSB (100 g plant^{-1} each) respectively whereas, the minimum (136.23 and $151.50 \text{ mg kg}^{-1}$) in the leaves of shoot bearing healthy and malformed panicles with F_1O_2 , respectively.

Table 4.52: Influence of organic sources and chemical fertilizer on iron content (mg kg⁻¹) in leaves of shoot bearing healthy panicle

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	151.90	136.10	163.10	170.40	179.40	181.90	163.80
310:100:270g NPK (75%RDF)	(F ₂)	161.00	141.90	168.20	173.30	189.40	194.90	171.45
415:130:360g NPK (100%RDF)	(F ₃)	154.30	134.30	174.90	181.00	188.37	196.57	171.57
520:160:450g NPK (125%RDF)	(F ₄)	170.90	169.40	176.80	184.50	189.40	196.80	181.30
Mean		159.53	145.43	170.75	177.30	186.64	192.54	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.21		1.48		2.96		
CD at 5%		3.45		4.23		8.50		
2013-14								
Without fertilizer (Control)	(F ₁)	152.17	136.37	163.37	170.67	179.67	181.50	163.96
310:100:270g NPK (75%RDF)	(F ₂)	161.27	142.17	168.47	173.23	189.67	195.17	171.66
415:130:360g NPK (100%RDF)	(F ₃)	153.90	133.90	175.17	181.27	188.63	196.83	171.62
520:160:450g NPK (125%RDF)	(F ₄)	171.17	169.67	177.07	184.77	189.67	197.07	181.57
Mean		159.63	145.53	171.02	177.48	186.91	192.64	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.52		0.64		1.28		
CD at 5%		1.49		1.83		3.66		
Pooled data								
Without fertilizer (Control)	(F ₁)	152.03	136.23	163.23	170.53	179.53	181.70	163.88
310:100:270g NPK (75%RDF)	(F ₂)	161.13	142.03	168.33	173.27	189.53	195.03	171.56
415:130:360g NPK (100%RDF)	(F ₃)	154.10	134.10	175.03	181.13	188.50	196.70	171.60
520:160:450g NPK (125%RDF)	(F ₄)	171.03	169.53	176.93	184.63	189.53	196.93	181.43
Mean		159.58	145.48	170.88	177.39	186.78	192.59	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.82		1.01		2.01		
CD at 5%		2.35		2.87		5.74		

Table 4.53: Influence of organic sources and chemical fertilizer on iron content (mg kg⁻¹) in leaves of shoot bearing malformed panicle

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	168.90	151.30	179.10	187.40	195.70	197.90	180.05
310:100:270g NPK (75%RDF)	(F ₂)	171.30	153.10	184.20	190.30	204.40	208.90	185.37
415:130:360g NPK (100%RDF)	(F ₃)	178.00	158.90	193.80	198.50	204.70	210.80	190.78
520:160:450g NPK (125%RDF)	(F ₄)	186.90	176.40	197.00	200.50	204.40	212.90	196.35
Mean		176.28	159.93	188.53	194.18	202.30	207.63	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.41		1.71		3.47		
CD at 5%		4.05		4.91		9.90		
2013-14								
Without fertilizer (Control)	(F ₁)	169.30	151.70	179.50	187.80	196.10	198.30	180.45
310:100:270g NPK (75%RDF)	(F ₂)	171.70	153.50	184.60	190.70	204.80	209.30	185.77
415:130:360g NPK (100%RDF)	(F ₃)	178.40	159.30	194.20	198.90	204.77	211.53	191.18
520:160:450g NPK (125%RDF)	(F ₄)	187.30	176.80	197.40	200.90	204.80	213.30	196.75
Mean		176.68	160.33	188.93	194.58	202.62	208.11	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.32		1.62		3.21		
CD at 5%		3.79		4.65		9.21		
Pooled data								
Without fertilizer (Control)	(F ₁)	169.10	151.50	179.30	187.60	195.90	198.10	180.25
310:100:270g NPK (75%RDF)	(F ₂)	171.50	153.30	184.40	190.50	204.60	209.10	185.57
415:130:360g NPK (100%RDF)	(F ₃)	178.20	159.10	194.00	198.70	204.73	211.17	190.98
520:160:450g NPK (125%RDF)	(F ₄)	187.10	176.60	197.20	200.70	204.60	213.10	196.55
Mean		176.48	160.13	188.73	194.38	202.46	207.87	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.26		1.56		3.12		
CD at 5%		3.62		4.68		8.95		

4.2.7 Manganese content in leaves of shoot bearing healthy and malformed shoots

It is obvious from the Table 4.54 and 4.55 that the content of Mn in leaves of shoot bearing healthy and malformed panicles markedly increased due to application of nutrient either by chemical fertilizer or organic sources. Higher Mn content (79.88 and 93.13 mg kg⁻¹) was observed with higher dose of fertilizer (520:160:450g NPK plant⁻¹) in leaves of shoot bearing healthy and malformed panicles, respectively and showed superiority over rest of the levels. Whereas, lower concentration of Mn (68.44 and 80.43 mg kg⁻¹) was recorded in the leaves of shoot bearing healthy and malformed panicles, respectively with control. The fertilizer dose of 75 and 100 per cent of recommended dose were statistically at par with each other.

As regards, the sources of organic sources, the maximum Mn content (83.84 and 96.13 mg kg⁻¹) in leaves of shoot bearing healthy and malformed panicle was recorded when plant nourished with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) ,respectively and followed by Mn content (80.16 and 92.90 mg kg⁻¹) under Vermicompost (25 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) The lowest content of Mn was noted with O₂ (i.e. 62.19 and 75.88 mg kg⁻¹) in the leaves of shoot bearing healthy and malformed panicles, respectively.

The interaction effect of organic and inorganic source of nutrients revealed significant effect on manganese content in leaves of shoot bearing healthy and malformed panicles was noted the higher value of manganese content (88.57 and 98.03 mg kg⁻¹) was recorded with 520:160:450 g NPK plant⁻¹ (125 % of RDF) applied in combination with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) in leaves of shoot bearing healthy and malformed panicles, respectively which was statistically at par with F₂O₆, F₄O₆, F₄O₅, F₂O₅ and F₃O₄. The minimum content of Mn (56.87 and 67.53 mg kg⁻¹) was recorded with no chemical fertilizer in combination of Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹each) in the leaves of shoot bearing healthy and malformed bearing panicles, respectively.

Table 4.54: Influence of organic sources and chemical fertilizer on manganese content (mg kg⁻¹) in leaves of healthy panicle

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	67.53	56.53	68.60	68.90	70.80	75.60	67.99
310:100:270g NPK (75%RDF)	(F ₂)	67.50	58.87	69.47	72.93	80.30	83.50	72.09
415:130:360g NPK (100%RDF)	(F ₃)	68.10	60.33	71.50	72.77	82.23	86.20	73.52
520:160:450g NPK (125%RDF)	(F ₄)	77.00	71.20	77.10	78.60	85.30	88.90	79.68
Mean		70.03	61.73	71.67	73.30	79.66	83.55	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.99		1.22		2.44		
CD at 5%		2.85		3.49		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	68.19	57.19	69.59	69.89	71.79	76.59	68.87
310:100:270g NPK (75%RDF)	(F ₂)	68.49	59.85	70.45	73.59	81.29	84.49	73.02
415:130:360g NPK (100%RDF)	(F ₃)	69.09	61.32	72.49	73.75	83.22	87.19	74.51
520:160:450g NPK (125%RDF)	(F ₄)	77.99	72.19	76.09	79.59	86.29	88.22	80.06
Mean		70.94	62.64	72.15	74.20	80.64	84.12	
		Inorganic sources		Organic sources		Interaction		
SEm±		2.19		2.68		5.36		
CD at 5%		6.25		7.65		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	67.87	56.87	69.10	69.40	71.30	76.10	68.44
310:100:270g NPK (75%RDF)	(F ₂)	68.00	59.37	69.97	73.27	80.80	84.00	72.57
415:130:360g NPK (100%RDF)	(F ₃)	68.60	60.83	72.00	73.27	82.73	86.70	74.02
520:160:450g NPK (125%RDF)	(F ₄)	77.50	71.70	76.60	79.10	85.80	88.57	79.88
Mean		70.49	62.19	71.92	73.76	80.16	83.84	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.55		1.91		3.82		
CD at 5%		4.45		5.45		NS		

Table 4.55: Influence of organic sources and chemical fertilizer on manganese content (mg kg^{-1}) in leaves of malformed panicle

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	69.50	67.20	83.60	83.90	85.80	90.60	80.10
310:100:270g NPK (75%RDF)	(F ₂)	82.20	70.87	83.80	87.60	95.30	98.50	86.38
415:130:360g NPK (100%RDF)	(F ₃)	83.20	72.00	86.50	93.70	93.90	96.20	87.58
520:160:450g NPK (125%RDF)	(F ₄)	86.20	92.00	92.10	93.60	95.30	97.57	92.79
Mean		80.28	75.52	86.50	89.70	92.58	95.72	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.76		0.93		1.86		
CD at 5%		2.17		2.65		5.30		
2013-14								
Without fertilizer (Control)	(F ₁)	70.17	67.87	84.27	84.57	86.47	91.27	80.77
310:100:270g NPK (75%RDF)	(F ₂)	82.87	71.87	84.47	88.27	95.97	99.50	87.16
415:130:360g NPK (100%RDF)	(F ₃)	83.77	72.67	87.17	95.33	94.57	96.87	88.39
520:160:450g NPK (125%RDF)	(F ₄)	86.87	92.67	92.77	94.27	95.97	98.57	93.52
Mean		80.92	76.27	87.17	90.61	93.24	96.55	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.45		0.56		1.11		
CD at 5%		1.29		1.58		3.17		
Pooled data								
Without fertilizer (Control)	(F ₁)	69.83	67.53	83.93	84.23	86.13	90.93	80.43
310:100:270g NPK (75%RDF)	(F ₂)	82.53	71.37	84.13	87.93	95.63	99.00	86.77
415:130:360g NPK (100%RDF)	(F ₃)	83.47	72.33	86.83	94.50	94.23	96.53	87.98
520:160:450g NPK (125%RDF)	(F ₄)	86.53	92.30	92.40	93.90	95.60	98.03	93.13
Mean		80.59	75.88	86.83	90.14	92.90	96.13	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.50		0.62		1.23		
CD at 5%		1.44		1.76		3.52		

4.5 Physico-chemical environment of soil as influence by organic and inorganic sources of nutrients

4.5.1 Soil pH

The hydrogen ion concentrations in post harvest soil samples were estimated in both the years and were presented in table 4.56. The results indicated that the pH value did not alter significantly neither due to application of inorganic fertilizers nor organic source of nutrients during both the years of experimentation.

Table 4.56: Effect of organic and inorganic sources of nutrient on soil pH

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer	(F ₁)	7.4	7.4	7.5	7.5	7.5	7.5	7.5
310:100:270g NPK (75%RDF)	(F ₂)	7.4	7.4	7.5	7.5	7.5	7.6	7.5
415:130:360g NPK (100%RDF)	(F ₃)	7.4	7.4	7.5	7.5	7.6	7.6	7.5
520:160:450g NPK (125%RDF)	(F ₄)	7.6	7.5	7.6	7.6	7.6	7.6	7.6
Mean		7.5	7.4	7.5	7.5	7.5	7.6	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.038		0.046		0.093		
CD at 5%		NS		NS		NS		
2013-14								
Without fertilizer	(F ₁)	7.5	7.4	7.5	7.5	7.5	7.6	7.5
310:100:270g NPK (75%RDF)	(F ₂)	7.5	7.5	7.5	7.5	7.5	7.6	7.5
415:130:360g NPK (100%RDF)	(F ₃)	7.5	7.5	7.5	7.6	7.5	7.6	7.5
520:160:450g NPK (125%RDF)	(F ₄)	7.5	7.5	7.5	7.6	7.6	7.6	7.6
Mean		7.5	7.5	7.5	7.5	7.5	7.6	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.039		0.047		0.094		
CD at 5%		NS		NS		NS		
Pooled data								
Without fertilizer	(F ₁)	7.5	7.4	7.5	7.5	7.5	7.5	7.5
310:100:270g NPK (75%RDF)	(F ₂)	7.5	7.5	7.5	7.5	7.5	7.6	7.5
415:130:360g NPK (100%RDF)	(F ₃)	7.5	7.5	7.5	7.5	7.6	7.6	7.5
520:160:450g NPK (125%RDF)	(F ₄)	7.6	7.5	7.6	7.6	7.6	7.6	7.6
Mean		7.5	7.5	7.5	7.5	7.5	7.6	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.029		0.035		0.070		
CD at 5%		NS		NS		NS		

4.5.2 Electrical conductivity (dSm^{-1})

Data on electrical conductivity of soil samples indicated that an application of organic and inorganic sources of nutrients did not influence the electrical conductivity in post harvest soils (Table 4.57).

Table 4.57: Effect of organic and inorganic sources of nutrient on soil electrical conductivity (dSm^{-1})

Treatments		Electrical conductivity (dS/m)						Mean
		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer	(F ₁)	0.24	0.24	0.26	0.24	0.26	0.27	0.25
310:100:270g NPK (75%RDF)	(F ₂)	0.26	0.26	0.23	0.26	0.26	0.24	0.25
415:130:360g NPK (100%RDF)	(F ₃)	0.27	0.26	0.23	0.23	0.24	0.25	0.24
520:160:450g NPK (125%RDF)	(F ₄)	0.25	0.24	0.26	0.23	0.25	0.24	0.25
Mean		0.25	0.25	0.25	0.24	0.25	0.25	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.006		0.007		0.014		
CD at 5%		NS		NS		NS		
2013-14								
Without fertilizer	(F ₁)	0.23	0.25	0.24	0.26	0.24	0.24	0.24
310:100:270g NPK (75%RDF)	(F ₂)	0.26	0.25	0.25	0.25	0.27	0.24	0.25
415:130:360g NPK (100%RDF)	(F ₃)	0.25	0.26	0.25	0.25	0.25	0.26	0.25
520:160:450g NPK (125%RDF)	(F ₄)	0.24	0.24	0.23	0.24	0.25	0.24	0.24
Mean		0.25	0.25	0.24	0.25	0.25	0.24	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.006		0.007		0.014		
CD at 5%		NS		NS		NS		
Pooled data								
Without fertilizer	(F ₁)	0.24	0.25	0.25	0.25	0.25	0.25	0.25
310:100:270g NPK (75%RDF)	(F ₂)	0.26	0.26	0.24	0.25	0.27	0.24	0.25
415:130:360g NPK (100%RDF)	(F ₃)	0.26	0.26	0.24	0.24	0.24	0.25	0.25
520:160:450g NPK (125%RDF)	(F ₄)	0.25	0.24	0.25	0.24	0.24	0.24	0.24
Mean		0.25	0.25	0.24	0.25	0.25	0.25	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.005		0.006		0.012		
CD at 5%		NS		NS		NS		

4.5.3 Organic carbon (%)

The carbon content in soil was determined after harvest of fruits in each year and data presented in Table 4.58. The increasing trend was observed over the year from its initial value (0.47). Statistical analyses of pooled data reveal that the various fertility levels influenced the organic carbon content significantly. The higher organic carbon content of 0.584% was recorded with the application of 520:160:450g NPK plant⁻¹ (125 % RDF), followed by 415:130:360 g NPK plant⁻¹ i.e. recommended dose of fertilizer. However, the lowest value of 0.515 % organic carbon content recorded under without application of chemical fertilizer which was statistically at par with 310:100:270g NPK plant⁻¹ (75% RDF).

Addition of organic source of nutrients significantly increased the organic carbon content over the years of experimentation. All the sources increased the organic carbon content from the base year and pooled data analyses revealed that the maximum organic carbon content (0.573%) was recorded with O₆ i.e. Vermicompost (25 kg) + Oil cake (2.5 kg) + Azotobacter + VAM + Trichoderma viridi + PSB (100g each) followed by O₅ (Vermicompost (25 kg) + Azotobacter + VAM + Trichoderma viridi + PSB (100g each)). The minimum value of 0.527 % organic carbon content was noted with the application of Azotobacter + VAM + Trichoderma viridi + PSB (100g each) alone. The application of oil cake and vermicompost alone or in combinations showed significant improvement in organic carbon content in post harvest soil of mango orchard.

The interaction of organic and inorganic source of nutrient did not showed significant effect on organic carbon content in soil. However, the organic carbon increased from 0.493 to 0.605 per cent with each and every source of nutrients. The higher value of organic carbon (0.605%) was recorded with the combined application of 520:160:450g NPK (125% RDF) along with Vermicompost (25 kg) + Oil cake (2.5 kg) + Azotobacter + VAM + Trichoderma viridi + PSB (100g each). Moreover, increasing doses of nutrients either form of chemical fertilizer or in form of organic source increased the organic carbon content in the soil of orchard.

Table 4.58: Effect of organic and inorganic sources of nutrient on soil organic carbon content (%)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	0.497	0.490	0.503	0.520	0.530	0.530	0.512
310:100:270g NPK (75%RDF)	(F ₂)	0.523	0.513	0.533	0.533	0.536	0.567	0.534
415:130:360g NPK (100%RDF)	(F ₃)	0.557	0.550	0.567	0.563	0.567	0.573	0.563
520:160:450g NPK (125%RDF)	(F ₄)	0.570	0.537	0.583	0.590	0.593	0.597	0.578
Mean		0.537	0.523	0.547	0.552	0.557	0.567	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.006		0.007		0.014		
CD at 5%		0.016		0.020		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	0.503	0.497	0.510	0.527	0.537	0.540	0.519
310:100:270g NPK (75%RDF)	(F ₂)	0.523	0.523	0.543	0.543	0.546	0.577	0.543
415:130:360g NPK (100%RDF)	(F ₃)	0.557	0.567	0.583	0.580	0.583	0.590	0.577
520:160:450g NPK (125%RDF)	(F ₄)	0.587	0.537	0.583	0.607	0.610	0.613	0.589
Mean		0.543	0.531	0.555	0.564	0.569	0.580	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.006		0.007		0.014		
CD at 5%		0.016		0.021		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	0.500	0.493	0.507	0.523	0.533	0.535	0.515
310:100:270g NPK (75%RDF)	(F ₂)	0.523	0.518	0.538	0.538	0.541	0.572	0.539
415:130:360g NPK (100%RDF)	(F ₃)	0.557	0.558	0.575	0.572	0.575	0.582	0.570
520:160:450g NPK (125%RDF)	(F ₄)	0.578	0.537	0.583	0.598	0.602	0.605	0.584
Mean		0.540	0.527	0.551	0.558	0.563	0.573	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.005		0.006		0.013		
CD at 5%		0.015		0.018		NS		

4.5.4 Bulk density (Mg m^{-3})

Data presented in Table 4.59 revealed that bulk density of soil was from the base year (1.48 Mg m^{-3}) and it has been observed that the minimum soil bulk density 1.362 , 1.337 and 1.350 Mg m^{-3} was recorded during the end of first and second year of experimentation as well as in pooled data, respectively with the higher doses of chemical fertilizer @ $520:160:450\text{g NPK}$ ($125\%\text{RDF}$). Whereas, the 75 and 100 per cent of recommended dose improved the soil bulk density over control but lower dose of fertilizer did not have significant effect on bulk density.

The organic source of nutrients showed significant improvement in soil porosity in terms of bulk density. The minimum bulk density of 1.357 Mg m^{-3} in pooled was recorded when plant nourished with Vermicompost (25 kg) + Oil cake (2.5 kg) + Azotobacter + VAM + Trichoderma viridi + PSB (100g each) followed by Vermicompost (25 kg plant^{-1}) + Azotobacter + VAM + Trichoderma viridi + PSB (100 g plant^{-1} each) and Vermicompost (25 kg plant^{-1}) + Oil cake ($2.5 \text{ kg plant}^{-1}$). However, the maximum bulk density (1.433 Mg m^{-3}) was recorded with Azotobacter + VAM + Trichoderma viridi + PSB (100 g plant^{-1} each).

The interaction between organic sources and chemical fertilizer was found to be non significant in all the crop seasons as well as pooled data whereas, minimum bulk density of 1.315 Mg m^{-3} was noted when plant nourished with fertilizer @ $520:160:450\text{g NPK plant}^{-1}$ (125% of recommended dose of fertilizer) in combination of Vermicompost (25 kg) + Oil cake (2.5 kg) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant^{-1} each).

Table 4.59: Effect of organic and inorganic sources of nutrient on soil bulk density (Mg m^{-3})

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	1.472	1.481	1.460	1.460	1.443	1.437	1.459
310:100:270g NPK (75%RDF)	(F ₂)	1.462	1.472	1.442	1.416	1.410	1.435	1.440
415:130:360g NPK (100%RDF)	(F ₃)	1.457	1.460	1.406	1.377	1.375	1.307	1.397
520:160:450g NPK (125%RDF)	(F ₄)	1.375	1.394	1.372	1.353	1.373	1.306	1.362
Mean		1.442	1.452	1.420	1.402	1.400	1.371	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.014		0.017		0.034		
CD at 5%		0.040		0.049		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	1.472	1.481	1.406	1.377	1.376	1.371	1.414
310:100:270g NPK (75%RDF)	(F ₂)	1.457	1.460	1.442	1.416	1.404	1.340	1.420
415:130:360g NPK (100%RDF)	(F ₃)	1.356	1.372	1.353	1.343	1.334	1.334	1.349
520:160:450g NPK (125%RDF)	(F ₄)	1.344	1.344	1.339	1.338	1.335	1.325	1.337
Mean		1.407	1.414	1.385	1.369	1.362	1.342	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.012		0.015		0.030		
CD at 5%		0.035		0.042		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	1.472	1.481	1.433	1.419	1.410	1.404	1.436
310:100:270g NPK (75%RDF)	(F ₂)	1.460	1.466	1.442	1.416	1.407	1.388	1.430
415:130:360g NPK (100%RDF)	(F ₃)	1.407	1.416	1.380	1.360	1.355	1.321	1.373
520:160:450g NPK (125%RDF)	(F ₄)	1.360	1.369	1.355	1.345	1.354	1.315	1.350
Mean		1.425	1.433	1.403	1.385	1.381	1.357	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.010		0.012		0.025		
CD at 5%		0.029		0.036		NS		

4.5.5 Available nitrogen (kg ha^{-1})

The available nitrogen in soil was determined after harvest of fruits during each year and data presented in Table 4.60. Pooled as well as year wise data indicated that the chemically fertilized plots showed the increasing trend in available nitrogen after each year over their initial values of (230.7 kg ha^{-1}). The higher available nitrogen (246.7 kg ha^{-1}) was recorded with 125 % of RDF ($520:160:450 \text{g NPK plant}^{-1}$) which was statistically at par with recommended dose of fertilizer ($415:130:360 \text{ g NPK plant}^{-1}$) whereas, the lower available nitrogen (234.2 kg ha^{-1}) was noted under control. Further, the each incremental dose of NPK increased the residual nitrogen in soil over control. The overall performance showed that the fertilizers application was able to maintain their original status of soil with respect to availability of nitrogen under high density orchard of mango.

Furthermore, the addition of vermicompost alone or in combination with oil cake or microbes showed its positive response with respect to availability of nitrogen in soil. Each and every dose of vermicompost proved significantly superior over control. The maximum value of available nitrogen in soil ($243.45 \text{ kg ha}^{-1}$) was recorded with Vermicompost (25 kg) + Oil cake (2.5 kg) + Azotobacter + VAM + *Trichoderma viridi* + PSB (100g plant^{-1} each) followed by rest of the organic sources except microbes (Azotobacter + VAM + *Trichoderma viridi* + PSB (100g plant^{-1} each) and Oil cake (2.5 kg) applied alone. The addition of nutrients through organic sources not only helped to maintain the original status of soil but also enhanced the nitrogen content over preceding season.

The interaction effect of organic and inorganic sources of nutrient did not showed any significant effect on available nitrogen in soil. However, higher available nitrogen in post harvest soil ($248.15 \text{ kg ha}^{-1}$) was noted when plant nourished with 125 percent of recommended dose of fertilizer ($520:160:450 \text{g NPK plant}^{-1}$) alongwith Vermicompost (25 kg) + Oil cake (2.5 kg) + Azotobacter + VAM + *Trichoderma viridi* + PSB (100g plant^{-1} each) and lower available nitrogen ($231.47 \text{ kg ha}^{-1}$) was noted under F_1O_2 .

Table 4.60: Effect of organic sources and chemical fertilizer on available nitrogen (kg ha^{-1}) in post harvest soil of orchard

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	231.9	231.8	232.5	236.0	235.9	235.6	233.9
310:100:270g NPK (75%RDF)	(F ₂)	242.2	241.3	242.4	242.8	242.6	242.7	242.4
415:130:360g NPK (100%RDF)	(F ₃)	245.4	244.9	245.9	247.2	246.3	246.5	246.0
520:160:450g NPK (125%RDF)	(F ₄)	247.0	243.2	247.3	244.6	246.7	247.6	246.1
Mean		241.6	240.3	242.1	242.6	242.9	243.1	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.42		0.52		1.03		
CD at 5%		1.20		1.47		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	232.0	231.9	233.0	236.7	236.3	236.4	234.4
310:100:270g NPK (75%RDF)	(F ₂)	242.3	241.8	242.9	242.9	242.7	243.1	242.6
415:130:360g NPK (100%RDF)	(F ₃)	246.5	246.0	247.0	248.0	247.4	247.3	247.0
520:160:450g NPK (125%RDF)	(F ₄)	248.1	244.3	248.4	246.0	248.2	249.0	247.4
Mean		242.2	241.0	242.8	243.4	243.7	244.0	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.34		0.42		0.84		
CD at 5%		0.98		1.20		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	231.9	231.9	232.8	236.4	236.1	236.0	234.2
310:100:270g NPK (75%RDF)	(F ₂)	242.3	241.6	242.7	242.9	242.7	242.9	242.5
415:130:360g NPK (100%RDF)	(F ₃)	245.9	245.4	246.5	247.6	246.9	246.9	246.5
520:160:450g NPK (125%RDF)	(F ₄)	247.6	243.8	247.9	245.3	247.5	248.3	246.7
Mean		241.9	240.7	242.4	243.0	243.3	243.5	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.37		0.45		0.90		
CD at 5%		1.05		1.29		NS		

4.5.6 Available phosphorus (kg ha^{-1})

Data presented in Table 4.61 shows available Phosphorus in post harvest soil. Available P in soil under various fertility levels enhanced from its initial value (12.6 kg ha^{-1}). The maximum available phosphorous in post harvest soil of mango orchard (16.3 kg ha^{-1}) was recorded with higher dose of chemical fertilizer (125% of RDF) and showed superiority over rest of the levels. It was 18.9, 10.1 and 7.23 per cent higher over without fertilizer (F_1) 310:100:270g NPK plant^{-1} (F_2) 415:130:360 g NPK plant^{-1} (F_3), respectively. Whereas, the lowest available phosphorous (13.7 kg ha^{-1}) was noted under F_0 (with fertilizer) which was significantly lower than other level of fertilizer.

As regard to addition of organic sources, response persists up to two years of experiment and showed their superiority in each season. The maximum available phosphorous value of 15.9 kg ha^{-1} was recorded with the application of Vermicompost (25 kg) + Oil cake (2.5 kg) + Azotobacter + VAM + Trichoderma viridi + PSB (100g each), followed by Vermicompost (25 kg) + Azotobacter + VAM + Trichoderma viridi + PSB (each 100g plant^{-1}) and Vermicompost (25 kg) + Oil cake (2.5 kg). The minimum content of phosphorous (14.1 kg ha^{-1}) was recorded with application of microbes alone i.e. Azotobacter + VAM + Trichoderma viridi + PSB (each 100g plant^{-1}) which was at par with microbe, oil cake and vermicompost applied alone.

Interaction of organic and inorganic sources did not found to be significant during crop season. Whereas, the maximum value of 17.1 kg ha^{-1} was noted with the 125 per cent of recommended dose of fertilizer in combination of Vermicompost (25 kg) + Oil cake (2.5 kg) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant^{-1} each) and minimum value of available phosphorous 12.87 kg ha^{-1} was recorded with the application of Oil cake 2.5 kg/plant.

Table 4.61: Effect of organic sources and chemical fertilizer on available phosphorous (kg ha⁻¹) in post harvest soil of orchard

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	12.2	12.8	12.5	13.9	14.3	14.3	13.3
310:100:270g NPK (75%RDF)	(F ₂)	13.9	13.3	14.8	15.0	15.0	15.5	14.6
415:130:360g NPK (100%RDF)	(F ₃)	14.0	13.5	14.9	15.3	15.5	16.5	15.0
520:160:450g NPK (125%RDF)	(F ₄)	15.7	15.2	15.6	16.3	16.6	16.9	16.1
Mean		14.0	13.7	14.4	15.1	15.4	15.8	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.21		0.26		0.52		
CD at 5%		0.61		0.74		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	13.5	13.5	13.6	14.2	14.6	14.6	14.0
310:100:270g NPK (75%RDF)	(F ₂)	14.9	14.0	15.1	15.3	15.4	15.5	15.0
415:130:360g NPK (100%RDF)	(F ₃)	14.7	14.2	15.2	15.7	15.9	16.5	15.4
520:160:450g NPK (125%RDF)	(F ₄)	16.4	15.9	16.7	15.9	16.9	17.2	16.5
Mean		14.9	14.4	15.2	15.3	15.7	16.0	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.20		0.25		0.49		
CD at 5%		0.56		0.71		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	12.9	13.1	13.1	14.0	14.4	14.4	13.7
310:100:270g NPK (75%RDF)	(F ₂)	14.4	13.7	14.9	15.1	15.2	15.5	14.8
415:130:360g NPK (100%RDF)	(F ₃)	14.4	13.9	15.1	15.5	15.7	16.5	15.2
520:160:450g NPK (125%RDF)	(F ₄)	16.0	15.6	16.1	16.1	16.8	17.1	16.3
Mean		14.4	14.1	14.8	15.2	15.5	15.9	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.19		0.24		0.47		
CD at 5%		0.55		0.67		NS		

4.5.7 Available potassium (kg ha^{-1})

The available potassium content in post harvest soils are presented in Table 4.62. Available K in soil under various fertility levels increased over the initial values (340.2 kg ha^{-1}). The maximum available potassium ($350.74 \text{ kg ha}^{-1}$) was recorded with higher dose of chemical fertilizer ($520:160:450 \text{g NPK plant}^{-1}$) which showed superiority over rest of the fertilizer doses. Incremental dose of chemical fertilizer increased the available potassium in the post harvest soil of mango orchard. The minimum available potassium (343.4 kg ha^{-1}) was noted under no fertilizer (F_0) which was significantly lower than other level of fertilizer.

As regards to the addition of organic sources, the maximum available potassium value of (351.4 kg ha^{-1}) was recorded with the application of Vermicompost (25 kg) + Oil cake (2.5 kg) + Azotobacter + VAM + Trichoderma viridi + PSB (100g each) followed by Vermicompost (25 kg) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant^{-1} each) and Vermicompost (25 kg) + Oil cake (2.5 kg) whereas, the minimum value of available potassium (342.2 kg ha^{-1}) was recorded with bio-inoculants. The incorporation of oil cake and vermicompost alone or mixed together also showed significant effect over application of microbes alone.

Interaction of organic and inorganic sources did not show significant effect on available potassium in the crop season as well as in pool data. However, the maximum value of (351.0 kg ha^{-1}) was noted with application of chemical fertilizer @ $520:160:450 \text{g NPK plant}^{-1}$ (125 % RDF) in combination of Vermicompost (25 kg) + Oil cake (2.5 kg) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant^{-1} each) and minimum value of available potassium (338.8 kg ha^{-1}) was recorded with the application of Azotobacter + VAM + Trichoderma viridi + PSB (each 100g plant^{-1}) alone.

Table 4.62: Effect of organic sources and chemical fertilizer on available potassium (kg ha⁻¹) in post harvest soil of orchard

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	338.6	337.3	342.5	341.5	345.8	346.4	342.0
310:100:270g NPK (75%RDF)	(F ₂)	347.5	340.2	345.6	342.8	348.0	348.9	345.5
415:130:360g NPK (100%RDF)	(F ₃)	349.2	341.7	348.9	345.9	350.2	351.9	348.0
520:160:450g NPK (125%RDF)	(F ₄)	349.8	343.6	350.6	347.5	351.4	352.5	349.2
Mean		346.3	340.7	346.9	344.4	348.9	349.9	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.65		0.80		1.60		
CD at 5%		1.86		2.28		NS		
2013-14								
Without fertilizer (Control)	(F ₁)	341.4	340.2	345.1	343.3	348.7	349.6	344.7
310:100:270g NPK (75%RDF)	(F ₂)	350.3	343.1	348.5	345.7	350.9	351.7	348.4
415:130:360g NPK (100%RDF)	(F ₃)	352.1	344.9	351.8	348.7	353.1	354.7	350.9
520:160:450g NPK (125%RDF)	(F ₄)	353.7	346.4	353.5	350.4	354.2	355.4	352.2
Mean		349.4	343.6	349.7	347.0	351.7	352.8	
		Inorganic sources		Organic sources		Interaction		
SEm±		1.05		1.29		2.58		
CD at 5%		3.01		3.68		NS		
Pooled data								
Without fertilizer (Control)	(F ₁)	340.0	338.8	343.8	342.4	347.3	348.0	343.4
310:100:270g NPK (75%RDF)	(F ₂)	348.9	341.7	347.0	344.3	349.5	350.3	346.9
415:130:360g NPK (100%RDF)	(F ₃)	350.6	343.3	350.4	347.3	351.6	353.3	349.4
520:160:450g NPK (125%RDF)	(F ₄)	351.7	345.0	352.0	348.9	352.8	354.0	350.7
Mean		347.8	342.2	348.3	345.7	350.3	351.4	
		Inorganic sources		Organic sources		Interaction		
SEm±		0.82		1.01		2.01		
CD at 5%		2.34		2.87		NS		

4.6 Economics of treatments

Data in relation to net profit obtained under various treatments are presented in Table 4.63. The maximum gross and net monitoring return as well as benefit cost ratio of Rs. 345/- Rs 216/- plant⁻¹ and 2.67 recorded when plant nourished plant fertilized recommended dose of fertilizer (415:130:360 g NPK plant⁻¹) whereas, the lowest gross and net monitoring return and benefit cost ratio of Rs.214/- Rs 105/- plant⁻¹ and 1.97 were noted with unfertilized plant i.e. control.

As regards, to organic sources higher gross return (Rs. 331/- plant⁻¹) with lowest net return of Rs 123/- plant⁻¹ as well as benefit cost ratio of 1.59 was noted with the application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) whereas, higher net monitoring return of Rs. 200/- plant⁻¹ with benefit cost ratio of 3.21 was recorded with application of Vermicompost (25 kg plant⁻¹) alone. The benefit cost ratio was higher with application of Oil cake alone (3.37). Furthermore, application of oilcake, vermicompost and bio-inoculants showed superiority when applied alone in terms of net monitoring return and benefit cost ratio.

Combined application of chemical fertilizer @ 415:130:360 g NPK plant⁻¹ in combination with Vermicompost (25 kg plant⁻¹) registered higher net return of Rs. 267/- with benefit cost ratio of 3.80 whereas, oil cake and bio-inoculants showed superiority when applied in combination with recommended dose of chemical fertilizer. Further, it was also noted that addition different sources of nutrient increase the production cost and reduced net profit as well as the benefit cost ratio.

Table 4.63: Effect of organic sources and chemical fertilizer on gross and net return and benefit cost ratio

	Treatments	Gross return (Rs.plant ⁻¹)			Net return (Rs.plant ⁻¹)			Benefit cost ratio		
		12-13	13-14	Mean	12-13	13-14	Mean	12-13	13-14	Mean
F ₀ O ₁	Without fertilizer+ O C (2.5kg)	179	225	201	122	167	144	3.11	3.91	3.50
F ₀ O ₂	Without fertilizer + Azt + VAM + TV	154	196	174	94	136	114	2.56	3.27	2.90
F ₀ O ₃	Without fertilizer+ VC (25 kg)	197	243	219	122	168	144	2.62	3.24	2.93
F ₀ O ₄	Without fertilizer+ VC (25 kg) + OC(2.5 kg)	194	244	219	62	112	86	1.47	1.84	1.65
F ₀ O ₅	Without fertilizer+ VC (25 kg) + Azt + VAM + TV	201	258	229	66	123	94	1.49	1.91	1.70
F ₀ O ₆	Without fertilizer+ VC (25 kg) + OC(2.5 kg)+ Azt + VAM + TV (100g each)	211	267	238	19	75	46	1.10	1.39	1.24
F ₁ O ₁	75% RDF+ OC(2.5kg)	193	249	220	120	177	148	2.65	3.34	3.03
F ₁ O ₂	75% RDF+ Azt + VAM + TV, (100g each)	173	226	119	98	151	123	2.30	3.00	2.64
F ₁ O ₃	75% RDF+ VC (25 kg)	237	292	264	146	202	174	2.62	3.23	2.92
F ₁ O ₄	75%RDF + VC (25 kg) + OC (2.5 kg)	241	303	272	93	156	124	1.63	2.05	1.84
F ₁ O ₅	75% RDF+ VC (25 kg) + Azt + VAM + TV	263	339	300	113	189	150	1.75	2.26	2.00
F ₁ O ₆	75% RDF+ VC (25 kg) + OC (2.5 kg)+ Azt + VAM + TV	287	366	326	79	158	118	1.38	1.76	1.57
F ₂ O ₁	100% RDF+ OC (2.5kg)	247	299	273	170	221	195	3.18	3.85	3.51
F ₂ O ₂	100% RDF+ Azt + VAM + TV	239	318	277	159	238	197	2.98	3.96	3.45
F ₂ O ₃	100% RDF+ Vermicompost (25 kg)	320	407	362	225	312	267	3.36	4.27	3.80
F ₂ O ₄	100% RDF + VC(25 kg) + OC (2.5 kg)	325	407	366	173	255	213	2.13	2.67	2.39
F ₂ O ₅	100% RDF+ VC (25 kg) + Azt + VAM + TV	332	424	377	177	269	222	2.14	2.73	2.43
F ₂ O ₆	100% RDF+ VC (25 kg) + OC (2.5 kg)+ Azt + VAM + TV	364	464	413	152	252	201	1.77	2.18	1.94
F ₃ O ₁	125% RDF+ OC(2.5kg)	255	317	285	172	234	202	3.08	3.83	3.45
F ₃ O ₂	125% RDF+ Azt + VAM + TV	241	312	275	156	226	190	2.83	3.66	3.23
F ₃ O ₃	125% RDF+ VC (25 kg)	286	342	314	185	242	214	2.85	3.41	3.13
F ₃ O ₄	125%RDF + Vermicompost (25 kg) + Oil cake (2.5 kg)	279	337	308	122	179	150	1.77	2.13	1.95
F ₃ O ₅	125% RDF+ VC (25 kg) + Azt + VAM + TV	286	368	326	126	208	166	1.79	2.30	2.04
F ₃ O ₆	125% RDF+ VC (25 kg) + OC (2.5 kg)+ Azt + VAM + TV	305	391	347	87	173	129	1.40	1.79	1.59

DISCUSSION

DISCUSSION

Present investigation was carried out for studying the “Effect of organic and inorganic source of nutrients on growth, flowering, fruiting, yield and quality of mango (*Mangifera indica* L.) cv. Amrapali under high density planting”. For this a field experiment was conducted at Horticulture Complex, Department of Horticulture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during 2012-13 and 2013-14. Influence of organic and inorganic sources on growth and development, flower and fruiting behavior, physicochemical composition of fruit, morphological parameters of healthy and malformed panicles, nutrient content in leaves of shoot bearing healthy and malformed panicles and its subsequent effect on soil environment. The recorded data in relation to field as well as laboratory are given in results chapter (4). The findings of the present investigations are interpreted and discussed here in the light of available literature and findings.

5.1 Soil characteristics and weather condition

A field experiment was conducted at Horticulture Complex, JNKVV during 2012-13 and 2013-14. The soil of experimental site was clay loam in texture (58.4% clay, 21.5 silt and 20.1% sand) having pH 7.46, electric conductivity (0.25 dSm^{-1}), bulk density (1.48 Mg m^{-3}) available N (230.7 kg ha^{-1}), P (12.6 kg ha^{-1}) and K (340.2 kg ha^{-1}) with low organic carbon (0.47%) which is situated at $22^{\circ}49'$ and $20^{\circ}80'$ North latitude and $78^{\circ}21'$ and $80^{\circ}58'$ East longitude at an altitude of 411.78 meter above the mean sea level. The rainfall pattern, (quantity, intensity and distribution), temperature, light and humidity during the crop growth period are important weather component, influencing the crop growth and its productivity. The ambient average maximum temperature was recorded 31.6 and 30.7°C whereas; minimum was 17.1 and 17.4°C during the growth and development of plants. The annual precipitation was 1353.5, 2542.5 and 225.4 mm with 49, 80 and 17 rainy days during 2012, 2013 and up to 25th meteorological week of 2014 (Table 3.1, 3.2 and Fig.5.1a and b), respectively.

5.2 Canopy development

Various growth parameters pertaining to height, length and spread of crown, shoot length, number of leaves are presented in Table 4.1 to 4.6 and Fig. 5.2. It was inferred that the application of chemical fertilizers significantly increased the crown height (68.8 cm), crown length (193.7 cm), spread in direction of east-west (229.3 cm) and south – north (225.0 cm), shoot length (15.3 cm) and number of leaves (10.5 shoot⁻¹) was recorded under 520:160:450g NPK plant⁻¹. The increase in the area of canopy consisted of height, length and spread might be due to induction of more shoot and their spread with the use of 125% recommended dose of NPK. These results are in accordance with the findings of Pathak and Ram (2005) who observed improvement in vegetative growth parameter in guava with application of fertilizers. Syamlal and Mishra (1989) who reported that higher dose of NPK resulted in more height and length of crown.

On an average increasing crown height (71.3cm), length (192.3 cm), canopy spread in direction of east-west (239.0 cm) and south – north (233.3 cm), shoot length (15.3 cm) and number of leaves (10.5 shoot⁻¹) were recorded when plant were nourished with a combination of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) over inoculation of bio-inoculants alone registered crown height (56.7cm), length (181.8 cm), canopy spread in direction of east-west (191.3 cm), south – north (196.9 cm) and shoot length (12.9 cm) as well as number of leaves (8.5). This might be attributed to the application of bulky organic manure with Azotobacter, VAM and PSB, secrete out Malic, Citric, Fumaric and Shikimic acids that improve the availability of soil nutrients. Moreover, the micro organisms in bio fertilizers maximize the availability of nutrient in soil, improve their uptake and utilization. The increase in plant height, spread, volume, shoot length, could be attributed to the stimulative activity of microflora in the rhizosphere leading to increase nutrient availability lead to vigorous plant growth (Singh et al. 2000 and Aseri et al. 2008). These results are in conformity with the results of Solaiman et al. (2003); Usha et al. (2003) and Mohamed (2005). They pointed out that bio-inoculation treatment improve the

availability of soil nutrient due to release of many harmonic substances which improve the growth and development of plants.

The positive improvement in crown height (75.5 cm), length (201.0 cm), spread in direction of east-west (251.7 cm) and south – north (248.3 cm), shoot length (16.1 cm) and number of leaves (11.7 shoot^{-1}) were with the use of chemical fertilizer 520:160:450g NPK plant^{-1} (125% of RDF) in combination with Vermicompost (25 kg plant^{-1}) + Oil cake (2.5 kg plant^{-1}) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant^{-1} each). The use of bio fertilizers attributed to improve nutrient use efficiency under balance use of organic and inorganic sources of nutrient. The increase in plant height, spread might be due to improvement of physical properties of soil, higher nutrient uptake due to increase in proliferation and activities of microorganisms which manifested in the form of enhanced growth and carbohydrates production as explained by Kumar et al. (2008) and Hassan et al. (2001). Application of vermicompost, Oil cake, alongwith bio inoculants create the favorable environment for the bio agents which might have favored root development and enhance the uptake of available nutrients resulting into faster cell division as well as elongation, consequently increase the plant canopy. These observations are corroborated with the findings of Villasurda (1990); Yadav et al. (2012) and Lal and Dayal (2014).

5.3 Reproductive behavior

The inception of bud and panicle emergence as well as appearance of 50% flowering are presented in Table 4.7 to 4.9 and depicted in Fig.5.3. The emergence of bud and panicles are the reproductive phase of tree. However, baseline was fixed on the basis of nutrient applied during 2012 and 2013. Results indicate that application of nutrient either through organic sources or chemical fertilizers, delayed initiation of bud and emergence of panicles. Moreover, period of initiation increased as increasing the level of chemical fertilizer. The 125% NPK (520:160:450g NPK plant^{-1}) delayed the bud emergence panicle initiation, as well as 50% flowering and takes 97.5, 113.2 and 131.3 days, respectively. Whereas, recommended dose of chemical fertilizer was taken (87.3, 102.8 and 120.8 days) for bud emergence, panicle initiation, as well as 50% flowering, respectively. Thus it could be concluded

that increase in level of chemical fertilizer over recommended dose delayed the reproductive phase i.e. bud formation and initiation as well as emergence of panicle. Since nitrogen nutrition is directly related with plant growth thus increase in dose might have improved the plant growth especially number of leaf and leaf size. The higher dose of nitrogen promotes vegetative growth at the cost of onset of reproductive stage. These results are in accordance with the result of Verma and Chouhan (2013).

The maximum number of days was taken by plant to bud emergence (87.6 days), panicle emergence (102.9 days) and attained 50% flowering (127.2 days) were recorded with the application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each). Delayed in bud and panicle emergence might be due to proper availability of nutrient for longer period increases the photosynthetic activities resulting in higher accumulation of carbohydrates. Relatively higher amount of carbohydrates could have promoted the growth rate. The above results are in conformity with the findings of Sarkar and Rahim (2012).

The significant change was recorded in days taken to bud emergence (101.3 days), panicle emergence (116.7days) and 50% flowering (135.7 days) with the combined application of 125% recommended dose of fertilizer Vermicompost @ 25 kg plant⁻¹ + Oil cake 2.5 kg plant⁻¹ + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each). The higher rate of nutrient through organic and inorganic sources increases the availability of nitrogen might promote vegetative growth at the cost of onset of reproductive stage. The result was in accordance with the result of Verma and Chouhan (2013).

5.4 Reproductive attributes

As regards, the panicle length, number of paniclets, fresh and dry matter accumulation as well as the number and percentage of healthy panicle were observed and presented in Table 4.10 to 4.17 and depicted in Fig. 5.3 and 5.4 which effect significantly with the application of nutrients either in the form of chemical fertilizers or in the form of organic sources. The application of chemical fertilizers

produced maximum panicle length (37.2 cm) with 125% recommended dose of chemical fertilizer and number of paniclets (37), number of healthy panicles (17.3 m²) and percentage (90.58), fresh weight of healthy (48.5 g) and dry weight of healthy (30.8 g) with the application of recommended dose of fertilizer (415:130:360g NPK plant⁻¹). The increase in these parameters probably because of the certain role of N and K in various metabolic processes which improved fruit bud differentiation, flowering intensity, higher ratio of hermaphrodite flower, fruit set and productivity, which in turn improve the yield. The results obtained in the present study are in accordance with the findings of Kashyap et al (2012) who reported the highest flowering intensity, higher ratio of perfect to male flower and yield with the combined application of nitrogen and potassium in pomegranate.

As regards, to the application of organic sources the maximum panicle length (35.7cm), number of paniclets (35), number of healthy panicles and percentage (15.9 m⁻² and 87.85 %), fresh weight (48.4 g) and dry weight of healthy (29.4 g) were recorded with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each). Similarly, due to rational partitioning of dry matter to economic sink, the yield attributes were improved. The above results are in conformity with the findings of Dalal et al. 2004 and Hebbara et al. (2006) in sapota.

The interaction of chemical fertilizer and organic sources registered the maximum panicle length (39.7cm) with 520:160:450g NPK plant⁻¹ (125% of RDF) and number of paniclets (40), number of healthy panicles and percentage (20.4 m² and 94.44%), fresh weight (55.0 g) and dry weight of healthy (33.5g) with 415:130:360 g NPK plant⁻¹ (RDF) in combination with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each). This might be attributed to improved nutrient use efficiency with the balanced use of organic and inorganic source of nutrients. Application of vermicompost with NPK fertilizer improved the soil texture and porosity due to bulkiness in nature, which may helped the plant root development and enhance the uptake of available nutrients resulting into faster cell division and cell elongation; consequently increase the panicle length number of paniclets fresh and dry weight of healthy panicle. Yadav et

al (2011) observed that the treatment containing the biofertilizers showed better results other than non- biofertilizers treatments. The Azotobacter in fixation of atmospheric nitrogen and PSB involve in solubilisation of phosphate in soil are responsible to compensate the half dose of NPK and maintain the soil environment which ultimately reflect on the flowering of tree. The positive response of Azotobacter and PSB were also reported in mango by Kulkarni and Hamilton (1994).

5.5 Yield attributes

Yield of the crop is an ultimate object of the grower to get maximum return per unit area and per unit time. The fruit yield of the crop significantly increased with the application of fertilizers (Table 4.20 to 4.24 and Fig.5.5). The application of chemical fertilizer 415:130:360 NPK plant⁻¹ (RDF) maximized the number of fruit set (21.8), fruit retention (15.6%), total number of fruit harvested (70 plant⁻¹) and yield (12.53 kg plant⁻¹) as well as minimum fruit drop (84.5%) and registered 61.26 % higher yield over control when pooled over the years (7.77 kg and 51 fruit plant⁻¹). The application of 125 % recommended dose of fertilizer (520:160:450g NPK plant⁻¹) produced 11.24 kg and number of 65 fruit plant⁻¹ over control. The above mentioned response of the crop to applied NPK is quite obvious due to induction of flower, fruit setting and fruit retention fruits size and weight are the major component of mango production. These parameters are highly affected due to nutrient management. The increase in yield was mainly attributed to relative increase in the availability of nutrients and better solute uptake by the plant. These findings are in accordance with the results of Korwar et al. (2006) and Pathak et al. (2005) in aonla. The higher fruit set and lower fruit drop incidence under nutrient application might be attributed to adequate nutrition under these treatments, which resulted into favourable metabolic process, availability of photosynthates to fruit development and adequate hormonal balance to augment fruit setting. The results are in agreement with those reported by Lal et al. (2003) and Birbal et al. (2013) in ber. The increase in both number and weight might be attributed to fact that there was increasing level of nutrients in assimilating area of crop due to which the rate of dry matter production was enhanced. Similarly, due to rational partitioning of dry matter to economic sink, the yield attributes were

improved. The above results are in conformity with the findings of Dalal et al. (2004) and Lal and dayal (2014).

Among the fertilizer treatment the combination of manures and biofertilizers exhibited profound effect on fruit set, fruit retention, fruit drop, number of fruit per plant and fruit weight. Result indicated that the efficiency of organic manures was more when supplemented with bio-inoculants. The organic sources of nutrients maximized the number of fruit at pea stage (21.8), fruit retention (15.0 %), total number of fruit harvested (68 plant^{-1}) and yield ($12.03 \text{ kg plant}^{-1}$) as well as minimum fruit drop (85.0%) was recorded with the application of Vermicompost (25 kg plant^{-1}) + Oil cake ($2.5 \text{ kg plant}^{-1}$) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant^{-1} each). Enriched treatments are able to produce more fruit set, retention of fruit at maturity, bearing of fruit per plant as well as yield. The higher yield achieve due to more fruit set in panicle and reducing the fruit drop with the use of O6. The increase in the yield attributes and yield attributes and yield of mango with the use of in enrich organic manures in the form of vermicompost and oil cake was due to optimum supply of plant nutrient and growth hormone at desired amount during entire period of growth, ultimately resulted in accumulation of more photosynthats in panicle and fruit resulted into more induction and retention in panicle with biomass. These results are in corroborate with the finding of Yadav et al. (2011) and Verma (2010)

The integration of inorganic and organic sources of nutrient maximized the number of fruit at pea stage (24.9), fruit retention (17.8 %), total number of fruit harvested (76 plant^{-1}) and yield ($15.00 \text{ kg plant}^{-1}$) as well as minimum fruit drop (82.2 %) was recorded with the application of 415:130:360 g NPK plant^{-1} (recommended dose of fertilizer) in combination with Vermicompost (25 kg plant^{-1}) + Oil cake ($2.5 \text{ kg plant}^{-1}$) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant^{-1} each). The supply of nutrients during entire period of fruit growth, ultimately resulting in accumulation of more photosynthates leading fruit weight and yield of fruits. The increase in both number and weight might be attributed to the fact that there was increasing levels of nutrients in assimilating area of crop due to which the rate of dry matter production was enhanced. The above results are in conformity with the findings of Dalal et al. (2004) and Lal and Dayal (2014).

5.6 Physical composition of fruit

The superior physical fruit quality with respect to fruit weight (173 g), length (93.9 cm), width (71.1cm), pulp (61.09 %), pulp: peel ratio (3.20), pulp: stone ratio (3.16) as well as minimum peel (19.66%) and peel: stone ratio (1.01) were observed under 125% of RDF (520:160:450g NPK plant⁻¹). The increase in quality of fruit is associated with dry matter content due to the fact that better nutrient availability and enhancing the uptake of solvent from rhizosphere resulting accumulation of more photosynthates and their translocation as well as synthesis of different growth regulator. The above findings in accordance with Gawande et al. (1998) and Patel et al. (2010).

The maximum fruit weight (170 g), length (87.9 cm), width (69.2 cm), pulp (62.48%), pulp: peel ratio (3.34) and pulp: stone ratio (3.40) and minimum peel (19.08%) was recorded with an application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB @100g plant⁻¹ each (Table 4.25 to 4.33 and Fig.5.6). The increase in fruit weight and pulp weight might be on account of incorporation of vermicompost, oilcake, and biofertilizers. Organic manures and biofertilizers have direct relation in N fixation, solubilizing phosphorus, production of phytohormone which increased the uptake of nutrients. These observations are in agreement with the Madhavi et al. (2008) in mango and Patel et al. (2010) in sapota. Yadav et el.(2011) reported that the quality improvement of fruits might be due to proper supply of nutrients and induction of growth hormones which stimulated cell division, cell elongation increase in number and weight of fruits, better root development and better translocation of water uptake and deposition of nutrients. This might be attributed due to improvement in fertilizer use efficiency while applied alongwith the organic Ranjan and Ghosh (2006).

Application of chemical fertilizers alongwith organic as a source of nutrients bring out the significant changes in physical composition of fruit .The maximum fruit weight (177.5 g), length (96.7 cm) and width (76.8 cm) was recorded with the application of 125% recommended dose of chemical fertilizer alongwith Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM +

Trichoderma viridi + PSB (100g plant⁻¹ of each inoculants). The fruit weight and size are highly correlated with dry matter content and balanced level of hormones. Superior physical fruit quality may be due to the fact that, goat manure combined with fertilizers enhances the nutrient availability by enhancing the capability of plants to better solute uptake from rhizosphere; also these are known for accumulation of dry matter and their translocation as well as favour synthesis of different growth regulators. The findings are in accordance with Gawande et al. (1998) and Patel and Naik (2010) in sapota.

5.7 Chemical composition of fruit

The fruit quality in terms of TSS (22.42 °B), total sugar (18.41%), non-reducing sugar (13.72%), reducing sugar (4.69%), ascorbic acid (56.84mg 100g pulp⁻¹), phenol (42.53mg litter⁻¹) TSS: Acid ratio (63.51) was maximum with an application of recommended dose of chemical fertilizer whereas, minimum was under unfertilized plant (Table 4.34 to 4.41 and Fig. 5.7). Improvement in the quality of fruit might be due to proper absorption and desired quantity of nutrients made available to plant with the use of chemical fertilizers. These results are in accordance with the findings of Robertse and Stassen (2004).

The fruit quality improved with an addition of organic sources of nutrients and maximum TSS (21.80 °B), total sugar (17.75%), non-reducing sugar (13.06%), reducing sugar (4.69%) and ascorbic acid (57.46 mg 100g pulp⁻¹) and (63.41) was recorded with an application of Vermicompost 25 kg plant⁻¹ + Oil cake 2.5 kg plant⁻¹ + Azotobacter + VAM + *Trichoderma* + PSB (100g each plant⁻¹) and minimum acidity 0.343 with maximum TSS acid ratio (63.41) with vermicompost + @25kg plant⁻¹ + bioinoculant. Inoculation of Azotobacter, PSB and VAM along with organics might have performed regulatory role on absorption of nutrients and translocation of metabolites especially carbohydrates which positively increase the quality of fruits. Results are in accordance with the findings of Ram et al. (2007), Madhavi et al. (2008) and Baviskar et al. (2011) Patel and Naik. (2010) they reported that carbohydrates reserve in roots and stem hydrolyzed into sugar during ripening which improve the fruit quality.

The combined use of chemical fertilizers and organic source resulted significant changes in chemical composition of fruits. The higher TSS (22.60⁰B), total sugar (18.87%), non-reducing sugar (13.94%), reducing sugar (4.94%), ascorbic acid (60.08mg 100g pulp⁻¹) and TSS: Acid ratio (66.86) was recorded with recommended dose of chemical fertilizer and Vermicompost @ 25 kg plant⁻¹ + Oil cake @ 2.5 kg plant⁻¹ + Azotobacter + VAM + Trichoderma + PSB (100g plant⁻¹ each). It might be due to balance fertilization stimulated cell division. Cell elongation which increases the size and weight of fruit, better root development promotes the nutrients absorption translocation of food and water as well as deposition of photosynthets. This was in accordance with the results of Yadav et al (2012). Nitrogen stimulates the functioning of enzymes in the physiological processes, which have improved the total soluble solids content of the fruits. The highest total sugar was attributed the involvement of nitrogen in various energy sources like amino acids and amino sugars. Similar findings are in the line with the Dutta et al. (2010) and Sharma et al. (2013). Kumar et al. (2008) reported that increased total sugar in apple fruit due to accumulation of more photosynthets might be ascribed to uptake of more nitrogen and potassium in plant system.

5.8 Severity, intensity and dry matter accumulation

In general, the higher fresh and dry weight was observed with malformed panicle than the healthy once under application of nutrients either through chemical fertilizer or organic sources (Table 4.17 to 4.19 and Fig.5.4). The fresh weight of malformed panicles (102.1 g) and dry weight of malformed panicles (41.5 g) were observed with 125% of RDF (520:160:450g NPK plant⁻¹) while it was lower with under unfertilized plant i.e. 85.2 and 36.3 g, respectively. Whereas, recommended dose of chemical fertilizer minimized the intensity (1.8 m²) and severity (9.42 %) of malformed panicles and maximum intensity (4.0 m²) and severity (25.97 %) of malformed panicles was noted under unfertilized plant. The nutrient deficiency may act as predisposing factor for malformation incidence. The increases in fresh and dry weight in malformed panicle might be due to fact that the more accumulated rather than its utilization. Shawky et al. (1978) reported that delayed in flower bud opening and reduce the incidence of flower malformation.

The higher fresh weight of malformed panicles (104.7 g) and dry weight of malformed panicles (41.0 g) with minimum intensity (2.2 m^2) and severity (12.15%) was recorded with Vermicompost (25 kg plant^{-1}) + Oil cake ($2.5 \text{ kg plant}^{-1}$) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant^{-1} each) however, minimum fresh (82.2 g) and dry weight (36.8 g) with maximum intensity (3.6 m^2) and severity (23.53 %) was observed with application of bio-inoculants alone. More nitrogen level in malformed panicle determines that might be more accumulation of nitrogen instead of utilization. This abnormality in nitrogen metabolism might be one cause of malformation of inflorescence.

The interaction of chemical fertilizer and organic sources registered the minimum intensity (1.2 m^2) and severity (5.56%) of malformed panicles with recommended dose of chemical fertilizer whereas, maximum fresh weight (115.2 g) and dry weight malformed panicles (43.9 g) was recorded with application of $520:160:450\text{g NPK plant}^{-1}$ (125% RDF) when applied in combination with Vermicompost (25 kg plant^{-1}) + Oil cake ($2.5 \text{ kg plant}^{-1}$) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant^{-1} each) whereas maximum intensity (5.2 m^2) and severity (34.4%) with minimum fresh weight (76.5 g) and dry weight (34.9 g) of malformed panicles was noted with no fertilizer with bio-inoculants alone. Nafees et al. (2007) reported that the early emerged shoots have less intensity of malformation of inflorescence as compared to late. The minimum incidence might be due to fact the higher nutrient level combination promote the vegetative growth.

5.8 Macro and micro nutrient content in leaves

The incremental dose of nutrient either in the form of chemical fertilizer or in organic sources increased the macro and micro nutrient content in leaves. In general, higher concentration of P and K in the leaves of shoots bearing healthy panicle than malformed. The reverse trend in case of N, Cu, Zn, Fe, and Mn was observed (Table 4.42 to 4.55 and Fig.5.9 and 5.10). Higher content of nitrogen (2.33 and 2.58%), phosphorus (0.35 and 0.32 %), potassium (58.39 and 71.46 mg kg^{-1}), copper (8.77 and 9.75 mg kg^{-1}), zinc (25.85 and 27.15 mg kg^{-1}), iron (181.43 and $196.55 \text{ mg kg}^{-1}$) and manganese (79.88 and 93.13 mg kg^{-1}) were recorded in the leaves of shoot bearing healthy and malformed panicles, respectively, under the application of 125%

of RDF (520:160:450g NPK plant⁻¹) over the leaves of unfertilized plant. Higher content of these nutrients might be due to fact that an application of NPK with increasing dose increases the dry matter accumulation and nutrient concentration. The increase in uptake of these nutrients might be related to the development of root and plant canopy which accelerate the absorption of nutrients. These results are in close conformity with the findings of Singh et al. (2012).

Organic sources also brought significant change in the nutrient content of leaves of shoot bearing healthy and malformed panicle. Maximum content of nitrogen (2.52 and 2.73%), phosphorus (0.36 and 0.33 %), potassium (61.31 and 75.89 mg kg⁻¹), copper (9.25 and 10.29 mg kg⁻¹), zinc (26.84 and 29.40 mg kg⁻¹), iron (192.59 and 207.87 mg kg⁻¹) and manganese (83.084 and 96.13 mg kg⁻¹) were recorded when plant nourished with Vermicompost @ 25 kg plant⁻¹ + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (each of 100g plant⁻¹). The higher concentration of macro and micro nutrient in leaves might be due to fact that, steady available of nutrients in vermicompost have resulted in increase uptake of nutrients by plants. Rajkhowa et al. (2000) and Chaudhary et al. (2003) observed an increase of N, P and K content with the application of vermicompost and farm yard manures. Hangarge et al. (2002) reported higher N, P and K content with the application of vermin-compost and cow dung slurry. It was interesting of note that, when P was applied with phosphorous solubilizing bacteria increase, the uptake of phosphorus and Mg both. This is possibly due to the improvement in soil conditions as well as mineralization of salts, making them readily available to the plant system. Singh et al. (2012).

Application of organic sources in combination with chemical fertilizer changed the nutrient content in the leaves. The potassium (62.90 and 77.82 mg kg⁻¹), zinc (27.33 and 30.03 mg kg⁻¹), iron (196.93 and 213.10 mg kg⁻¹) and manganese (88.57 and 98.03 mg kg⁻¹) increased with increase dose of NPK upto 125 % recommended dose of chemical fertilizers along with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) in leaves of shoot bearing healthy and malformed panicle, respectively. Content of higher N may be attributed to an improvement in soil aeration, retention of soil

moisture in root zone, promote microbial nitrogen fixation due to conjoint application,. The addition of vermicompost and VAM improved physical condition of soil, retention moisture, root development through mycelial network of arbuscular mycorrhizal fungi, thus increased the water absorption and nutrients which increased the nutrient contents of leaf (Morselli et al., 2004; Gupta et al.2005). Phosphorus is applied to the soil chemically in organic form and get fix and made it unavailable to the plant. However, it released slowly due to presence of phosphorus solubilizing micro-organisms (Sundara et al.2002). On the other hand Azotobacter inoculation secretes plant harmones in the rhizosphere, which maintains the status of soil pH and make easy to take up by plant. The steady availability of nutrients in vermicompost, resulted in increased the uptake of nutrients by plants (Rajkhowa et al.2000). The increase in micro nutrient concentration in leaf might be increased in availability of nutrients in root zone due to addition of vermicompost and biofertilizers alongwith inorganic fertilizer (Prakash et al.2002; Sen 2003).VAM fungi increases root colonization, which in turn increased the surface area for absorption. In other studies, it is inferred that in the soil solution (like Zn and Cu) and the application of VAM fungi converted complex and insoluble form of nutrients to soluble form and make them easy to take up by plant (Balakrishnan et al., 2001). Vasanthi and Kumarswamy (1999) reported significantly higher content of Fe and Cu due to application of vermicompost.

Thus it could be concluded that the combined effect of conjoining organic and inorganic nutrient source on improving the leaf nutrient content.

5.9 Soil pH and electric conductivity

Combined applications of chemical fertilizers and organic manures did not found to change pH and EC of soils significantly (Table 4.56 and 4.57). However, values of pH and EC were lower under interpretation of chemical and organic manures which may partially be attributed to the production of organic acids during decomposition of organic manures. The results are in accordance with the findings of Srikanth et al. (2000).

5.10 Organic carbon

The data in relation to organic carbon content in post harvest soils has been presented in Table 4.58 and depicted in Fig.5.8. Results revealed that chemical fertilizers as well as vermicompost significantly changed the content of organic carbon in soils recorded after harvest of fruits. The soil organic carbon increases from 0.512 to 0.519 % with the increasing level of NPK over 520:160:450g NPK plant⁻¹ recorded after two crop seasons. The increasing soil organic carbon with the fertilizer application is possibly due to the proliferation and elongation of cell as well as accumulation of photosynthates in the root which ultimately increased the total root biomass. These results are in close agreement with those of Singh *et al.* (1998) and Kusro *et al.* (2014). The increase in organic carbon content due to use of fertilizers can be attributed to higher contribution of biomass to the soil in the form of litter and residues. However, the difference in the organic carbon content due to application of fertilizers might be result of differential rate of oxidation of organic matter by microbes (Trehan, 1997). Organic carbon plays an important role in maintaining soil health and shows use of fertilizers has contributed in improving the soil health.

The application of Vermicompost (25 kg plant⁻¹) with Oil cake (2.5 kg plant⁻¹) and inoculation Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) proved superior over rest of the treatments. The enrichment in organic carbon with vermicompost might be due to the fact that further decomposition of vermicompost, add more organic carbon to the soil. The results are in agreement with Sharma *et al.* (2013) who observed that when cent per cent nitrogen was applied in the form of FYM augmented with Azotobacter markedly improve the organic carbon content in soil. The increased organic carbon was due to enhanced root growth, accumulation of organic residues and direct incorporation of organic matter in soil Singh *et al.* (2012) observed an increased organic carbon in basin with application of FYM, oil cake and cow pit. The buildup of organic carbon build up over the year is a function of microbial activity and organic matter decomposition. In a study silty loam soil, Albinach *et al* (2001) found significant increase in soil organic matter after four years of organic amendment. The results are in close conformity with the findings of Adak *et al.* (2014).

5.11 Bulk density

For studying the effect of chemical fertilizer and organic sources of nutrient on soil physical condition, soil bulk density was determined after each crop season. Results revealed that (Table 4.59 and Fig.5.8) the increasing level of chemical fertilizer decreases the bulk density from 1.459 to 1.337 and recorded with 125% recommended dose of fertilizer over unfertilized basin of plant. The increase in soil organic carbon increases the soil aggregation and porosity of soil consequently decreases the bulk density. The improvement in soil porosity may also be due to enhancement in organic carbon content of soil and production of some adhesive agents like polysaccharides due to the action of microbes under originally abounded environment contributed to the better aggregation, which increase the porosity of the soil (Burns and Davies 1986).

The increasing level of nutrient by using combination of organic sources, showed improvement in soil porosity in terms of bulk density, over bio inoculants alone. Data pertaining of leaves presented in preceding chapter, clearly revealed that addition of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) significantly produced higher leaf biomass (Table 4.59) which had direct effect on organic carbon content (Table 4.60). This increase in organic carbon content increases the soil aggregation and porosity of soil consequently decreases the soil bulk density. The improvement in soil porosity may also be due to enhancement in organic carbon content of soil and production of sum adhesive agents like polysaccharides due to the action of microbes under organically amended environment contributed to the better aggregation. Thus, increased the porosity of the soil (Burns and Davies 1986). The findings are also in confirmation with the result of Mishra et al. (2011), Singh et al. (2012) and Srikanth et al. (2000). They reported that the use of organics, either in the form of FYM or vermicompost make the soil porous and reduce the soil bulk density.

5.12 Available Nitrogen, Phosphorous and Potassium

The content of nitrogen, phosphorus and potassium in post harvest soils were determined after each crop season during both the years. The result of study (Table

4.60 to 4.62 and Fig. 5.8) showed that the increasing recommended dose of fertilizer significantly increases the residual nitrogen (5.34%), phosphorous (18.97%) and potassium (18.97%) in soil when tree was fertilized with 520:160:450g NPK plant⁻¹) and found significantly superior over preceding level of fertility except potassium which was at par with the recommended dose of fertilizer. The available nutrient status in post harvest soil increased successively with increasing level of chemical fertilizers. The results are in close conformity with the findings of Dutta et al. (2010) and Prasad et al (2010) who reported that the application of different nutrients through chemical fertilizer, manures and biofertilizers significantly increased the soil nitrogen, phosphorous and potassium contents.

The addition of organic sources showed its positive response with respect to nitrogen, phosphorous and potassium availability in soil recorded after harvest of crop in each season. The incremental level of nutrient through different sources of organic nutrient proved significantly superior over bio inoculants alone. Moreover, the addition of Vermicompost @ 25 kg plant⁻¹ + Oil cake @ 2.5 kg plant⁻¹ inoculated with Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) recorded 243.1, 244.0 and 243.5kg N, 15.8, 16.0 and 15.9 kg P and 349.9, 352.8 and 351.4 kg K ha⁻¹ in post harvest soil of consecutive two cropping seasons as well as pooled data, respectively and found significantly superior over O₂. The contribution of vermicompost along with nitrogen, phosphate and potash in post harvest soil might be due to higher content of ammonium and phosphates levels in vermicompost stabilized the level of nutrient in soil found that the presence of organic matter synchronized the nutrient released and plant uptake as it slowdown in nutrient leaching. The findings are also in confirmation with the Korwar et al. (2006), Mishra et al. (2011) and Singh et al. (2012)

The available nitrogen status in post harvest soil increased successively with increasing level of nitrogen, it was due to the integration of organic and inorganic sources of nutrients, because of the vermicompost favored mineralization process of organic sources The presence of organics promote the microbial activities which could have stimulated the nitrification process. A build up of nitrogen and organic carbon in soil with different sources and levels amended with bio-fertilizer has also been reported by Mishra et al. (2011). The increase in available phosphorous with vermicompost was due to release of more phosphorous from organic compounds,

increase in microbial population as well as decomposition product of humic substance (Sharma et al. 2013). The increased availability of potassium was due to the production of organic acid from organic complex. Application of organic manures significantly reduces the fixation of added as well as native phosphorous and made it available to fruits plant. These results are in agreement with the results of Patidar and Mali (2004).

5.13 Economics of treatments

Net profit obtained under various treatments are presented in Table 4.63 and reveal that net return as well as benefit cost ratio influenced markedly due to different sources of nutrients. The higher net return and benefit cost ratio of Rs 196 plant⁻¹ and 2.52 were recorded with recommended dose of fertilizer (415:130:360 g NPK plant⁻¹). The increasing dose of fertilizer increased the yield attributes resulted higher yield and gross return plant⁻¹. The increase in yield gave higher net profit and per rupee investment in terms of benefit cost ratio.

As regards, to the organic sources higher net return of Rs. 182 plant⁻¹ with cost benefit ratio of 3.50 was recorded under application of Oil cake @ 2.5 kg plant⁻¹ whereas, the lowest net return of Rs 110 plant⁻¹ with benefit cost ratio of 1.53 was noted with the application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each). Intregation of various components of organic sources add the cost of input which increase the total cost of production hence, reduce the net profit as well as the benefit cost ratio.

The combined application of 415:130:360g NPK plant⁻¹ (RDF) with oil cake (2.5 kg plant⁻¹) registered higher net return of Rs. 226 with benefit cost ratio of 3.90 whereas, oil cake, bio-inoculants and vermicompost showed superiority when applied in combination with chemical fertilizer either applied recommended dose or 125% of RDF. Further, it was noted that addition different sources of nutrient increase the production cost and reduced net profit as well as the benefit cost ratio. This was due to higher yield and yield attributes in these treatments. The similar findings were also reported by Shukla et al. (2009) and Dwivedi (2013).

**SUMMARY, CONCLUSIONS AND
SUGGESTIONS FOR FUTURE WORKS**

SUMMARY, CONCLUSION AND SUGGESTIONS FOR FUTURE WORK

6.1 Summary

Mango (*Mangifera indica* L.) has been cultivated for more than 5000 years ago and has a wide genetic diversity. It occupies a prominent place amongst the fruits grown in India and acknowledged as “King of Fruits”. At present, mango covers 2.50 million hectares of area with a total production of 18.0 million tonnes, which works out to a low average productivity of 7.2 metric tonnes per hectare. Moreover, factors like soil type, moisture regime in the root zone, climatic condition, plant age etc. are the factors which affect the absorption and assimilation of minerals. Any deviation from optimum i.e. insufficient or excess amounts of any nutrient in the soil, resulted in deficiency or toxicity of the element in the plant which ultimately causes physiological maladies. These nutritional imbalances causes’ disturbances in normal histological, physiological and biochemical activities which affect almost all parts of the plant, affecting yield, quality and post harvest storage life of horticultural crops. However, the integrated plant nutrient supply through the use of organic and inorganic fertilizers is the best means to provide nutrients to the plants in balanced and effective manner.

It has been realized that optimum yields from efficient use of nutrients under high density planting, high yielding varieties and better management of the orchards may result in higher mango productivity which can be considered to a revolution in mango production by avoiding the risk of soil and water pollution. Keeping the above points in view, the present study entitled “Effect of organic and inorganic source of nutrients on growth, flowering, fruiting, yield and quality of mango (*Mangifera indica* L.) cv. Amrapali under high density planting” has been carried out with the following objectives;

1. To assess the impact of different sources of nutrient on yield and quality of mango cv. Amrapali
2. To study the combined effect of vermicompost and fertilizer on flowering, fruiting and quality of mango

3. To determine the effect of organic and inorganic sources of nutrient on physico - chemical properties of soil and
4. To account out economics for nutrient management of mango cv. Amrapali under HDP.

A field experiment was conducted at Horticulture Complex, JNKVV, Jabalpur during 2012-13 and 2013-14. The soil of experimental site was clay loam in texture (58.4% clay, 21.5 silt and 20.1% sand) having pH 7.46, electric conductivity (0.25 dSm^{-2}), bulk density (1.48 Mg m^{-3}) available N (230.7 kg ha^{-1}), P (12.6 kg ha^{-1}) and K (340.2 kg ha^{-1}) with low organic carbon (0.47%). The experiment consisted of four levels of chemical fertilizers (F_1 : Without fertilizer, F_2 : 310: 100: 270 NPK g plant⁻¹ (75% of RDF), F_3 : 415: 130: 360 NPK g plant⁻¹ (100% of RDF) and F_4 : 520: 160: 450 NPK g plant⁻¹ (125% of RDF) and six organic sources (O_1 : Oil cake 2.5 kg plant⁻¹, O_2 : Azotobacter+ VAM + Trichoderma viridi + PSB (100g plant⁻¹ each), O_3 : Vermicompost (25 kg plant⁻¹), O_4 : Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹), O_5 : Vermicompost (25 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each), O_6 : Vermicompost (25 kg plant⁻¹) + Oil cake (2.5kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each). The various observations recorded from seventy two plants, which were selected randomly and tagged in each replication. The observation on growth, morphological characters, yield and its attribute characters, physicochemical composition of fruits, intensity and severity of malformation, mineral composition of healthy and malformed panicles as well as soil environment were determined and statistically analyzed.

- The canopy of plant characterized as crown height, length, spread in north-south and east- west direction, shoot length and number of leaves per shoots. The maximum height (68.8 cm), length (193.7 cm), crown width east -west (229.3 cm) and south north (225.0 cm) in directions, shoot length (14.6cm), number of leaves (10.7) were recorded with the application of 125%RDF i.e. 520:160:450g NPK plant⁻¹. Whereas, minimum crown height (60.6 cm), length (178.6 cm), crown width in east-west (196.9 cm) and south-north (202.3 cm) directions, shoot length (13.2cm), number of leaves (8.1) were recorded under control.

- The application of different organic source influenced the canopy. The significantly higher crown height (71.3 cm), crown length (192.3 cm), crown width in east-west (239.0 cm) and south-north (233.3 cm) directions, shoot length (15.3 cm), number of leaves (10.5) were recorded with the application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) whereas, minimum crown height (56.7 cm), length (181.8 cm), crown width in east-west (191.3 cm) and south-north (196.9 cm) directions, shoot length (12.9 cm) number of leaves (8.5) were noted under bio inoculants alone (O₂).
- As regards to the interaction of sources of nutrients combined application of 125% recommended of fertilizer and a set of organic source (F₄O₆) registered maximum value of crown height (75.5 cm), length (201.0 cm), width in east-west (251.7 cm) and south-north (248.3 cm) directions, shoot length (16.1 cm), number of leaves (11.7). Whereas, the minimum crown height (50 cm), length (174.5 cm), crown width in east-west (171.7 cm) and south-north (185.8 cm) direction, shoot length (12.4 cm), number of leaves (7) were noted with no fertilizer with bio inoculants alone (F₁O₂).
- The maximum number of days were taken by plant to bud emergence (97.5), panicle emergence (113.2) and attained 50% flowering (131.3) were recorded with application of chemical fertilizer @ 520:160:450g NPK plant⁻¹ whereas, lesser days were taken to bud emergence (71.2), panicle emergence (86.8) and attained 50% flowering (104.9) were recorded when plant not fertilized chemically.
- The application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) takes 87.6 days to emergence of bud, 102.9 days to panicle emergence and attained 50% flowering within days (127.2) were recorded.
- This phenomenon slightly changed while plant nourished with the interaction of nutrient management 125% RDF with combination of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) takes only 101.3 and 116.7 days to emergence of bud

and panicle respectively. However, period of 50% flowering slightly increase and take 135 days.

- The application of 125 % of recommended dose of chemical fertilizer produced maximum panicle length (39.3 cm), fresh (102.1g) and dry weight (41.5g) of malformed panicles whereas, number of paniclelets (37), number of healthy panicles and percentage (17.3 m² and 90.58%), fresh weight (48.5g) and dry weight of healthy (32.3g) were noted with recommended dose of chemical fertilizer. The minimum panicle length (30.8cm), number of paniclelets (30), number of healthy panicles and percentage (11.4m² and 74.03 %), fresh weight of healthy (35.7g) and malformed panicles (85.2g) and dry weight of healthy (22.6g) and malformed panicles (36.3g) were observed under unfertilized plant.
- As regards, to the application of organic sources the maximum panicle length (37.4cm), number of paniclelets (35), number of healthy panicles and percentage (15.9 m² and 87.85%), fresh weight of healthy (48.4g) and malformed panicles (104.7g) and dry weight of healthy (29.4g) and malformed panicles (41.0g) were recorded with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) however, minimum panicle length (33.6cm), number of paniclelets (31), number of healthy panicles and percentage (11.7 m² and 76.47 %), fresh weight of healthy (34.5g) and malformed panicles (82.2 g) and dry weight of healthy (23.4g) and malformed panicles (36.8 g) were obtained under bio-inoculants alone.
- The interaction of chemical fertilizer and organic sources registered the maximum panicle length (41.3 cm), fresh (115.2 g) and dry weight (43.9 g) of malformed panicle with 125% of RDF whereas, number of paniclelets (40), number of healthy panicles and percentage (20.4 m² and 94.44%), fresh weight of healthy (55.0 g) dry weight of healthy (33.5 g) with recommended dose of fertilizer applied incombination with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) however, minimum panicle length (30.4cm), number of paniclelets (28), number of healthy panicles and percentage (9.9m² and 65.56%) fresh weight of healthy (30.9g) and malformed panicles (76.5g) and dry weight of healthy

(21.0g) and malformed panicles (34.9 g) were recorded with no fertilizer with bio-inoculants alone.

- The application of either in the form of chemical fertilizer (F_3) or as organics (O_6) both has shown ability to minimize the intensity (1.8 and 2.2 m^2) as well as severity (9.42 and 12.5%) respectively over others.
- This intensity and severity further reduced when plant nourished with RDF in combination with Vermicompost (25 kg $plant^{-1}$) + Oil cake (2.5 kg $plant^{-1}$) + Azotobacter + VAM + Trichoderma viridi + PSB (100g $plant^{-1}$ each) and recorded only 1.2 m^2 and 5.56 % of malformed panicles.
- The chemical fertilizer maximized the number of fruit at pea stage (21.8), fruit retention (15.6 %), total number of fruit harvested (70 $plant^{-1}$) and yield (12.53 kg $plant^{-1}$) as well as minimum fruit drop (84.5%) were recorded with the application of recommended dose of fertilizer whereas, the minimum number of fruit at pea stage (16.1), fruit retention (12.3%), total number of fruit harvested (51 $plant^{-1}$), yield (7.77 kg $plant^{-1}$) and maximum fruit drop (87.7%) were recorded with control (F_1).
- The organic sources of nutrient maximized the number of fruit at pea stage (21.8), fruit retention (15.0%), total number of fruit harvested (68 $plant^{-1}$) and Yield (12.03 kg $plant^{-1}$) alongwith minimum fruit drop (85.0%) were recorded with Vermicompost (25 kg $plant^{-1}$) + Oil cake (2.5 kg $plant^{-1}$) + Azotobacter + VAM + Trichoderma viridi + PSB (100g $plant^{-1}$ each) whereas, the minimum number of fruit at pea stage (15.8), fruit retention (12.9%), total number of fruit harvested (53 $plant^{-1}$), yield (8.41kg $plant^{-1}$) with maximum fruit drop (87 %) were recorded when applied bio-inoculants alone.
- The integration of inorganic and organic sources of nutrient maximized the number of fruit at pea stage (24.9), fruit retention (17.8%),total number of fruit harvested (76 $plant^{-1}$) and yield (15.00 kg $plant^{-1}$) as well as minimum fruit drop (88.2%) were recorded with the application of recommended dose of fertilizer in combination with Vermicompost (25 kg $plant^{-1}$) + Oil cake (2.5 kg $plant^{-1}$) + Azotobacter + VAM + Trichoderma viridi + PSB (100g $plant^{-1}$ each) whereas, the minimum number of fruit at pea stage (13.2), fruit retention (11.3%), total

number of fruit harvested (43 plant⁻¹), yield (6.33 kg plant⁻¹) and maximum fruit drop (88.4%) was recorded with bio-inoculants alone.

- Physical composition of fruit increased with the application of chemical fertilizer, the maximum fruit weight (173 g), length (93.9 cm), width (71.1 cm), pulp (61.09%), pulp: peel (3.20), pulp: stone (3.16) and minimum peel (19.66%) and peel: stone ratio (1.01) were recorded with the application of 125% of RDF (520:160:450g NPK plant⁻¹) whereas, minimum fruit weight (151.6 g), length (71.7cm), width (52.8cm), pulp (57.86%), pulp : peel (2.59), pulp stone (2.99), maximum peel (22.70%) and peel : stone (1.18) were noted with unfertilized plant.
- Physical composition of fruit increase with the use of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) increases fruit weight (170 g), length (87.9 cm), width (69.2cm), pulp (62.48%), pulp: peel (3.34) and pulp: stone (3.40) however it reveals the peel (19.08%).
- Interaction of chemical fertilizer and organic sources resulted significantly higher fruit weight (177.5 g), length (96.7cm) and width (76.8 cm) with F₄ O₆.
- Chemical composition with use of recommended dose of chemical fertilizer maximize the TSS (22.42⁰B), total sugar (18.41%), non-reducing sugar (13.72%), reducing sugar (4.69%), ascorbic acid (56.84mg 100g pulp⁻¹), phenol (42.53 mg litter⁻¹) and TSS: Acid ratio (63.51).
- Use of organic sources significantly improve the composition of fruit and maximize TSS (21.80⁰B), total sugar (17.75%), non-reducing sugar (13.06%), reducing sugar (4.69%) and ascorbic acid (57.46mg 100g pulp⁻¹), was recorded with the application of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each), maximum TSS : Acid ratio (63.41) and minimum acidity (0.343) were noted with Vermicompost (25 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) .
- Application of chemical fertilizer along with organic sources of nutrient resulted significant changes in chemical composition of fruits. The higher TSS (22.60⁰B),

total sugar (18.87%), non-reducing sugar (13.94%), reducing sugar (4.94%), ascorbic acid (60.08mg 100g pulp⁻¹) and TSS: Acid ratio (66.86) were recorded with the recommended dose of chemical fertilizer in combination with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each. However, minimum TSS (20.02⁰B), total sugar (15.11%), non-reducing sugar (11.57%), reducing sugar (3.55%), ascorbic acid (44.33 mg 100g pulp⁻¹), and TSS: Acid ratio (51.07) were recorded when applied bio-fertilizer alone.

- The maximum nitrogen (2.33 and 2.58%), phosphorus (0.35 and 0.32 %), potassium (58.39 and 71.46 mg kg⁻¹), copper (8.77 and 9.75 mg kg⁻¹), zinc (25.85 and 27.15 mg kg⁻¹), iron (181.43 and 196.55 mg kg⁻¹) and manganese (79.88 and 93.13 mg kg⁻¹) content were recorded when plant receiving higher dose of chemical fertilizer i.e. 520:160:450g NPK plant⁻¹ (125% of RDF) while the minimum nitrogen (2.08 and 2.33%), phosphorus (0.31 and 0.28 %), potassium (51.01 and 61.19 mg kg⁻¹), copper (7.98 and 9.00 mg kg⁻¹), zinc (23.65 and 24.79 mg kg⁻¹), iron (163.88 and 180.25 mg kg⁻¹) and manganese (68.44 and 80.43 mg kg⁻¹) content were recorded in leaves of shoot bearing healthy and malformed panicle, respectively when plant not fertilized.
- Use of organic sources O₆ significantly improve the nutrient content of nitrogen (2.52 and 2.73%), phosphorus (0.36 and 0.33 %), potassium (61.31 and 75.89 mg kg⁻¹), copper (9.25 and 10.29 mg kg⁻¹), zinc (26.84 and 29.40 mg kg⁻¹), iron (192.59 and 207.87 mg kg⁻¹) and manganese (83.084 and 96.13 mg kg⁻¹) in leaves of shoots bearing healthy and malformed panicles respectively.
- Integrated nutrient management consisted of 125% RDF in combination with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) maximize the content of potassium (62.90 and 77.82 mg kg⁻¹), zinc (27.33 and 30.03 mg kg⁻¹), iron (196.93 and 213.10 mg kg⁻¹) and manganese (88.57 and 98.03 mg kg⁻¹) in leaves of shoots bearing healthy and malformed panicles
- The physical chemical properties of soil changed with the change in nutrient sources applied to plant .The increase in dose of chemical fertilizer significantly

increase the N, P and K content in post harvest soils and 125% of RDF recorded the maximum content of 246.7, 16.3 and 350.7kg NPK, kg ha⁻¹ respectively. The other factors like organic carbon (0.58) bulk density (1.35 Mg m⁻³) were maximize with the higher dose of fertilizer i.e.125%of RDF.

- Organic sources like vermicompost, oilcakes as well as microorganisms applied together, markedly improve the nitrogen (243.5 kg ha⁻¹), phosphorus (15.9 kg ha⁻¹), potassium (351.4%), organic carbon (0.573%) and bulk density (1.357 Mg m⁻³) over applied alone
- As regards to economic aspect, net return (Rs.216/- plant⁻¹) and return per rupee investment (2.67) were recorded when the plant nourished by recommended dose and proved superior over others (Appendix I).
- On the other hand the treatment which proved more yield and favorable to the other parameters showed inverse relation with economic aspect. Hence, higher net return of Rs. 200/- plant⁻¹ with cost benefit ratio of 3.21 was recorded under application of vermicompost @ 25 kg plant⁻¹ whereas, Oil cake 2.5 kg plant⁻¹ registered net profit of Rs.172/- plant⁻¹ with 3.37 return per rupee investment.
- The increase in organic component as source of nutrients, thus increased the cost and reduced the net return as well as B : C ratio.

6.2 Conclusion

On the basis of findings it could be concluded that;

Sources of nutrient on yield and quality

The number of fruits set at pea stage, total number of fruits per plant as well as fruit retention and yield per plant increases with increasing dose of chemical fertilizer and high number was recorded with recommended dose of chemical fertilizer i.e. 415:130:360 g NPK plant⁻¹. Organic sources like vermicompost, oilcake as well as bio- inoculants @ 25, 2.5 kg and 100g each, respectively proved to be the best treatment with regards to fruit set, retention of fruits and weight of fruit as well as fruit yield plant⁻¹. Similarly, the integration of chemical fertilizers 100% RDF and organics in a combination with bio inoculants gave higher fruit yield plant⁻¹ with more no. of fruit setting, fruits plant⁻¹ and their retention as well as weight of fruits.

Organic sources and fertilizer on flowering, fruiting and quality

Quality of fruits regarding TSS, total sugar, non reducing sugar, ascorbic acid, phenol and TSS: acid ratio increases with the increase in dose of fertilizers and maximum values were noted at 100% RDF. The acidity reduced with the 100% RDF chemical fertilizers. Application of vermicompost (25 kg plant⁻¹) and oil cake (2.5 kg plant⁻¹) alongwith PSB, VAM, Trichoderma, Azotobacter @100g each proved to be the best treatment to obtimize the quality parameters. The integration of 100% RDF of NPK along with Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) seems to be the best combination for getting quality fruit yield.

Organic and inorganic sources of nutrient on soil properties

Increasing doses of fertilizer improved the soil conditions by reducing soil bulk density and increasing organic carbon in post harvest soils. The addition of organic sources significantly improves the soil porosity in terms of reducing bulk density. The vermicompost (25 kg plant⁻¹) and oil cake (2.5 kg plant⁻¹) along with Azotobacter, PSB, VAM, Trichoderma (100 g each), recorded lowest value of bulk density which indicated soil porosity.

The soil organic carbon significantly increases with the addition of organics along with inoculants over the base year. The integration of inorganic and organic sources of nutrients 125% RDF along with combination of Vermicompost (25 kg plant⁻¹) + Oil cake (2.5 kg plant⁻¹) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant⁻¹ each) proved to be the best combination to improve soil organic carbon.

Chemical fertilizers increased the available nitrogen, phosphorus and potassium content of soil each year. This increase in availability of nutrient was with 125% of RDF. The combined application of vermicompost, oil cake along with inoculants not only maintains the original nutrient status of soil but also enhanced the content of nitrogen, phosphorus and potassium. As regards, the combination of chemical fertilizers 125% RDF and vermicompost, oil cake and microbes proved to be the best combination for manage soil nutrient status for a longer period.

Economics for nutrient management under HDP

The recommended dose of chemical fertilizers proved to be the economics and gave more net return (Rs.216/- plant⁻¹) as well as return per rupees investment (2.67). On the other hand, the organic sources of nutrient which gave more yield and favorable to the other parameters showed inverse relation with economic aspect. Hence, higher net return of Rs. 200/- plant⁻¹ with cost benefit ratio of 3.21 was recorded with application of vermicompost @ 25 kg plant⁻¹ whereas, higher cost benefit ratio of 3.37 with net return of Rs 172 plant⁻¹ was under oil cake applied @ 2.5 kg plant⁻¹. However, the component of organics sources when increases it reduced the benefit cost ratio and net profit. Hence the combination of 100% RDF @ 415:130:360 g NPK plant⁻¹ along with vermicompost @ 25kg alone proved beneficial as it gave more profit.

6.3 Suggestions for future work

- Lookup to the findings, the work on the aspect of green manuring may be concentrated also be included alongwith the use of vermicompost and oil cake.
- The rock phosphate alongwith green manure may be tested for soil enrichment and to increase the rate of decomposition of matter.
- In situ inoculation of effective species of earth worm may enhance for better and faster utilization of leaf litter.
- Some essential micro nutrients may be included in the future plan in addition to recommended dose of chemical fertilizer .

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APPENDICES

Certificate

Publication of Research Paper form Ph. D. thesis work

This is to certify that Miss **RAJNEE SHARMA** Ph. D. Scholar of the Department of **HORTICULTURE** submitted the thesis entitled “**Effect of organic and inorganic source of nutrients on growth, flowering, fruiting, yield and quality of mango (*Mangifera indica* L.) cv. Amrapali under high density planting**” on 15.01.2015 has published the following two research papers from the research work conducted for Ph.D. thesis.

1. Sharma Rajnee, Jain PK, Sharma BL and Pandey SK. 2014. Influence of organic and inorganic source of nutrients on physico-chemical properties of soil under high density mango orchard (*Mangifera indica* L.). JNKVV Res J 48 (3):280-283.
2. Composition of macro and micro nutrients in leaves of shoot bearing healthy and malformed panicle in mango as influence by different source of nutrients coauthored by Sharma Rajnee, Jain PK, Pandey SK and Sharma TR. Accepted in JNKVV Res J 49 (2) scheduled for 2015.

Both the papers (it may be one paper and one typed manuscript with proof of acceptance) are attached with the thesis as appendix at the end.

Date: 15.01.2015

Chairman of Advisory Committee

Name	: Dr. P.K. Jain
Designation	: University Professor and Head
Department	: Department of Horticulture
College	: College of Agriculture, Jabalpur

**Signature and Seal
Professor and Head**

Annexure -I

Influence of organic sources and chemical fertilizer on gross return (Rs plant⁻¹)

Treatments		OC @2.5kg (O ₁)	BI @100g (O ₂)	VC @25kg (O ₃)	VC+OC (O ₃ +O ₁) (O ₄)	VC+BI (O ₃ +O ₂) (O ₅)	VC+OC+BI (O ₃ +O ₁ +O ₂) (O ₆)	Mean
2012-13								
Without fertilizer (Control)	(F ₁)	179	154	197	194	201	211	189
310:100:270g NPK (75%RDF)	(F ₂)	193	173	237	241	263	287	232
415:130:360g NPK (100%RDF)	(F ₃)	247	239	320	325	332	364	305
520:160:450g NPK (125%RDF)	(F ₄)	255	241	286	279	286	305	275
Mean		219	202	260	260	271	292	
2013-14								
Without fertilizer (Control)	(F ₁)	225	196	243	244	258	267	239
310:100:270g NPK (75%RDF)	(F ₂)	249	226	292	303	339	366	296
415:130:360g NPK (100%RDF)	(F ₃)	299	318	407	407	424	464	387
520:160:450g NPK (125%RDF)	(F ₄)	317	312	342	337	368	391	344
Mean		272	263	321	323	347	372	
Pooled data								
Without fertilizer (Control)	(F ₁)	201	174	219	219	229	238	214
310:100:270g NPK (75%RDF)	(F ₂)	220	119	264	272	300	326	264
415:130:360g NPK (100%RDF)	(F ₃)	273	277	262	366	377	413	346
520:160:450g NPK (125%RDF)	(F ₄)	285	275	314	308	326	347	310
Mean		245	232	290	292	309	332	

Mango market sale price @ Rs 25 per kg and Rs 30 per kg for the year 2012-13 and 2013-14, respectively

Annexure -II

Influence of organic and inorganic sources on net monitoring return (Rs plant⁻¹)

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	122	94	122	62	66	19	81
310:100:270g NPK (75%RDF)	(F ₂)	120	98	146	93	113	79	108
415:130:360g NPK (100%RDF)	(F ₃)	170	159	225	173	177	152	176
520:160:450g NPK (125%RDF)	(F ₄)	172	156	185	122	126	87	141
Mean		146	127	170	113	121	84	
2013-14								
Without fertilizer (Control)	(F ₁)	167	136	168	112	123	75	130
310:100:270g NPK (75%RDF)	(F ₂)	177	151	202	156	189	158	172
415:130:360g NPK (100%RDF)	(F ₃)	221	238	312	255	269	252	258
520:160:450g NPK (125%RDF)	(F ₄)	234	226	242	179	208	173	210
Mean		200	188	231	176	197	165	
Pooled data								
Without fertilizer (Control)	(F ₁)	144	114	144	86	94	46	105
310:100:270g NPK (75%RDF)	(F ₂)	148	123	174	124	150	118	140
415:130:360g NPK (100%RDF)	(F ₃)	195	197	267	213	222	201	216
520:160:450g NPK (125%RDF)	(F ₄)	202	190	214	150	166	129	175
Mean		172	156	200	143	158	124	

Mango market sale price @ Rs 25 per kg and Rs 30 per kg for the year 2012-13 and 2013-14, respectively

Annexure -III

Influence of organic sources and chemical fertilizer on benefit cost ratio

Treatments		OC	BI	VC	VC+OC	VC+BI	VC+OC+BI	Mean
		@2.5kg	@100g	@25kg	(O3+O1)	(O3+O2)	(O3+O1+O2)	
		(O ₁)	(O ₂)	(O ₃)	(O ₄)	(O ₅)	(O ₆)	
2012-13								
Without fertilizer (Control)	(F ₁)	3.11	2.56	2.62	1.47	1.49	1.10	2.06
310:100:270g NPK (75%RDF)	(F ₂)	2.65	2.30	2.62	1.63	1.75	1.38	2.06
415:130:360g NPK (100%RDF)	(F ₃)	3.18	2.98	3.36	2.13	2.14	1.77	2.59
520:160:450g NPK (125%RDF)	(F ₄)	3.08	2.83	2.85	1.77	1.79	1.40	2.29
Mean		3.01	2.67	2.86	1.75	1.79	1.41	
2013-14								
Without fertilizer (Control)	(F ₁)	3.91	3.27	3.24	1.84	1.91	1.39	2.59
310:100:270g NPK (75%RDF)	(F ₂)	3.34	3.00	3.23	2.05	2.26	1.76	2.61
415:130:360g NPK (100%RDF)	(F ₃)	3.85	3.96	4.27	2.67	2.73	2.18	3.28
520:160:450g NPK (125%RDF)	(F ₄)	3.83	3.66	3.41	2.13	2.30	1.79	2.85
Mean		3.73	3.47	3.54	2.17	2.30	1.78	
Pooled data								
Without fertilizer (Control)	(F ₁)	3.50	2.90	2.93	1.66	1.70	1.24	2.32
310:100:270g NPK (75%RDF)	(F ₂)	3.03	2.64	2.92	1.84	2.00	1.57	2.33
415:130:360g NPK (100%RDF)	(F ₃)	3.51	3.45	3.80	2.39	2.43	1.94	2.92
520:160:450g NPK (125%RDF)	(F ₄)	3.45	3.23	3.13	1.95	2.04	1.59	2.57
Mean		3.37	3.06	3.20	1.96	2.04	1.59	

Mango market sale price @ Rs 25 per kg and Rs 30 per kg for the year 2012-13 and 2013-14, respectively