EFFECT OF INTEGRATED NUTRIENT MANAGEMENT AND SEED PRIMING ON NUTRIENT UPTAKE AND YIELD OF LITTLE MILLET (*Panicum sumatrense*)

M.Sc. (Ag) Thesis

by

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Thesis

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CERTIFICATE - I

This is to certify that the thesis **"Effect of Integrated Nutrient Management and seed priming on nutrient uptake and yield of little millet (*Panicum sumatrense*)"** submitted in partial fulfillment of the degree of **Master of Science in Agriculture** of the Indira Gandhi Krishi Vishwayidya1aya, Raipur, is a record of the bonafide research work carried out by **Vivek Patel** under my guidance and supervision. The subject of the thesis has been approved by student s Advisory Committee and Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma or certificate course. All the assistance and help received during the course of the investigations have been duly acknowledged.

Chairman

Date: 17/06/2020

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE

Chairman (Dr. S.S. Sengar)

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Member (Dr. N.K. Rastogi)

Member (Dr. A.K. Singh)

CERTIFICATE- II

This is to certify that the thesis entitled **"Effect of Integrated Nutrient Management and seed priming on nutrient uptake and yield of little millet (*Panicum sumatrense*)"** submitted by **Vivek Patel** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur, in partial fulfilment of the requirements for the degree of Master of science in Agriculture in the Department of Soil Science and Agricultural Chemistry has been approved by the external evaluator and Student's Advisory Committee after oral examination, ***under the chairmanship of Head of the Department.***

Major Advisor

Date 4/07/2020

Signature of Head of the Department

(Name......Koshlendra Tedia......**)**

Faculty Dean ____________________

Approved/ Not approved

Director of Instructions ____________________

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I start in the name of God-who has bestowed upon me all the physicaland mental attributes that I posses and skill to cut through and heal a fellowhuman.

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*How can I express my thanks to "**God**" because there is no any word to express it. So, my lord, please realize and accept my feelings.*

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LIST OF NOTATIONS/ SYMBOLS

Notations/ Symbols	Description
^0C	Degree Celsius
%	Per cent
@	At the rate
N	North
S	South
E	East
W	West
Rs	Rupees
M	Metre
G	Gram
Kg	Kilogram
mm	Millimetre
hr	Hour

LIST OF ABBREVIATIONS

Abbreviations	Description	Abbreviations	Description
%	Per cent	m^{-2}	Per metre square
@	At the rate	No.	Number
a.i.	Active ingredient	NS	Non significant
B:C	Benefit cost ratio	d.f.	Degree of freedom
CD	Critical Difference	etc.	Etcetera
Day^{-1}	Per day	Q	Quintal
$t\ ha^{-1}$	Ton per hectare	Rs	Rupees
^{0}C	Degree Celsius	SEm$\underline{+}$	Standard error of mean
DAS	Days after sowing	$Rs\ ha^{-1}$	Rupees per hectare
et al.	And others/ co-worker	*viz.*	For example
Fig.	Figure	N	Nitrogen
ha	Hectare	P	Phosphorus
ha^{-1}	Per hectare	K	Potassium
HI	Harvest index	S	Significant
hr	Hours	G	Gram
i.e.	That is	FYM	Farm yard manure
Kg	Kilogram	OC	Organic carbon
Kmph	Kilometer per hour	mm	Millimetre
cm	Centimeter	M	Metre
cm^2	Centimeter square	L	Litre
max.	Maximum	min.	Minimum

THESIS ABSTRACT

a) Title of the Thesis	:	Effect of Integrated Nutrient Management and seed priming on nutrient uptake and yield of little millet (Panicum sumatrense)
b) Full Name of the Student	:	Vivek Patel
c) Major Subject	:	Soil Science and Agricultural Chemistry
d) Name and Address of the Major Advisor	:	Dr S.S.Sengar, Dean College of agriculture and research station, chhuikhadan, Rajnandgaon (C.G.)
e) Degree to be awarded	:	Master of Science in Agriculture (Soil Science and Agricultural Chemistry)

Signature of the Student

Signature of Major Advisor

Date: 17/06/2020

Signature of Head of the Department

ABSTRACT

A study entitled **"Effect of Integrated Nutrient Management and seed priming on nutrient uptake and yield of little millet (*Panicum sumatrense*)"** was conducted under field condition at the experimental plots of DKS farm, IGKV, Bhatapara Dist- Baloda Bazaar, Chhattisgarh during *kharif* season of the year 2019. The soil of the experimental field was alfisol and climate was sub-humid with a total rainfall of 872.2 mm during the crop growth. The objectives of the study were to study the effect of integrated nutrient management and seed priming on growth, yield, quality parameters and nutrient content of little millet and to study the physico-chemical and micro-

constituted with five nutrient management N1 (control), N2 (125 kg Neem cake + 1.25 tons ha^{-1} vermicompost), N3 (50 kg/ha N : 50 kg/ha P_2O_5 : 50 kg /ha K_2O and 2% Borax spray at flowering), N4 (125 kg Neem cake + 1.25 tons ha^{-1} vermicompost + 50 kg/ha N : 50 kg/ha P_2O_5 : 50 kg /ha K_2O and 2% Borax spray at flowering) and N5 (Recommended dose of fertilizer i.e. 20 Kg/ha N : 20 Kg/ha P_2O_5 : 10 Kg /ha K_2O) with four priming treatment P1 (control), P2 (Hydro priming for 8 hrs), P3 (Seed priming with 2% KH_2PO_4 for 8 hrs) and P4 (Seed priming with 20% liquid *Pseudomonas fluorescens*).

Results revealed that all the physico-chemical properties except pH and EC of post harvest soil were enhanced in integrated nutrient management. The highest OC%, higher level of plant available macronutrients and micronutrients and higher microbial population was found in N4 treatment. Results also revealed that all the growth parameters of little millet were enhanced by integrated nutrient management and the highest value of field emergence, plant height at 45DAS, 60DAS and plant height at harvest, number of effective tillers/plant and DAS 1st flowering and 50% flowering were found higher in N4 treatment.The effect of seed priming was seen only in early days of plant growth for P3 and P4 treatments which were latter masked by environmental factors and no interaction effect was seen during complete growth period of little millet.

Although effect of integrated nutrient management was non-significant for all the essential macronutrient and cationic micronutrient content in grain and straw of little millet, however enhanced uptake was found in N4 treatment for all the nutrients due to better growth and yield parameters of little millet crop, which resulted in higher dry mass production of the crop.

Due to addition of neem cake and verimicompost along with inorganic fertilizers better physical, chemical and biological soil condition was provided to the plant which resulted in better crop growth and yield parameter of plant and ultimately, the yield of little millet was increased through integrated nutrient management practices.

शोध सारांश

अ)	शोध का शीर्षक	:	एकीकृत पोषक तत्व और बीज प्राइमिंग का कुटकी (पैनिकम सुमैट्रेन) के पोषक तत्व अवशोषण और उपज पर प्रभाव
ब)	छात्र का पूरा नाम	:	विवेक पटेल
स)	मुख्य विषय	:	**मृदा विज्ञान एवं कृषि रसायन**
द)	मुख्य सलाहकार का नाम एवं पता	:	डॉ.एस.एस. सेंगर अधिष्ठाता, कृषि महाविद्यालय एवं अनुसंधान केन्द्र छूईखदान, राजनंदगांव (छ. ग.)
इ)	उपाधि का नाम	:	स्नातकोत्तर (कृषि), **मृदा विज्ञान एवं कृषि रसायन**

विवेक

छात्र के हस्ताक्षर

Bsengar

मुख्य सलाहकार के हस्ताक्षर

दिनॉकः 17/06/2020

विभागाध्यक्ष के हस्ताक्षर

सारांश

वर्ष 2019 के खरीफ मौसम के दौरान डी. के. एस फार्म, इं.गा. कृषि विश्वविद्यालय भाटापारा, जिला बलौदाबाजार छ.ग. के भूखंड में एकीकृत पोषक तत्व और बीज प्राइमिंग का कुटकी (पैनिकम सुमैट्रेन) के पोषक तत्व अवशोषण और उपज पर प्रभाव नामक अध्ययन किया गया। प्रयोगात्मक क्षेत्र की मिट्टी अल्फिसोल थी, और फसल के विकास के दौरान 872.7 मिलीमीटर की कुल वर्षा के साथ जलवायु उप–नम थी। अध्ययन का उददेश्य एकीकृत पोषक तत्व और बीज प्राइमिंग का कुटकी के विकास, उपज गुणवत्ता मानकों और पोषक तत्व अवशोषण पर प्रभाव और मिट्टी के भौतिकी रासायनिक और सूक्ष्म जैविक गुणों के विकास का अध्ययन करना था। अध्ययन में पांच पोषक तत्व प्रबंधन उपचार N1(नियंत्रण), N2 (125 कि.ग्रा नीम केक +125 टन/हे0 केंचुंआ खाद), N3 (50 कि.ग्रा. /हे0 N : 50 कि.ग्रा./हे0 P_2O_5 : 50 कि.ग्रा./हे0 K_2O और फूल पर 2 प्रतिशत बोरेक्स का छिटकाव), N4 (125 कि.ग्रा नीम केक +125 टन/हे0 केंचुंआ खाद + 50 कि.ग्रा. /हे0 N : 50 कि.ग्रा./हे0 P_2O_5 : 50 कि.ग्रा./हे0 K_2O और फूल पर 2 प्रतिशत बोरेक्स का छिटकाव) और N5 (अनुशंसित खुराक अर्थात 20 कि.ग्रा./हे0 N : 20 कि.ग्रा./हे0 P_2O_5: 10 कि.ग्रा./हे0 K_2O) के साथ चार प्राइमिंग उपचार P1(नियंत्रण), P2 (8 घंटे के लिए हाइड्रोप्राईमिंग), P3 (8घंटे के लिए 2 प्रतिशत KH_2PO_4में बीज का प्राइमिंग), और P4 (20 प्रतिशत तरल स्यूडोमोनास फ्लोरिसेंस के साथ प्राइमिंग) का प्रयोग किया गया।

प्राइमिंग), और P4 (20 प्रतिशत तरल स्यूडोमोनास फ्लोरिसेंस के साथ प्राइमिंग) का प्रयोग किया गया।

परिणामों से पता चला कि फसल के बाद की मिट्टी के पी. एच और ई. सी. को छोड़ कर सभी भौतिक एवं रासायनिक गुणों को एकीकृत पोषण तत्व प्रबंधन ने बढ़ाया। उच्चतम कार्बनिक कार्बन प्रतिशत, उच्च स्तर पर पौधो को उपलब्ध स्थूल और धनायनित सूक्ष्म पोषक तत्व तथा उच्च सूक्ष्म जीव जनसंख्या N4 उपचार मे पाया गया।

परिणामों से यह भी पता चला कि कुटकी के सभी विकास मानकों, बीज का क्षेत्र से उद्भव, बुआई के बाद 45 दिन, 60 दिन और फसल कटाई के समय की ऊँचाई, प्रभावी कंसे /पौधे की संख्या और फसल के बुआई के बाद प्रथम फूल और 50 प्रतिशत फूलों के आने के दिनो में वृद्वि हुई। बीज प्राइमिंग का प्रभाव केवल P3 और P4 उपचारों के लिए पौधों के विकास के शुरुवाती दिनों में देखा गया था, जो बाद में पर्यावरणीय कारकों द्वारा कम कर दिया गया। कुटकी के पूर्ण विकास के दौरान परस्पर प्रभाव कही नही देखा गया।

हालांकि कुटकी के दाने और पुआल में सभी आवश्यक स्थूल और धनायनित सूक्ष्म पोषक तत्वों की मात्रा के लिए एकीकृत पोषक तत्व प्रबंधन का प्रभाव गैर महत्वपूर्ण था। लेकिन फसल के बेहतर वृद्वि और पैदावार मापदंडो के कारण N4 उपचार में बेहतर पोषक तत्व का अव"ाोषण पाया गया। जिससे फसल में अधिक शुष्क उत्पादन प्राप्त हुआ।

अकार्बनिक उर्वरकों के साथ साथ नीम खली और केंचुंआ खाद को शामिल करने से पौधों को बेहतर भौतिक, रासायनिक और जैविक गुणोंयुक्त मिट्टी की स्थिति प्रदान की गई। जिसके परिणाम स्वरुप, फसल में बेहतर वृद्वि और उपज मापदंड प्राप्त हुए और अंततः एकीकृत कृषि प्रबंधन के माध्यम से कुटकी की उपज में वृद्वि हुई।

CHAPTER - I

INTRODUCTION

Millets are known for store-houses of nutrition as on dietary criterion, as compared with rice and wheat. Millets nutritional composition varied species to species and is depended on the generic as well as the environmental factors (McDonough *et al*., 2000). Millets have very high fiber content as compared to major cereals crop. However, millets are categorized into low and high protein millets. Pearl millet, barnyard millet, foxtail millet, and proso millet have high protein content of 14.5%, 11.8%, 11.7% and 13.4%, respectively (McDonough et al.) 2000. Millets are rich source of vitamin B and minerals like Phosphorous, Potassium, Magnesium, Copper, Iron, Manganese and Zinc. Millets have nearly 4.2% oil content of which 50% are polyunsaturated fatty acids. Millets are also known to act as an antioxidants and rich in non-nutritional components such as flavonoids, phytates, tannis and phenols. Due to presence of exceptionally valuable phytochemicals, it can be used in the industry and pharmaceuticals too as reported by Pradeep and Guha, 2010. The Government of India has declared the year 2018, as "**National Year of Millets**" and designated "Millets" as "**Nutri-Cereals**" to recognize the nutritional and socio-economic importance.. Millets are adapted to wide range of temperatures, soil-moisture regimes and input conditions supplying food and feed for a large segment of the population, especially those with low socio-economic status particularly in the developing world. All these have made millets quite indispensable to tribal, rainfed and hill agriculture where crop substitution is challenging .Besides, many types of millet also form major raw material for potable alcohol and starch production in industrialized countries.

Little millet (*Panicum sumatrense* Roth ex Roemer and Schultes), known as kutki in Hindi, samai in Tamil, same in Kannada, samalu in Telugu, chama in Malayalum, sava in Marathi, gajaro in Gujrati and kangani in Bengali is one of the hardiest short duration minor cereal crop belong to the family Poaceae (Gramineae) and is indigenous to Indian sub continent. The species name is based on a specimen collected from Sumatra (Indonesia) (de Wet et al., 1983). It can withstand both drought and waterlogging (Doggett, 1989). Little millet is widely grown in India, Sri Lanka, Pakistan, Western Myanmar. Little millet can tolerate water logging and drought conditions (Rachie, 1975). The seeds color is usually yellow and is generally smaller than those of proso millet (Bavec and Bavec, 2006). The 1000 seed weight ranges between 2.09 - 2.30g (Ninganagoudar et al., 2012).

The little millet is rich in nutritive values with respect to proteins, carbohydrates, and minerals. Proximate analysis of little millet per 100g edible portion shows that it contains 9.7 % of proteins, 60.9% of starch, 5.2% of fats, 7.6 % of crude fibers, 4.9% ash, 17.0 mg of calcium (McDonough et al., 2000). The dietary fiber and starch in little millet exhibit low glycemic index and hypolipidemic effects. Millet's antioxidants for example polyphenols, tannins, phenolic compounds, flavonoids play a major role in improving health by reducing the chances of diseases such as cardiovascular disease, diabetes, cataract, gastrointestinal and inflammation problems. Little millet contains high fat, comprising mainly of the healthy polyunsaturated fatty acids (PUFA).

Little millet along with kodo millet and sorghum is grown in total area of 102.60 thousand hectare land in Chhattisgarh, with a total production of 25350 MT. The average productivity of these millets in Chhattisgarh is 247 kg ha^{-1}. The major millets producing districts in Chhattisgarh are Dantewara, Balrampur, Jagdalpur, Sukma and Koria. These six districts share is about 59.31 % in the total production of these millets.

One of the major constraints in present day agriculture is its long-term sustainability. Both, the over and under application and the poor management of resources have damaged the environment. For example, in developed countries over application of various resources has led to environmental contamination of water resources and soils (Conway and Pretty 1991; Bumb and Baanante 1996; NRC 1989). Because agriculture is a soil-dependent industry that uptake nutrients from the soil, effective and efficient approaches to slowing down removal and returning nutrients to the soil will be required in order to maintain and increase crop productivity and sustain agriculture for the long term. For better utilization of resources and to produce crops with less expenditure, integrated nutrient management is the best approach.

Seed priming is a prescribed hydration process which involves soaking of seed in water and drying back to storage moisture that check germination, but permits pre-germinative physiological and biochemical processes to occur (Rinku et al., 2017). These processes that precede the germination are triggered by priming. Therefore, primed seed rapidly imbibe and revive the seed metabolism resulting in higher seed viability and vigour and a reduction in intrinsic physiological heterogeneity in germination and crop stand. There are various methods of priming of seeds. Some of scientists consider the hydro priming superior to other methods. Whereas nutrient priming is considered to be novel technique that combine the positive effects of seed priming with an improved nutrient supply.

The productivity of little millet is very low on account of inadequate and imbalanced application of fertilizers, non-addition of secondary and micronutrients, organic manure as well as biofertilizers. Another reasons for low productivity is the use of locally available untreated seeds.

In view of above facts, the experiment on **"Effect of Integrated Nutrient Management and seed priming on nutrient uptake and yield of little millet (*Panicum sumatrense*)"** was conducted with the following objectives

1. To evaluate the effect of INM and seed priming on growth, yield, and quality parameters of little millet.
2. To study the physico-chemical and micro-biological properties of soil as influenced by various treatments.
3. To evaluate the effect of INM and seed priming on primary and secondary nutrient content and their uptake in little millet.
4. To evaluate the effect of INM and seed priming on micronutrient content and their uptake in little millet.

CHAPTER–II

REVIEW OF LITERATURE

Little millet is one among the small millets gaining lot of importance. It is reliable catch crop, rich in nutritive values, has high antioxidants and is good for diabetic patients. The productivity of little millet is very low on account of inadequate and imbalanced application of fertilizers, non addition of secondary and micronutrients, organic manure as well as biofertilizers and use of locally available untreated seeds. Nutrient management by integration of secondary and micronutrients, organic sources, biofertilizer along with suitable seed treatment may increase the little millets productivity. In this chapter, a brief resume of research work done in Chhattisgarh, India and abroad pertaining to the **"Effect of Integrated Nutrient Management and seed priming on nutrient uptake and yield of little millet (*Panicum sumatrense*)"** has been mentioned. The literatures available are summarized in this chapter under the following heads.

2.1 Effect of integrated nutrient management and seed priming on the physico-chemical properties of soil.

2.2 Effect of integrated nutrient management and seed priming on the micro-biological properties of soil.

2.3 Effect of integrated nutrient management and seed priming on growth, yield, and quality parameters of little millet.

2.4 Effect of integrated nutrient management and seed priming on primary and secondary nutrient content and their uptake in little millet.

2.5 Effect of integrated nutrient management and seed priming on micronutrient content and their uptake in little millet.

2.1 Effect of integrated nutrient management and seed priming on the physico-chemical properties of soil

Excessive concentration of organic and inorganic material in the soil adversely affects its physico-chemical characteristics and may induce abnormalities in plant growth and development. The eventual soil is a chemically, physically and biologically complex dynamic system. Their constituents are constantly undergoing changes, the rates of which are influenced by a number of factors of the environment. The effect of nutrient management practices and seed priming are reviewed under following head.

2.1.1 Effect of integrated nutrient management and seed priming on the pH, EC and organic carbon

Khan *et al.* (2011) conducted a field experiment in Hyderabad (A.P.) in sweet sorghum and found that conjoint use of organic and inorganic sources of nutrient had non-significant effect on soil pH and EC. However, soil organic carbon significantly increased with the integration of nutrient sources.

Kannan *et al.* (2013) carried out a field experiment at Pollachi (Tamil Nadu) to study the effect of INM on soil fertility and productivity on maize (*Zea mays*) and found no significant variations of pH due to integration of various inorganic fertilizers and organic manure.

Dubey *et al.* (2014) carried out a field experiment at Jabalpur (M.P.) with an aim to study the effect of different nutrient management practices on soil-properties under different rice-based cropping systems during 2004-05 to 2007-08. The experimental results revealed that pH and EC was unchanged over their initial status after completion of fourth crop-cycle in all the treatments.

Rani *et al.* (2017) carried out field experiment in little millet during *Kharif* 2015, at agriculture research station, Vizianagaram (A.P.) to study the effect of integrated use of organic manures in combination with different levels of inorganic fertilizers (NPK) on physico-chemical properties of soil. The results revealed that there was no significant difference of various treatment combinations on soil pH and EC. The organic carbon was higher in field where inorganic sources are used in conjunction with organic sources however, the differences were non-significant as compared with the treatment in which no organic manure was added.

2.1.2 Effect of integrated nutrient management and seed priming on available macronutrients

Gogoi *et al.* (2015) carried out a field experiment taking rice as test crop and found that available N, P and K content of soil were significantly affected by integrated nutrient treatments which showed up to 65.29, 81.03 and 21.46%

increase of these nutrients over control, respectively. Significantly highest exchangeable Ca and Mg and available S as compared to control and RDF were observed from the treatment of 50% RDF (inorganic) + 50% N (FYM) i.e. T4 treatment, followed by 50% N (inorganic) + 50% N (FYM) + PK (adjusted) i.e. T6 treatment.

Samant (2017) carried out a field experiment who found that available primary and secondary nutrient content of surface soil after harvest of rice significantly increased with application of FYM and biofertilizers in combination with chemical fertilizers over sole fertilizer application and control.

Pallavi *et al.* (2016) carried out a field experiment at Rajendranagar, Hyderabad to study the effect of INM on soil fertility taking finger millet as test crop. The results revealed that available nitrogen, phosphorus and potassium in the post-harvest soil samples significantly affected by the use of integrated use of organic and inorganic sources of nutrient.

Kanwar *et al.* (2017) carried a field experiment to study the effect of organic and inorganic nutrition on fertility status of soil. They found that available primary nutrients and sulphur in soil at harvest of crop were recorded significantly maximum with the application of vermicompost @ 5 t ha^{-1} over control.

Pareek *et al.* (2018) studied the effect of organic and inorganic sources of NPK and foliar spray of micronutrient on soil physico chemical parameters. They found out that integrated nutrient treatments in combination with a set of organic manure, inorganic fertilizers and micronutrient application significantly improved N, P_2O_5 and K_2O availability in the soil after harvest over application of inorganic fertilizers alone but the foliar application of chemicals did not affect these parameters significantly.

Roy *et al.* (2018) conducted a field experiment in Rachi, (Jharkhand) to study the effect of integrated nutrient management practices on post-available primary macronutrients and found that available nitrogen and phosphorus significantly increased when organic manure and inorganic fertilizers were used in conjunction, however the available potassium was non-significantly affected by combined application of nutrient sources.

Mishra *et al.* (2019) conducted a field experiment. Data in regard to available status of N, P, K and S revealed that available status of all the nutrients were slightly increased in all the treatments in comparison to its initial value, except control and 75% RDN.

2.1.3 Effect of integrated nutrient management and seed priming on available micronutrients

Kanzaria *et al.* (2010) conducted a field experiment in Jamkhambhalia (Gujarat) opined that the incorporation of organic sources improved the availability of cationic micronutrients in the soil however the difference was non-signification except for iron.

Lakshmi *et al.* (2013) conducted a field experiment in Visakhapatnam (A.P.) taking rice as test crop who found that the available micronutrient status (Zn, Fe, Cu and Mn) observed under integrated nutrient treatments were higher over chemical fertilizers and control.

Rani *et al.* (2017) carried out field experiment in Vizianagaram (A.P.) on little millet found that when different organic manures applied in conjunction with different level of fertilizers had significantly higher level of available micronutrients Zn, Fe, Cu and Mn than treatments in which no organic manures were added.

2.2 Effect of integrated nutrient management and seed priming on the micro-biological properties of soil

Although, plant physiologists sometimes view soil as simply a source of nutrients to plants, it is actually a complex ecosystem hosting bacteria, fungi, protists, and animals (Bonkowski*et al.*,2009; Muller *et al.*,2016). Plants exhibit a diverse array of interactions with these soil-dwelling organisms, which span the full range of ecological possibilities (competitive, exploitative, neutral, commensal, mutualistic). The effects of integrated nutrient management and seed priming on these complex ecosystems are reviewed under following heads.

2.2.1 Effect on total bacterial count

Khaddar and Yadav (2006) carried out a field experiment found that the FYM treated plot registered the maximum bacterial population at all the stages of crop growth, which was significantly higher than plots receiving both organic and inorganic sources of nutrients. Among all the treatments, the control plot showed the minimum count of bacterial population.

Vineela *et al.* (2008) studied the effects of fertilization, manuring and long-term cropping, and their integration on microbial community in soil samples from five long-term fertilizer experiments under various rainfed production systems in the semi-arid tropics (SAT) of India. They found that higher bacterial population was associated with the conjoint use of organic and inorganic sources of nutrients in all soil types and cropping systems.

Nakhro *et al.* (2010) carried out a field experiment in Meghalaya to examine the microbial population under organic and inorganic practices in paddy. The experimental results revealed that the organic plots showed a significant variation in bacterial population as compared with the inorganically treated plot and control.

Tao *et al.* (2015) conducted a field experiment to investigate the impacts of organic-supplementation of a chemical fertilizer for improving soil biological activity and found that the bacterial community significantly increased in soils receiving organic-supplemented fertilizers, which had greater bacterial populations than in the control and chemical fertilizer treatments.

Sanjeeta *et al.* (2019) opined that bacterial population significantly increased with the conjoint use of inorganic fertilizer along with the organic sources of nutrient.

2.2.2 Effect on total actinomycetes count

Walia *et al.* (2010) carried out a field experiment and found that treatments where 50% of the recommended N was substituted through FYM and wheat cut straw, respectively, gave the highest viable count of actinomycetes ranging from (41.9 to 44.3) × 10^4cfu g^{-1}. The application of inorganic fertilizers, irrespective of their dose, invariably produced low counts of actinomycetes (19.3 to 25.7) × 10^4cfu g^{-1}.

Thakare and Wake (2015) conducted a field experiment taking pearl millet as the test crop found that the actinomycetes population in field under different treatments exhibited higher values and minimum values associated with the organic and control plots, respectively.

Mairan and Dhawan (2016) carried out a field experiment to evaluate the impact of application of organic and inorganic source of nutrients on soil microbial population under different cropping systems. After two cropping cycles, the soil microbial properties were significantly influenced due to various combinations of manurial treatments. The population of actinomycetes decreased in higher proportion in control followed by farmer's practice, however, highest population of actinomycetes was observed in the treatment receiving FYM. Fertilizer application alone showed relatively less increase in population of actinomycetes.

2.2.3 Effect on total fungi count

Nakhro *et al*. (2010) carried a field experiment in Meghalaya to examine the microbial population under organic and inorganic practices in paddy. The experimental results revealed a significant difference in fungal population between control and treated plots (organic and inorganic).

Swer *et al*. (2011) through his field experiment opined that population count and diversity of fungi was significantly higher in organically fertilized plots as compared to the control.

Brar *et al*. (2015) concluded a long term experiment to study the effect of different nutrient management practices on microbial dynamics in Ludhiana (Punjab) in maize crop. The population of microbes was found significantly higher in organically treated plots as compared to inorganic fertilizers. Significantly higher fungal population (89.70×10^4cfu g^{-1} soil) were observed in plots treated with FYM + non-edible oil cakes + biofertilizers which was significantly higher than control plots.

Nakhro and Dkhar (2010) carried out a field experiment in Meghalaya for a period of two years to study the effect of organic and inorganic fertilizers on soil microbial population at two depths. They found that at the surface soil, the fungal population was significantly higher in organic plots as compared with control plots however, it was at par with inorganic plots. Whereas, at subsurface level, the significant difference was found among different treatments with highest fungal population in organic plots followed by inorganic plots and control plots, respectively.

Gachande and Shaikh (2017) carried out a field experiment at Nanded district of Maharashtra, India found that the organic inputs applied in field had more number of total colonies and diversity of fungi species in rhizosphere compared to inorganic managed field.

2.2.4 Effect on total microbial count

Mallikarjun and Maity (2018) carried out field experiment during kharif season of 2015 and 2016 in Sriniketan, West Bengal to find out the effect of integrated nutrient management (INM) practices on biological properties of soil in rice. The results revealed that soil biological properties were significantly improved by the conjoint use of organic and inorganic fertilizers after harvest of crop during consecutive years of experimentation. The population of bacteria, actinomycetes and fungi was significantly higher than in control during consecutive years of experimentation.

Gupta *et al*. (2019) carried a field trial to study the effect of integrated use of nutrients sources on microbial population in sub tropical zone of jammu. The result revealed that microbial population increased by 149% cfu × 10^{-4} when vermicompst was applied in conjunction with organic sources of nutrients over control plot, while the increase was recorded 70% cfu × 10^{-4} in comparison to plot where only inorganic sources of nutrients were used.

2.3 Effect of integrated nutrient management and seed priming on growth, yield, and quality parameters of little millet

The final yield of a crop depends upon its growth parameter of crop like field emergence, germination time, plant height, leaf length and flowering time and growth parameters of crop like numbers of productive tillers, Inflorescence length and numbers of spikes plant^{-1}, test weight. A brief review of work done on the effect of integrated nutrient management and seed priming on growth, yield and quality parameters of crops are presented under following heads.

2.3.1 Effect of integrated nutrient management and seed priming on field emergence

Sarlach *et al.* (2013) conducted an experiment on wheat in Ludhiana(Punjab)and found that the effect of different seed priming treatments were non-significant regarding germination percentage, however, germination percentage increased from 85% in control to 95% in different treatments.

Shah *et al.* (2013) carried out a field experiment to study the effect of seed priming on field emergence. They found that emergence was not significantly affected by priming, though statistically non-significant, the emergence was greatest with seed priming compared with non-priming.

Patil *et al.* (2018) conducted a field experiment on finger millet found that germination percentage was significantly higher with plots receiving only inorganic sources of nutrient (80.41 %) which was at par with plots receiving integrated sources of nutrients (80.2 %) and significantly higher than plots receiving only organic source of nutrient (77.28 %) and control plots (75.81 %).

Damalas *et al*. (2019) carried out laboratory and field trials for two years to study the effect of hydro-priming on faba bean germination and field performance. The laboratory trials showed that hydro-priming did not affect significantly final seed germination percentage and in field trials germination and seedling emergence in the field was significantly affected by hydro-priming particularly under limited soil moisture condition whereas the beneficial effect of hydro priming was masked when rainfall followed sowing.

Balaji and narayanan (2019) conducted a field experiment to study the effect of various bio-priming agents on seed quality of minor millets found that the seeds bio primed with *Pseudomonas fluorescens* 20 % (dry and liquid formulation) for 6 h was able to germinate earlier in all the studied minor millets trials. In little millet speed of emergence (73.2), the germination percentage (90 %), and vigour index (1341) was found higher when compared to unprimed seed and other treatments.

Sime and Aune (2019) investigated the effect of on- farm seed priming and fertilizer micro- dosing on maize in semi- arid agro- ecological conditions in Ethiopia found that fertilizer application did not significantly affect days to emergence and percent seed germination in neither primed nor non primed seeds. However, it significantly increased seedling uniformity and vigor compared to no fertilized plants as well as to most no primed plants.

2.3.2 Effect of integrated nutrient management and seed priming on days to flowering

Raundal *et al.* (2017) carried out a field experiment to study the response of little millet varieties to different levels of fertilizers found that higher level of fertilizer increased days to 50% flowering however, the difference was non-significant. The maximum no. of days for 50% flowering was taken by 150% RDF (85) followed by 125% and 100% RDF (84) and least days was taken by 75% RDF (84).

Singh *et al.* (2018) conducted an experiment at Sabour (Bihar) during kharif season 2014 found that Days taken to 50 % flowering and maturity of rice were affected significantly with increasing doses of nutrients (NPK) from 0 to 100% RDF applied either through fertilizers alone or in combination with organic manure. Maximum number of days taken to 50% flowering and maturity were recorded with 50 % RDF+50 % N as FYM which remained at par to all the treatment where 25-50 % N applied as organic source and with 100 % RDF but lowest number of days were recorded with control.

2.3.3 Effect of integrated nutrient management and seed priming on plant height

Moeinzadeh *et al.* (2010) reported that in sunflower, biopriming with *Pseudomonas fluorescens* UTPf76 and UTPf86 strains resulted in highest shoot height (28.2 cm), and root length (35.9 cm) in comparison with control with shoot height (13.70 cm), root length (26.3 cm).

Prabudoss *et al.* (2013) carried out a field experiment on kodo millet. The results showed that integrated nutrient management involving combined use of NPK fertilizers, vermicompost and biofertilizer significantly influenced the plant height at flowering and dry matter production.

Shah *et al.* (2013) conducted a field experiment in Khyber Pakhtunkhwa province of Pakisthan found that the average plant height was not significantly affected by seed priming, however, there was a trend in the data where plant height tends to be greater for the seed primed than un-primed treatment.

Raundal *et al.* (2017) carried out an experiment during kharif 2016 at Kolhapur (Maharashtra) The significantly higher plant height of little millet was recorded at 150 percent RDF which was on par with 125 percent RDF and significantly superior over rest of the treatments.

2.3.4 Effect of integrated nutrient management and seed priming on number of effective tillers

Rani *et al.* (2017) conducted a field experiment to study the effect of integrated nutrient management on growth characters of little millet found that productive tillers per plant was found highest with the conjoint use of organic and inorganic sources of nutrient.

Patil *et al.* (2018) carried out a field experiment in Ratnagiri (Maharashtra) taking finger millet as test crop found that Seed priming with 20% liquid *Pseudomonas fluorescence* (3.73), seed priming with 2% KH_2 PO_4 (3.28) and hydroprimed seed (3.47) showed significantly higher no. of tillers plant^{-1} over no primed seed (2.86).

Senthilkumar *et al.* (2018) carried out a field experiment to study the response of integrated use organics and fertilizers on pearl millet found that maximum number of tillers per hill was noticed with application of 125% recommended fertilizer + vermicompost @ 5 t ha^{-1} recording 7.47 and 8.40 at 60 and 90 DAT, respectively which was significantly higher than control plots.

Monish *et al.* (2019) conducted a field experiment in Tamil Nadu on foxtail millet found that the number of tillers per plant increased with different combinations of organic and inorganic sources along with bio-fertilizers. The different combinations significantly influenced the total tiller numbers as compared to control.

Thesiya *et al.* (2019) conducted a field experiment in Gujarat found that total number of productive tillers per plant were significantly influenced by the integration of organic sources with chemical fertilizers at 30 DAT, 60 DAT and 90 DAT and at harvest.

2.3.5 Effect of integrated nutrient management and seed priming on test weight

Sarlach, *et al.* (2013) conducted an experiment in wheat found that the effect of different priming treatments was non-significant on test weight of wheat.

Mondal *et al.* (2016) carried out a field experiment in sriniketan(West Bengal) found that though other growth and yield parameters of hybrid rice were affected by the integration of organic and inorganic sources of nutrients but test weight was not affected by nutrient sources.

Charate *et al.* (2018) carried out a field experiment in Bengaluru (Karnataka) to evaluate the effect of nitrogen and potassium levels on growth and yield attributes of little millet found that higher doses of fertilizers (60 kgha^{-1} N and 30 kgha^{-1} K) did not affect the test weight significantly compared to lower doses of fertilizers (20 kgha^{-1} N and 10 kgha^{-1} K).

Divyashree *et al.* (2018) conducted a field experiment and found that the different level of fertilizer 10, 20 and 30 kg N ha^{-1}, 0 and 20 kg P ha^{-1}, 0 and 10 kg K ha^{-1}did not affect the test weight of little millet significantly.

2.3.6 Effect of integrated nutrient management and seed priming on grain and straw yield

Field experiment was conducted by Mahajan *et al.* (2011) at Punjab Agricultural University Ludhiana to enhance the performance of dry direct seeded basmati rice with four seed priming treatments (control, osmo hardening, water hardening and hydro-priming). Crop with hydro priming gave superior performance as compared to other seed priming treatments. Highest grain yield of Pusa Basmati 1121 was obtained with hydro-priming at 60 kg/ha of N application applied in 3 splits.

Meena *et al.* (2013**)** conducted an experiment for two consecutive years 2010-11 and 2011-12 to evaluate the influence of hydro-priming on grain yield of wheat. The experiment was conducted with seed priming treatments (dry seed, hydro-priming, and pre-germinated seeds) in subplots. Pre germinated seed produced significantly higher grain yield (5.49 t/ha), which was statistically similar to hydro-priming (5.30 t /ha).

Malinda *et al.* (2015) evaluated that application of 100 per cent NPK + FYM increased finger millet yield (3086 kg ha^{-1}) by 9.5 per cent compared to NPK alone (2946 kg ha^{-1}).

Rani *et al.* (2017) carried out field experiment in little millet during *Kharif* 2015 to study the effect of integrated use of different types of organic manures in combination with different levels of inorganic fertilizers (NPK).The result revealed that grain and straw yields were significantly influenced with the application of different types of organic manures in conjunction with inorganic fertilizers and found highest in the treatment 100% RDF + Neem cake @ 1 t ha^{-1}and found on par with the treatment of 100% RDF+FYM @ 5 t ha^{-1} and 100% RDF + Vermicompost @ 2 t ha^{-1}, 75% RDF + Neem cake @ 1 t ha-1+*Azospirillum* 5 kg ha^{-1} +*PSB* @ 5 kg ha ha^{-1} and 75% RDF + Vermicompost @ 2 t ha^{-1}+*Azospirillum* 5 kg ha^{-1} +*PSB* @ 5 kg ha^{-1}

Raundal *et al.* (2017) carried out an experiment in little millet during kharif 2016 at Kolhapur, Maharashtra and found that the fertilizer level 150 per cent RDF recorded significantly highest grain and straw yields followed by 125 per cent RDF.. The fertilizer level 100 per cent and 75 per cent RDF recorded lowest grain and straw yield as compared to 125 and 150 per cent RDF.

Zida *et al.* (2017) carried out a field experiment, Hydro priming of pearl millet seeds was tested during two growing seasons in Burkina Faso. A total of 32 field experiments were distributed equally between two agro-ecological zones: The Northern zone receiving on average less than 600 mm annual precipitation and the Central zone receiving 600 to 900 mm annual rainfall. Hydro priming was performed by soaking of seeds in water for 6 h, followed by air-drying overnight. In the Northern zone, an increase of both emergence and yield was observed for hydro primed seeds in both years of testing. This was reflected by a higher yield observed in 13 out of 16 field experiments, increased median yield and an increase of the relative yield by +29% as a field average. In contrast, in the Central zone, a net negative effect on crop emergence was observed in both years, and only 5 out of 16 field experiments showed a yield increase for hydro primed seeds. Meteorological data confirmed the difference in rainfall between the two zones. Hydro priming by 6 h of soaking and drying of seeds overnight appears as a simple method to increase yield of pearl millet significantly in the most arid out of two agro-ecological zones tested in Burkina Faso. Drying of seeds overnight is a novel agronomically feasible approach, allowing a full day for subsequent sowing.

2.4 Effect of integrated nutrient management and seed priming on primary and secondary nutrient content and their uptake

Macronutrients play a very important role in plant growth and development. Their functions range from being structural units to redox-sensitive agents. The effect of different nutrient management practices and seed priming on these macronutrient uptake was reviewed under following head.

2.4.1 Nitrogen content and its uptake

Chung *et al.* (2000) conducted a field experiment in Taichung, central Taiwan to study the effect of Organic Matter and Inorganic Fertilizer on Nitrogen uptake of corn plants found that compost with an adequate amount of inorganic N fertilizer could reach a high N accumulation, even higher than those of the conventional chemical N fertilizer treatment.

Divyashree *et al.* (2018) carried out a field experiment taking little millet as test crop found that Highest NPK application of 30:20:10kg NPK ha^{-1}, retained higher content of nitrogen at any time of growth stage in both grain (1.36%) and straw (0.87%)

Roy *et al.* (2018) conducted a field experiment in Rachi (Jharkhand) to study the effect integrated nutrient management practices on nutrient uptake of finger millet found that there is significant improvement in the nutrient uptake of nitrogen when the inorganic sources of nutrients are used in conjunction with organic sources.

2.4.2 Phosphorus content and its uptake

Khan *et al.* (2011) conducted a field experiment in Hyderabad (A.P.) in sweet sorghum and found that Perusal data on phosphorus content and their uptake in stover and grain was significantly affected by the judicious use of organic manures with inorganic fertilizer i.e. Poultry manure, Vermicompost, FYM and biofertilizers i.e. Azospirillum, VAM.

Prabudoss *et al.* (2018) carried out a field experiment in Anna Malainagar Tamil nadu, found that the Phosphorus uptake of transplanted kodo millet was significantly influenced by various INM practices. Among them, application of 125 % recommended dose of fertilizers (55:27.5:0 kg NPK ha^{-1}) + soil application of Azospirillum @ 2 kg ha^{-1} + vermicompost @ 2 t ha^{-1} recorded significantly higher NPK uptake in transplanted kodo millet.

Keshri *et al.* (2017) carried out a field experiment in Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya,Raipur during *Kharif* season 2015-16 taking rice as test crop found that highest nitrogen uptake was found in 100% General Recommended Dose with seed priming with 0.5% P and 0.1% Zn followed by 100% GRD with water soaked seed as compared to dry seed 100% GRD (control).

Rani *et al.* (2017) carried out field experiment in little millet during *Kharif* 2015, at agriculture research station, Vizianagaram (A.P.) to study the effect of integrated use of organic manures in combination with different levels of inorganic fertilizers (NPK) on nutrient uptake by little millet. The uptake of total phosphorus was found highest in the treatments where 100% RDF was applied in conjunction with different organic manures which were significantly higher than controls and 100% RDF.

2.4.3 Potassium content and its uptake

Mondal *et al.* (2016) conducted a field experiment at Sriniketan (West Bengal) found that the potassium contents in grain and straw was non-significantly affected due to the different nutrient management practices. However, nutrient supply through conjunctive use of chemical and organic sources tended to increase the nutrient content in both grain and straw as compared to those of supplying nutrients through only chemical fertilizers.

Keshri *et al.* (2017) carried out a field experiment in Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur during *Kharif* season 2015-16 found that highest potassium uptake was found in 100% GRD with seed priming with 0.5% P and 0.1% Zn followed by 100% GRD with water soaked seed as compared to dry seed 100% GRD (control).

Rani *et al.* (2017) carried out field experiment taking little millet as test crop found that the uptake of all potassium was found highest in the treatments where 100% RDF was applied in conjunction with different organic manures which were significantly higher than controls and 100% RDF.

Roy *et al.* (2018) conducted a field experiment in Rachi (Jharkhand) to study the effect of integrated nutrient management practices on nutrient uptake of finger millet and found that there was significant improvement in the nutrient uptake of potassium when the inorganic sources of nutrients are used in conjunction with organic sources.

2.4.4 Secondary nutrient content and its uptake

Lavanya (2008) carried out a field experiment and found that calcium and magnesium content in finger millet crop did not vary considerably by using different sources and levels of fertilizer except for treatment involving lime application which showed high calcium uptake.

Saraswathi *et al.* (2018) carried out a field experiment found that total calcium and magnesium uptake by ragi crop was significantly higher in treatment receiving STCR based NPK and compost @ 10 t ha^{-1} T3 (67.55 and 44.43 kg ha^{-1}) and lowest was in control (38.46 and 22.98 kg ha^{-1}). Total S uptake (18.32 kg S ha^{-1}), was recorded highest with the application of STCR based NPK and compost @ 10 t ha^{-1}.

2.5 Effect of integrated nutrient management and seed priming on micronutrient content and their uptake in little millet.

Micronutrients are essential nutrients required in small quantities for normal growth and development of plants. The concentration of these nutrients in plants is found often within 100 mg kg^{-1}(on dry weight basis) except for iron and manganese. These elements are also known as minor and trace elements, but this does not mean that they are less important than macronutrients. The brief review of work done on effect of integrated nutrient management and seed priming on micronutrient uptake is given here.

Dhaliwal *et al.* (2014) carried out a laboratory analysis on the plant samples of rice and wheat collected from the long-term field experiment of Department of Soil Science, PAU, Ludhiana found that the concentration of Zn, Cu, Fe and Mn (26.74, 4.93, 39.18 and 24.60 mg kg^{-1}, respectively) in wheat grains and (27.07, 2.97, 36.72 and 52.28 mg kg^{-1}, respectively) in rice grains was found higher in the treatments where organic manure was added along with chemical fertilizers. Similarly, the uptake of Zn, Cu, Fe and Mn (123.1, 23.6, 189.4 and 112.1 g ha^{-1} respectively) in wheat grains and (158.4, 17.3, 194.0 and 306.1 g ha^{-1}, respectively) in rice grains were found higher where organic manure was added along with chemical fertilizers.

Keshri *et al.* (2017) carried out a field experiment in Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya,Raipur during *Kharif* season 2015-16 taking rice as test crop found that highest zinc uptake was found in

100% GRD with seed priming with 0.5% P and 0.1% Zn followed by 100% GRD with water soaked seed as compared to dry seed 100% GRD (control).

Rani *et al.* (2017) carried out field experiment in little millet at Vizianagaram (A.P.) studied the effect of integrated use of organic manures in combination with different levels of inorganic fertilizers (NPK) on nutrient uptake by little millet found that the cationic micronutrients uptake was found highest with the application of organic manures in conjunction with the inorganic manures.

Prasanth *et al.* (2019) carried out a field experiment in Bengaluru taking finger millet as a test crop found higher cationic micronutrient content in grain and straw in T5 treatment which received FYM @ 10 t ha^{-1} + 100% RDF and T4(FYM @ 10 t ha^{-1} + 50% RDF). The lower micronutrient concentration in grain and straw was registered in T1 i.e absolute control. Significantly higher cationic micronutrient uptake by grain and straw was recorded in T5 treatment which received FYM @ 10 t ha^{-1} + 100% RDF and it was on par with T4 (FYM @ 10 t ha^{-1} + 50% RDF). The lower iron, copper, zinc and manganese uptake by grain and straw was observed in T1 absolute control.

Puniya *et al.* (2019) carried out a field experiment on rice-wheat cropping system and found that the nutrient management had a significant influence on the micronutrient uptake in rice and wheat. Uptake of Fe, Mn, Cu and Zn by grain and straw of rice and wheat with the application of NPK + Zn + FYM was significantly higher than all other nutrient management treatments except NPK + FYM. The lowest uptake of micronutrients by the grain and straw of rice and wheat was obtained with the control.

CHAPTER – III

MATERIALS AND METHODS

Research study entitled **"Effect of Integrated Nutrient Management and seed priming on nutrient uptake and yield of little millet (*Panicum sumatrense*)"** was conducted in DKS farm, IGKV, Bhatapara, Dist- Baloda Bazar, Chhattisgarh under field conditions. The materials used and methodology adopted during the course of experiment is described in this chapter.

3.1 Experimental site

The field experiment was conducted at DKS farm, IGKV, Bhatapara, Dist-Baloda Bazar, Chhattisgarh during *kharif* season, 2019. Experimental site was situated at 21°45'25" North latitude and 81° 59'22" East longitudes having an altitude of about 930 m above Mean sea level (MSL).

3.2 Meteorological observations

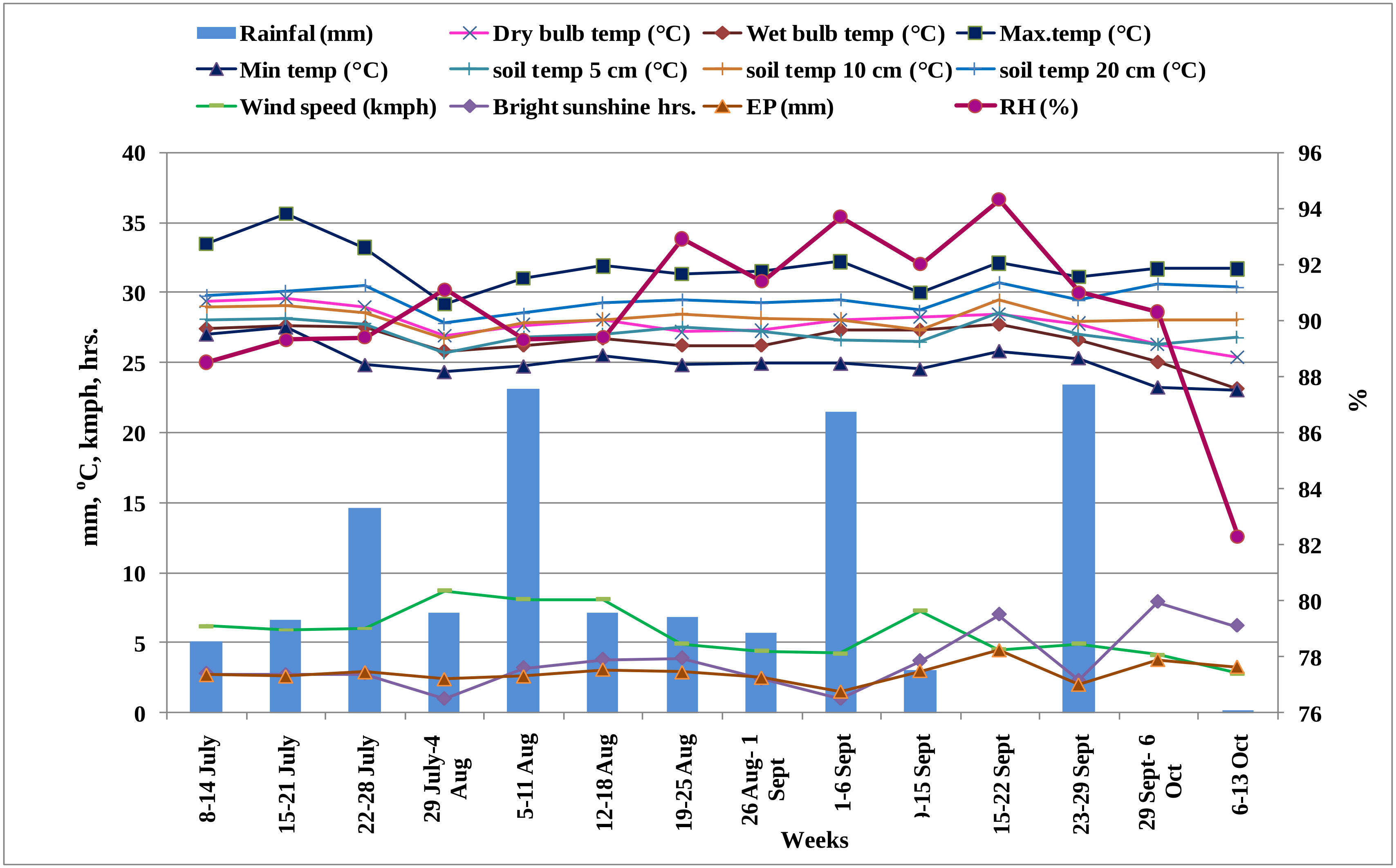
The climate of the place is subtropical. It receives rainfall mainly from South-West monsoon (June-October). The weather data during experimental period was collected from the meteorological observatory located at D.K.S. College of Agriculture & Research station, Alesur, Bhatapara (IGKV). The weekly mean meteorological data during the crop growth period is furnished in Appendix A and depicted in figure 3.1.

The total rainfall received during the crop growth period was 872.2 mm. The weekly mean rainfall during the crop growth period ranged from 0 mm during 15-22 Sept to 23.4 mm during 23-29 Sept in which the crop received 163.8 mm rainfall. The highest single day rainfall i.e. 138.7mm was received on 8 August.

The weekly mean maximum temperature during the crop growth period ranged from 29.2^{o}C to 35.6^{o}C with an average of 31.9 ^{o}C and the weekly mean minimum temperature 23.0^{o}C to 27.3^{o}C with an average 25 ^{o}C, while the weekly mean dry bulb temperature ranged from 25.4^{o}C to 29.6 ^{o}C with an average of 27.8 ^{o}C and weekly mean wet bulb temperature ranged from 23.1 ^{o}C to 27.6 ^{o}C with an average of 26.5 ^{o}C.

The mean relative humidity ranged from 82.3% to 94.3% with an average of 90.35 %.. The weekly mean sunshine hours varied from 1.0 to 7.9 hours with an average of 3.6 hours per day. The mean wind speed ranged from 2.8 to 8.7 kmph with an average of 5.7 kmph. The mean EP ranged from 1.5 to 4.9 mm with an average of 2.84 mm.

Fig 3.1 Mean weekly meteorological observations



3.3 Details of the field experiment

3.3.1 Physico-chemical properties

The present study was taken up in *kharif* 2019. Representative soil samples were collected before layout of the experiment and analyzed after processing.

Table 3.1: Physico-chemical properties of experimental soil

S.No.	Particulars	Values	Status
I. Physical properties			
1	Sand (%)	18	
2	Silt (%)	52	
3	Clay (%)	30	
4	Soil textural class	Silty clay loam	
II. Chemical properties			
1	pH (1:2.5)	7.20	Neutral
2	EC (dSm^{-1} at 25^{0}C)	0.80	Non saline
3	Organic carbon (%)	0.68	Medium
4	Available N (kg ha^{-1})	125.44	Low
5	Available P (kg ha^{-1})	17.02	Medium
6	Available K (kg ha^{-1})	484.96	High
7	Available Ca (kg ha^{-1})	5488.00	High
8	Available Mg (kg ha^{-1})	1975.68	High
9	Available S (mg kg^{-1})	19.04	Low
10	Available Fe (mg kg^{-1})	17.15	High
11	Available Zn (mg kg^{-1})	2.07	High
12	Available Cu (mg kg^{-1})	2.37	High
13	Available Mn (mg kg^{-1})	5.21	Medium

3.3.2 Lay-out of the experiment

The experiment was laid out in split plot design with 5 main plot treatments and 4 sub plot treatments, replicated thrice.

1.	Experimental Design	:	Split Plot Design
2.	Replication	:	3
3.	No of treatments		
	• Main plot treatment	:	5
	• Sub plot treatment	:	4
4.	General recommended dose of Fertilizer	:	20 kg/ha N: 20 kg/ha P_2O_5 : 10 kg/ha K_2O

Table 3.2 details of the experiment

1.	Crop	:	*Panicum sumatrense* Roth ex Roemer and Schultes
2.	Variety	:	CG Kutki 2
3.	Plot size (gross)	:	3 m × 5 m
4.	Total number of plots	:	60
5.	Establishment method	:	Direct seeding
6.	Row to row spacing	:	30 cm
7.	Plant to plant spacing	:	10 cm
8.	Soil type	:	*Alfisol*

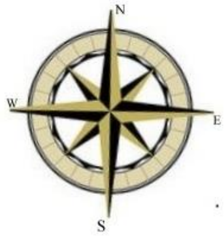
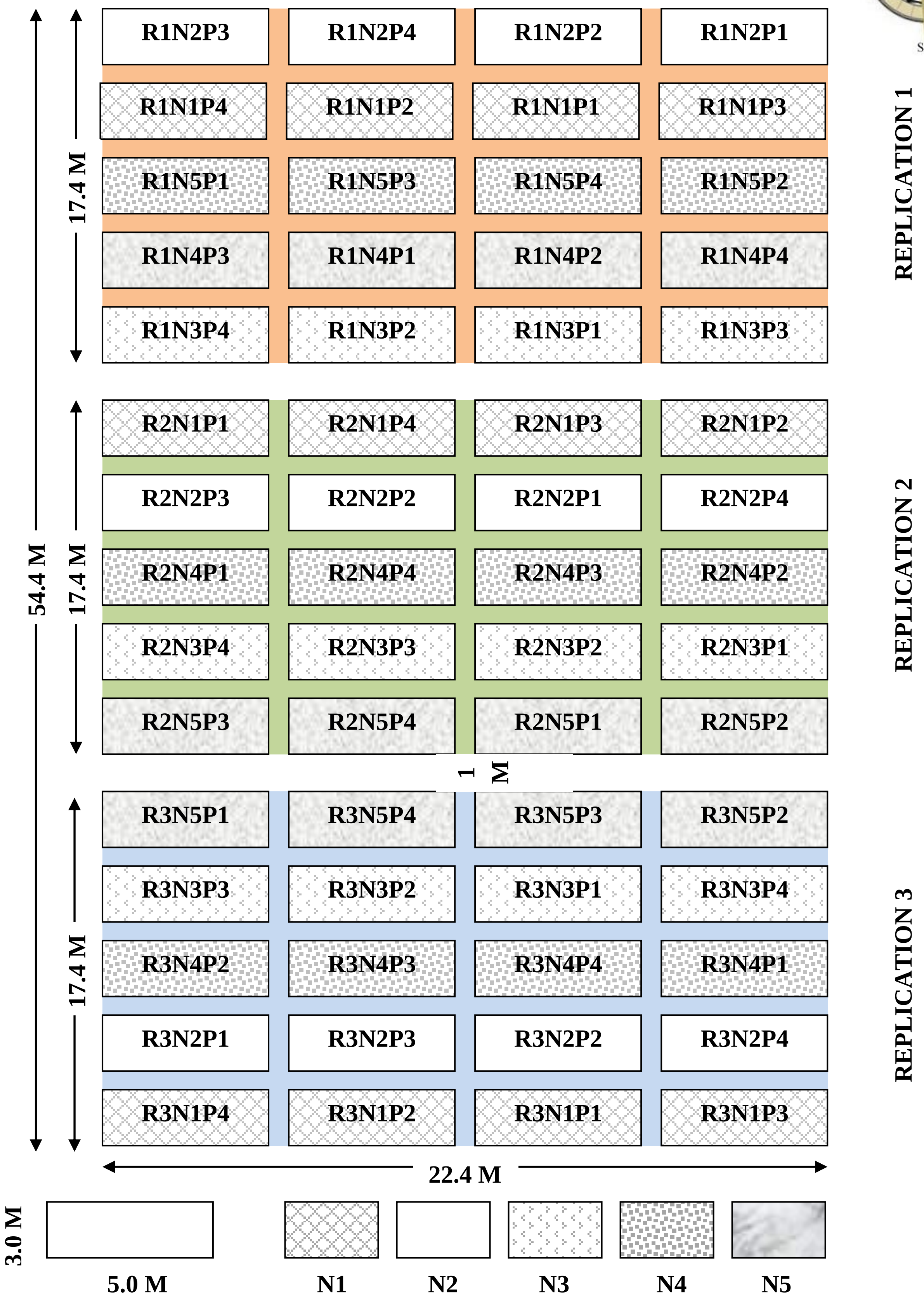


Fig 3.2 Layout of the field experiment



3.3.3 Treatment details

		I. Main-Plot treatments (Nutrient management)
N1	:	Control.
N2	:	125 kg Neem cake + 1.25 tons ha^{-1} vermicompost.
N3	:	50 kg/ha N : 50 kg/ha P_2O_5 : 50 kg /ha K_2O and 2% Borax spray at flowering.
N4	:	125 kg Neem cake + 1.25 tons ha^{-1} vermicompost + 50 kg/ha N : 50 kg/ha P_2O_5 : 50 kg /ha K_2O and 2% Borax spray at flowering.
N5	:	Recommended dose of fertilizer i.e. 20 kg/ha N : 20 kg/ha P_2O_5 : 10 kg /ha K_2O.

		I. Sub-Plot treatments (priming)
P1	:	Control.
P2	:	Hydropriming for 8 hrs by adopting seed to solution ratio of 1:1 and then mixing with Carbendazim @ 2.5-3 gm kg^{-1} seeds and leaving the mixture for 24 hrs before sowing.
P3	:	Seed priming with 2% KH_2PO_4 for 8 hrs by adopting seed to solution ratio of 1:1 and then mixing with Carbendazim @ 2.5-3 gm kg^{-1} seeds and leaving the mixture for 24 hrs before sowing.
P4	:	Seed priming with 20% liquid *Pseudomonas fluorescens.*

- Magnesium through $MgSO_4$ @ 20 kg $acre^{-1}$ and calcium CaO @ 6 kg $acre^{-1}$ was applied uniformly in all the plots before seeding except control treatment plots.

Table3.2 Crop calendar during *kharif 2019*

S.No.	Field operation	Date	Days after sowing
1.	Land preparation and leveling	9/07/19	-
2.	Initial soil samples collection	11/07/19	-
3.	Priming of seeds	11/07/19	-
`4.	Sowing of seeds	12/07/19	-
5.	Manure and fertilizer application in plots	12/07/19	-
6.	Thinning	16/07/19	4
7.	Hand weeding	12/08/19	30
8.	Insecticide application	02/09/19	51
9.	Top dressing of urea	03/09/19	52
10.	Foliar spray of Borax	11/09/19	60
11.	Harvesting of crop	12/10/19	90
12.	Plot wise soil sample collection (after harvest)	15/10/19	93

3.4 Cultivation details

3.4.1 Field preparation

The experimental field was dry ploughed twice and later leveled uniformly. Field laid out and prepared bunds for 60 individual plots. Nine lines were demarked manually with the help of mattock for line sowing of little millet.

3.4.2 Sowing method

Direct seeding method was adopted for sowing the little millet after priming as per treatments. Seeds were shown at 3-4 cm depth manually.

3.4.3 Thinning

Thinning was performed four days after seeding to maintain desired plant to plant spacing of 30 × 10 cm, and to maintain desired plant population.

3.4.4. Irrigation management

Being a rainfed crop under study there was no single irrigation applied to the field. Crop experiment was totally dependent on rainfall occurred during the crop season that was 872.2 mm.

3.4.5 Weed management

Manual weeding by hand was performed at 30 DAS, for control of weeds and keeps the crop weed competition at minimum level during critical period for weed control.

3.4.6 Fertilizer application

Fertilizers were applied as per the treatments. One third of nitrogen, full dose of phosphorous and full dose recommended dose of potassium were applied in the form of urea, SSP and MOP as basal dose at the time of sowing. One-third nitrogen required was applied at maximum tillering stage as urea and remaining one-third nitrogen was applied at panicle initiation stage as urea. Magnesium through $MgSO_4$ @ 20 kg acre^{-1} and calcium CaO @ 6 kg acre^{-1} was applied uniformly in all the plots before seeding except control treatment plots. 2% Borax spray application at the rate of 300 liters ha^{-1} was done at the time of flowering.

3.4.7 Manures application

Organic manures in the form of neem cake and vermicompost were applied as per the treatments. Manure was applied uniformly in plots using broadcasting method. The composition of neem cake was N (Nitrogen 2.61%), P (Phosphorus 0.78%), K(Potassium 1.34%), and composition of vermicompost was N (Nitrogen 0.69%), P(Phosphorus 0.47%) and K(Potassium 0.71%).

3.4.7 Plant protection

The crop was affected from stem borer. However, monocrotophos @ 1.5 ml/liter of water was sprayed at maximum tillering stage (45 DAS).

3.4.8 Harvesting

The crop was harvested manually at 90 DAS. The five representative sample plants were harvested separately, and then crop was harvested from net plot area and kept for threshing. The plants from each plot were sun dried properly to facilitate easy threshing. Threshing was performed manually using the wooden sticks followed by winnowing.

3.5 Growth and yield parameters

3.5.1 Field emergence

Field emergence was recorded by counting the number of seeds germinated and emerged in the field on 10th day after sowing. The field emergence was calculated by using following formula suggested by Saha and Basu (1981).

$$\text{Field emergence (\%)} = \frac{\text{Number of seedlings emerged}}{\text{Total number of seeds sown}}$$

3.5.2 Days to 1st flowering

Days to 1st flowering was taken from sowing to the stage when first flowers in each plot was observed and the days taken for the first flowering from the date of sowing was counted and the mean values were expressed in days.

3.5.3 Days to 50% flowering

Days to 50% flowering was taken from sowing to the stage when ears have emerged from main tiller in 50 percent population of each plot and mean was expressed as days.

3.5.4 Plant height

Plant height was measured at 45 and 60 days after sowing and at harvest. Five plants were randomly selected and tagged for all the intermittent height measurement, and their height was measured from ground level to the tip of the earhead of main tiller.

3.5.5 Number of effective tillers per plant

Total number of panicles per plant was counted from each of selected sample plants and average was calculated.

3.5.6 Test weight/ thousand grain weight (g)

From each plot hundred grains were counted “MANUALY” and weight was recorded using electric balance and then converted in test weight in grams by multiplies by ten.

Test weight = 100 grain weight × 10

3.5.7 Grain and straw yield

From each plot, grain and straw yields were recorded for five sample plant and whole plot separately. The straw was sun dried properly in field and the yield was recorded. The grain weight was taken after threshing the crop for each plot separately. The grain and straw yields were expressed as kg ha^{-1}.

3.6 Collection and preparation of samples

3.6.1 Plant samples

Plant samples were collected at harvest of little millet and were oven dried with hot air oven until the constant weight was achieved. Dried samples were prepared by grinding with grinding machine and analyzed for plant nutrients content.

3.6.2 Soil samples

Initially, a representative soil sample (0-15 cm depth) was taken by collecting soil from eight different places followed by quartering process, the soil was passed through 2 mm sieve. After harvest of crop surface, soil samples (0-15 cm depth) were collected from each plot separately and shade dried, samples are powdered with wooden rod and sieved in 2 mm sieve and analyzed for pH, EC, OC, Available major and micronutrients.

3.7 Analysis

3.7.1 Analysis for study the chemical properties of soil

The soil samples collected plot wise from 15 cm depth, analyzed for physico-chemical properties and contents of NPK, following standard procedures which are described below.

3.7.1.1 pH

Soil reaction (pH) was determined in 1:2.5 soil to water suspension using pH meter (Systronic Digital pH meter 335) after shaking the sample with water for 30 minutes (Jackson, 1967).

3.7.1.2 Electrical conductivity

Electrical conductivity was measured in the supernatant solution of 1 : 2.5 soil to water solution which was used a day before for pH measurement.

3.7.1.3 Organic carbon

Organic carbon content was determined by method described by Walkley and Black (1934) which involve determination of partly decomposed fraction of organic matter by oxidation of readily oxidizable organic carbon by potassium dichromate in presence of sulphuric acid.

3.7.1.4 Available Nitrogen

Available N in the soil was determined as mineralizable N using alkaline $KMnO_4$ method given by Subbaiah and Asija (1956) and expressed as kg ha^{-1}.

3.7.1.5 Available Phosphorus

Available P was extracted by Olsen's reagent i.e. 0.5 M $NaHCO_3$ as described by Olsen *et al.* (1954). Ascorbic acid method of Watanabe and Olsen (1965) was used for reducing the extractant partially for development of characteristic blue colour. Intensity of blue color was measured spectrophotometrically at 660 nm by using UV Spectrophotometer (SHIMADZU UV-1800). The available phosphorus content expressed as kg P_2O_5 ha^{-1}.

3.7.1.6 Available Potassium

Neutral (pH 7) normal (1N) ammonium acetate (Muhr *et al*. 1965) was used for extraction of available K from soil and was measured by using Flame photometer (Elico CL 378) and expressed as kg K_2O ha^{-1}.

3.7.1.7 Available Calcium and Magnesium

Calcium and magnesium were extracted using Neutral (pH 7) normal (1N) ammonium acetate (Muhr *et al*. 1965). Then, calcium and magnesium in the extract was determined by using ammonium chloride-ammonium hydroxide buffer and Eriochrome Black T indicator by titrating it against versenate solution. Calcium was estimated by titrating the ammonium acetate extract of the soil against the versenate solution in presence of sodium hydroxide and mureixide.

3.7.1.8 Available Sulphur

Available S in soil was extracted using 0.15% $CaCl_2$ and extracted-S was measured turbidimetrically. Turbidity was developed based on precipitation of sulphate ions as $BaSO_4$. Turbidity developed was measured using spectrophotometer at 420 nm wavelength.

3.7.1.9 Available Fe, Mn, Zn and Cu

DTPA-extraction method was used for determination of available iron, manganese, zinc and copper in soil. It involves extraction of soil with DTPA-$CaCl_2$-TEA reagent (pH 7.3) and measuring the extracted amounts in AAS.

3.7.2 Analysis for study the biological properties of soil viz. population count of Bacteria, Actinomycetes and fungi.

For isolation of bacteria, actinomycetes and fungi from soil, three different media were used for specific group of micorflora. Rose Bengal media (appendix B1) was used for fungi, nutrient agar media (appendix B2) for bacteria and Kenknight media (appendix B3) was used for growing actionmycetes which were sterilized in an autoclave at 121^0C temperature and 15 psi for 15 minutes. For microbial counting serial dilution of soil samples were done by taking 1gm of soil in 9 ml of sterilized water in a dilution tube. This constituted 10^{-1} concentration. Using a fresh sterile pipette took 1 ml of this suspension was added to 9 ml of sterile water to get 10^{-2}dilution. This sequence was continued till a dilution of 10^{-7}.

3.8 Plant Analysis

3.8.1 Digestion of plant samples for Nitrogen estimation.

0.25 gm of prepared plant samples were taken and transferred to digestion tube. Then 1 gm of salt mixture was added to these plant samples in the digestion tube followed by addition of 5 ml of concentrated sulphuric acid and left for pre digestion over night. Next morning, the digestion tubes were digested with the help of digester.

3.8.2 Estimation of Nitrogen content

Total nitrogen was estimated by micro-kjeldhal as per procedure suggested by AOAC (1995).

3.8.3 Digestion of plant samples for P, K, Ca, Mg, S and micronutrient estimation.

One gram of powdered sample was digested with 10ml di-acid mixture (nitric acid and perchloric acid at 10:4) after overnight pre digestion. The white residue left at the bottom of flask was diluted with water to known volume after filtration. This extract was used in the estimation of P, K, Ca, Mg, S and micronutrients.

3.8.4 Estimation of Phosphorus content

Phosphorus content of plant samples were measured by vanadomolybdo phosphoric acid yellow color method using an aliquot of diacid digested sample. The intensity of yellow color developed was measured at 430 nm using spectrophotometer (Jackson, 1973).

3.8.5 Estimation of Potassium content

Potassium content of plant samples were determined by using the diacid digested extract. The reading of potassium was taken with the help of flame photometer (Chapman and pratt, 1961).

3.8.6 Estimation of Calcium and Magnesium content

The calcium and magnesium in the diacid extract of plant sample was determined by using ammonium chloride-ammonium hydroxide buffer and

Eriochrome Black T indicator by titrating it against versenate solution. Calcium was estimated by titrating the diacid extract of the plant sample against the versenate solution in presence of sodium hydroxide and mureixide (Piper, 1966).

3.8.7 Estimation of Sulphur content

The diacid extract of plant sample was used for determination of sulphur content in plant samples by turbidity method and turbidity developed was measured with the help of spectrophotometer at 420 nm (Jackson, 1973).

3.8.8 Estimation of micronutrient content

Micronutrient content of plant samples were determined by using the diacid digested extract. The reading of iron, manganese, zinc and copper was taken with the help of atomic absorption spectrophotometer (Zosoki and Burau, 1977).

3.8 Nutrient Uptake

Uptake of primary, secondary and micronutrient was calculated using the grain and straw yields and nutrient content using the formula.

$$\text{Macro nutrient uptake (kg ha}^{-1}) = \frac{(\%) \text{ nutrient content in plant material} \times \text{yield (kgha}^{-1})}{100}$$

$$\text{Micro nutrient uptake (g ha}^{-1}) = \frac{\text{nutrient content in plant material(PPM)} \times \text{yield (kgha}^{-1})}{1000}$$

3.9 Statistical analysis

All the field and laboratory experiment results were recorded and tabulated in systematic manner. The final observations were statistically analyzed by split plot design (Gomez and Gomez, 1984). For significant treatment effects, standard error of means (SEm) and critical differences were calculated at 5% of probability.

ANOVA				
Source of variation	**d.f**	**SS**	**MS**	**F**
Replication	r-1	RSS	RMS	RMS/ EMS(a)

A	a-1	ASS	AMS	AMS/ EMS(a)
Error (a)	(r-1) (a-1)	ESS(a)	EMS(a)	
B	b-1	BSS	BMS	BMS/ EMS(b)
AB	(a-1) (b-1)	ABSS	ABMS	ABMS/ EMS(b)
Error (b)	a (r-1) (b-1)	ESS (b)	EMS(b)	
Total	rab -1	TSS		

CHAPTER - IV
RESULTS AND DISCUSSION

The field experiment on **"Effect of Integrated Nutrient Management and seed priming on nutrient uptake and yield of little millet (*Panicum sumatrense*)"** was carried out during *kharif* season of 2019-20 at DKS farm, IGKV, Bhatapara, Dist- Baloda Bazar and data pertaining to various crop growth and soil parameters recorded during and after the harvest are presented below. The results are presented in appropriate tables and graphs and briefly discussed under the following heads.

4.1 Effect of integrated nutrient management and seed priming on soil pH, EC and OC

The data on effect of INM and seed priming on soil pH, EC and OC% was shown in table 4.1 and depicted in fig 4.1.

4.1.1 Effect of integrated nutrient management and seed priming on soil pH

Soil pH ranged from 7.31 to 7.34 (Table 4.1). Soil pH differed non-significantly due to nutrient management treatments. The highest pH was found in N1 and N4 (7.34) followed by N3 (7.33) and the lowest pH was associated with N2 treatment (7.31).

Soil pH differed non-significantly due to priming treatment however the highest pH was found in P1, P2 and P4 (7.33) followed by P2 treatment (7.32).

The interaction effect of N×P for soil pH was found to be differed non-significantly. Maximum soil pH was recorded in N1P3 (7.4) and least was recorded in N1P4 treatment combination (7.29).

Soil pH was affected non-significantly by various treatment combinations. This might be due to the buffering capacity of soil. Similar results were also reported by Dubey *et al.* (2014).

4.1.2 Effect of integrated nutrient management and seed priming on soil EC

Soil EC ranged from 0.8 to 0.9 dS/m (Table 4.1). Soil EC differs non-significantly due to nutrient management treatments. Higher EC was recorded in N2, N3 and N4 (0.9 dS/m) and the lower EC was recorded in N1 and N4 treatment (0.9 dS/m).

Soil EC also differed non-significantly due to priming treatments. The highest EC was found in P1, P2 and P4 (0.9 dS/m) followed by P2 (0.8 dS/m).

The interaction effect of N×P for soil EC was also found to be differed non-significantly.

The EC differed non-significantly due to various treatment combinations, similar results were found by Kannan *et al*. (2013) and Dubey *et al.* (2014).

4.1.3 Effect of integrated nutrient management and seed priming on OC% in soil

The organic carbon content varied from 0.61% to 0.86% (Table 4.1). The highest organic carbon content in soil was found in N4 treatment (0.86 %) which was significantly higher than all the treatments followed by N2 treatment (0.82 %) which was statistically at par with N3 treatment (0.79%). The lowest organic matter content in soil was observed for control plots N1 treatment (0.61%) which was statistically significantly lower than remaining treatments.

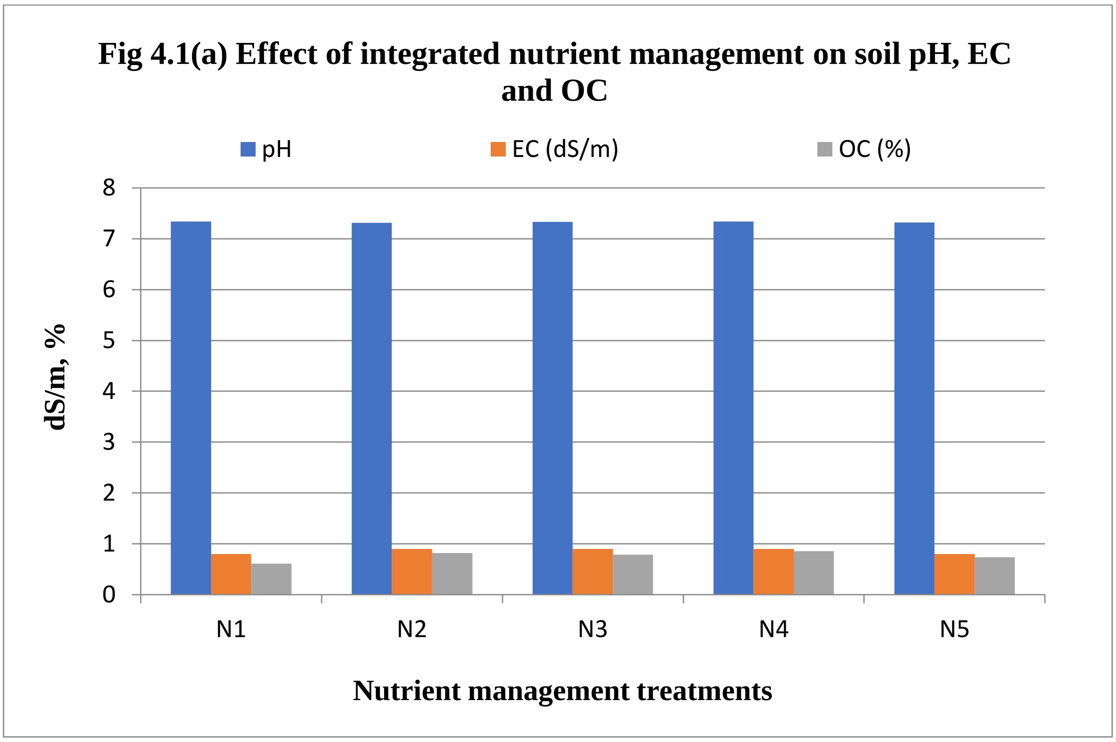
The soil organic carbon content differed non-significantly due to various seed priming treatments. The highest soil organic carbon content was found in P3 treatment (0.8%) and the lowest organic carbon content was associated with P1 and P2 treatment (0.75%).

The interaction effect of N×P for soil organic carbon content was found to be differed non-significantly. Maximum soil organic carbon content was recorded in N4P2 and N3P3 (0.91 %) and lowest recorded in N1P3 treatment combinations (0.52%).

Higher build up of organic carbon content was found by conjoint use of organic and inorganic nutrient combinations. This might be due to enhanced root growth and production of more crop residues leading to build up of more organic residues in soil. Similar findings were also reported by Khan *et al.* (2011) and Rani *et al.* (2017).

Table 4.1: Effect of integrated nutrient management and seed priming on soil pH, EC and OC

Treatments	pH	EC (dS/m)	OC (%)
Nutrient management			
N1: Control	7.34	0.8	0.61[d]
N2: 125 kg Neem cake + 1.25 tons ha^{-1} vermicompost	7.31	0.9	0.82[ab]
N3: 50 kg/ha N : 50 kg/ha P_2O_5 : 50 kg /ha K_2O and 2% Borax spray at flowering.	7.33	0.9	0.79[bc]
N4: N2+N3	7.34	0.9	0.86[a]
N5: Recommended dose of fertilizer i.e. 20 kg/ha N : 20 kg/ha P_2O_5 : 10 kg /ha K_2O	7.32	0.8	0.74[c]
SEm±	**0.02**	**0.02**	**0.02**
C.D.(P=0.05)	**NS**	**NS**	**0.05**
Priming			
P1: Control	7.33	0.8	0.75
P2: Hydropriming for 8 hrs	7.32	0.8	0.75
P3: Seed priming with 2% KH_2PO_4 for 8 hrs	7.33	0.8	0.8
P4: Seed priming with 20% liquid *Pseudomonas fluorescens*	7.33	0.9	0.76
SEm±	**0.02**	**0.02**	**0.02**
C.D.(P=0.05)	**NS**	**NS**	**NS**
Interaction	**NS**	**NS**	**NS**



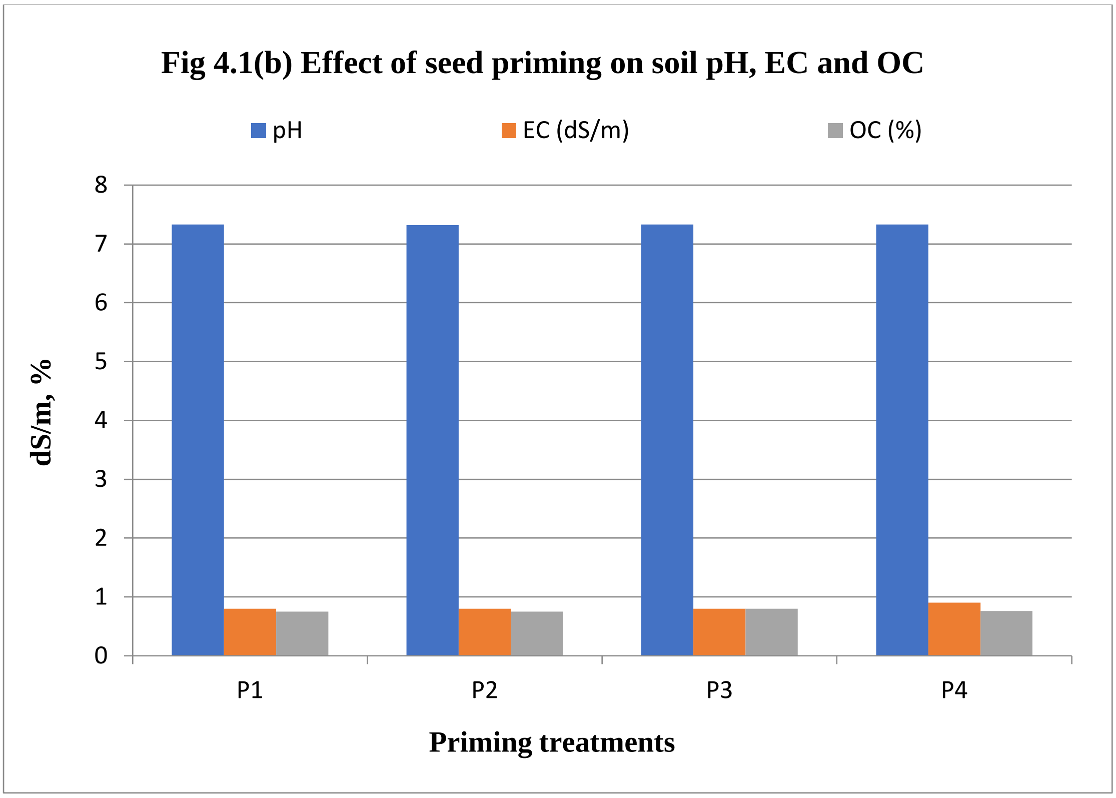


Fig 4.1 Effect of integrated nutrient management and seed priming on soil pH, EC and OC

4.2 Effect of integrated nutrient management and seed priming on available macronutrient (kg/ha) in soil

The data on effect of INM and seed priming on soil available macronutrient are presented in table 4.2 and depicted in fig 4.2.

4.2.1 Effect of integrated nutrient management and seed priming on available nitrogen (kg/ha) in soil

Plant available nitrogen in soil varied from 122.3 kg/ha to 146.3 kg/ha (Table 4.2). The highest available nitrogen was found in N4 treatment (146.3 kg/ha) which was on par with N3 treatment (141.1 kg/ha) but statistically significantly higher than N1 (122.3 kg/ha) and N5 treatment (125.4 kg/ha).

Available nitrogen differed non-significantly due to priming treatment. The highest available nitrogen was found in P4 (138 kg/ha) followed by P1 and P2 treatment (135.5 kg/ha) and the lowest was associated with P3 treatment (132.1 kg/ha).

The interaction effect of N×P for available nitrogen was found to be differed non-significantly. Maximum available nitrogen was recorded in N4P1 and N4P4 (150.5 kg/ha) and the least recorded in N1P1 treatment combination (108.7 kg/ha).

This might be due to higher amount of N and OC content present in organic manure which hastens the process of mineralization during crop growth. Another reason for higher available nitrogen may be due to addition of mineral fertilizer N along with organic sources which have contributed to the reduction of C:N ratio and thus increased the rate of decomposition resulting in faster availability resulting in availability of nutrients from manures. Similar beneficial effect of INM was reported on available N by Samant *et al.* (2017).

4.2.2 Effect of integrated nutrient management and seed priming on available phosphorus (kg/ha) in soil

Plant available phosphorus in soil varied from 18.0 kg/ha to 21.6 kg/ha (Table 4.2). The highest available phosphorus was found in N4 treatment (21.6 kg/ha) which was statistically higher then rest of the treatments. The lowest soil available phosphorus was found in N1treatment (18.0 kg/ha).

Available phosphorus content differed non-significantly due to various priming treatment. The highest available phosphorus was found in P4 (19.9 kg/ha) followed by P3treatment (19.6 kg/ha) and the lowest was associated with P1 and P2 treatment (19.4 kg/ha).

The interaction effect of N×P for available phosphorus was found to be differed non-significantly. Maximum available phosphorus was recorded in N4P4 (21.8 kg/ha) and the least recorded in N1P1 treatment combination (17.3 kg/ha).

Higher available phosphorus in case of integration of nutrients might be due to release of organic acids during microbial decomposition which helped in the solubility of native phosphates thus increasing available phosphorus. The applied organic matter may have led to formation of coating on the sesquioxide clay mineral. Similar results were reported by Pallavi *et al*. (2016) and Pareek *et al.* (2018).

4.2.3 Effect of integrated nutrient management and seed priming on available potassium (kg/ha) in soil

Plant available potassium in soil varied from 479.5 kg/ha to 515.0 kg/ha (Table 4.2). The highest available potassium content was found in N4 and N3 treatment (515 kg/ha) however it is statistically similar with rest of the treatments. The lowest soil available potassium content was found in N1 treatment (479.5 kg/ha).

Available potassium differed non-significantly due to priming treatments. The highest available potassium content was found in P4 treatment (517 kg/ha) followed by P2 (503.3 kg/ha) and lowest available phosphorus was associated with P3 treatment (490.4 kg/ha).

The interaction of N×P for available potassium content was found to be differed non-significantly. Maximum available potassium was recorded in N5P4 (544.3 kg/ha) and the least was recorded in N1P1 treatment combination (458.5 kg/ha)

The beneficial effect on integration of available potassium may be ascribed to the reduction of K fixation and release of potassium due to the interaction of organic matter with the clay mineral besides the direct potassium addition to the potassium pool of the soil. However, due to the higher initial status of available potassium, the difference was non-significant for various treatment combinations. Similar results were found by Roy *et al*. (2018).

4.2.4 Effect of integrated nutrient management and seed priming on available calcium (kg/ha) in soil

Plant available calcium in soil varied from 5515.4 kg/ha to 5771.5 kg/ha (Table 4.2). The highest available calcium content in soil was found in N4 treatment (5771.5 kg/ha) which was statistically at par with N3 (5698.4 kg/ha) and N2 treatment (5689.2 kg/ha) and significantly different from N5 (5606.9 kg/ha) and N1 (5515.4 kg/ha) treatments.

Plant available calcium in soil differed non-significantly due to priming treatments. The highest available calcium content was found in P2 treatment (5736.8 kg/ha) followed by P3 (5636.8 kg/ha) and the lowest was associated with P1 treatment (5612.4 kg/ha).

The interaction effect of N×P for soil available calcium was found to be differed non-significantly. Maximum available calcium was recorded in N3P3 (5817.3 kg/ha) and the least recorded in N5P1 treatment combination (5414.8 kg/ha).

The enhanced availability of calcium in the integrated nutrient treated plots and the lower availability of soil available calcium in control plots might be due to the application of calcium CaO @ 6 kg acre^{-1}which is applied uniformly in all the plots before seeding except control treatment plots. Similar findings were also reported by Gogoi *et al*. (2015).

4.2.5 Effect of integrated nutrient management and seed priming on available magnesium (kg/ha) in soil

Plant available magnesium in soil varied from 1959.2 kg/ha to 2036 kg/ha (Table 4.2). The highest available magnesium content in soil was found in N4 treatment (2036 kg/ha) however, no significant difference was found among different nutrient management practices. The lowest soil available magnesium content was found in N1 treatment (1959.2 kg/ha).

Plant available magnesium in soil differed non-significantly due to priming treatments. The highest available magnesium was found in P3 (2010.8 kg/ha) followed by P4 (2006.4 kg/ha) and lowest was recorded in P1 and P2 treatment (1959.2 kg/ha).

The interaction effect of N×P for soil available magnesium was found to be differed non-significantly. Maximum available magnesium content was recorded in N2P3 (2129.34kg/ha) and the least was recorded in N1P2 treatment combination (1909.8kg/ha).

The enhanced availability of magnesium in the integrated nutrient treated plots and the lower availability of soil available magnesium in control plots might be due to application of the Magnesium through $MgSO_4$ @ 20 kg acre^{-1} which was applied uniformly in all the plots before seeding except control treatment plots, however the difference was non-significant due to high value of initial magnesium content. Similar findings were also reported by Gogoi *et al.* (2015).

4.2.6 Effect of integrated nutrient management and seed priming on available sulphur (kg/ha) in soil

Plant available sulphur in soil varied from 18.6 kg/ha to 21.1 kg/ha (Table 4.2). The highest available sulphur was found in N4 treatment (21.1 kg/ha) which was statistically similar to N2 (20 kg/ha) and N3 treatment (19.5 kg/ha). However, it was significantly higher than N5 (19 kg/ha) and N1 (18.6 kg/ha) treatments.

Available sulphur to plant differed non-significantly between priming treatments. The highest available sulphur was found in P1 treatment (20.7 kg/ha) followed by P4 (20.2 kg/ha) and the lowest was recorded in P3 treatment (18.3 kg/ha).

The interaction effect of N×P for available sulphur was found to be differed non-significantly and Maximum available sulphur was recorded in N1P4 (24.6 kg/ha) and least recorded in N5P3 (17.2 kg/ha) treatment combination.

The higher value of plant available sulphur in soil might be ascribed due to enhanced mineralization process of sulphur by microorganism in the integrated nutrient management practices. Similar results were reported by Kanwar *et al.* (2017) and Mishra *et al.* (2019).

Table 4.2: Effect of integrated nutrient management and seed priming on plant available macronutrient (kg/ha) in soil

Treatment	Available nitrogen (kg/ha)	Available phosphorus (kg/ha)	Available potassium (kg/ha)	Available calcium (kg/ha)	Available magnesium (kg/ha)	Available sulphur (kg/ha)
Nutrient management						
N1: Control	122.3	18.0	479.5	5515.4	1959.2	18.6
N2:125 kg Neem cake + 1.25 tons ha^{-1} vermicompost	138.0	18.9	507.6	5689.2	1986.7	20.0
N3: 50 kg/ha N : 50 kg/ha P_2O_5 : 50 kg /ha K_2O and 2% Borax spray at flowering.	141.1	20.3	515.0	5698.4	2008.6	19.5
N4: N2+N3	146.3	21.6	515.0	5771.5	2036.0	21.1
N5: Recommended dose of fertilizer i.e. 20 kg/ha N : 20 kg/ha P_2O_5 : 10 kg /ha K_2O	125.4	19.2	498.1	5606.9	2003.1	19.0
SEm±	**3.99**	**0.1**	**12.4**	**30.1**	**41.43**	**0.5**
C.D.(P=0.05)	**13.03**	**0.4**	**NS**	**98.3**	**NS**	**1.5**
Priming						
P1: Control	133.0	19.4	501.2	5612.4	1988.9	20.7
P2: Hydropriming for 8 hrs	135.5	19.4	503.3	5736.8	1988.9	19.4
P3: Seed priming with 2% KH_2PO_4 for 8 hrs	132.1	19.6	490.4	5656.3	2010.8	18.3
P4: Seed priming with 20% liquid *Pseudomonas fluorescens*	138.0	19.9	517.4	5619.7	2006.4	20.2
SEm±	**2.54**	**0.2**	**8.6**	**37.6**	**27.09**	**0.6**
C.D.(P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Interaction	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Fig 4.2 (a) Effect of integrated nutrient management on plant available N, P, K and S (kg/ha) in soil

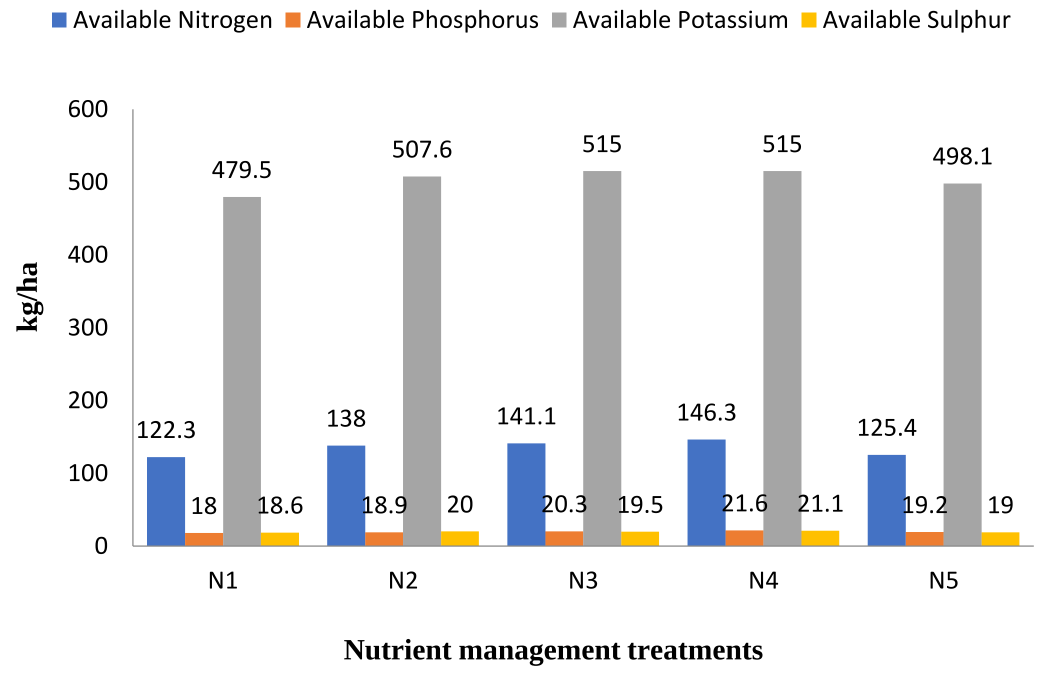


Fig 4.2 (b)Effect of seed priming on plant available N, P, K and S (kg/ha) in soil

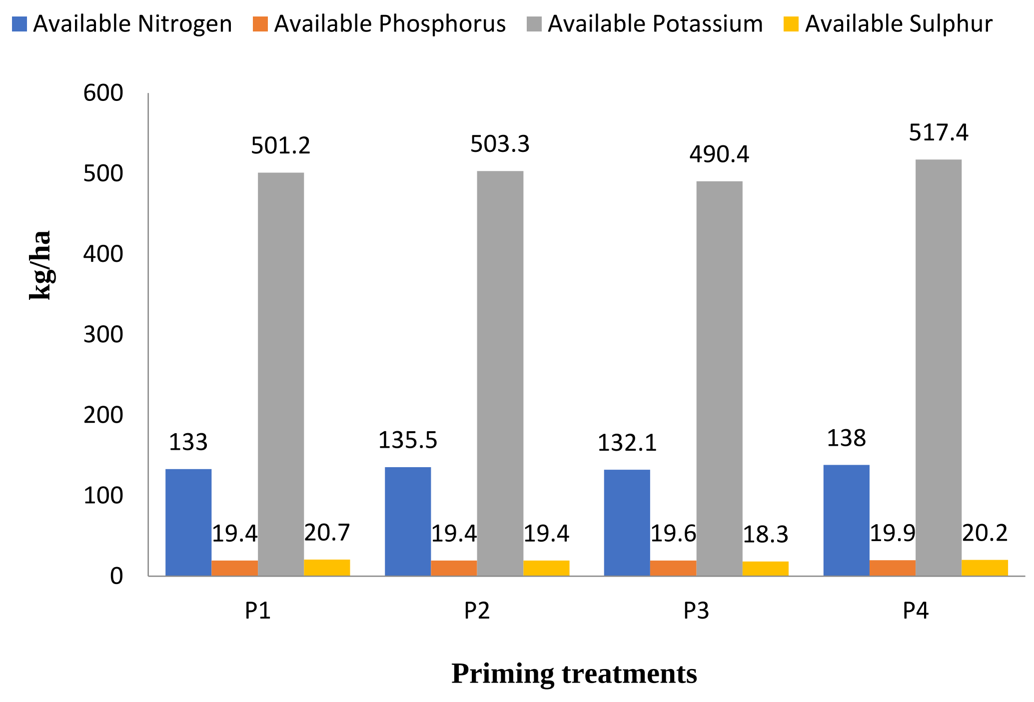


Fig. 4.2 (c) Effect of integrated nutrient management plant available Ca and Mg (kg/ha) in soil

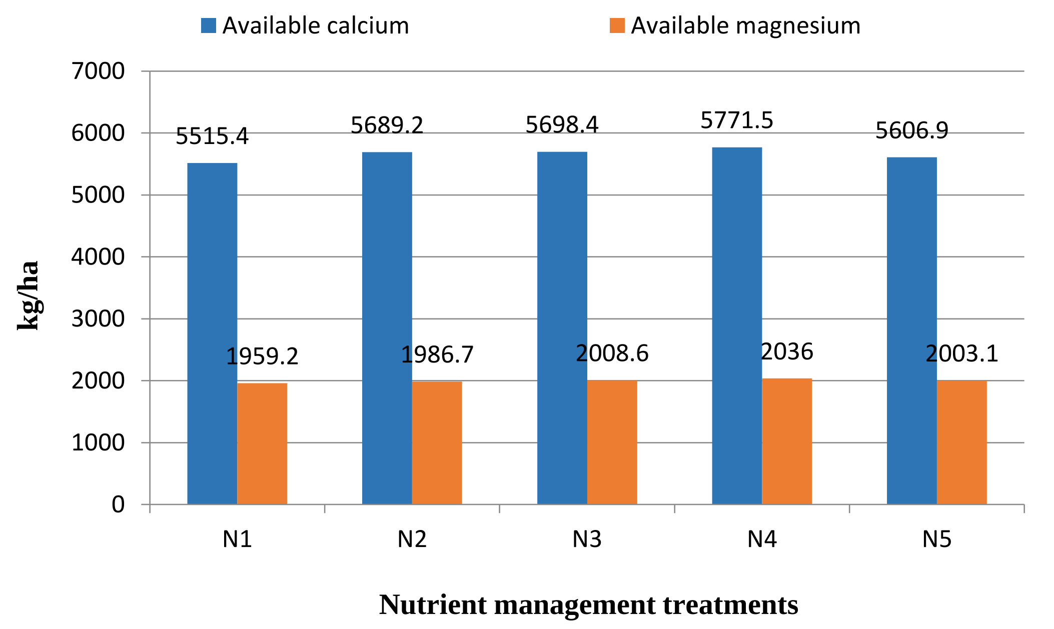


Fig 4.2 (d) Effect of seed priming on plant available Ca and Mg (kg/ha) in soil

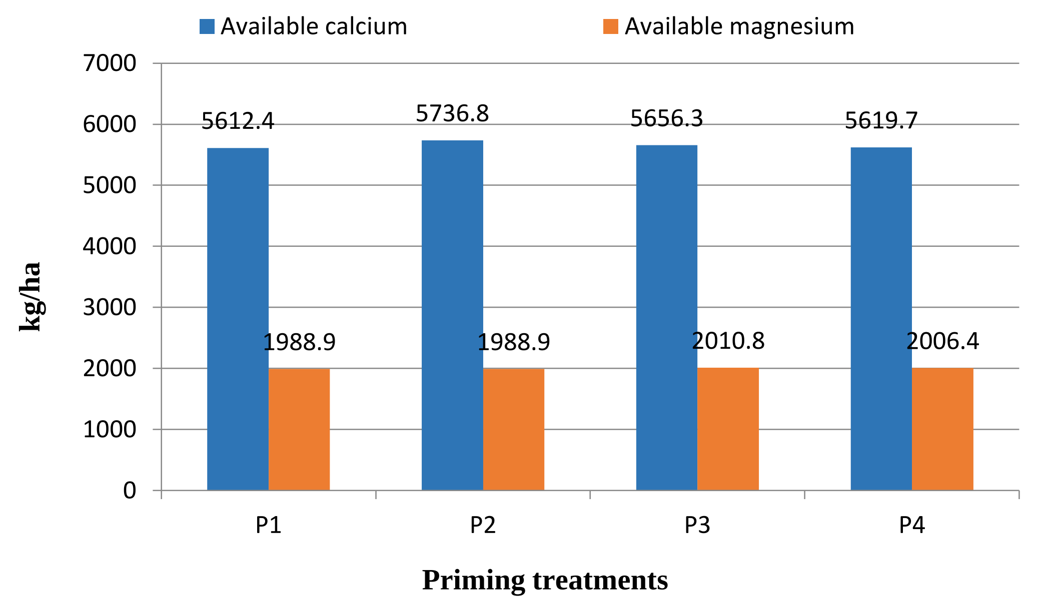


Fig 4.2 Effect of integrated nutrient management and seed priming on plant available macronutrient in soil

4.3 Effect of integrated nutrient management and seed priming on available micronutrient (mg/kg) in soil

The data on effect of INM and seed priming on soil available micronutrient are shown in table 4.3 and depicted in fig. 4.3.

4.3.1 Effect of integrated nutrient management and seed priming on available Fe (mg/kg) in soil

Plant available iron in soil varied from 20.88 mg/kg to 17.50 mg/kg (Table 4.3). The highest available iron was found in N4 treatment (20.88 mg/kg) which was significantly higher than rest of the treatments. The lowest soil available iron was found in N1 treatment (17.50 mg/kg).

Plant available iron in soil differed non-significantly between priming treatments. Highest available iron was found in P1 treatment (19.16 mg/kg) followed by P4 (19.14 mg/kg) and the lowest was recorded in P3 treatment (18.77 mg/kg).

The interaction effect of N×P for plant available iron in soil was found to be differed non-significantly. The maximum available iron was recorded in N4P3 (21.53 mg/kg) and the lowest was recorded in N1P3 (17.43 mg/kg) treatment combination.

The higher availability of available iron in soil particularly with use of integrated nutrient management may be ascribed to mineralization, reduction in fixation of nutrients by organic matter and complexing properties of humic substances released from vermicompostswith micronutrients. Similar results were reported by Kanzaria *et al.* (2017).

4.3.2 Effect of integrated nutrient management and seed priming on available Mn (mg/kg) in soil

Plant available manganese in soil varied from 7.16 mg/kg to 5.66 mg/kg (Table 4.3). The highest available manganese was found in N4 treatment (7.16 mg/kg) which was significantly higher than rest of the treatments. The lowest soil available manganese was found in N1 treatment (5.66 mg/kg).

Plant available manganese in soil differed non-significantly between priming treatments. The highest available iron was found in P1 (6.24 mg/kg) followed by P2 (6.14 mg/kg) and the lowest was recorded in P3 and P4 treatment (6.12 mg/kg).

The interaction effect of N×P for plant available manganese in soil was found to be differed non-significantly. Maximum available manganese was recorded in N4P1 (7.57 mg/kg) and the lowest was recorded in N3P4 treatment combination (5.32 mg/kg).

The higher availability of available manganese in soil particularly with use of integrated nutrient management may be ascribed to mineralization, reduction in fixation of nutrients by organic matter and complexing properties of humic substances released from vermicomposts with micronutrients. Lakshmi *et al*. (2013) reported similar results.

4.3.3 Effect of integrated nutrient management and seed priming on available Cu (mg/kg) in soil

Plant available copper in soil varied from 2.35 mg/kg to 3.9 mg/kg (Table 4.3). The highest available copper was found in N4 treatment (2.35 mg/kg) which was statistically at par with N3 treatment (3.55 mg/kg) and significantly higher than rest of the treatments. The lowest soil available copper was found in N1 treatment (2.35 mg/kg).

Plant available copper in soil differed non-significantly between priming treatment. The highest available copper was found in P3 (3.35 mg/kg) followed by P1 treatment (3.2 mg/kg) and lowest was recorded in P4 treatment (3.00 mg/kg).

The interaction effect of N×P for plant available copper in soil was found to be differed non-significantly. Maximum available copper was recorded in N4P3 (4.23 mg/kg) and lowest was recorded in N1P4 treatment combination (2.18 mg/kg).

The higher availability of available copper in soil particularly with use of integrated nutrient management may be ascribed to mineralization, reduction in fixation of nutrients by organic matter and complexing properties of humic substances released from vermicomposts with micronutrients. Similar results were reported by Rani *et al*. (2017).

4.3.4 Effect of integrated nutrient management and seed priming on available Zn (mg/kg) in soil

Plant available zinc in soil varied from 2.15 mg/kg to 2.57 mg/kg (Table 4.3). The highest available zinc was found in N4 treatment (2.57 mg/kg) which was significantly higher than rest of the treatments. The lowest soil available zinc was found in N1 treatment (2.15 mg/kg).

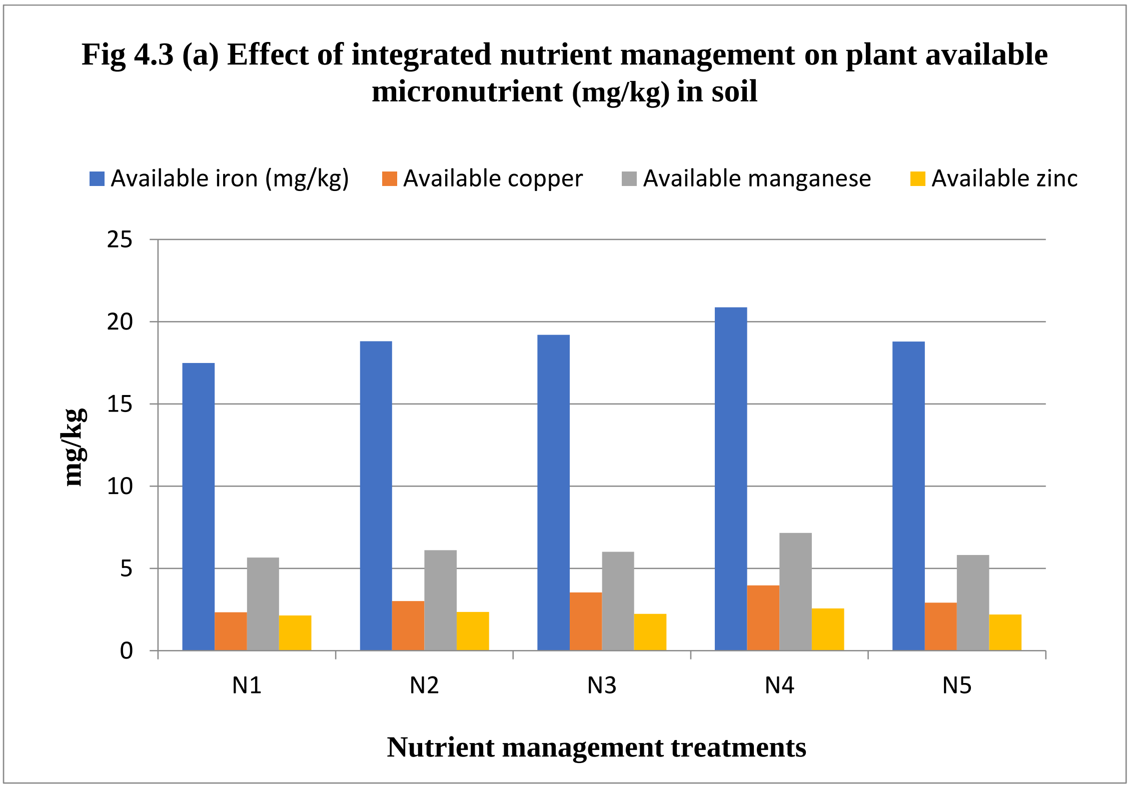
Plant available zinc in soil differs non-significantly between priming treatment. Highest available zinc was found in P1 (2.33 mg/kg) followed by P3 treatment (2.32 mg/kg) and lowest was recorded in P4 treatment (2.27 mg/kg).

The interaction effect of N×P for plant available zinc in soil was found to be differed non-significantly. Maximum available zinc was recorded in N4P1 (2.70 mg/kg) and thr lowest was recorded in N1P4 treatment combination (2.09 mg/kg).

The higher availability of zinc in soil particularly with use of integrated nutrient management may be ascribed to mineralization, reduction in fixation of nutrients by organic matter and complexing properties of humic substances released from vermicomposts with micronutrients. Similar results were reported by Kanzaria *et al*. (2010) and Rani *et al*. (2017).

Table 4.3: Effect of integrated nutrient management and seed priming on available micronutrient (mg/kg) in soil

Treatment	Available iron (mg/kg)	Available copper (mg/kg)	Available manganese (mg/kg)	Available zinc (mg/kg)
Nutrient management				
N1: Control	17.50^{c}	2.35^{c}	5.66^{b}	2.15^{c}
N2:125 kg Neem cake + 1.25 tons ha^{-1} vermicompost	18.82^{b}	3.02^{b}	6.11^{b}	2.35^{b}
N3: 50 kg/ha N : 50 kg/ha P_2O_5 : 50 kg /ha K_2O and 2% Borax spray at flowering.	19.21^{b}	3.55^{a}	6.02^{b}	2.25^{bc}
N4: N2+N3	20.88^{a}	3.97^{a}	7.16^{a}	2.58^{a}
N5: Recommended dose of fertilizer i.e. 20 kg/ha N : 20 kg/ha P_2O_5 : 10 kg /ha K_2O	18.81^{b}	2.93^{b}	5.82^{b}	2.21^{c}
SEm±	**0.18**	**0.14**	**0.22**	**0.03**
C.D.(P=0.05)	**0.60**	**0.46**	**0.71**	**0.11**
Priming				
P1: Control	19.17	3.20	6.24	2.33
P2: Hydropriming for 8 hrs	19.10	3.09	6.14	2.31
P3: Seed priming with 2% KH_2PO_4 for 8 hrs	18.77	3.35	6.12	2.32
P4: Seed priming with 20% liquid *Pseudomonas fluorescens*	19.15	3.01	6.12	2.27
SEm±	**0.22**	**0.11**	**0.17**	**0.04**
C.D.(P=0.05)	**NS**	**NS**	**NS**	**NS**
Interaction	**NS**	**NS**	**NS**	**NS**



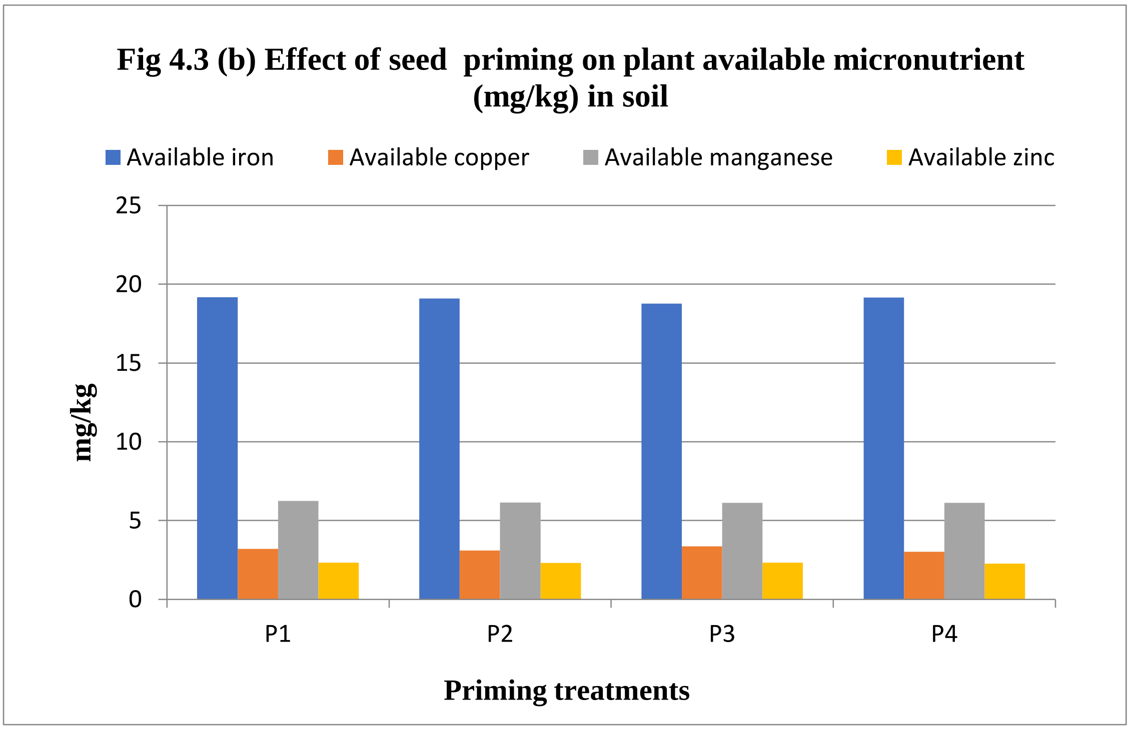


Fig 4.3 Effect of integrated nutrient management and seed priming on available micronutrient

4.4 Effect of integrated nutrient management and seed priming on soil microbial count

The data on effect of INM and seed priming on soil microbial count are shown in table 4.4 and depicted in fig 4.4.

4.4.1 Effect of integrated nutrient management and seed priming on total bacteria population

Bacterial population was ranged from 81.67 to 97.67 × 10 $^{-7}$cfu g$^{\mathbf{-1}}$ in soil samples (Table 4.4). The highest bacterial population in post harvest soils was found in N4 treatment (97.25 × 10 $^{-7}$cfu g^{-1}) which was statistically similar to N3 (93.67 × 10 $^{-7}$cfu g^{-1}) and N2 treatment (93.08 × 10 $^{-7}$cfu g^{-1}) and significantly higher than N1 treatment (81.67 × 10 $^{-7}$cfu g^{-1}).

Total bacterial population in post harvest soil samples differed non-significantly due to priming treatments. The highest bacterial population was found in P3 (93.70 × 10 $^{-7}$cfu g^{-1}) followed by P2 (91.53 × 10 $^{-7}$cfu g^{-1}) and the lowest bacterial population was recorded in P4 treatment (89.87 × 10 $^{-7}$cfu g^{-1}).

The interaction effect of N×P for total bacterial population in soil was found to be differed non-significantly. Maximum bacterial population was recorded inN4P2 (103 × 10 $^{-7}$cfu g^{-1}) and the lowest was recorded in N1P1 treatment combination (81.00 × 10 $^{-7}$cfu g^{-1}).

Treatments having integrated source of nutrients showed significantly higher bacterial population, this may be due to addition of organic manure which provided sufficient organic matter and acted as a substrate and sources of food for bacteria. The N1 treatment recorded lower bacterial count might be attributed to lack of sufficient organic substrate. Tao *et al.* (2015) and Sanjeeta *et al.* (2019) reported similar results.

4.4.2 Effect of integrated nutrient management and seed priming on total actinomycetes population

Actinomycetes population was ranged from 28.47 to 33.25 × 10 $^{-5}$cfu g$^{\mathbf{-1}}$ in post harvest soil (Table 4.4). The highest actinomycetes population in post harvest soil was found in N4 treatment (33.25 × 10 $^{-5}$cfu g^{-1}) which was statistically significantly higher than rest of the treatments. The lowest actinomycetes count was found in N1 treatment (28.47 × 10^{-5}cfu g^{-1}).

Total actinomycetes population in post harvest soil differed non-significantly between priming treatments. The highest actinomycetes population was found in P1 (30.60 × 10^{-7}cfu g^{-1}) followed by P2 treatment (29.87 × 10^{-7}cfu g^{-1}) and lowest actinomycetes population was recorded in P4 treatment (29.33 × 10^{-7}cfu g^{-1})

The interaction effect of N×P for total actinomycetes population in soil was found to be differed non-significantly. Maximum actinomycetes population was recorded in N4P1 (35 × 10^{-5}cfu g^{-1}) and the lowest was recorded in N1P3 treatment combination (27.67 × 10^{-7}cfu g^{-1})

Actinomycetes population was less than bacterial population is post-harvest soil, however treatments receiving organic manures showed significantly higher actinomycetes population than control plot N1 treatment which is supported by the findings of Thakare and Wake (2015), and Mairan and Dhawan (2016).

4.4.3 Effect of integrated nutrient management and seed priming on total fungi population

Fungi population was ranged from 7.87 to 9.67 × 10^{-4}cfu $g^{\mathbf{-1}}$ in post harvest soil (Table 4.4). The highest fungi population in post harvest soil was found in N4 treatment (9.67× 10^{-4}cfu g^{-1}) which was at par with N2 (9 × 10^{-4}cfu g^{-1}) and statistically higher than rest of the treatments. The lowest fungi population was found in N1 treatment (7.87 × 10^{-4}cfu g^{-1}).

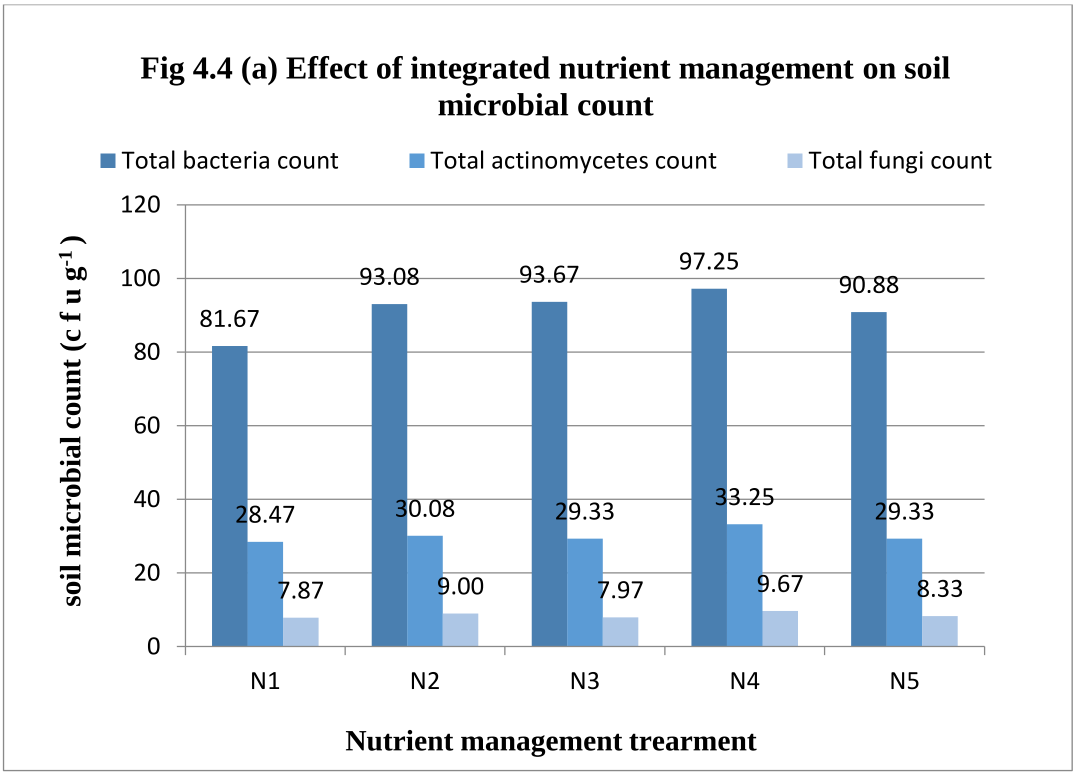
Total fungi population in post harvest soil differed non-significantly between priming treatments. Highest fungi population was found in P3 (8.76 × 10^{-7}cfu g^{-1}) followed by P2 (8.62 × 10^{-7}cfu g^{-1}) and the lowest fungi population was recorded in P4 treatment (8.34 × 10^{-7}cfu g^{-1}).

The interaction effect of N×P for total fungi population in soil was found to be differed non-significantly. Maximum fungi population was recorded in N4P2 (10.33 × 10^{-5}cfu g^{-1}) and the lowest was recorded in N1P4 treatment combination (7.49 × 10^{-7}cfu g^{-1}).

These results are closely confirmative with the recent result reported by Nakhro and Dkhar (2015) and Brar *et al*.(2015) who stated that the fungi population increased in organically amended plot compared to controlled plots which may be due to addition of organic amendments that might have large impact on size and activity of fungal population.

Table 4.4: Effect of integrated nutrient management and seed priming on soil microbial count

Treatment	Total bacteria count $\times 10^{-7}$ cfu g^{-1} soil	Total actinomycetes count $\times 10^{-5}$ cfu g^{-1} soil	Total fungi count $\times 10^{-4}$ cfu g^{-1} soil
Nutrient management			
N1: control	81.67^{c}	28.47^{c}	7.87^{c}
N2:125 kg Neem cake + 1.25 tons ha^{-1} vermicompost	93.08^{ab}	30.08^{b}	9.00^{ab}
N3: 50 kg/ha N : 50 kg/ha P_2O_5 : 50 kg /ha K_2O and 2% Borax spray at flowering.	93.67^{ab}	29.33^{bc}	7.97^{c}
N4: N2+N3	97.25^{a}	33.25^{a}	9.67^{a}
N5: Recommended dose of fertilizer i.e. 20 kg/ha N : 20 kg/ha P_2O_5 : 10 kg /ha K_2O	90.88^{b}	29.33^{bc}	8.33^{bc}
SEm±	**1.94**	**0.34**	**0.25**
C.D.(P=0.05)	**6.33**	**1.11**	**0.82**
Priming			
P1: control	90.13	30.60	8.56
P2: Hydropriming for 8 hrs	91.53	29.87	8.62
P3: Seed priming with 2% KH_2PO_4 for 8 hrs	93.7	30.13	8.76
P4: Seed priming with 20% liquid *Pseudomonas fluorescens*	89.87	29.78	8.34
SEm±	**1.75**	**0.30**	**0.16**
C.D.(P=0.05)	**NS**	**NS**	**NS**
Interaction	**NS**	**NS**	**NS**



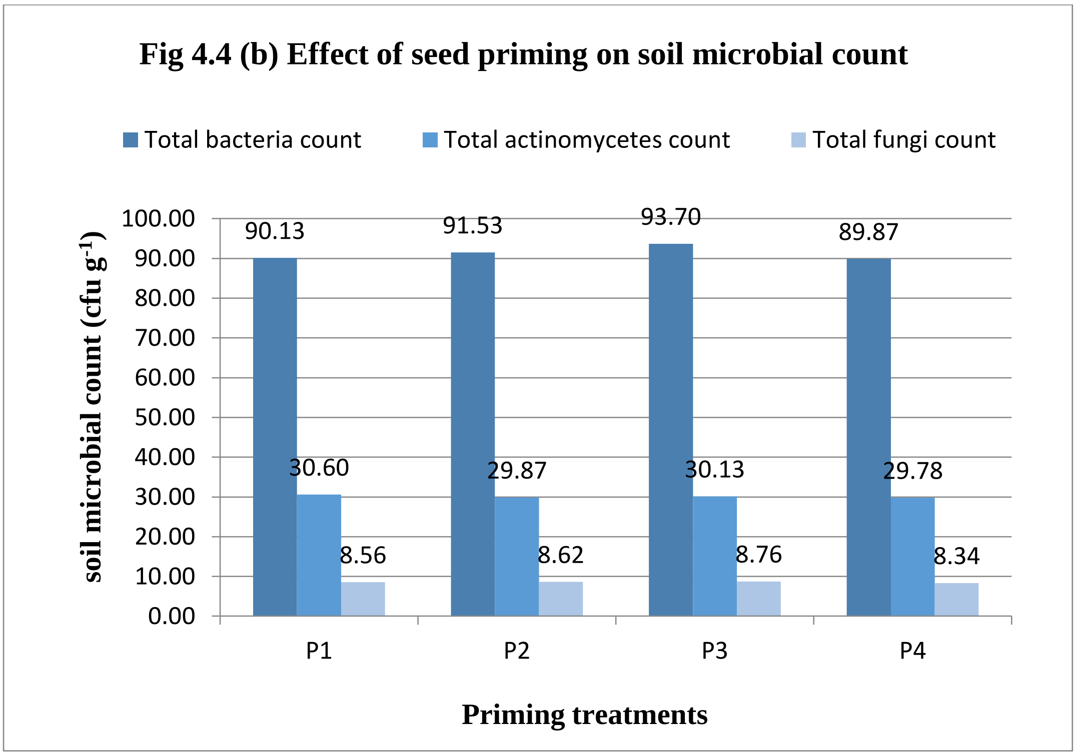


Fig 4.4 Effect of integrated nutrient management and seed priming on soil microbial count

4.5 Effect of integrated nutrient management and seed priming on growth and yield parameters of little millet

The data on effect of INM and seed priming on growth and yield parameters of little millet are shown in table 4.5 and depicted in fig 4.5.

4.5.1 Effect of integrated nutrient management and seed priming on field emergence (%)

Field emergence of little millet seeds varied from 88.3% to 84.6% (Table 4.5). The highest Field emergence was found in N4 treatment (88.3%) however, the difference was non-significant to other treatments. The lowest field emergence in the field was found in N1 and N2 (84.6%) treatments.

Field emergence in the field differed non-significantly between priming treatments. The highest filed emergence was found in P3 (87.7%) followed by P4 (87.3%) treatments. The lowest field emergence was found in P2 treatment (84.3%).

The interaction effect of N×P for field emergence in the field was found to be differed non-significantly. Maximum field emergence was recorded in N4P4 (91.7%) and the lowest field emergence was recorded in N1P2 (80%) treatment combination.

The field emergence in the field was higher is integrated nutrient management and seed primed with 2% KH_2PO_4 and bioprimed seed with 20% liquid *Psedomonas fluorescens* however, the difference was non-significant. This might be due to the higher rainfall on the week of sowing. Similar results were found by Damalas *et al*. (2019) and Sime and Anue (2019).

4.5.2 Effect of integrated nutrient management and seed priming on plant height (cm)

The highest plant height at 45 DAS of little millet crop was found in N4 (82.8 cm) which was at par with N3 (82.6) significantly higher than N2 (77.7 cm) and N1 (76.9). Lowest plant height at 45 DAS was found in N1 (76.9 cm). Same trend was followed by plant height at 60 DAS and plant height at harvest where the highest plant height at 60 DAS (107 cm) and plant height at harvest (153.9 cm) was found in N4 treatment. Whereas the lowest plant height at 45 DAS (76.9 cm), 60 DAS (100.3 cm) and at harvest (140.1 cm) was found in N1 treatment which remains significantly low than N4 treatment in all the stages of growth.

Plant height at 45 DAS, 60 DAS and plant height at harvest differed non-significantly between priming treatment. However lowest height at 45 DAS (79.3 cm), 60 DAS (102.3 cm) and plant height at harvest (148.1 cm) was recorded by N1 treatment. The higher plant heights in all the stages of crop growth were recorded by N3 and N4 treatments however the difference was non-significant. Interaction effect of N×P was also found non-significant for plant height at all the growth stages.

The increased height in N4 and N3 treatments might be due to the immediate release of available nutrients from the inorganic fertilizer whereas lowest value of plat growth was recorded at absolute control N1 due to lack available nutrients to the crop at early time. Similar finding were reported by Prabudoss *et al.* (2013) and Raudal *et al.* (2017). Priming treatment did not affect the height inspite of early emergence this may be due to heavy rainfall in 2nd week after sowing. Similar results were found by Shah *et al.* (2013).

4.5.3 Effect of integrated nutrient management and seed priming on number of effective tillers/plant

Number of effective tillers/plant of little millet varied from 5.4 to 6.5 (Table 4.5). Number of effective tillers/plant was found highest in N4 treatment (6.5) which was at par with N3 (6.4) and significantly higher than the other treatments. Lowest number of effective tillers/plant was found in N1 treatment (5.4).

Number of effective tillers/plant differed non-significantly between priming treatments. The highest numbers of effective tillers/plant was found in P3 treatment (6.1) followed by P4 treatment (6) and the lowest number of tillers/plant was recorded in P1 treatment (5.8).

The interaction effect of N×P for numbers of effective tillers/plant was found to be differed non-significantly. Maximum numbers of effective tillers/plant was recorded in N4P3 (6.9) and the lowest number of effective tillers/plant was recorded in N1P1 treatment combinations (5.1).

The enhancement in tiller number through use of integrated nutrient might be due to luxuriant availability of nutrient for growth and development of auxillary bud from which tillers are emerged. These results are in corroborative with the findings of Senthilkumar *et al*. (2018) and Monish *et al*. (2019). In priming treatment higher number of effective tiller/plant was found in seed primed with 2% KH_2PO_4 which is in conformity with the findings of Patil *et al.* (2017).

4.5.4 Effect of integrated nutrient management and seed priming on DAS to 1st flowering

The DAS to 1st flowering of little millet seeds varied from 43 to 45 (Table 4.5). The highest DAS to 1st flowering was found in N4 treatment (45) which was significantly higher than N2 and N1 treatments (44).

The DAS to 1st flowering differed non-significantly between priming treatments. The maximum DAS to 1st flowering was found in P3 and P4 treatments (45) and the lowest DAS to 1st flowering was recorded in P1 treatment (44).

The interaction effect of N×P for DAS to 1st flowering was found to be differed non-significantly. Maximum DAS to 1st flowering was recorded in N4P4 (46) and the lowest DAS to 1st flowering was recorded in N2P1 treatment combinations (43).

The increased DAS to 1st flowering in N3 and N4 treatment might be due to better availability of nutrients applied either through fertilizers or in combination with organic sources increased vegetative phase of the crop vis-a-vis delayed flowering. The results have got close conformity with the findings of Singh *et al.* (2018).

4.5.5 Effect of integrated nutrient management and seed priming on DAS to 50% flowering

The DAS to 50% flowering of little millet seeds varied from 53 to 54. The highest DAS to 50% flowering was found in N3 and N4 treatment (54). However, no significant difference was found between different treatments. The lowest DAS to 50% flowering was found in N1 (53).

The DAS to 50% flowering differed non-significantly between priming treatment. The highest DAS to 50% flowering was found in P4 and P3 treatments (54) and the lowest DAS to 50% flowering was recorded in P1 and P2 treatments (53).

The interaction effect of N×P for DAS to 50% flowering was found to be differed non-significantly. The maximum DAS to 50% flowering was recorded in N4P3 and N3P4 treatment combinations (55) and lowest DAS to 50% flowering was recorded in N2P1 and N1P treatment combinations (52).

The significant difference which was observed in DAS to 1st flowering was reduced in DAS to 50% flowering. This might be due to release of nutrients from mineralization of organic matter in soil which hasten the flowering process however, still longer time was taken by N3 and N4 treatments for 50% flowering might be due to better availability of nutrients applied either through fertilizers or in combination with organic sources. The results have got close conformity with the findings of Singh *et al.* (2018).

4.5.6 Effect of integrated nutrient management and seed priming on Test weight (g)

Test weight of little millet remained same 2.5 g for all the nutrient management practices and seed priming treatments (Table 4.5).

The interaction effect of N×P for test weight was also found to be differed non-significantly.

Test weight is not affected by any treatment combinations. This might be due to the fact that test weight is a very stable varietal character and does not vary much among the nutrient management practices. The results are inconformity with the findings of Mondal *et al*. (2016) and Charate *et al*. (2018).

Table 4.5: Effect of integrated nutrient management and seed priming on growth and yield parameters of little millet

Treatment	Field emergence (%)	Plant height at 45 DAS (cm)	Plant height at 60 DAS (cm)	Plant height at harvest (cm)	DAS to 1st flowering	DAS to 50 % flowering	No. of effective tillers/Plant	Test weight (g)
Nutrietn management								
N1: control	84.6	76.9	100.3	140.1	44	53	5	2.5
N2:125 kg Neem cake + 1.25 tons ha^{-1} vermicompost	84.6	77.7	100.8	144.8	44	53	6	2.5
N3: 50 kg/ha N : 50 kg/ha P_2O_5 : 50 kg /ha K_2O and 2% Borax spray at flowering.	87.5	82.6	106.0	151.7	45	54	7	2.5
N4: N2+N3	88.3	82.8	107.0	153.9	45	54	7	2.5
N5: Recommended dose of fertilizer i.e. 20 kg/ha N : 20 kg/ha P_2O_5 : 10 Kg /ha K_2O	85.0	79.4	102.3	151.7	45	54	6	2.5
SEm±	**1.43**	**1.3**	**1.0**	**0.4**	**0.3**	**0.2**	**0.1**	**0.0**
C.D.(P=0.05)	**NS**	**4.2**	**3.1**	**1.1**	**1.1**	**NS**	**0.4**	**NS**
Priming								
P1: control	84.7	79.3	102.3	148.0	44	53	6	2.5
P2: Hydropriming for 8 hrs	84.3	79.6	103.3	148.1	44	53	6	2.5
P3:Seed priming with 2% KH_2PO_4 for 8 hrs	87.7	79.6	103.5	148.9	45	54	6	2.5
P4:Seed priming with 20% liquid *Pseudomonas fluorescens*	87.3	81.1	103.5	148.8	45	54	6	2.5
SEm±	**1.54**	**0.9**	**0.5**	**0.5**	**0.5**	**0.2**	**0.1**	**0.0**
C.D.(P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Interaction	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

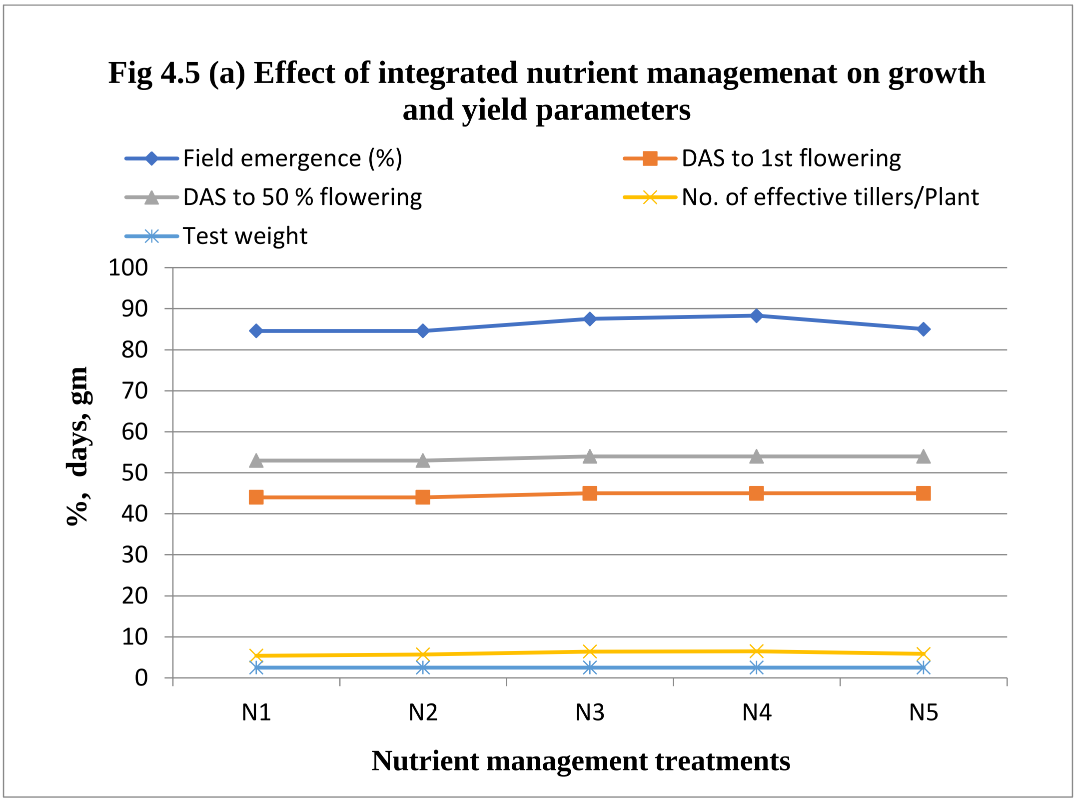


Fig 4.5 (a) Effect of integrated nutrient managemenat on growth and yield parameters
Field emergence (%)
DAS to 1st flowering
DAS to 50 % flowering
No. of effective tillers/Plant
Test weight
%, days, gm
100
90
80
70
60
50
40
30
20
10
0
N1
N2
N3
N4
N5
Nutrient management treatments

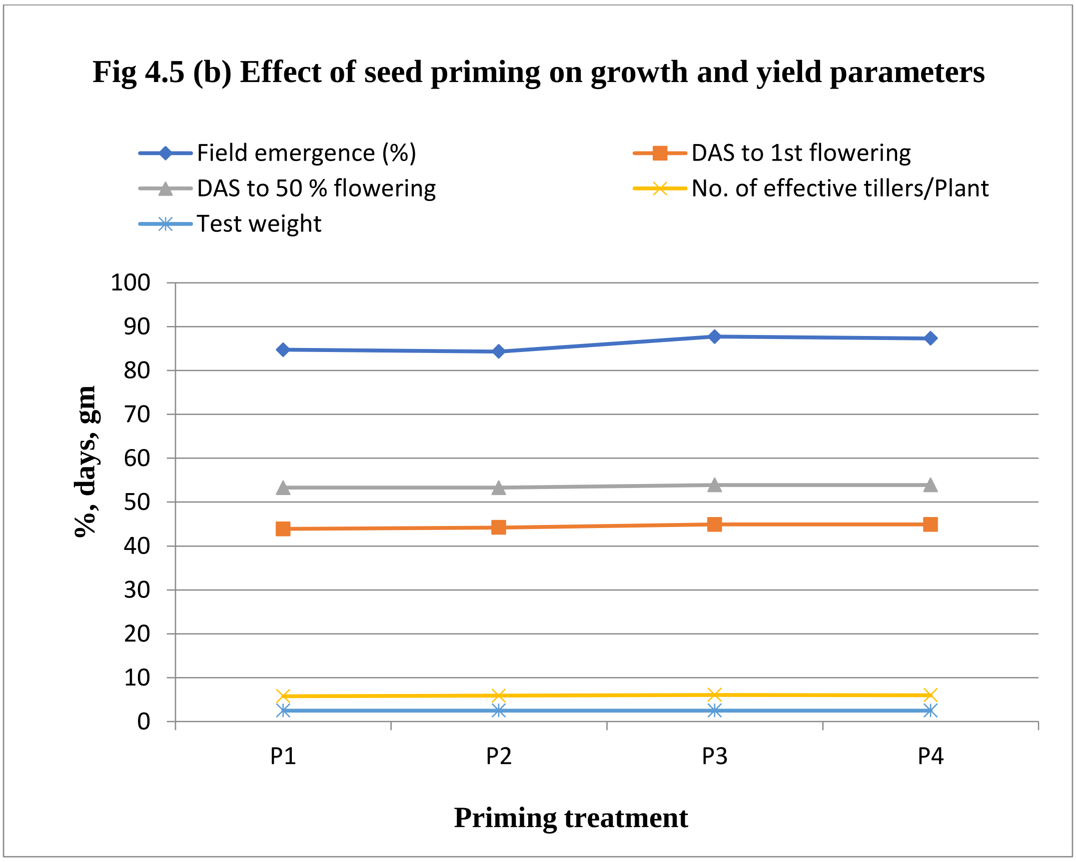
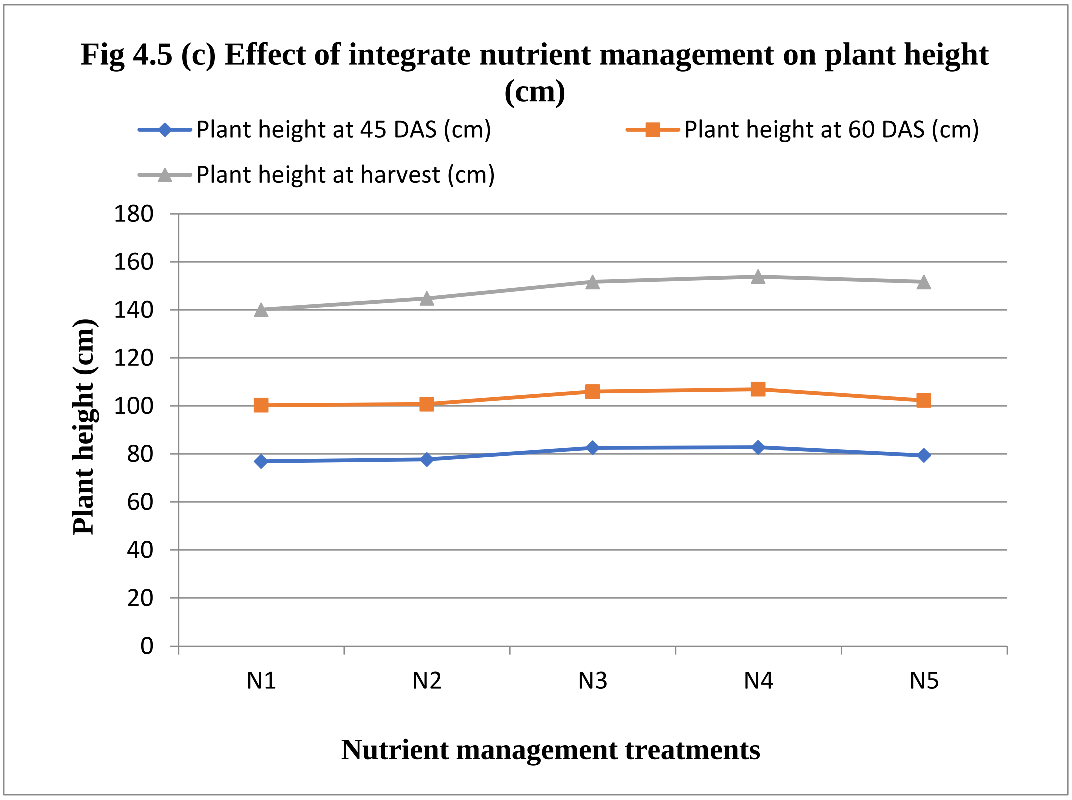


Fig 4.5 (b) Effect of seed priming on growth and yield parameters
Field emergence (%)
DAS to 1st flowering
DAS to 50 % flowering
No. of effective tillers/Plant
Test weight
%, days, gm
100
90
80
70
60
50
40
30
20
10
0
P1
P2
P3
P4
Priming treatment



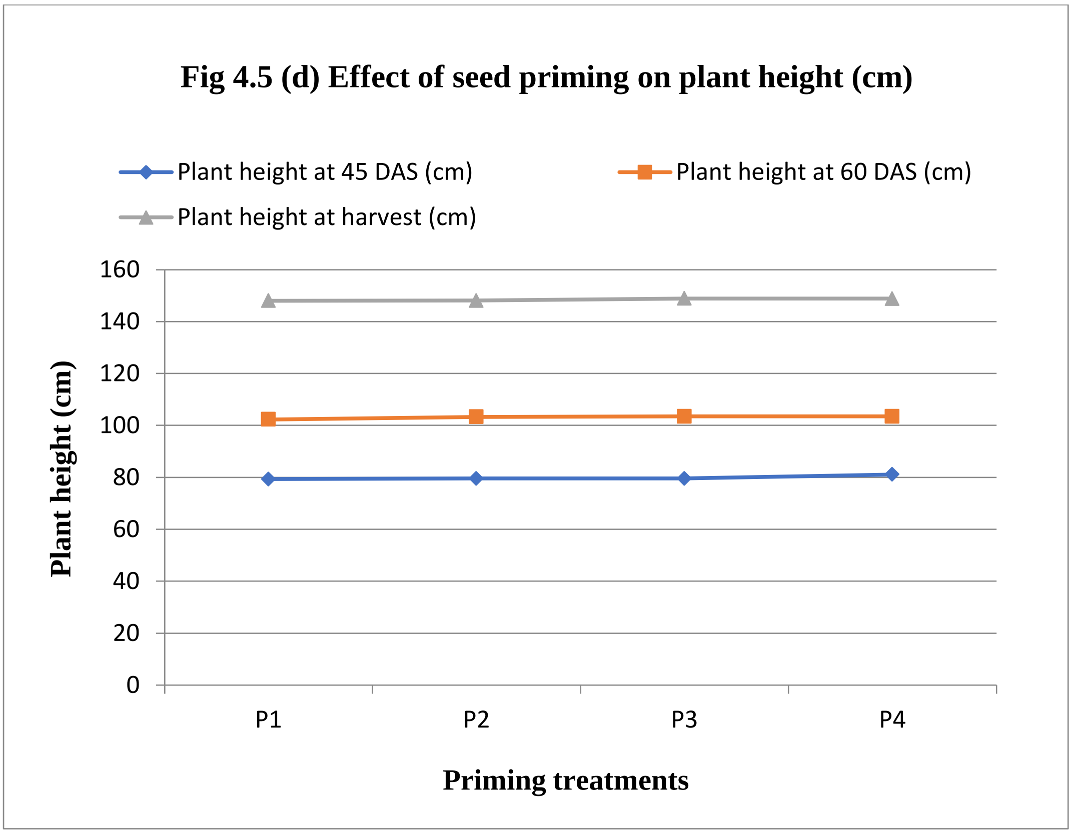


Fig 4.5 Effect of integrated nutrient management and seed priming on growth and yield parameters of little millet

4.6 Effect of integrated nutrient management and seed priming on yield (q/ha) of little millet

The data on effect of INM and seed priming on yield of little millets are shown in table 4.6 and depicted in fig. 4.6.

4.6.1 Effect of integrated nutrient management and seed priming on grain yield (q/ha)

Grain yield of little millet varied from 8.8 q/ha to 10 q/ha (Table 4.6). The highest grain yield was recorded in N4 treatment (10 q/ha) which was at par with N3 treatment (9.81 q/ha) and significantly higher than the other treatments. The lowest grain yield was recorded in N1 treatment (8.8 q/ha).

Grain yield differed non-significantly between priming treatment. The highest grain yield was found in P4 treatment (9.75 q/ha) followed by P3 (9.74 q/ha) and the lowest yield was recorded in P2 treatment (9.21 q/ha).

The interaction effect of N×P for grain yield was found to be differed non-significantly. Maximum grain yield was recorded in N3P4 (10.71 q/ha) and the minimum grain yield was recorded in N1P1 treatment combinations (8.52 q/ha).

Higher grain yield with combined application of organic manure and inorganic fertilizers may be due to increased availability of nutrients which improved the soil properties, this in turn, increased absorption and translocation of nutrients by crop leading to increased production of photosynthates by the crop. Organic manures provided favorable environment for microorganisms like *Azospirillium* which fixes atmospheric nitrogen available to plant and PSB which converts insoluble phosphate into soluble forms by secreting organic acids. These results are in line with the findings of Malinda *et al.* (2015) and Rao *et al* (2018).

4.6.2 Effect of integrated nutrient management and seed priming on straw yield (q/ha)

Straw yield of little millet varied from 83.15 q/ha to 94.72 q/ha (Table 4.6). The highest straw yield was recorded in N4 treatment (94.72 q/ha) which was at par with N3 treatment (94.14 q/ha) and significantly higher than the other treatments. The lowest straw yield was found in N1 treatment (83.15 q/ha).

Straw yield differed non-significantly between priming treatments. The highest straw yield was found in P3 treatment (91.51 q/ha) followed by P4 (90.07 q/ha) and lowest straw yield was recorded in P1treatment (88.14 q/ha).

The interaction effect of N×P for straw yield was found to be differed non-significantly. Maximum straw yield was recorded in N4P3 (98.24 q/ha) and the lowest straw yield was recorded in N1P1treatment combinations (80.21 q/ha).

Higher straw yield recorded in integrated nutrient management plots may be due to enhancement of the photosynthetic rate resulting in more vegetative growth and dry matter production. These results are in conformity with the findings of Raudal *et al*. (2017) and Rao *et al*. (2018).

4.6.3 Effect of integrated nutrient management and seed priming on biological yield (q/ha)

Biological yield of little millet varied from 91.95 q/ha to 104.72 q/ha (Table 4.6). The highest biological yield was found in N4 treatment (104.72 q/ha) which was at par with N3 treatment (103.96 q/ha) and significantly higher than the other treatments. The lowest biological yield was found in N1 treatment (91.95 q/ha).

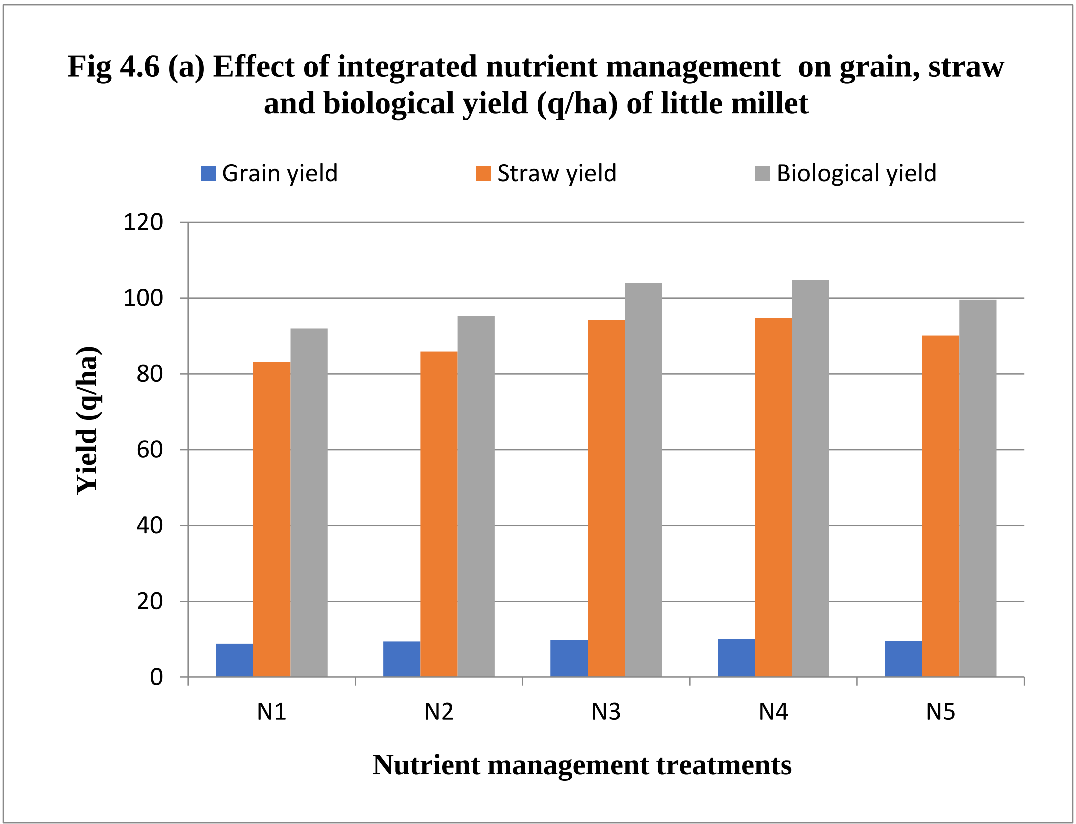
Biological yield differed non-significantly between priming treatments. The highest grain yield was found in P3 treatment (101.25 q/ha) followed by P4 (99.82 q/ha) and lowest biological yield was recorded in P1 treatment (97.47 q/ha).

The interaction effect of N×P for biological yield was found to be differed non-significantly. Maximum biological yield was recorded in N4P3 (108.11 q/ha) and the lowest biological yield was recorded in N1P1 treatment combinations (88.66 q/ha).

Greater total yield of little millet in integrated nutrient management is due to enhanced growth and yield parameters. The results obtained were in close conformity of Rani et al.(2017) and Raudhal et al.(2017). Seed priming with 20% *Pseudomonas fluorescens* and 2% KH_2PO_4 showed higher yield than hydro priming and control however their effects were masked by the rainfall on the week of sowing and next week after showing. Similar results for pearl millet were obtained by Zida *et al.* (2017).

Table 4.6: Effect of integrated nutrient management and seed priming on grain, straw and biological yield of little millet (q/ha)

Treatment	Grain yield	Straw yield	Biological yield
Nutrient management			
N1: Control	8.80[c]	83.15[c]	91.95[c]
N2:125 kg Neem cake + 1.25 tons ha^{-1} vermicompost	9.41[b]	85.84[c]	95.25[c]
N3: 50 kg/ha N : 50 kg/ha P_2O_5 : 50 kg /ha K_2O and 2% Borax spray at flowering.	9.81[ab]	94.14[a]	103.96[a]
N4: N2+N3	10.00[a]	94.72[a]	104.72[a]
N5: Recommended dose of fertilizer i.e. 20 kg/ha N : 20 kg/ha P_2O_5 : 10 kg /ha K_2O	9.52[b]	90.07[b]	99.59[b]
SEm±	**0.13**	**1.23**	**1.28**
C.D.(P=0.05)	**0.43**	**4.01**	**4.18**
Priming			
P1: Control	9.33	88.14	97.47
P2: Hydropriming for 8 hrs	9.21	88.61	97.82
P3: Seed priming with 2% KH_2PO_4 for 8 hrs	9.74	91.51	101.25
P4: Seed priming with 20% liquid *Pseudomonas fluorescens*	9.75	90.07	99.82
SEm±	**0.17**	**1.28**	**1.27**
C.D.(P=0.05)	**NS**	**NS**	**NS**
Interaction	**NS**	**NS**	**NS**



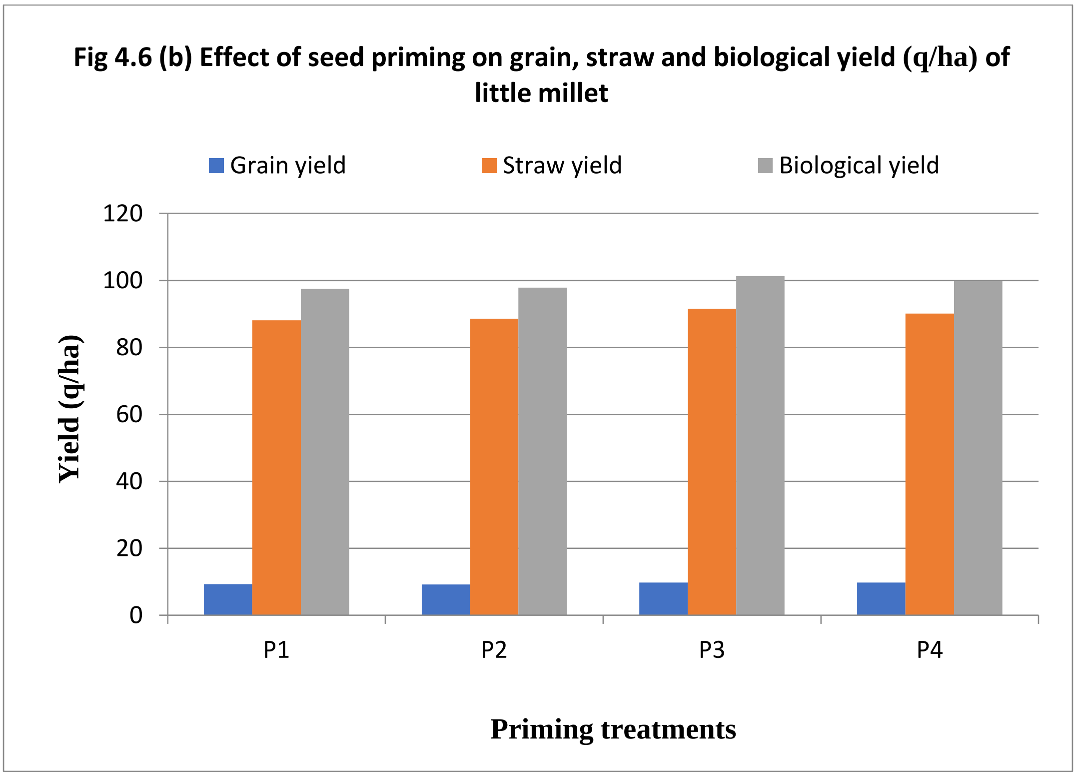


Fig. 4.6 Effect of integrated nutrient management and seed priming on grain, straw and biological yield (q/ha) of little millet

4.7 Effect of integrated nutrient management and seed priming on N, P and K content (%) of little millet

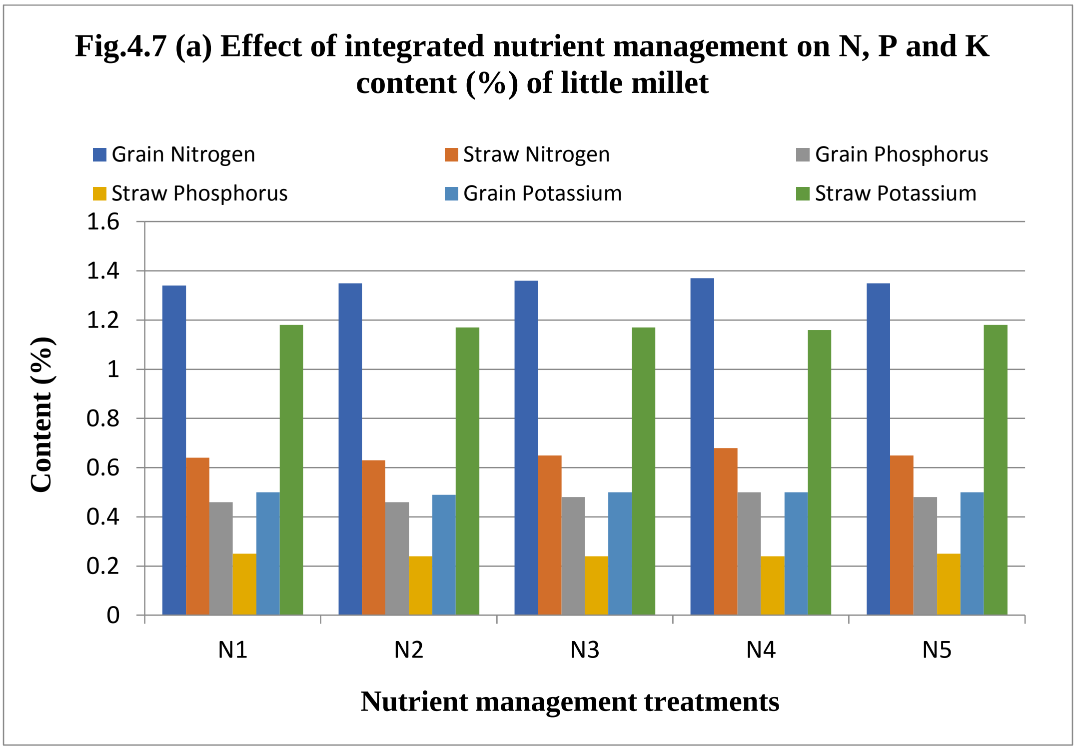
The data on effect of INM and seed priming on N, P and K content of little millet are shown in table 4.7 and depicted in fig.4.7.

As shown in table 4.7 nutrient content of little millet grain follow the order N>K>P where as in little millet straw, K content was highest followed by N and then by P content. The range of variation in primary nutrient content for different treatment combinations was also small. Nitrogen content ranged from 1.34% to 1.37% in grain and from 0.63% to 0.68% in straw. Phosphorus content in little millet grain ranged from 0.46% to 0.50% and in straw it ranged from 0.24% to 0.25%. Higher content of potassium was found in straw than grain and it ranged from 0.49% to 0.50% for grain and 1.16% to 1.18% for straw. Higher nutrient content of N (1.37%), P (0.50%) and K (1.18%) in grain was associated with N4 treatment. Similarly higher N (0.68%), P (0.25%) and K (1.18%) content in little millet straw were associated with N4 treatment. This might be due to increased nutrient availability of nutrients and higher meristematic activities of top and roots of the plants. However, it differed non-significantly from other treatments might be due to dilution effect, and higher plant available nutrient status of soil. Similar results were reported by Mondal *et al*. (2016) and Rani *et al.* (2017).

No trend was found for priming treatments for nutrient content and treatment differed non- significantly due to priming treatments. This might be due to higher rainfall during crop growth. Also no interaction effect was observed for N×P. similar results were reported by Zida *et al*. (2017) and Damalas *et al*. (2019).

Table 4.7: Effect of integrated nutrient management and seed priming on N, P and K content (%) of little millet

Treatment	Nitrogen content (%)		Phosphorus content (%)		Potassium content (%)	
Nutrient management	Grain	Straw	Grain	Straw	Grain	Straw
N1: Control	1.34	0.64	0.46	0.25	0.5	1.18
N2:125 kg Neem cake + 1.25 tons ha^{-1} vermicompost	1.35	0.63	0.46	0.24	0.49	1.17
N3: 50 kg/ha N : 50 kg/ha P_2O_5 : 50 kg /ha K_2O and 2% Borax spray at flowering.	1.36	0.65	0.48	0.24	0.5	1.17
N4: N2+N3	1.37	0.68	0.5	0.24	0.5	1.16
N5: Recommended dose of fertilizer i.e. 20 kg/ha N : 20 kg/ha P_2O_5 : 10 kg /ha K_2O	1.35	0.65	0.48	0.25	0.5	1.18
SEm±	**0.02**	**0.01**	**0.01**	**0**	**0.01**	**0.02**
C.D.(P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Priming						
P1: Control	1.36	0.66	0.48	0.25	0.49	1.17
P2: Hydropriming for 8 hrs	1.35	0.65	0.47	0.24	0.5	1.16
P3:Seed priming with 2% KH_2PO_4 for 8 hrs	1.34	0.65	0.49	0.24	0.5	1.17
P4:Seed priming with 20% liquid *Pseudomonas fluorescens.*	1.36	0.63	0.46	0.24	0.5	1.18
SEm±	**0.02**	**0.01**	**0.01**	**0**	**0.01**	**0.02**
C.D.(P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Interaction	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**



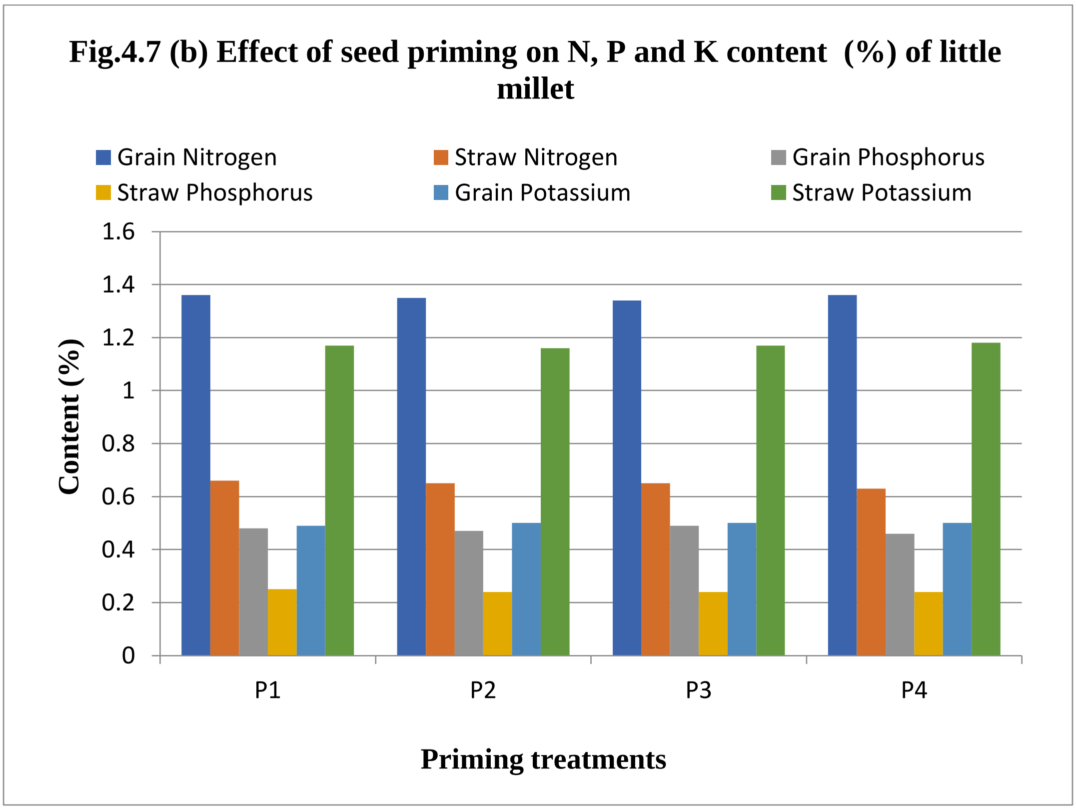


Fig 4.7 Effect of integrated nutrient management and seed priming on N, P and K content (%) of little millet

4.8 Effect of integrated nutrient management and seed priming on N, P and K uptake (kg/ha) of little millet

The data on effect of INM and seed priming on N, P and K uptake of little millet are shown in table 4.8 and depicted in fig 4.8.

4.8.1 Effect of integrated nutrient management and seed priming on nitrogen uptake (kg/ha)

Nitrogen uptake of little millet grains varied from 11.77 kg/ha to 13.7 kg/ha (Table 4.8). The highest N uptake in little millet grains was found in N4 treatment (13.7 kg/ha) which was at par with N3 treatment (13.38 kg/ha) and significantly higher than N2 (12.69 kg/ha) and N1 treatment (11.77 kg/ha). The lowest N uptake in little millet grains was found in N1 treatment (11.77 kg/ha). In case of little millet straw, N uptake varied from 52.98 kg/ha to 64.05 kg/ha. The highest N uptake in little millet straw was found in N4 treatment (64.05 kg/ha) which was at par with N3 treatment (61.58 kg/ha) and significantly higher than the other treatments. The lowest N uptake was found in N1 treatment (11.77 kg/ha).Total N uptake of little millet varied from 64.75 kg/ha to 77.74 kg/ha. Trend remains same for total N uptake and the highest N uptake was found in N4 (77.74 kg/ha) which was at par with N3 (74.96 kg/ha) and significantly higher than the N1, N2 and N5 treatments. The lowest N uptake was found in N1 treatment (64.75 kg/ha).

Nitrogen uptake of little millet grains and straw and total N uptake differed non-significantly between priming treatments. The highest N uptake of little millet grains was found in P4 (13.3 kg/ha) and the lowest N uptake in little millet grains was recorded in P1 treatment (12.72 kg/ha). In case of little millet straw, the highest N uptake was found in P3 (59.69 kg/ha) and the lowest N uptake was recorded in P4 treatment (56.86 kg/ha). The highest total N uptake was found in P3 treatment (72.75 kg/ha) and the lowest total N uptake was recorded in P4 treatment (70.76 kg/ha).The interaction effect of N×P for N uptake of little millet grain and straw for total N uptake was found to be differed non-significantly.

The increase uptake of nitrogen in integrated nutrient management plots might be due to increased dry matter production and due to balanced release of these nutrients into soil upon manure decomposition, which resulted in vigorous growth and uptake of nutrients. Similar results were reported by Divyashree *et al.* (2017) and Roy *et al.* (2018).

4.8.2 Effect of integrated nutrient management and seed priming on phosphorus uptake (kg/ha)

Phosphorus uptake of little millet grains varied from 4.08 kg/ha to 4.97 kg/ha (Table 4.8). Highest P uptake by little millet grain was found in N4 (4.97 kg/ha) which was statistically similar to N3 treatment (4.71kg/ha) and significantly higher than the other treatments. The lowest P uptake was found in N1 treatment (4.08 kg/ha). In case of straw, P uptake of little millet straw varied from 20.42 kg/ha to 23.05 kg/ha. The highest P uptake was found in N4 treatment (23.05 kg/ha) which was significantly higher than the other treatments. The lowest P uptake was found in N1 treatment (20.42 kg/ha).Total P uptake of little millet varied from 24.50 kg/ha to 28.02 kg/ha. The highest total P uptake was found in N4 treatment (28.02 kg/ha) which was at par with N3 (27.17 kg/ha) and significantly higher than N1, N2 and N5 treatment and lowest P uptake was found in N1 treatment (24.50 kg/ha).

Phosphorus uptake in little millet grains and straw and total P uptake differed non-significantly between priming treatments. The highest P uptake in grains was found in P3 treatment (4.75 kg/ha) and the lowest P uptake was recorded in P2 treatment (4.35 kg/ha). In case of straw, highest P uptake was found in P1 treatment (22.16 kg/ha) and the lowest P uptake was recorded in P2 treatment (21.65 kg/ha). Total uptake of P by crop was found highest in P3 treatment (26.73 kg/ha) and lowest P uptake was recorded in P2 treatment (26 kg/ha). No interaction effect of N×P for P uptake of grains, straw and total P uptake was found significant.

The increased uptake of phosphorus by little millet in integrated nutrient management might be due to solubilizing effect of organic acids which are produced from the decomposition of organic matter and reducing the fixation of phosphorus and increasing the availability of phosphorus resulting in higher dry matter mass production and uptake of phosphorus by little millet. Similar results were reported by Khan *et al.* (2011) and Prabudoss *et al.* (2014).

4.8.3 Effect of integrated nutrient management and seed priming on potassium uptake (kg/ha)

Potassium uptake of little millet grains varied from 4.36 kg/ha to 5.0 kg/ha (Table 4.8). The highest K uptake of little millet grains was found in N4 treatment

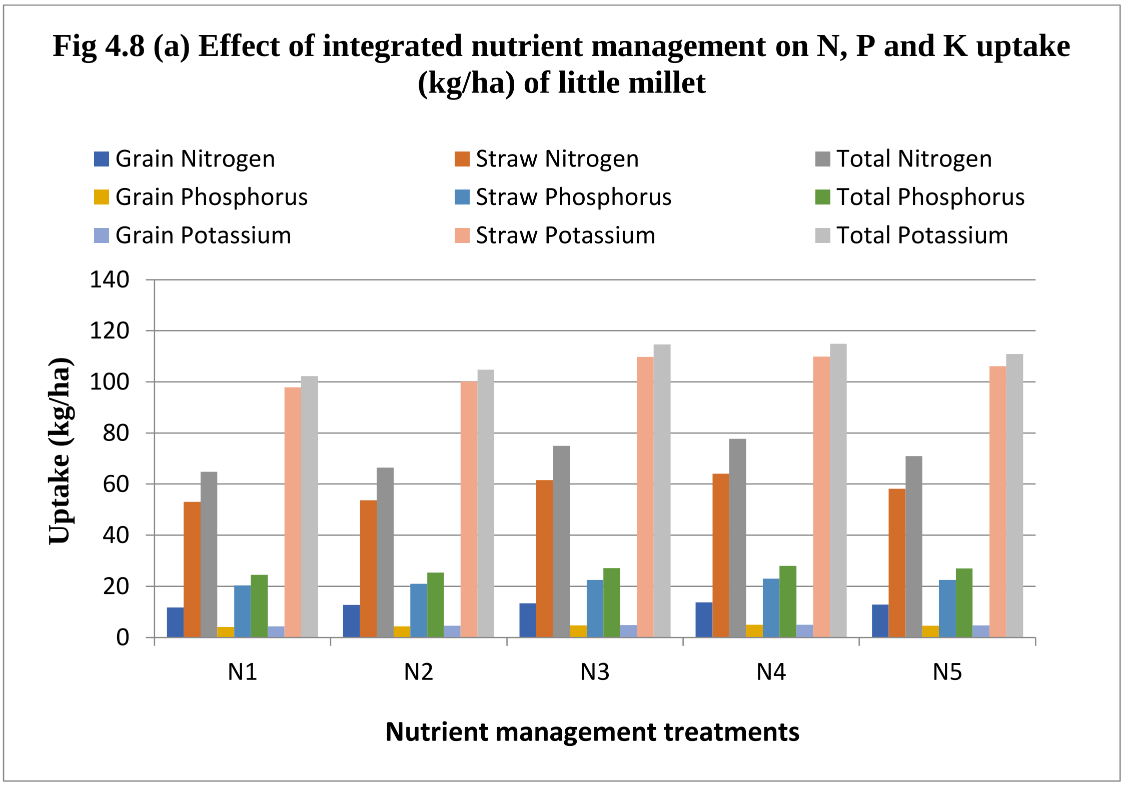
(5.0 kg/ha) which was at par with N3 treatment (4.87 kg/ha) and significantly higher than N2 (4.64 kg/ha) and N1 treatment (4.36 kg/ha). The lowest K uptake was found in N1 treatment (4.36 kg/ha). In case of K uptake of little millet straw, variation was recorded from 97.85 kg/ha to 109.9 kg/ha. The highest K uptake by little millet in straw was found in N4 treatment (109.9 kg/ha) which was at par with N3 (109.76 kg/ha) and significantly higher N2 (100.7 kg/ha) and N1 treatment (97.85 kg/ha). The lowest K uptake by little millet straw was found in N1 (97.85 kg/ha).Total K uptake of little millet crop varied from 102.2 kg/ha to 114.9 kg/ha. The highest K uptake was found in N4 treatment (114.9 kg/ha) which was at par with N3 (114.62 kg/ha) and significantly higher than N1, N2 treatment. The lowest N uptake was found in N1 treatment (102.2 kg/ha).

Potassium uptake of little millet in grains, straw and total K uptake differed non-significantly between priming treatments. The highest K uptake was found in P4 treatment (4.89 kg/ha) and the lowest K uptake was recorded in P1 treatment (4.60 kg/ha). In case of straw, the highest K uptake was found in P3 treatment (106.94 kg/ha) and the lowest K uptake was recorded in P2 (102.85 kg/ha).Total K uptake by little millet crop was highest in P3 (111.78 kg/ha) and the lowest K uptake was recorded in P2 (107.44 kg/ha). The interaction effect of N×P for K uptake by little millet grain, straw and total K uptake was found to be differed non-significantly.

The highest potassium uptake might be because potassium is likely to be maintained in exchangeable form in soils treated with organic manures due to high exchange capacity of organic colloids formed during decomposition of organic manure which in turn restricted the K^+ ions getting fixed by inorganic clay particles in soil which results in increased in growth parameters and higher K uptake by little millet. Similar results were reported by Mondal *et al.* (2016) and Roy *et al.* (2018).

Table 4.8: Effect of integrated nutrient management and seed priming on N, P and K uptake (kg/ha) of little millet

Treatment	Nitrogen Uptake (kg/ha)			Phosphorus Uptake (kg/ha)			Potassium Uptake (kg/ha)		
Nutrient management	Grain	Straw	total	Grain	Straw	total	Grain	Straw	total
N1: Control	11.77	52.98	64.75	4.08	20.42	24.5	4.36	97.85	102.2
N2:125 kg Neem cake + 1.25 tons ha^{-1} vermicompost	12.69	53.69	66.38	4.37	21.04	25.41	4.64	100.07	104.71
N3: 50 kg/ha N : 50 kg/ha P_2O_5 : 50 kg /ha K_2O and 2% Borax spray at flowering.	13.38	61.58	74.96	4.71	22.47	27.17	4.87	109.76	114.62
N4: N2+N3	13.7	64.05	77.74	4.97	23.05	28.02	5	109.9	114.9
N5: Recommended dose of fertilizer i.e. 20 kg/ha N : 20 kg/ha P_2O_5 : 10 kg /ha K_2O	12.87	58.12	70.99	4.57	22.44	27.02	4.72	106.16	110.88
SEm±	**0.23**	**1.28**	**1.35**	**0.09**	**0.43**	**0.45**	**0.1**	**2.55**	**2.63**
C.D.(P=0.05)	**0.76**	**4.17**	**4.41**	**0.29**	**1.41**	**1.48**	**0.33**	**8.31**	**8.56**
Priming									
P1: Control	12.72	58.04	70.76	4.53	22.16	26.68	4.6	103.37	107.97
P2: Hydropriming for 8 hrs	12.44	57.75	70.19	4.35	21.65	26	4.59	102.85	107.44
P3: Seed priming with 2% KH_2PO_4 for 8 hrs	13.06	59.69	72.75	4.75	21.97	26.73	4.84	106.94	111.78
P4: Seed priming with 20% liquid *Pseudomonas fluorescens.*	13.3	56.86	70.16	4.52	21.75	26.28	4.84	105.83	110.67
SEm±	**0.29**	**1.37**	**1.38**	**0.11**	**0.52**	**0.56**	**0.12**	**2.2**	**2.26**
C.D.(P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Interaction	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**



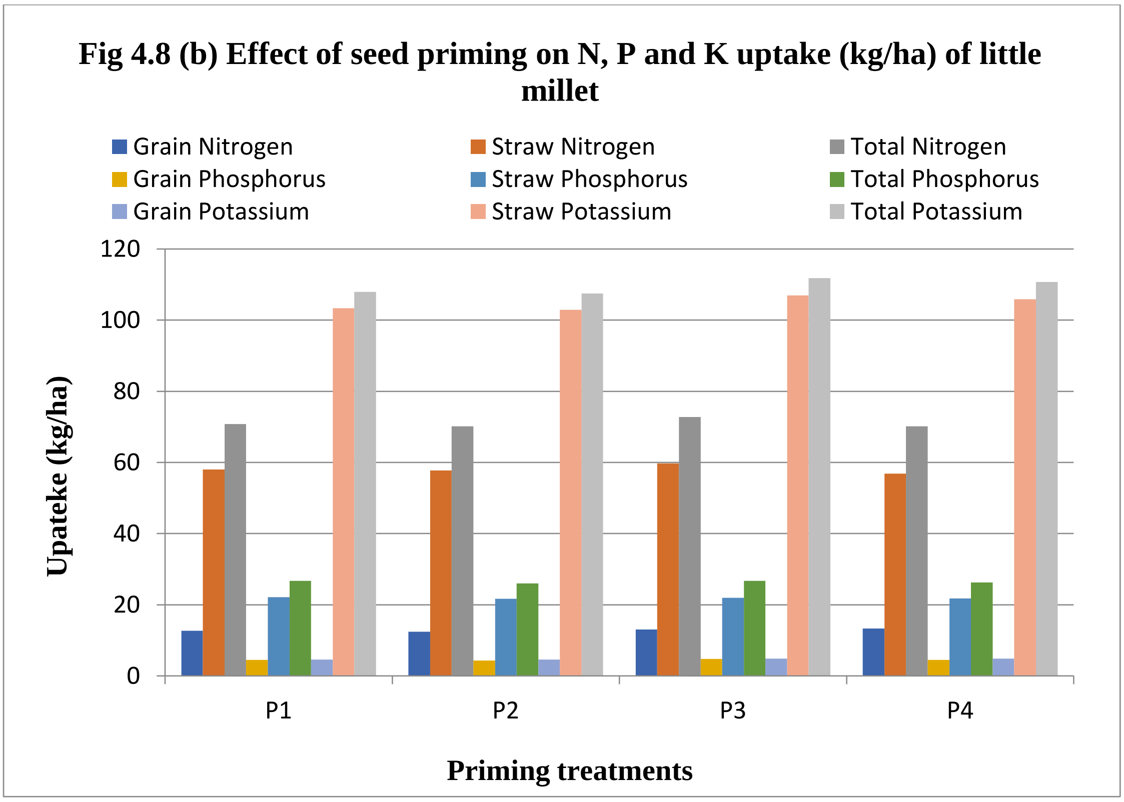


Fig 4.8 Effect of integrated nutrient management and seed priming on N, P and K uptake (kg/ha) of little millet

4.9 Effect of integrated nutrient management and seed priming on Ca, Mg and S content (mg/100g) of little millet

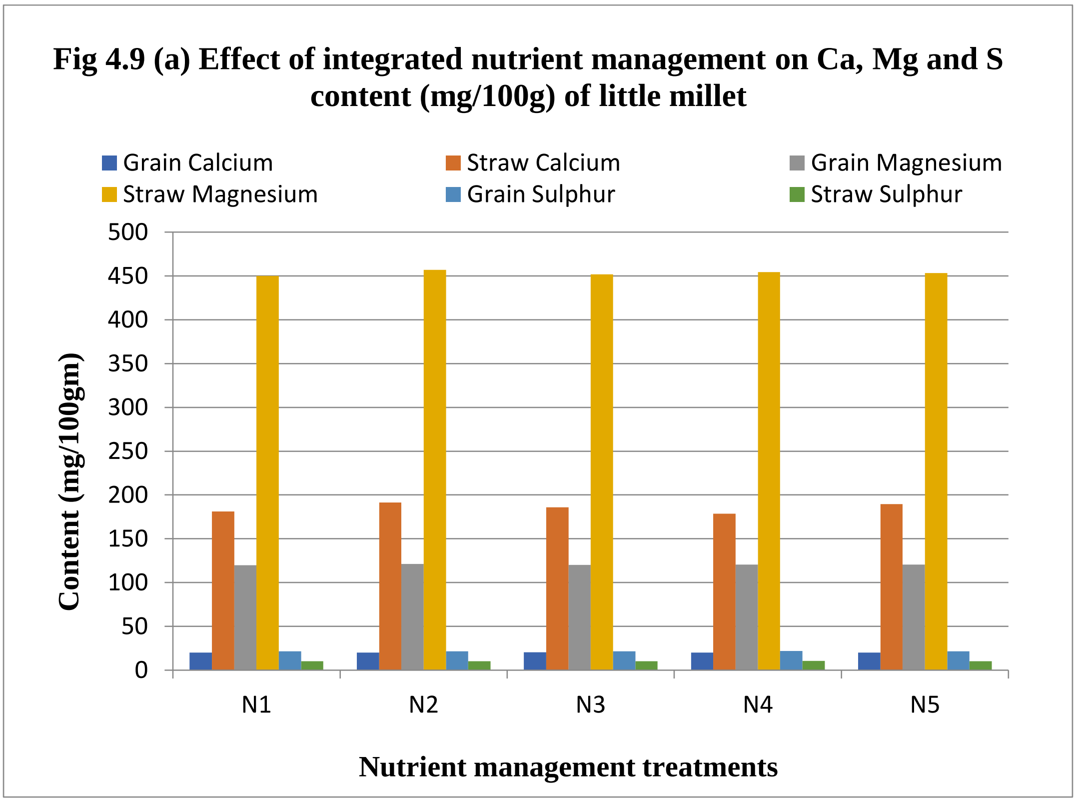
The data on effect of INM and seed priming on Ca, Mg and S content of little millet are shown in table 4.9 and depicted in fig. 4.9.

It is clear from the table 4.9 that magnesium content was highest among all the secondary nutrient content in both grain and straw of little millet followed by calcium and sulphur. The calcium content of little millet grain ranged from 19.97 mg/100g to 20.23 mg/100g and in straw it ranged from 178.57 mg/100g to 191.31 mg/100g. The magnesium content of little millet grain ranged from 119.92 mg/100g to 121.34 mg/100g and in straw it ranged from 450.00 mg/100g to 457.01 mg/100gm. The sulphur content of little millet grain ranged from 10.47 mg/100g to 10.14 mg/100g and in straw it ranges from 21.41 mg/100g to 21.96 mg/100g.

No trends were observed for secondary nutrient uptake by little millet grains and straw for nutrient management practices and priming treatments also no interaction effect of N×P was seen for secondary nutrient content. This might be due to higher initial status of Ca (5488 kg/ha) and Mg (1975.68 kg/ha). No effect of priming treatment was observed due to higher rainfall during crop growth (872.2 mm) and lower nutritional requirement of little millet.

Table 4.9: Effect of integrated nutrient management and seed priming on Ca, Mg and S content (mg/100g) of little millet

Treatment	Calcium content (mg/100g)		Magnesium content (mg/100g)		Sulphur content (mg/100g)	
Nutrient management	Grain	Straw	Grain	Straw	Grain	Straw
N1: Control	20.03	181.11	119.92	450.00	21.59	10.14
N2:125 kg Neem cake + 1.25 tons ha^{-1} vermicompost	19.97	191.31	121.34	457.01	21.44	10.27
N3: 50 kg/ha N : 50 kg/ha P_2O_5 : 50 kg /ha K_2O and 2% Borax spray at flowering.	20.23	186.08	120.05	452.00	21.52	10.29
N4: N2+N3	20.10	178.57	120.44	454.50	21.96	10.47
N5: Recommended dose of fertilizer i.e. 20 kg/ha N : 20 kg/ha P_2O_5 : 10 kg /ha K_2O	19.92	189.44	120.59	453.42	21.41	10.14
SEm±	**0.38**	**1.95**	**2.32**	**8.76**	**0.42**	**0.14**
C.D.(P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Priming						
P1: Control	20.00	189.5	120.94	448.2	21.56	10.12
P2: Hydropriming for 8 hrs	20.20	181.97	120.31	459.4	21.52	10.34
P3: Seed priming with 2% KH_2PO_4 for 8 hrs	19.92	185.04	120.42	446.6	21.67	10.29
P4: Seed priming with 20% liquid *Pseudomonas fluorescens*	20.08	184.7	120.19	459.33	21.58	10.3
SEm±	**0.3**	**2.65**	**1.76**	**6.68**	**0.31**	**0.21**
C.D.(P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Interaction	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**



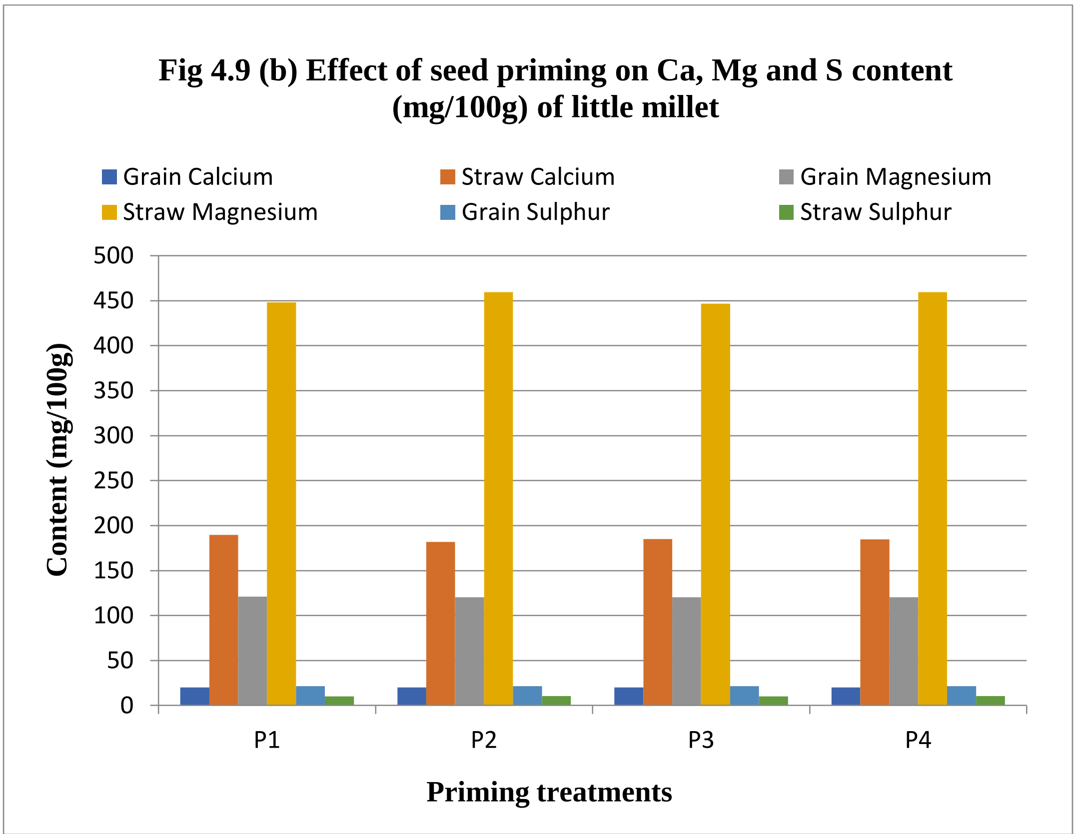


Fig 4.9 Effect of integrated nutrient management and seed priming on Ca, Mg and S content (mg/100g) of little millet

4.10 Effect of integrated nutrient management and seed priming on Ca, Mg and S uptake (kg/ha) of little millet

The data on effect of INM and seed priming on Ca, Mg and S uptake of little millet are shown in table 4.10 and depicted in fig 4.10.

4.10.1 Effect of integrated nutrient management and seed priming on calcium uptake (kg/ha)

Calcium uptake of little millet grains varied from 0.18 kg/ha to 0.20 kg/ha (Table 4.10). The highest Ca uptake of little millet in grains was found in N3 and N4 treatment (0.20 kg/ha) which differed significantly from N1 treatment (0.18 kg/ha). In case of Ca uptake of little millet in straw, variation was found from 15.09 kg/ha to 17.48 kg/ha. The highest Ca uptake in little millet straw was found in N3 treatment (17.68 kg/ha) which was significantly higher than N2 (16.43 kg/ha) and N1 treatment (15.09 kg/ha). Total Ca uptake of little millet crop varied from 17.68 kg/ha to 15.27 kg/ha. The highest total Ca uptake was found in N3 treatment (17.68 kg/ha) and the lowest Ca uptake was found in N1 treatment (15.27 kg/ha).

Ca uptake of little millet grains, straw and total Ca uptake differed non-significantly between priming treatments. The highest Ca uptake in little millet grains was found in P4 (0.2 kg/ha) whereas other treatment recorded an uptake of 0.19 kg/ha. In case of straw the highest Ca uptake was found in P3 treatment (16.91kg/ha) and the lowest Ca uptake was recorded in P2 treatment (16.1 kg/ha). Total Ca uptake by little millet crop was highest in P3 (17.11 kg/ha) and the lowest Ca uptake was recorded in P2 (6.10 kg/ha). The interaction effect of N×P for Ca uptake by little millet grain, straw and total Ca uptake was found to be differed non-significantly.

Higher Ca uptake in little millet grains, straw and total Ca uptake was seen in plots treated with inorganic fertilizers and integrated nutrient management and the lowest Ca uptake was seen in control plots, this might be due to the application of calcium CaO @ 6 kg acre^{-1}which is applied uniformly in all the plots before seeding except control treatment plots. Similar results were reported by Gogoi *et al*. (2015) and Saraswati *et al*. (2018).

4.10.2 Effect of integrated nutrient management and seed priming on magnesium uptake (kg/ha)

Among all the secondary nutrients the highest uptake of Magnesium was found in little millet crop. Magnesium uptake by grains of little millet varied from 1.06 kg/ha to 1.20 kg/ha (Table 4.10). The highest Mg uptake by little millet in grains was found in N4 treatment (1.20 kg/ha) which was significantly higher than N1 (1.06 kg/ha) and statistically similar to other treatments. In little millet, Mg uptake, variation in straw was found from 37.47 kg/ha to 43.08 kg/ha. The highest Mg uptake of little millet in straw was found in N4 treatment (43.08 kg/ha) and the lowest Mg uptake was found in N1 treatment (37.47 kg/ha). Total Mg uptake of crop varied from 38.53 kg/ha to 44.28 kg/ha. The highest total Mg uptake was found in N4 treatment (44.28 kg/ha) and Lowest Mg uptake was found in N1 (38.53 kg/ha).

Priming treatment didn't affect Mg uptake of little millet in grains, straw and total Mg uptake by crop significantly. The highest Mg uptake in little millet grains was found in P3 and P4 (1.17 kg/ha) and the lowest uptake of Mg by grains of little millet was found in P2 treatment (1.11 kg/ha). In case of straw, the highest Mg uptake was found in P4 treatment (42.54 kg/ha) and the lowest Mg uptake was found in P1 treatment (39.57 kg/ha). Total Mg uptake by little millet crop was highest in P2 (41.85 kg/ha) and lowest Mg uptake by little millet crop was recorded in P1 (40.7 kg/ha). The interaction effect of N×P for Mg uptake by little millet grain, straw and total Mg uptake was found to be differed non-significantly.

Higher Mg uptake in little millet grains, straw and total Mg uptake was seen in plots treated with inorganic fertilizers and integrated nutrient management and the lowest Mg uptake was seen in control plots this might be due to application of the Magnesium through $MgSO_4$ @ 20 kg acre^{-1} which was applied uniformly in all the plots before seeding except in control treatment plots. Similar results were also reported by Lavanya (2008) and Samant (2015).

4.10.3 Effect of integrated nutrient management and seed priming on sulphur uptake (kg/ha)

Among all the secondary nutrients sulphur uptake was found minimum in little millet crop. Sulphur uptake by little millet grains had very narrow range however, control plots showed significantly lower S uptake from rest of the treatments. Sulphur uptake of little millet grains varied from 0.09 kg/ha to 0.1 kg/ha. The lowest S uptake by grains of little millet was found in N1 treatment (0.09 kg/ha) and remaining treatments had S uptake of 0.1 kg/ha. In little millet, straw S uptake variation was found from 1.8 kg/ha to 2.08 kg/ha. The highest S uptake of little millet straw was found in N4 (2.08 kg/ha) and lowest S uptake was found in N1 treatment (1.80 kg/ha). Total S uptake of little millet crop varied from 1.89 kg/ha to 2.19 kg/ha. The highest total S uptake was found in N4 treatment (2.19 kg/ha) and the lowest S uptake was found in N1 treatment (1.89 kg/ha).

Priming treatment didn't affect S uptake of little millet grains, straw and total S uptake significantly. Lower value of S uptake by little millet grain was seen in P1 (0.09 kg/ha) however, it differed non-significantly from other treatment. Similar results were found for straw and total S uptake where no significant variations were found among different priming treatments. The interaction effect of N×P for S uptake by little millet grain, straw and total Mg uptake was found to be differed non-significantly.

Higher S uptake in little millet grains, straw and total S uptake in integrated nutrient management treatment was seen. This might be ascribed due to enhanced mineralization process of sulphur by microorganism in the integrated nutrient management practices which makes sulphur readily available to plant and results in more vegetative growth and uptake by little millet crop. Similar results were reported by Kanwar *et al.* (2017) and Mishra *et al.* (2019).

Table 4.10: Effect of integrated nutrient management and seed priming on Ca, Mg and S uptake (kg/ha) of little millet

Treatment	Calcium Uptake (kg/ha)			Magnesium Uptake (kg/ha)			Suphur Uptake (kg/ha)		
Nutrient management	Grain	Straw	total	Grain	Straw	total	Grain	Straw	total
N1: Control	0.18	15.09	15.27	1.06	37.47	38.53	0.09	1.8	1.89
N2:125 kg Neem cake + 1.25 tons ha^{-1} vermicompost	0.19	16.43	16.61	1.14	39.27	40.41	0.1	1.84	1.94
N3: 50 kg/ha N : 50 kg/ha P_2O_5 : 50 kg /ha K_2O and 2% Borax spray at flowering.	0.20	17.48	17.68	1.18	42.49	43.67	0.1	2.02	2.12
N4: N2+N3	0.20	16.90	17.1	1.20	43.08	44.28	0.1	2.08	2.19
N5: Recommended dose of fertilizer i.e. 20 kg/ha N : 20 kg/ha P_2O_5 : 10 kg /ha K_2O	0.19	17.06	17.25	1.15	40.88	42.03	0.1	1.93	2.03
SEm±	**0**	**0.27**	**0.27**	**0.03**	**0.95**	**0.97**	**0**	**0.05**	**0.05**
C.D.(P=0.05)	**0.01**	**0.87**	**0.87**	**0.08**	**3.11**	**3.18**	**0.01**	**0.15**	**0.15**
Priming									
P1: Control	0.19	16.69	16.88	1.13	39.57	40.7	0.09	1.9	2
P2: Hydropriming for 8 hrs	0.19	16.1	16.29	1.11	40.75	41.85	0.1	1.91	2
P3: Seed priming with 2% KH_2PO_4 for 8 hrs	0.19	16.91	17.11	1.17	40.87	42.04	0.1	1.98	2.08
P4: Seed priming with 20% liquid *Pseudomonas fluorescens.*	0.2	16.65	16.85	1.17	41.37	42.54	0.1	1.94	2.04
SEm±	**0**	**0.35**	**0.35**	**0.03**	**0.86**	**0.87**	**0**	**0.04**	**0.04**
C.D.(P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Interaction	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Fig 4.10 (a) Effect of integrated nutrient management on Ca, Mg and S uptake (kg/ha) of little millet

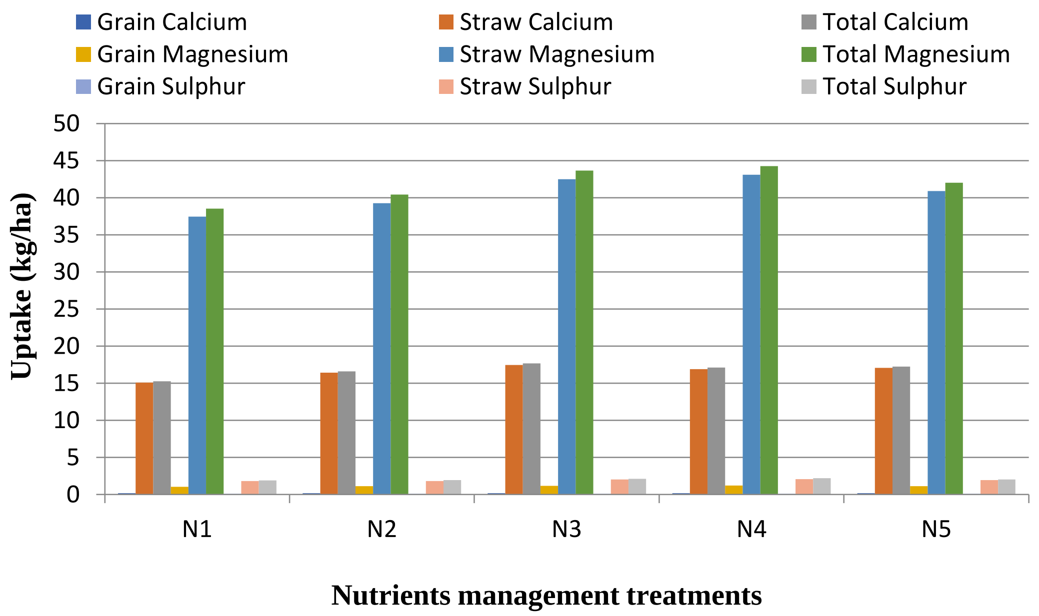


Fig 4.10 (b) Effect of seed priming on Ca, Mg and S uptake (kg/ha) of little millet

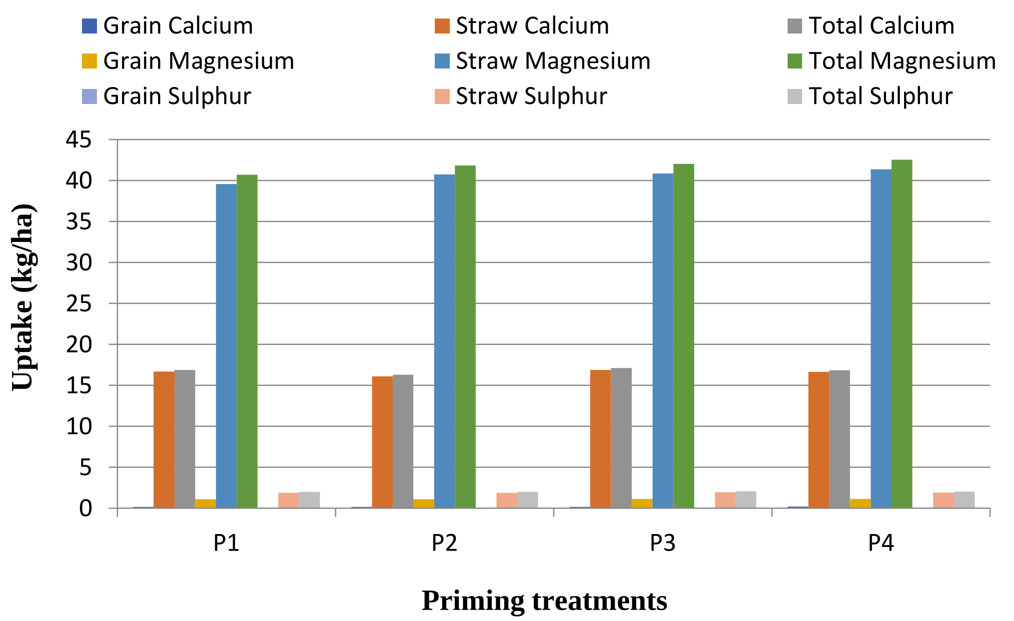


Fig 4.10 Effect of integrated nutrient management and seed priming on Ca, Mg and S uptake (kg/ha) of little millet

4.11 Effect of integrated nutrient management and seed priming on micronutrient content (mg/100g) of little millet

The data on effect of INM and seed priming on micronutrient content of little millet are shown in table 4.11 and depicted in fig.4.11.

As shown as table 4.10 Micronutrient content of little millet grains found in the order Fe>Zn>Cu>Mn and the similar order was found for micronutrient content in straw of little millet. The range of different micronutrient content was very narrow in grain and straw of little millet. The iron content of little millet straw was higher than little millet grain and ranged from 8.39 mg/100g to 8.78 mg/100g in little millet grain and 35.94 mg/100g to 38.81 mg/100g in little millet straw. The manganese content was lowest among cationic micronutrients and ranged from 0.74 to 0.78 mg/100g in little millet grains and 0.78 to 0.81 mg/100g in little millet straw. Copper content of little millet grain and straw was nearly same and ranged from 0.94 mg/100g to 1.03 mg/100g for little millet grain and 0.94 mg/100g to 0.99 mg/100g in little millet straw. Zinc content of little millet grain varied from 3.49 mg/100g to 3.58 mg/100g and from 4.04 mg/100 g to 4.12 mg/100g in little millet straw.

No trend regarding micronutrient content in grain and straw was found for nutrient management and priming treatments. This may be due to the higher plant available Fe (17.15 mg/kg), Mn (5.21 mg/kg), Cu (2.37 mg/kg) and Zn (2.07 mg/kg) content of the initial soil and the lower requirements of micronutrients by the plants.

Table 4.11 Effect of integrated nutrient management and seed priming on micronutrient content (mg/100g) of little millet

Treatment	**Iron content (mg/100g)**		**Manganese content (mg/100g)**		**Copper content (mg/100g)**		**Zinc content (mg/100g)**	
Nutrient management	Grain	straw	Grain	straw	Grain	straw	grain	Straw
N1: Control	8.39	35.94	0.77	0.79	0.94	0.94	3.49	4.04
N2:125 kg Neem cake + 1.25 tons ha^{-1} vermicompost	8.57	36.28	0.76	0.81	1.03	0.94	3.55	4.06
N3: 50 kg/ha N : 50 kg/ha P_2O_5 : 50 kg /ha K_2O and 2% Borax spray at flowering.	8.78	37.98	0.74	0.80	0.98	0.99	3.45	4.12
N4: N2+N3	8.71	38.81	0.78	0.80	1.00	0.97	3.58	4.05
N5: Recommended dose of fertilizer i.e. 20 kg/ha N : 20 kg/ha P_2O_5 : 10 kg /ha K_2O	8.76	38.62	0.75	0.78	1.02	0.95	3.54	4.04
SEm±	**0.36**	**1.17**	**0.01**	**0.02**	**0.02**	**0.02**	**0.09**	**0.17**
C.D.(P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Priming								
P1: Control	8.67	38.48	0.75	0.79	1.03	0.96	3.67	4.08
P2: Hydropriming for 8 hrs	8.56	38.93	0.76	0.82	0.99	0.96	3.54	4.04
P3:Seed priming with 2% KH_2PO_4 for 8 hrs	9.19	35.83	0.77	0.79	0.97	0.96	3.48	4.11
P4:Seed priming with 20% liquid *Pseudomonas fluorescens*	8.15	36.85	0.74	0.79	1.00	0.96	3.40	4.02
SEm±	**0.29**	**1.19**	**0.01**	**0.01**	**0.02**	**0.02**	**0.10**	**0.16**
C.D.(P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Interaction	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Fig 4.11 (a) Effect of integrated nutrient management on Fe and Zn content (mg/100g) of little millet

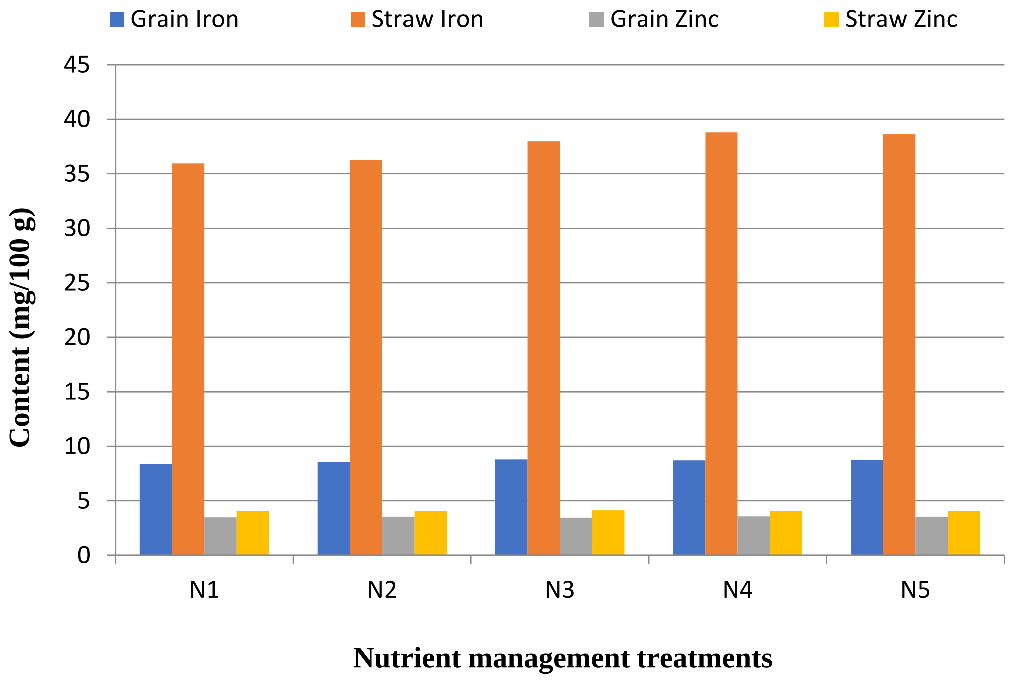
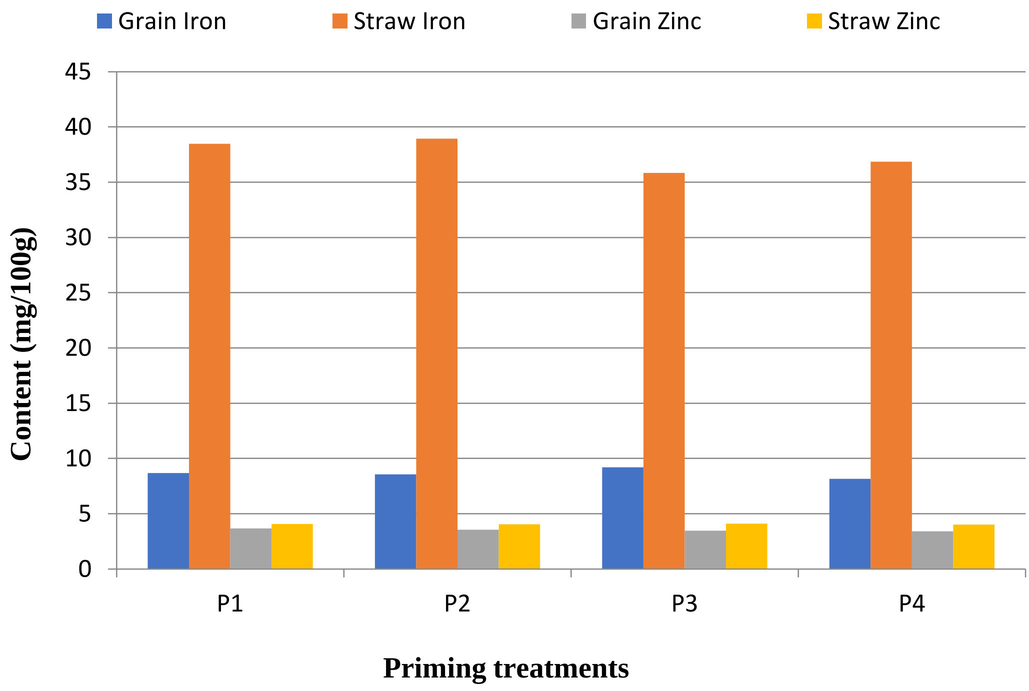
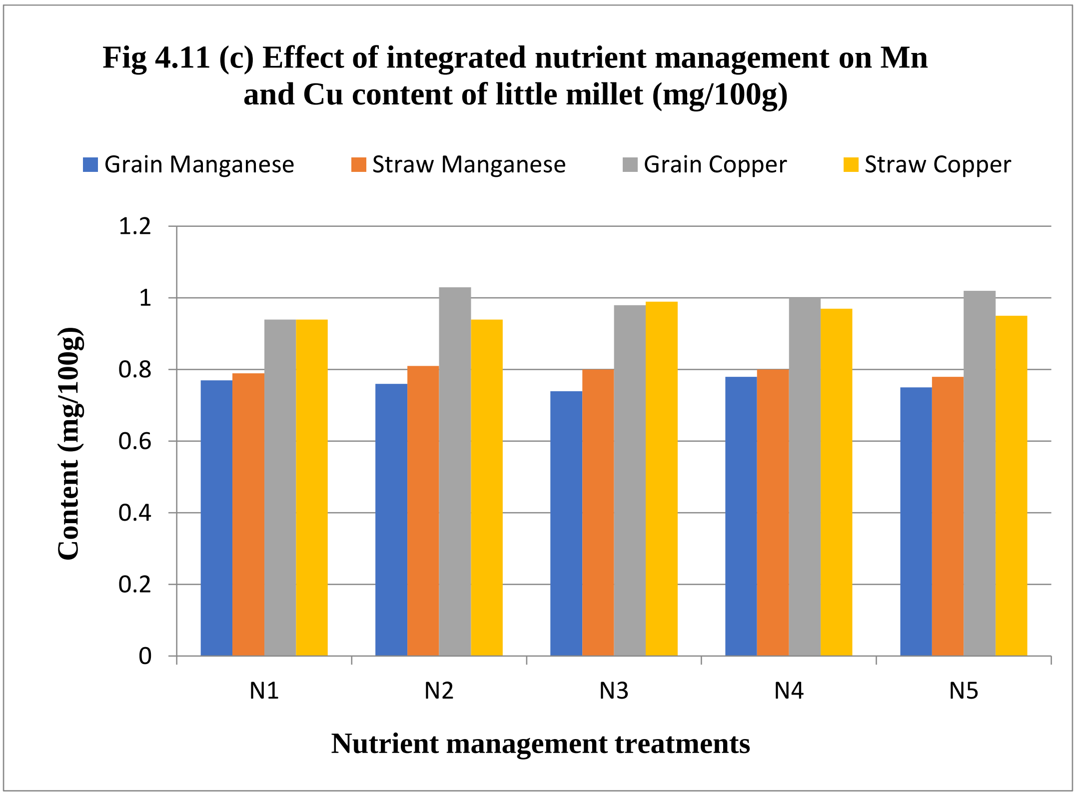


Fig 4.11 (b) Effect of seed priming on Fe and Zn content (mg/100g) of little millet





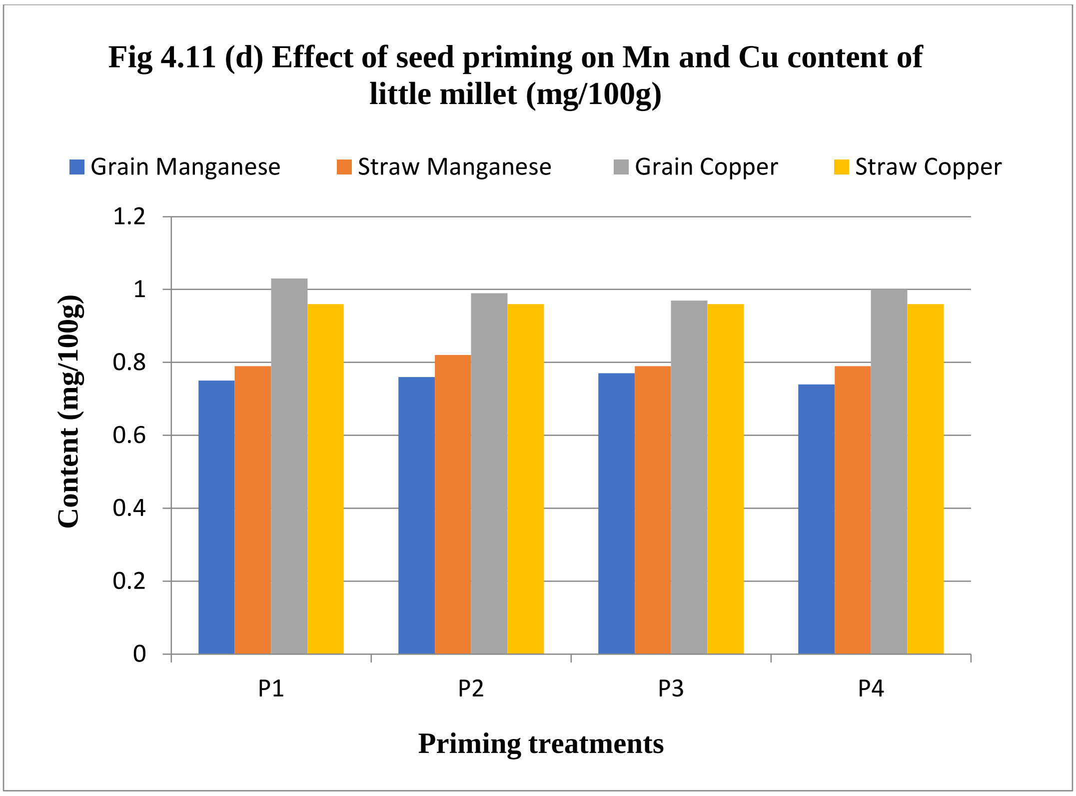


Fig 4.11 Effect of integrated nutrient management and seed priming on micronutrient content (mg/100g) of little millet

4.12 Effect of integrated nutrient management and seed priming on micronutrients uptake (g/ha) of little millet

The data on effect of INM and seed priming on micronutrient uptake of little millet are shown in table 4.12 and depicted in fig 4.12.

As shown in table no 4.12 Fe uptake in little millet grain was found highest among all the micronutrients and followed the order Fe>Zn>Cu>Mn. Similar order was followed for little millet straw's micronutrient uptake and total uptake of different micronutrients.

In little millet grains, the highest, the values of Fe (86.7 g/ha), Mn (7.76 g/ha), Cu (9.99 g/ha) and Zn (35.44 g/ha) uptake was recorded by N4 treatment. The lowest value of Fe (73.79 g/ha), Mn (6.73 g/ha), Cu (8.31 g/ha) and Zn (30.71 g/ha) uptake by little millet grains was found in N1 treatment which was significantly lower than N4 except for iron where difference was non-significant. For priming treatments, no trend was found for different micronutrients uptake and interaction affect for N×P was also found non-significant.

In case of little millet straw also, the highest values for Fe (3677.17 g/ha), Mn (75.84 g/ha), and Zn (383.61 g/ha) uptake was recorded by N4 and only in the case of copper, the highest uptake was seen by N3 (93.18 g/ha) which was just 1.29 g/ha more than N4treatment and differed non-significantly with N4. The lowest value of Fe (2990.95 g/ha), Mn (65.79 g/ha), Cu (78.51 g/ha) and Zn (333.83 g/ha) uptake by little millet straw was recorded in N1 treatment which was significantly lower than N4 except for Mn where the difference doesn't reach the level of significance.

The highest total uptake of Fe (3763.87 g/ha), Mn (83.59 g/ha), and Zn (383.61 g/ha) of little millet was seen in N4 treatment and the highest total Cu uptake of little millet was seen in N3 treatment (102.82 g/ha) whereas total uptake of all the micronutrients i.e Fe (3064.74 g/ha), Mn (72.52 g/ha), Cu (86.82 g/ha) and Zn (364.54 g/ha) was seen in N1 treatment. For priming treatments, no trend was found for different micronutrients, uptake and interaction affect for N×P was also found non-significant.

Higher cationic micronutrient uptake by little millet grain and straw in case of integrated nutrient management might be due to complexing properties of manures with micronutrients that had prevented precipitation, fixation, leaching and kept them in soluble form by microbial activity and higher uptake of these micronutrients by crop. Similar results were reported by Prasanth *et al*. (2019) and Punia *et al.* (2019).

4.12 Effect of integrated nutrient management and seed priming on micronutrient uptake (g/ha) of little millet

Treatment	Iron Uptake (g/ha)			Manganese Uptake (g/ha)			Copper Uptake (g/ha)			Zinc Uptake (g/ha)		
Nutrient management	grain	straw	total	grain	straw	total	grain	straw	total	grain	Straw	total
N1: Control	73.79	2990.95	3064.74	6.73	65.79	72.52	8.31	78.51	86.82	30.71	333.83	364.54
N2:125 kg Neem cake + 1.25 tons ha^{-1} vermicompost	80.65	3111.43	3192.08	7.15	69.25	76.41	9.71	80.99	90.7	33.33	347.9	381.23
N3: 50 kg/ha N : 50 kg/ha P_2O_5 : 50 kg /ha K_2O and 2% Borax spray at flowering.	86.62	3564.94	3651.56	7.27	75.29	82.56	9.64	93.18	102.82	33.85	386.62	420.47
N4: N2+N3	86.7	3677.17	3763.87	7.76	75.84	83.59	9.99	91.89	101.88	35.66	383.61	419.28
N5: Recommended dose of fertilizer i.e. 20 kg/ha N : 20 kg/ha P_2O_5 : 10 kg /ha K_2O	83.72	3474.29	3558.01	7.12	69.91	77.03	9.66	85.04	94.7	33.66	364.32	397.98
SEm±	**3.66**	**96.64**	**99.61**	**0.19**	**2.29**	**2.39**	**0.2**	**1.62**	**1.79**	**0.73**	**8.82**	**9.19**
C.D.(P=0.05)	**NS**	**315.17**	**324.83**	**0.61**	**NS**	**NS**	**0.66**	**5.29**	**5.82**	**2.37**	**28.78**	**29.98**
Priming												
P1: Control	80.94	3403.32	3484.26	7.01	69.42	76.43	9.61	84.42	94.02	34.14	357.77	391.9
P2: Hydropriming for 8 hrs	78.76	3446.09	3524.85	7.01	72.25	79.26	9.09	85.27	94.36	32.62	358.61	391.24
P3: Seed priming (2% KH_2PO_4 for 8 hrs)	89.73	3284.56	3374.29	7.52	72.17	79.69	9.45	87.29	96.73	33.87	375.12	408.99
P4: Seed priming (20% *P. fluorescens)*	79.75	3321.06	3400.81	7.28	71.02	78.3	9.71	86.72	96.42	33.14	361.53	394.67
SEm±	**3.46**	**123.75**	**125.49**	**0.21**	**1.39**	**1.47**	**0.25**	**1.65**	**1.71**	**1.04**	**7.55**	**7.71**
C.D.(P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Interaction	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Fig. 4.12 (a) Effect of integrated nutrient management on Fe and Zn uptake (g/ha) of little millet

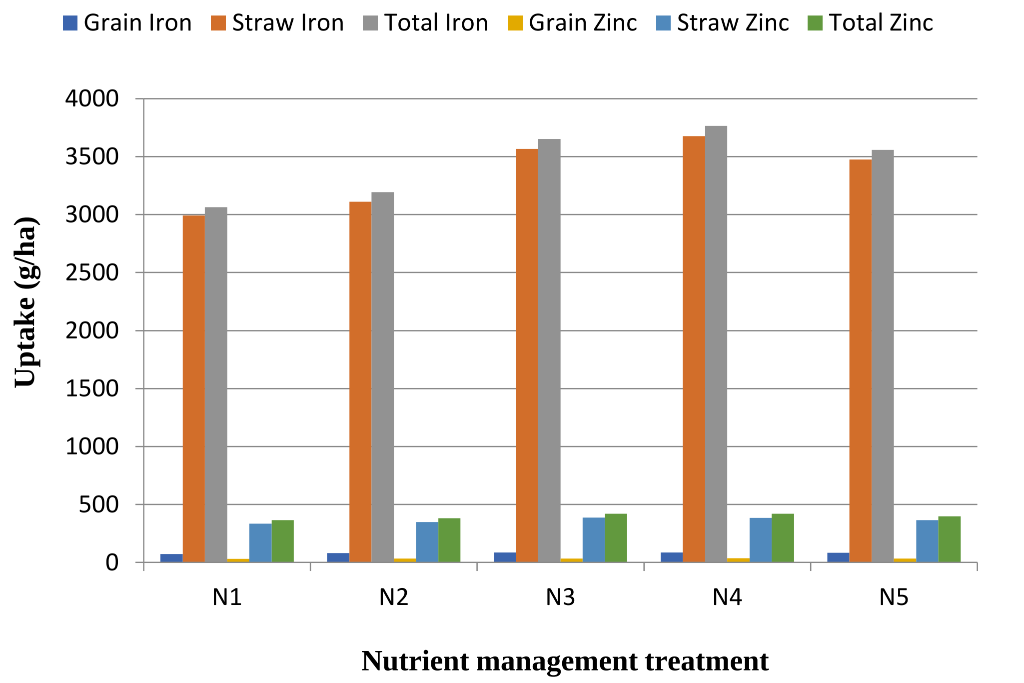


Fig. 4.12 (b) Effect of seed priming on Fe and Zn uptake (g/ha) of little millet

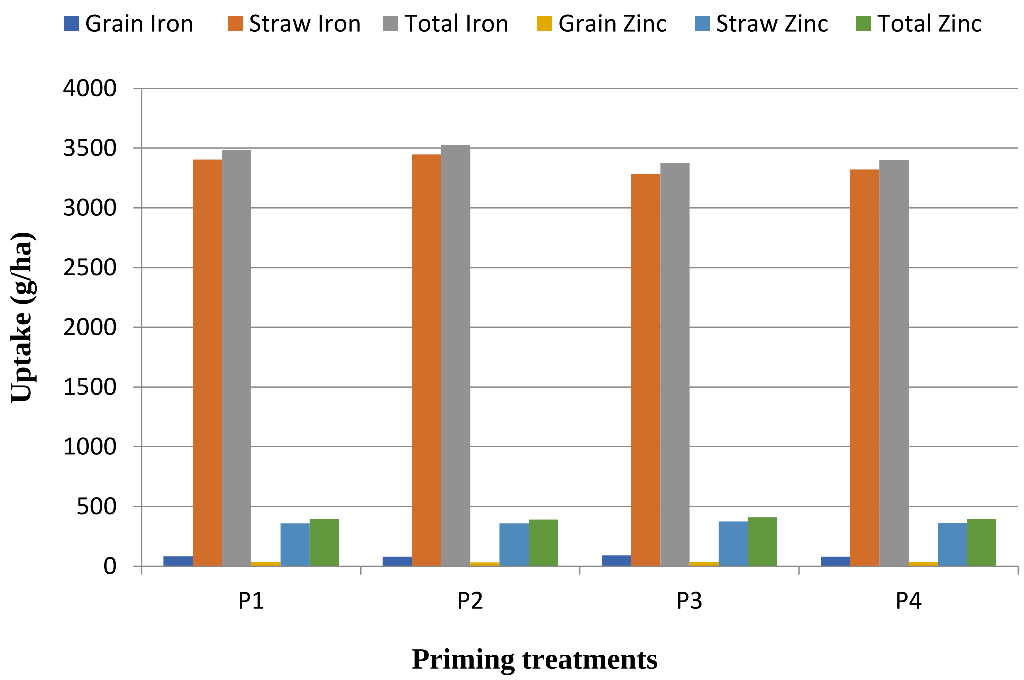


Fig. 4.12 (c) Effect of integrated nutrient management and seed priming on Mn and Cu uptake (g/ha) of little millet

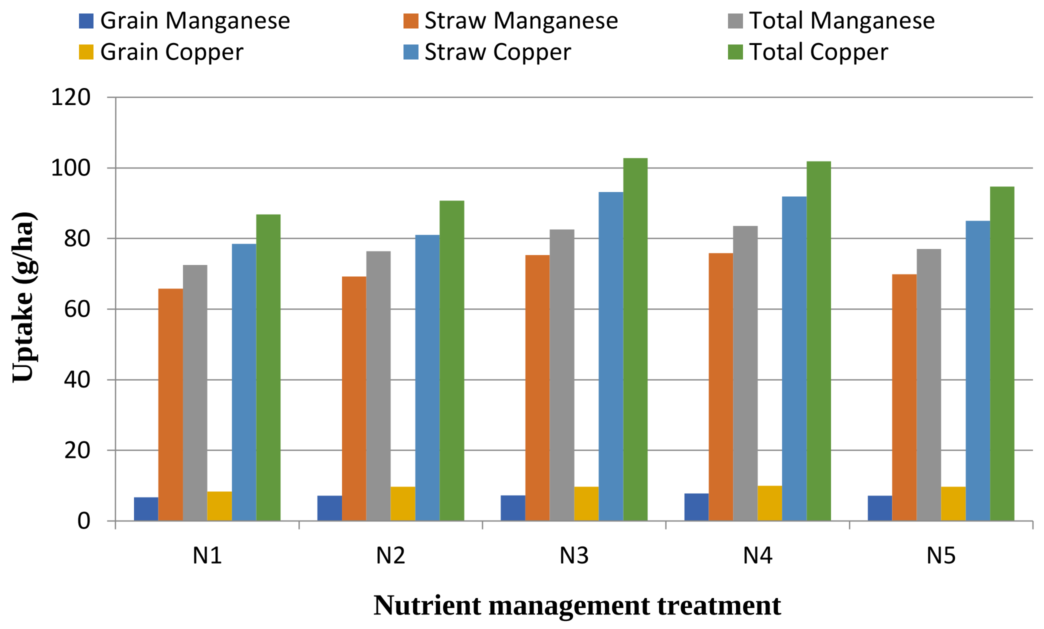


Fig. 4.12 (d) Effect of seed priming on Mn and Cu uptake (g/ha) of little millet

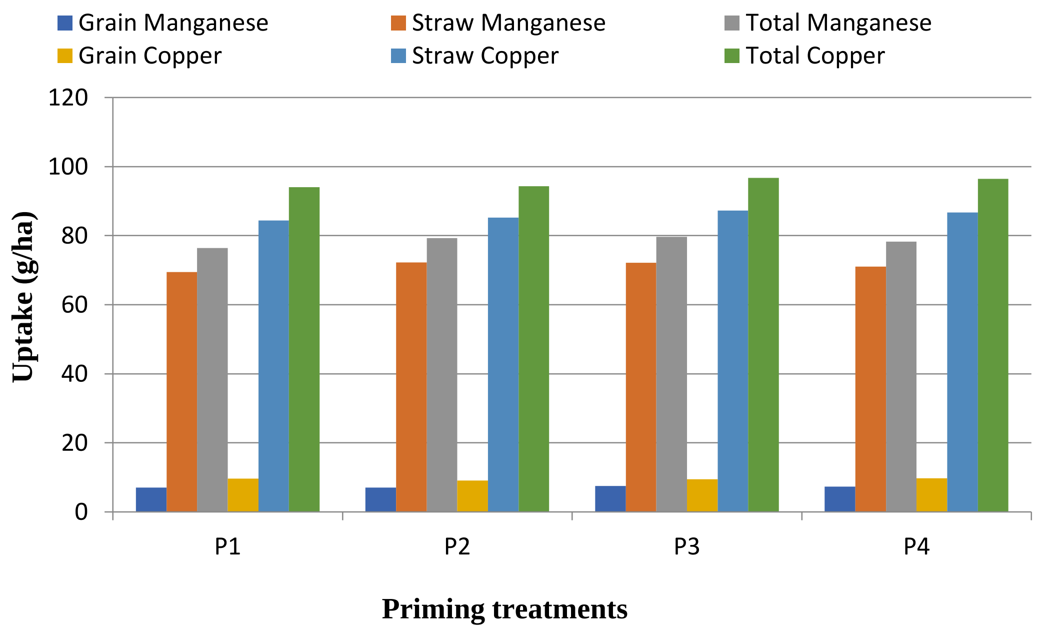


Fig. 4.12 Effect of integrated nutrient management and seed priming on micronutrient uptake (g/ha) of little millet

Sowing of little millet seeds at D.K.S. farm I.G.K.V., Bhatapara

Measurement of little millets plant height at harvest

CHAPTER - V
SUMMERY AND CONCLUSION

Research study entitled **"Effect of Integrated Nutrient Management and seed priming on nutrient uptake and yield of little millet (*Panicum sumatrense*)"** was conducted in DKS farm, IGKV, Bhatapara, Dist- Baloda Bazar, Chhattisgarh under field conditions aimed to achieve following objectives:

1. To evaluate the effect of INM and seed priming on growth, yield, and quality parameters of little millet.
2. To study the physico-chemical and micro-biological properties of soil as influenced by various treatments.
3. To evaluate the effect of INM and seed priming on primary and secondary nutrient content and their uptake in little millet.
4. To evaluate the effect of INM and seed priming on micronutrient content and their uptake in little millet.

The major findings of the experiment are given below:

- pH and EC were not affected by any treatment significantly. High OC content (0.86%) was found in N4 treatment where both organic and inorganic source of nutrients were applied.
- Higher level of plant available nitrogen (146.3 kg/ha), phosphorus (21.6 kg/ha) and potassium (515kg /ha) was found in N4 treatment which was varied non-significantly to N3 treatment where only chemical fertilizers was applied and significantly higher than N1 (control) except for potassium where significance level of difference was not reached due to higher level of potassium in initial soil.
- Higher level of plant available calcium (5771.5 kg/ha), magnesium (2036.0 kg/ha) and sulphur (21.1kg/ha) was found in N4 treatment which was followed by N3 treatment and least available calcium, magnesium and sulphur was found in N1 treatment which was significantly lower than N4 treatment except for plant available magnesium.

- All the plant available cationic micronutrient viz. iron (20.876 mg/kg), copper (3.97 mg/kg), manganese (7.162 mg/ kg) and zinc (2.576) were higher in N4 treatment. The lowest values for plant available iron (17.503 mg/kg), copper (2.346 mg/kg), manganese (5.663 mg/kg) and zinc (2.148 mg/kg) were associated with N1 treatment.
- The microbial population was also found highest in integrated nutrient management and higher values of total bacterial count(93.67×10^{-7}cfu g^{-1}), total actinomycetes count (33.25×10^{-5}cfu g^{-1}) and total fungi (9.67×10^{-4}cfu g^{-1}) count was found in N4 treatment.
- All the growth parameters viz. plant height at 45DAS (82.6cm), 60DAS (107 cm), plant height at harvest (153.9 cm), numbers of effective tillers (6.5) and DAS to 1st flowering (53 days) and 50% flowering (54 days) except field emergence (88.3 %) and test weight (2.5 gm) was found significantly higher in integrated nutrient management treatment and the lowest values are found in control N1 treatment.
- Nitrogen, Phosphorus and Potassium content in grain and straw differed non-significantly due to any of the treatments and varied from 1.34% to 1.37%, 0.46% to 0.50% and 0.49% to 0.50% for nitrogen, phosphorus and potassium, respectively in little millet grain and from 0.63% to 0.68%, 0.24% to 0.25% and 1.16% to 1.18%for nitrogen, phosphorus and potassium respectively in little millet straw.
- The nutrient uptake of primary nutrient found significantly high due to enhanced growth and yield parameters in integrated nutrient management. Higher uptake of nitrogen (13.7 kg/ha), phosphors (4.97 kg/ha) and potassium (5.0 kg/ha) was found in N4 treatment in little millet grain, similarly higher uptake of nitrogen (64.05 kg/ha), phosphors (23.05 kg/ha) and potassium (109.90 kg/ha) was found in little millet straw in N4 treatment only.
- Nutrient content of all the secondary nutrients in plant tissue differed non-significantly due to any of the applied treatment and varied from 19.97 to 20.23 mg/100gm, 119.92 to 121.34 mg/100gm and 10.47 to 10.14 mg/100gm for calcium, magnesium and sulphur respectively in little millet

grain where as in straw it ranged from 178.57 to 191.31 mg/100gm, 450.00 to 457.01 mg/100gm and 21.41 to 21.96 mg/100gm for calcium, magnesium and sulphur, respectively.

- Higher values of calcium (0.20 kg/ha), magnesium (1.20 kg/ha) and sulphur (0.1 kg/ha) uptake in little millet grain was found in N4 treatment which was statistically similar to N3 treatment. The lowest uptake was found in N1 treatment. Similar results were obtained in case of little millet straw.
- Micronutrient content of little millet grains found in the order Fe>Zn>Cu>Mn and the similar order was found for micronutrient content in straw of little millet which were not affected significantly by any treatments. The range of micronutrient content in little millet grain and straw was also very narrow and ranged from 8.39 to 8.78 mg/ 100g, 0.74 to 0.78 mg/ 100gm, 0.94 to 1.03 mg/ 100 gm and 3.49 to 3.58mg / 100gm for iron, manganese, copper and zinc, respectively in grain and 35.94 to 38.81mg/100gm, 0.78 to 0.81 mg/100gm, 0.94 to 0.99 mg/100 gm, 4.04 to 4.12 mg/100gm for iron, manganese, copper and zinc, respectively in straw.
- In case of micronutrients, highest uptake was found for iron and followed the order Fe>Zn>Cu>Mn in little millet grain and straw. N4 treatment recorded the highest values of Fe (86.7 g/ha), Mn (7.76 g/ha), Cu (9.99 g/ha) and Zn (35.44 g/ha) uptake in grain and Fe (3677.17 g/ha), Mn (75.84 g/ha), and Zn (383.61 g/ha) in straw of little millet. Lowest uptake of micronutrients was seen by control N1 treatment.
- Due to increase in growth and yield parameters in N4 treatment, the highest grain (10 q/ha) and straw (94.72 q/ha) yield was recorded in N4 treatment plots and the lowest grain (8.8 q/ha) and straw (83.15 q/ha) was recorded in N1 treatment.

CONCLUSIONS

Organic carbon content in soil was found higher in the treatments where chemical fertilizers in combination with organic manures were applied.

The available N, P, Ca, S and cationic micronutrients in soil increased significantly and found higher where either higher doses of chemical fertilizers or the chemical fertilizers in combination with organic manures were applied except for K and Mg.

Microbial population viz. total bacterial count, total actinomycetes count and total fungi count was found higher in treatments where organic manures or chemical fertilizers in combination with organic manure were applied. Priming doesn’t affect any of the soil parameter under study.

Plant height at 45 DAS, 60 DAS and plant height at harvest, numbers of tillers/ plant, DAS to 1st flowering and 50% flowering were improved where either higher doses of chemical fertilizers or the chemical fertilizers in combination with organic manures were applied however, the priming treatments influenced the plant growth parameters only at early growth stages of plants.

The grain, straw and ultimately the biological yields were found higher where either higher doses of chemical fertilizers or the chemical fertilizers in combination with organic manures were applied however, the priming treatments did not influenced the yield significantly.

The nitrogen, phosphorus, potassium, calcium, magnesium and sulphur contents in plant tissue were not affected significantly by nutrient management and seed priming treatments.

The nutrient uptake of nitrogen, phosphorus, potassium, calcium, magnesium and sulphur were found in higher range with where either higher doses of chemical fertilizers or the chemical fertilizers in combination with organic manures were applied. No effect of seed priming was seen for nutrient uptake of these elements by plants.

The content of cationic micronutrient namely Fe, Mn, Cu, Zn in plant tissue was not affected by any nutrient management and seed priming treatments.

The uptake Fe, Cu and Zn by grain straw and ultimately total uptake in little millet increased significantly where either higher doses of chemical fertilizers or the chemical fertilizers in combination with organic manures were applied, however manganese uptake was influenced significantly only in grain.

Scope for future research

- Breeding work needs to be initiated for reducing the height of the little millet for reducing the lodging of the crop and increasing yield.
- Nutrient management practices should be more standardized for the varieties which were released recently and are more nutrient responsive.
- More package of practices should be developed for different environmental conditions and agro-climatic zones.
- More priming reagents should be tested for better growth and yield of the little millet.
- Little millet is a poor men tribal crop. Low yield discourages for large scale adaptation of the crop, this may lead to extinction of crop. Vocal for local policy C. G. should go for large scale subsidy and higher support price. Little millet has potential for branding the state.

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Appendix A: Weekly meteorological data during crop growth period (8 July 2015 to 13 Dec 2015)

Date	**Temperature (°C)**				**Soil temperature (°C)**				**Wind**	**Bright sun**	**Rain**	**EP**
	Dry	**Wet**	**Max.**	**Min.**	**5 cm**	**10 cm**	**20 cm**	**RH (%)**	**Speed**	**shine**	**(mm)**	**(mm)**
8-14 July	29.4	27.4	33.5	27	28.1	29	29.8	88.5	6.2	2.8	5.1	2.7
15-21 July	29.6	27.6	35.6	27.5	28.2	29.1	30.1	89.3	5.9	2.7	6.6	2.6
22-28 July	29	27.5	33.2	24.8	27.8	28.6	30.5	89.4	6	2.8	14.6	2.9
29 July-4 Aug	26.9	25.8	29.2	24.3	25.7	26.7	27.8	91.1	8.7	1	7.2	2.4
5-11 Aug	27.7	26.2	31	24.7	26.8	27.8	28.5	89.3	8.1	3.2	23.1	2.6
12-18 Aug	28.1	26.7	31.9	25.5	27	28.1	29.3	89.4	8.1	3.8	7.2	3.1
19-25 Aug	27.2	26.2	31.3	24.8	27.6	28.5	29.5	92.9	4.9	3.9	6.9	2.9
26 Aug- 1 Sept	27.3	26.2	31.5	24.9	27.3	28.2	29.2	91.4	4.4	2.4	5.7	2.5
1-6 Sept	28.1	27.3	32.2	24.9	26.6	28.1	29.5	93.7	4.2	1	21.5	1.5
9-15 Sept	28.3	27.3	30	24.5	26.5	27.3	28.7	92	7.3	3.7	3.1	3
15-22 Sept	28.5	27.7	32.1	25.8	28.6	29.5	30.7	94.3	4.5	7	0	4.5
23-29 Sept	27.8	26.6	31.1	25.3	27	27.9	29.5	91	4.9	2.3	23.4	2
29 Sept- 6 Oct	26.3	25	31.7	23.2	26.3	28	30.6	90.3	4.1	7.9	0	3.8
6-13 Oct	25.4	23.1	31.7	23	26.8	28.1	30.4	82.3	2.8	6.2	0.2	3.3

Appendix B(1): Composition of Rose Bengal media

S.NO.	Ingredients	Quantity (1000 mL)
1	Dextrose	10.00 gm
2	peptone	5.00 gm
3	KH_2PO_4	1.00gm
4	$MgSO_4$	0.50 gm
5	Streptomycin	0.03gm
6	Agar-agar	15.00g
7	Rose Bengal	0.035gm
8	Distilled water	1000ml

Appendix B(2): Composition of Nutrient agar media

S.NO.	Ingredients	Quantity (1000 mL)
1	Peptone	5 gm
2	Yeast Extract	2 gm
3	Sodium Chloride	5 gm
4	Agar	5 gm

Appendix B(3): Composition of Kenknight media

S.NO.	Ingredients	Quantity (1000 mL)
1	Dextrose	1.0 gm
2	KH_2PO_4	0.1 gm
3	$NaNO_3$	0.1 gm
4	KCl	0.1 gm
5	$MgSO_4.H_2O$	0.1 gm
6	Agar	15.0 gm
7	Distilled water	1000 ml

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