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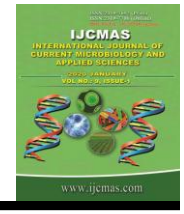

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Appraisement of Total Organic Carbon under Different Levels of +Nitrogen in Different Size Soil Aggregates in Cereal-Pulse Based Cropping System in Rained Condition

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A B S T R A C T

The effect of increasing levels of nitrogen on organic carbon and nutrient status under finger millet, maize and field bean, cultivated soil was studied in the experiment. Experiment was conducted at AICRPDA, under rainfed condition. Split plot design was used which consist of three levels of nitrogen viz., high (100% Recommended dose RD), medium (50% RD) and low (no application of nitrogen) as subplot and type of crop grown as finger millet, field bean and maize were grown as main plot under rainfed condition. Apart from nitrogen, other cultural practices were followed as per the package of practices. Soil samples were separated in to two size aggregates, macro (>250 µm) and micro (>250 µm) using wet sieving method. Total organic carbon (TOC) was analysed in each group of aggregates under cultivation of field bean, finger millet and maize separately and available nutrients of soil were analysed and recorded after the harvesting of crop. It was found that increased level of nitrogenous fertilizer enhanced the total organic carbon in all the crops and impact was more pronounced under maize (cereal crop). Macro aggregates recorded with higher accumulation of TOC as compared to micro aggregates. Available nitrogen and micronutrients were recorded in increasing trend with increase in the nitrogen level. Available phosphorus and potassium content in soil a decreased in content with increasing the levels of nitrogen. The interaction effect of crop grown and level of nitrogen was recorded non-significant under available nutrients content in rainfed condition. The Thus, it was concluded that higher nitrogen level increased the TOC as well as maintained the soil nutrient status in the soil as compared to low level. Cultivation of different crops has differential impact on soil nutrient status and plays an important role in the soil fertility.

Introduction

Cereal-pulse based cropping system is one of the most adopted types of cropping system among the farmers of Karnataka. Finger millet, field bean and maize are among the major crops grown in the state under cereal pulse based cropping system. The cultivation of these crops affects the soil nutrient status differentially. Field bean being the nitrogen fixing crop improves the fertility of the soil in long term. Finger millet is the staple crop of Karnataka state and included in dietary routine along with maize. Finger millet in Karnataka occupies about 1 million ha area with production of 1.8 million tons. It is cultivated on varied soils and climatic conditions owing to wider adaptability and tolerance to stress situations. Similarly, Karnataka contributes in field bean nearly 90 % of area and production in the country (Sultan Singh et al., 2010). It is grown annually in an area of 79,462 ha (66,976 ha in Kharif and 12,486 in Rabi / summer) with a production of 68014 tons (64,215 in Kharif and 3,799 tonnes Rabi / summer) in Karnataka (Anon., 2010). India produces about 2% the world's maize produce. Karnataka is the leading producer of maize in India producing around 16% of India's total Maize production. Normal area under maize cultivation is 11.3 lakh in Karnataka and accounted highest production compared to whole of India (Anon., 2017).

The crop growth is mainly governed by the nutritional status, specifically nitrogen as it is a structural constituent of plant cell and constitutes amino acids, proteins, nucleic is acids, etc. Nitrogen is normally a key factor in achieving optimum grain yields (Fageria *et al.*, 1997). It is, however, one of the most expensive inputs and if used improperly, can pollute the ground water. Combined with low soil fertility, low nitrogen rates as a risk management strategy might contribute to nitrogen deficiency (Monjardino *et al*., 2013; Monjardino *et al*., 2015). The different level of nitrogen affects the yield as well soil nutrient status and it imparts its effect differentially among crop types.

Soil aggregation immensely effect on carbon-nitrogen dynamics. The possible mechanism of aggregates interaction (macro and micro aggregates) with dynamics/ kinetics of soil organic carbon-nitrogen is the confinement of plant debris or decomposed organic matter (OM) inside the micro aggregates and forming a stable macro aggregates by occluded of old organic C in micro aggregates as binding agent (Blanco-Canqui and Lal, 2004). Soil aggregates in various size groups is a major accumulator of organic matter (Elliott and Coleman, 1988).The deets on total organic carbon in various sized soil aggregates is very crucial as it facilitate to quantify the content of (OM) organic matter, which can be potentially conserved in soil, which in turn affects soil structure (Kadlec *et al.*, 2012). Keeping these points in view, the study has been carried out to see the effect of different level of nitrogen on TOC under finger millet, field bean and maize cultivation and their interactive effect on soil available nutrients.

Materials and Methods

The present study was conducted in two different experimental plots, one under rainfed condition at AICRPDA and another irrigated at AICRP on Agroforestry, GKVK, UAS, Bengaluru during the season 2016-2017. The experimental field has been divided according to the split plot design into 36 plots which have three main treatments as cropping system which includes finger millet, field bean and maize crops. This main plots are further divided into three sub-plots which represents three levels of nitrogen high, medium and low and details of these treatments is mentioned in the table below. The cultivation practices followed as per the package and practices of UAS, Bengaluru prescribed for the above mentioned crops apart from the nitrogen application. The experimental details are:

Location: AICRPDA and AICRP on Agroforestry, GKVK, Bengaluru
Crop: Finger millet, Maize, Field Bean/Lablab
Statistical Design: Split Plot
Number of Treatments: 9
Number of Replications: 4
Season: *Kharif* 2017

Treatment details:

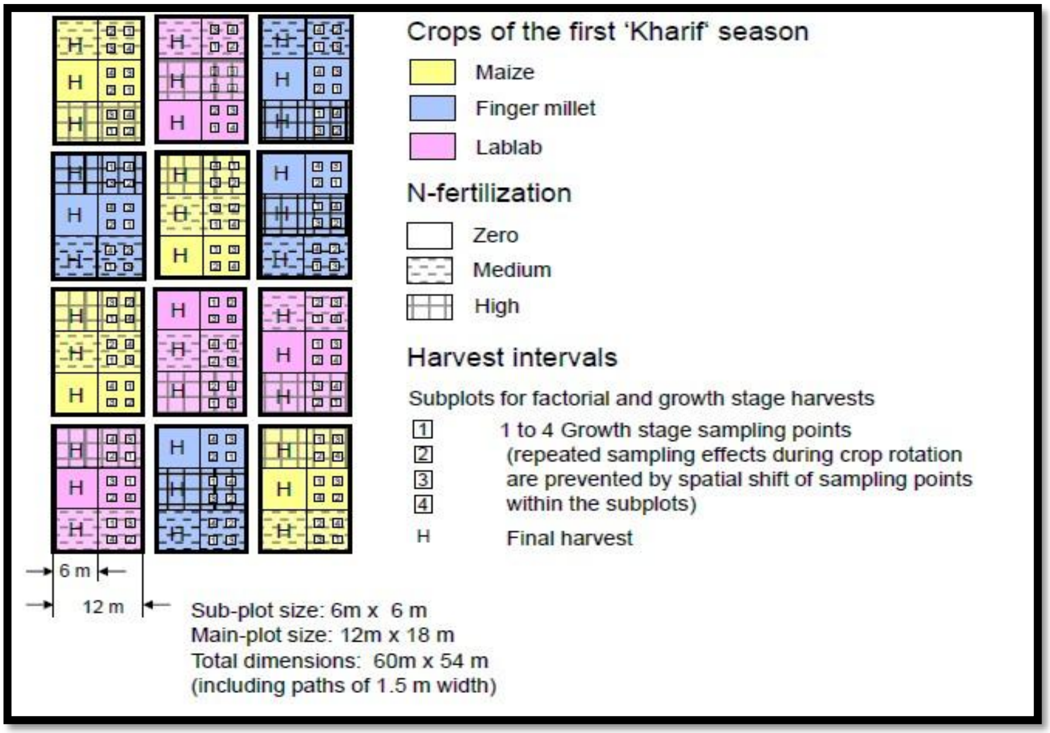
Three main plot treatments consist of cultivation of crops like maize, finger millet and field bean which are further divided into three subplots representing low dose of nitrogen that implies zero amount of nitrogen was applied, medium implies that 50% of the recommended dose of nitrogen had applied and high level which consist of 100% of recommended dose of nitrogen was applied. All other nutrients were applied as per the recommended doses of that particular crop. This set of experiment was conducted in this manner at both irrigated and rainfed condition at the respective selected fields.

		Mains plot	**Sub plot**	**Total dimension**
Rainfed	**Plot size (sq.m)**	**12×18**	**6×6**	**60×54**
	Spacing(cm)	**13.5 x 9 Finger millet**	**30×30 Maize**	**45×15 Field bean/lablab**
Irrigated	Plot size (sq. m)	18×30	6×6	**96×78**
	Spacing(cm)	**18×6 Finger millet**	**60×30 Maize**	**60×15 Field bean/ lablab**

Fertilizers details:

Crops varieties	**Irrigated (kg ha^{-1})**			**Rainfed (kg ha^{-1})**		
	Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus	**Potassium**
Finger millet MR-6	100	50	50	50	37.5	**40**
Field bean HA-4	25	50	25	25	50	**25**
Maize Nityashree	**150**	**75**	**40**	**100**	**50**	**25**

Layout of the experiment



Cultivation of crops

The crops were cultivated adopting the package of practices in the plots according to the given layout and carried out all the intercultural operation timely. Except the nitrogen all the nutrients were applied at the basal dose and nitrogen was applied in two splits, along 2/3 as basal and rest during tillering stage. The varieties sown are MR-6 for finger millet, HA-4 for field bean, Nityashree for maize. The crops were harvested at optimum stage (plot wise) and the yield were pooled crop wise under different level of nitrogen.

Collection, processing and analysis of soil samples

The soil samples from each of the 36 plots have been collected from 0-15 cm depth after the harvest of crops and analysed for the soil physico-chemical properties and nutrient status to analyse the effect of different level of nitrogen as well as cropping system on soil nutrient status and soil properties. Initial soil samples were collected before the sowing of crop and analysed basic soil properties

Separation of soil aggregates into macro and micro aggregates

Soil samples have been separated into two different size soil aggregates using wet sieving method. The method used for aggregate-size separation was adapted for the aggregate hierarchy theory over a range of soils from Elliott (1986). Briefly a 100-g subsample (air-dried or rewetted) was submerged for 5 min on a 0.25-mm sieve. Aggregates were separated by moving the sieve (by hand) up and down 3 cm with 50 repetitions during 2 min. The 0.25-mm aggregates were collected. This procedure was repeated for every sample.

All aggregate fractions were oven-dried and weighed (Yoder, 1936).

Statistical analysis:

The data obtained was subjected to analysis using OPSTAT software with spilt plot analytical method without any transformation. Least square difference was used to compare the treatment effect at P<0.05.

Methodology used to determine available nutrients

Parameter	Method	Reference
pH (1:2:Soil:water suspension)	Potentiometric method	**Jackson, 1973**
EC (1:2:Soil:water suspension)	Conductometric method	**Jackson, 1973**
Soil organic Carbon	Wet oxidation method	**Walkey and Black, 1934**
Available N	Kjeldahl-distillation	**Subbaiah and Asija, 1956**
Available P_2O_5	Brays extraction method	**Bray and Kurtz. 1945**
Available K_2O	Flame photometry	**Jackson, 1973**
DTPA extractable Micronutrients	**Atomic Absorption Spectrophotometer**	**Lindsay and Norvell, 1978**

Results and Discussion

Initial soil properties

Parameters	Values
pH	5.90
EC(dSm-1)	0.13
Available Nitrogen (kg ha-1)	284
Available Phosphorus (P_2O_5) (kg ha-1)	21.66
Available potassium (K2O) (kg ha^{-1})	91.69
DTPA extracted iron (mg kg-1)	11.08
DTPA extracted manganese (mg kg-1)	16.22
DTPA extracted zinc (mg kg-1)	1.34
DTPA extracted copper (mg kg-1)	1.26
Exchangeable calcium (m eq/ 100g soil)	2.5
Exchangeable magnesium (m eq/100g soil)	0.5
Boron (ppm)	0.5

Total organic carbon (TOC)

The distribution of total organic carbon in two different size groups of aggregates, macro and micro, influenced by different levels of nitrogen up to the depth of 90 cm in soil after the harvest of field bean crop, finger millet and maize is presented respectively, in the Table 1, Table 2, and Table 3.

Different levels of nitrogen showed significant impact on distribution of total organic carbon and increase in TOC in soil was observed with increasing levels of nitrogen in all the three crops. Significantly highest mean TOC was observed under N_3level of nitrogen 5.02 g kg $^{-1}$, 5.44 g kg $^{-1}$ and 5.64 g kg $^{-1}$ under field bean, finger millet and maize cultivated soil, respectively. The lowest was observed under N_1level of nitrogen application with a mean value of 4.01g kg $^{-1}$, 3.98 g kg $^{-1}$, 4.88 g kg $^{-1}$ followed by 4.54 g kg $^{-1}$, 4.66 g kg $^{-1}$, 5.20 g kg $^{-1}$ under N_2 level of nitrogen, respectively in field bean, finger millet and maize cultivated soil irrespective of depth and size of the aggregates. This may be attributed to increased nitrogen application increases the root biomass which add the organic matter and thereof total organic carbon content. As nitrogen is the key element for the soil fertility as well as crop growth which leads to higher production of biomass and hence more return to soil in terms of total organic carbon. Kundu*et al.* (2002) reported that SOC content improved in fertilized plots as compared to the unfertilized plots was due to C addition through the roots and crop residues, higher humification rate constant, and lower decay rate (Chatterjee *et al.*, 2018, Saroa and Lal, 2003; Tisdall and Oades, 1982; Bandyopadhyay and Lal, 2015).

Aggregates size affect the distribution of TOC significantly and higher content (4.81 g kg $^{-1}$) was observed under macro aggregates than under micro aggregates (4.24 g kg $^{-1}$) in field bean. Similarly, soil under finger millet and maize cultivation showed significantly higher TOC content under macro aggregates with the value of 5.03 g kg $^{-1}$ and 5.55 g kg $^{-1}$ respectively. In micro aggregates lower content of TOC was noticed with the mean value of 4.52 g kg $^{-1}$, 4.93 g kg $^{-1}$ respectively under finger millet and maize cultivation. Among the soils cultivated with different crops, lowest content was observed under field bean. Macro aggregates in all the three crops contained higher total organic carbon content. This might be due to fact that macro aggregates were formed from micro aggregates and organic matter works as one of the binding agent and organic carbon constitutes 58 % of organic matter and hence contributes higher organic carbon content in the same (Park *et al.,* 2007). Six *et al.* (2000 b) also reported that organic matter acts as one of the binding agent and as per the hierarchical theory of aggregation macro aggregates are formed by coalescing of micro aggregates.

Significant difference of TOC was observed with different depths from 0-15 cm to 75-90 cm. The TOC decreased from 6.62 g kg $^{-1}$ to 2.02 g kg $^{-1}$ from surface soil to the depth of 90 cm in field bean grown soil. Similar trend was followed under finger millet and maize cultivated soil and higher TOC amount was recorded in surface soil samples and declined with increasing depths. The range of TOC with respect to depths deceased from 6.97 g kg $^{-1}$ to 2.32 g kg $^{-1}$ and 7.63 g kg $^{-1}$ to 2.55 g kg $^{-1}$, respectively for finger millet and maize crop grown soil. Highest mean total organic carbon was obtained at 0-15 cm depth with a mean value of 6.62 g kg $^{-1}$, 6.97 g kg $^{-1}$ and 7.63 g kg $^{-1}$ irrespective of nitrogen level and aggregate sizes in field bean, finger millet and maize cultivated soil, respectively. The declined in the TOC content with increasing depth, might be due to the slow or even negligible leaching of organic carbon up to deeper layers. The addition of organic matter was higher at the surface and which converted to various different forms and undergoes mineralization and even lost as carbon dioxide. Thus, very meagre amount of organic carbon reaches to the lower depth and hence the concentration of TOC gradually declined with depth. Similar trend of TOC distribution was documented by Liu *et al*. (2003).

The interactions of all the three factors i.e, nitrogen levels, aggregates sizes and depths was found as non-significant in field bean, finger millet and maize harvested soil. The effect obtained on the distribution of total organic carbon was solely with the individual factors. Although, the trend showed higher TOC content at N_3level of nitrogen at surface soil (0-15 cm). The TOC content decreases, with increasing depth and from N_3 to N_1 levels in the micro aggregates. The TOC content over the nitrogen levels varied with a mean value of 4.01 to 5.02 g kg $^{-1}$, 3.98 to 5.44 g kg $^{-1}$ and 4.88 to 5.64 g kg $^{-1}$ in field bean, finger millet and maize grown soil irrespective of the size of the aggregates and depth. Similarly, macro aggregates were recorded with higher content of TOC with a mean value of 4.28, 4.48 and 5.24 g kg $^{-1}$, respectively under N_1, N_2 and N_3levels of nitrogen in field bean, finger millet and maize grown soil irrespective of depth. Thus, the interaction of the three factors with each other was found non-significant and effect of individual factor was pronounced.

Available macronutrients

Available nitrogen

The available nitrogen content under rainfed experiment was found significantly higher in the plot which receive higher dose of nitrogen (N_3) fertilizer under field bean cultivation (498.86 kg ha-1) (Table 4). This might be due to the nitrogen fixing ability of the field bean crop which increases the available nitrogen content in the soil. This was followed by same level (N_3) of nitrogen application under maize cultivated field with value of 416.71 kg ha-1. The lowest for available nitrogen was found with low nitrogen level *i.e*, no application of nitrogen (N_1) under finger millet. These results are confirmatory with Mourya (2011) who found linear increase in available nitrogen with increasing the dose of nitrogen fertilizers. The amount of added fertilizers was higher in the maize crop as compared to other two crops and hence imparted higher amount of available nitrogen in the soil. The soil under finger millet at N_1 level of nitrogen was recorded with lowest amount of available nitrogen which might be due to no application of fertilizer (151.01kg ha-1). These results are also supported by the Goshu*et al*. (2015). However, there was no significant difference observed with the interaction of crop grown and nitrogen levels applied.

Available phosphorus

Significantly higher amount (61.30 kg ha-1) of available phosphorus was recorded in the N_1 treatment under field bean (lablab) cultivation in rainfed experiment (Table 4). The probable reasons may be low rate nitrogen application leads to poor vegetative and root growth which leads to low rate of nutrient absorption from the soil and hence more abundance of phosphorus in it. The lowest amount was observed in N_3 treatment with higher dose of nitrogen under maize crop as maize is an exhaustive crop and absorb higher amount of nutrient from the soil leaving lesser content in the soil. Similar results were in the favor of findings of Mourya (2011) who found decrease in the phosphorus availability with increase in nitrogen dosage. Du Preez (1999) and Eludoyin (2011) also found decrease in available phosphorus under corn cultivation due to higher absorption by thecrop.

Table.1 Effect of different levels of nitrogen on distribution of total organic carbon (TOC) in macro and micro aggregates in field bean under rained condition

Total organic carbon (TOC) g kg^{-1}													
N levels		**N_1**			**N_2**			**N_3**			**Mean**		
Depth	**A.S**	**Macro**	**Micro**	**Pooled Mean (A)**	**Macro**	**Micro**	**Pooled Mean (A)**	**Macro**	**Micro**	**Pooled Mean (A)**	**Macro (B)**	**Micro (B)**	**Pooled Mean (C)**
0-15		6.07	5.40	5.74	6.98	6.19	6.59	7.92	7.13	7.53	6.99	6.24	**6.62**
15-30		5.43	4.98	5.21	6.05	5.44	5.74	6.86	6.18	6.52	6.11	5.53	**5.82**
30-45		4.75	4.30	4.53	5.29	4.91	5.10	5.87	5.21	5.54	5.30	4.80	**5.05**
45-60		4.11	3.51	3.81	4.64	4.19	4.41	5.18	4.48	4.83	4.64	4.06	**4.35**
60-75		3.27	2.47	2.87	3.69	3.10	3.40	3.87	3.33	3.60	3.61	2.97	**3.29**
75-90		2.05	1.79	1.92	2.15	1.89	2.02	2.35	1.91	2.13	2.18	1.86	**2.02**
Mean aggregates		4.28	3.74	**4.01**	4.80	4.29	**4.54**	5.34	4.71	**5.02**	**4.81**	**4.24**	

Factors	**C.D. (5%)**	**SE(d)**	**SE(m) ±**
A: N levels	0.19	0.10	0.07
B: Aggregate size	0.15	0.08	0.06
AXB	N/A	0.13	0.10
C: Depth	0.27	0.13	0.10
AXC	0.46	0.23	0.16
BXC	N/A	0.19	0.13
AXBXC	N/A	0.33	0.23

Table.2 Effect of different levels of nitrogen on distribution of total organic carbon (TOC) in macro and micro aggregates in finger millet under rained condition

Total organic carbon (TOC) g kg^{-1}													
N levels		**N_1**			**N_2**			**N_3**			**Mean**		
Depth	**A.S**	**Macro**	**Micro**	**Pooled Mean (A)**	**Macro**	**Micro**	**Pooled Mean (A)**	**Macro**	**Micro**	**Pooled Mean (A)**	**Macro (B)**	**Micro (B)**	**Pooled Mean (C)**
0-15		6.63	5.88	6.26	7.33	6.44	6.89	8.18	7.34	7.76	7.38	6.55	**6.97**
15-30		5.60	5.22	5.41	6.30	5.84	6.07	7.42	6.80	7.11	6.44	5.95	**6.20**
30-45		4.79	4.23	4.51	5.25	4.87	5.06	6.73	5.97	6.35	5.59	5.02	**5.31**
45-60		4.42	3.78	4.10	4.77	4.23	4.50	5.47	4.91	5.19	4.89	4.31	**4.60**
60-75		3.07	2.80	2.93	3.41	2.81	3.11	3.66	3.82	3.74	3.38	3.14	**3.26**
75-90		2.35	1.96	2.16	2.50	2.15	2.33	2.67	2.29	2.48	2.51	2.13	**2.32**
Mean aggregates		4.48	**3.98**	4.23	4.93	4.39	**4.66**	5.69	5.19	**5.44**	**5.03**	**4.52**	

Factors	**C.D. (5%)**	**SE(d)**	**SE(m) ±**
A: N levels	0.33	0.17	0.12
B: Aggregate size	0.27	0.14	0.10
AXB	N/A	0.23	0.17
C: Depth	0.47	0.23	0.17
AXC	N/A	0.41	0.29
BXC	N/A	0.33	0.23
AXBXC	N/A	0.57	0.41

Table.3 Effect of different levels of nitrogen on distribution of total organic carbon (TOC) in macro and micro aggregates in maize under rained condition

Total organic carbon (TOC) g kg^{-1}													
N levels		**N_1**			**N_2**			**N_3**			**Mean**		
Depth	**A.S**	**Macro**	**Micro**	**Pooled Mean (A)**	**Macro**	**Micro**	**Pooled Mean (A)**	**Macro**	**Micro**	**Pooled Mean (A)**	**Macro (B)**	**Micro (B)**	**Pooled Mean (C)**
0-15		7.38	6.34	6.86	7.85	7.40	7.62	8.69	8.10	8.40	7.98	7.28	**7.63**
15-30		6.41	5.67	6.04	7.21	6.38	6.80	7.88	7.40	7.64	7.17	6.48	**6.82**
30-45		5.96	5.09	5.53	6.51	5.83	6.17	6.60	6.18	6.39	6.36	5.70	**6.03**
45-60		5.22	4.45	4.83	4.91	4.48	4.70	5.60	4.76	5.18	5.24	4.56	**4.90**
60-75		3.65	3.10	3.37	3.62	3.30	3.46	3.94	3.46	3.70	3.73	3.29	**3.51**
75-90		2.83	2.51	2.67	2.76	2.15	2.45	2.91	2.14	2.53	2.83	2.27	**2.55**
Mean aggregates		5.24	4.53	**4.88**	5.48	4.92	**5.20**	5.94	5.34	**5.64**	**5.55**	**4.93**	

Factors	**C.D. (5%)**	**SE(d)**	**SE(m) ±**
A: N levels	0.35	0.17	0.12
B: Aggregate size	0.28	0.14	0.10
AXB	N/A	0.25	0.17
C: Depth	0.49	0.25	0.17
AXC	N/A	0.43	0.30
BXC	N/A	0.35	0.25
AXBXC	N/A	0.60	0.43

Table.4 Available NPK status at rainfed experiment

Parameters kg ha^{-1}	Crops	Nitrogen level		
		N_1	N_2	N_3
Available Nitrogen	Field bean	301.07	396.32	**498.86**
	Finger millet	251.84	312.86	**371.59**
	Maize	271.57	389.19	**416.71**
CD(p=0.05)	**Crops: 54.74**	**Nitrogen level:27.42**	**Interaction:NS**	
Available Phosphorus	Field bean	61.30	51.81	**41.16**
	Finger millet	42.89	35.65	**28.34**
	Maize	35.14	34.88	**29.69**
CD(p=0.05)	**Crops: 6.62**	**Nitrogen level: 5.09**	**Interaction:NS**	
Available Potassium	Field bean	128.56	102.35	**79.16**
	Finger millet	102.18	86.25	**73.79**
	Maize	153.89	112.43	**94.42**
CD(p=0.05)	**Crops:20.70**	**Nitrogen level: 22.44**	**Interaction:NS**	

A: Crop type; B: Nitrogen level

Table.5 Available micronutrient status at rainfed experiment

Parameters mg kg^{-1}	Crops	Nitrogen level		
		N_1	N_2	N_3
DTPA Extractable Iron	Field bean	8.89	9.83	**10.72**
	Finger millet	8.92	10.87	**12**
	Maize	10.25	12.83	**15.31**
CD (p=0.05)	Crops: 2.32	Nitrogen level : 1.08	**Interaction: NS**	
DTPA Extractable Zinc	Field bean	1.57	1.88	**2.83**
	Finger millet	1.04	1.66	**3.01**
	Maize	1.88	2.69	**4.28**
CD (p=0.05)	Crops: 0.84	Nitrogen level : 0.42	**Interaction: NS**	
DTPA Extractable Manganese	Field bean	15.33	17.05	**21.89**
	Finger millet	11.65	14.88	**17.74**
	Maize	14.46	16.73	**18.46**
CD (p=0.05)	Crops: NS	Nitrogen level : 2.11	**Interaction: NS**	
DTPA Extractable Copper	Field bean	0.95	1.15	**1.25**
	Finger millet	1.06	1.18	**1.28**
	Maize	1.5	1.28	**1.78**
CD (p=0.05)	**Crops: NS**	**Nitrogen level : 0.12**	**Interaction: B at same level of A- 0.23 A at same level of B- 0.39**	

A: Crop type; B: Nitrogen level

Available potassium

Available potassium was recorded significantly higher (153.89 kg ha-1) in maize crop followed by finger millet plot under N_1 low application of nitrogen while lowest amount of 70.39 kg ha-1 was observed under field bean cultivation with higher nitrogen (N_3) application in rainfed field experiment (Table 4). This might be due to the similar reason as observed in phosphorus, optimum supply of nitrogen flourished good vegetative growth and which in turn enhances the uptake of nutrient and deplete the available nutrient content in the soil

The lowest amount observed in N_3 level of nitrogen may be due to the more uptake of nutrients from the soil under all the crops. These result were in complimentary to Mourya (2011) who also found decrease in potassium with increase in the nitrogen level under French bean.

Available micronutrients

DTPA extractable iron, manganese, zinc and copper analysed under rainfed experiment recorded significantly higher amount under (N_1) high dose of nitrogen application irrespective of the crops. However, among the different crops higher content of iron, zinc and copper was observed under maize crop with 15.31, 4.28 and 1.78 Kg ha-1, respectively. DTPA extractable Mn was found higher under field bean cultivation (21.89 Kg ha-1) at N_3 level of nitrogen. Similar, results were obtained by Rangaraj *et al*. (2007) and Sandhya *et al.* (2017) who found higher available micronutrients in the treatment which receives higher doses of nitrogen in finger millet crop.

Manganese was reported significantly higher under field bean crop irrespective of dose of nitrogen and reported higher interactive value of 21.89 kg ha-1 in N_3 level of nitrogen in field bean crop. The lower amount of iron, zinc, manganese and copper micronutrient was observed under N_1 level of nitrogen irrespective of crops type grown and lowest value observed was 8.89, 1.04, 11.65, 0.95 mg kg-1 in case of iron, zinc, manganese and copper (Table no 5). The interaction of crop grown type and level of nitrogen application was found non-significant under both rainfed and irrigated conditions. The higher availability of micronutrients under N_3 level of nitrogen was due to the more vegetative growth of the crop due to more application of nitrogen which leads to increase activity of roots and microbes and secretions which may increase the availability of micronutrients.

It is concluded that the present study investigated the effect of different level of nitrogen on the accumulation of total organic carbon under cereal-pulse based cropping system and found out increase in total organic carbon under cultivation of finger millet, maize and field bean with increase in the levels of nitrogen. The macro aggregates accumulated more amount of organic carbon as compared to the micro aggregates. The depth wise distribution showed higher accumulation of TOC at surface soil (0-15 cm) due to abundance of organic matter at this layer. The amount of available nutrients was also affected by different levels of nitrogen along with the type of crop cultivated and significantly higher content of available nitrogen and micronutrients were also found significantly higher under high level of nitrogen application under maize crop. The available phosphorus and potassium was recorded in declining trend with increasing the level of nitrogen fertilizers. Among different crop type maize being exhaustive crop was reported with higher mining and lower availability of these nutrients. Field bean fixes atmospheric nitrogen and reported with higher content of available nitrogen. However, the interaction effect of nitrogen level and crop grown type was found non-significant.

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