

Original Research Article

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Effect of Differential Levels of Fertilizer and Row Spacing of Brown Top Millet [*Brachiaria ramosa* (L.)] on Soil Physicochemical Properties of Entisol of Bastar Plateau Zone of Chhattisgarh

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ABSTRACT

A field study was conducted at S.G. College of Agriculture and Research Station, Jagdalpur (Chhattisgarh). The experiment was laid out in a split plot design with 3 levels of fertilizer as main plot and 4 levels of row spacing as sub plot with 3 replications. Results showed that the effect of levels of fertilizer on soil properties, the highest values of available N (255 kg ha⁻¹), P (10.8 kg ha⁻¹) and Fe (35.8 ppm) in soil were recorded with 125% of RDF and these parameters increased significantly with the increase in levels of fertilizer from 75 to 100 and 100 to 125% of RDF. The increase in available N and P with increased levels of fertilizer for these nutrients were obvious but increase in available Fe with increasing fertilizer doses of only NP fertilizer might be either due to the acidifying effect during the nitrification of urea or through replacement of Fe²⁺ from exchangeable site on clay by the NH₄⁺ ion formed after its hydrolysis of urea. Whereas in case of effect of row spacing on soil properties, the highest values of available N (233 kg ha⁻¹), P (9.3 kg ha⁻¹) and K (198 kg ha⁻¹) in soil were recorded under 60 cm row spacing. The available N in soil increased significantly with increasing the row spacing from 22.5 to 45 cm, 30 to 60cm and 45 to 60 cm, but the values are at par with each other when the row spacing increased from 22.5 to 30 cm, 30 to 45 cm. The available P in soil increased significantly with increasing row spacing from 22.5 to 30 cm and 30 to 60 cm but the values are at par with each other when the row spacing increased from 30 to 45 and 45 to 60 cm. The available K in soil increased significantly with increasing row spacing from 22.5 to 45 cm, however the values are at par with each other when row spacing increased from 22.5 to 30, 30 to 45 and 45 to 60 cm. The increase in available N P and K with increased row spacing was found might be due to their less utilization in wider spacing having lower plant population in comparison to narrow row spacing. The crop with narrow spacing had greater plant population that could be able to utilize more available nutrients in the soil. The other soil parameters under study were found non significant with the levels of fertilizer and row spacing.

Keywords

Brown Top Millet,
Row spacing,
Fertilizer doses,
Entisols, Soil
properties

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Introduction

Browntop millet (*Brachiaria ramosa* L.) belongs to the family Poaceae (Grass family)

and is called with different names at different places like locally called as pedda-sama and korne, Korale in Kannada and Andakorra in

Telugu (Fuller, 2014). Recently this crop is gaining popularity in several dry parts of India in terms of cultivation and consumption. In India, though the crop gaining lots of importance because of its nutritional value; its cultivation and the distribution is very low and is restricted to Andhra Pradesh, Karnataka, and Tamil Nadu states of South India (Kimata *et al.*, 2000). The brown top millets are also rich in many nutrients and are very delicious. The millet is free from gluten and rich in essential nutrients. Also, it's rich in fiber (12.5%) compared to other crops. Lower incidence of cardiovascular diseases, duodenal ulcer, and hyperglycemia (diabetes), reported among those who regularly consume millets.

Nutrient supply in soil is one of the most important factors that determine the growth of the crop. Fertilizer is the major source of plant nutrients required in sufficient quantity to maintain the nutrient supply in the soil. The response of crop to fertilizers varies widely from place to place, depending upon the native fertility level of soil, environmental condition and genotype. A crop would express its full potential only when it is backed up by good agronomic practices. Optimum plant density provides conditions for proper light interception throughout the crop growth period. Further, it is important to realize that plant density should be defined not only in terms of number of plants per unit area but also in terms of arrangement of these plants on the ground (planting geometry/spatial arrangement) as it helps in efficient harvesting of solar energy with least competition for growth factors viz., water and nutrient uptake which ultimately decides the expression of phenotypic and genotypic character of the crop.

Chhattisgarh has four different soil types i.e. *Entisols*, *Inceptisols*, *Alfisols*, and *Vertisols* mainly developed by the action and

interaction of relief, parent material, and climatic factors. *Entisols* cover 19.5% cultivated area of the state, most of the Bastar plateau contains these soils are known for absence or near absence of horizons that reflects the soil formation process. Though, the *Entisols* aren't thought well for the production of many crops, millets can be grown successfully. The soil is very hard and harsh which leads to limited root and shoot growth. With proper water supply and fertilization, these soils can be used in agriculture (USDA-NRCS, 2006).

Intensive land use with continuous use of higher doses of inorganic fertilizers significantly influences soil health. This has raised concerns about the potential long term adverse effects on soil health and environmental quality (Sarkar and Singh 1997). Marked deterioration in soil physicochemical properties resulting from continuous application of nitrogen (N), phosphorus (P), and potassium (K) fertilizers was reported (Parameswar *et al.*, 1989). Many attempts have been made to utilize the land for the millets still the information on effect of nutrient doses and row spacing are lacking. Henceforth, an attempt has been made to undertake this study with the objective to know the effect of level of fertilizer and row spacing of brown top millet on soil physicochemical properties.

Materials and Methods

Location and physiographic setting

The experiment was carried out during *Kharif* 2019 at Upland Research cum Instructional Farm, Shaheed Gundadhur College of Agriculture and Research Station, Lamker, Jagdalpur, Bastar (Chhattisgarh). Bastar plateau agro-climatic zone lies between the latitude ranging from 17044' to 20030' North and longitude from 82015' to 82020' East

and, physiographically, is a part of Dandyakaranya upland, which is characterized by undulating topography with well marked elevations and depression with complex and heterogeneous setting (Ratre, 2014).

Climate and weather conditions

The climate of the zone is hot and sub humid with hot summer and cool winter. The zone receives an annual rainfall of 1300 to 1600 mm mostly in the month of July and August. The zone is flats in some parts while most of it undulating with slopes of varying magnitude (Ratre, 2014).

Soil type

In Bastar, the land is undulating and hence the soils vary considerably from top of the hillock to the valley. The soil types in Bastar district vary from *Marhan* (*Entisols*) to *Gabhar* (*Vertisols*). *Gabhar* is the valley portion of the undulating terrain. *Tikra* (*Inceptisols*) and *Mal* (*Alfisols*) lies in between these two (Ratre, 2014). Most of the Bastar plateau contains these *Entisols*. Though, the *Entisols* aren't good for the production of many crops, millets were grown better. It may form in a variety of climatic conditions. The soil is very hard and harsh which leads to limited root and shoot growth. With proper water supply and fertilization, these soils can be used in agriculture (USDA-NRCS, 2006).

Cropping history of the experimental field

Sometimes, the experimental results may get affected by the previous crop grown and the experiment carried out over there in that particular area. Henceforth, knowing the cropping history may help in solving many technical errors. The crops being taken during last 3 years were maize during kharif season of 2016 and 2017 and brown top millet during kharif season of 2018.

Experimental details

The field experiment was framed with a total of 12 treatment combination of the application of 3 differential levels of fertilizer with 4 differential levels of row spacing of brown top millet (variety wild) in a split plot design with 3 replications and its impact on crop yield was assessed after harvesting of crop. The fertilizer levels were composed of 75, 100 and 125% of recommended dose of fertilizer (RDF) which was 40:20:00 kg nitrogen: phosphorous: potassium ha⁻¹. The row spacing of brown top millet tested under study was 22.5, 30, 45 and 60 cm. In the present experiment two split doses of nitrogen was applied, initial dose of 50% was applied during the time of sowing and the rest was applied 15 days after sowing.

Crop management

The plot was ploughed well using tractor drawn disc plough; cultivator was used to break the clods and to loosen the soil before taking the experiment. The layouts were made concerning different treatments and replications. The seeds which were locally available were hand sown in the experimental plot on 27 July 2019. Weeds may be the major obstacles in the present experiment. Henceforth, three hand weeding was carried out to suppress there activity. The plant protection measures were taken as per the need of the crop. Once when the fingers were matured the crop was harvested manually.

Observations recorded

Soil samples before and after harvest of crop were collected and analyzed for estimation of pH, EC, OC and available N, P, K, Mn, Zn, Fe and Cu using standard procedures. The data of analysis of initial soil samples are presented in table 1. The pH was recorded using pH meter. The electrical conductivity of

soil was estimated using EC meter. The organic C in soil was estimated using Walkley and Black titration method (1934). The N was determined by alkaline potassium permanganate method of Subbiah and Asija, 1956. Soil available phosphorus was extracted by NaHCO₃ (pH 8.5) as described by Olsen *et al.*, (1954) and P in extract was determined by ascorbic acid method using spectrophotometer (Watnabe and Olsen 1965). The soil potassium was extracted by neutral normal ammonium acetate and determined with the help of flame photometer as described by Muhr *et al.*, (1965). The available micronutrients Zn, Cu, Fe and Mn were extracted by using 0.005 M diethylene triamine penta acetic acid, 0.01 M calcium chloride dehydrate and 0.1 M amine buffered at pH 7.3 (Lindsay and Norvell, 1978) and content were analyzed using atomic absorption spectrophotometer (AAS).

Results and Discussion

The variations in the soil parameters due to levels of fertilizer and row spacing are presented in table 2 and figure 1-10 and the results are interpreted and discussed with the supportive reasons here under following heads.

pH

The data clearly reveals that the fertilizer levels, applied to brown top millet in an *Entisol*, had no significant effect on soil pH. Several workers have reported that the application of fertilizers at different levels had no significant impact on soil reaction (Deekshitha *et al.*, 2017 and Jamal *et al.*, 2010). The no effect of fertilizer levels on soil pH may be due to high buffering capacity of soils (Kumar and Tarafdar, 2011).

The mean soil pH values ranged narrowly between 5.5 and 5.6 under different fertilizer

levels. Similarly, Wany (2012) reported the soil pH ranging from 4.3-5.5 in *Entisols*. Jena *et al.*, (2008) also reported the soil pH in the range of 4.6 to 7.5, in a study with an *Entisol* in deltanic alluvium of coastal Orissa. The data clearly showed that row spacing of brown top millet, in an *Entisol* at Bastar plateau region of Chhatisgarh, had no significant effect on soil pH. No significant combined effect of fertilizer doses and row spacing on soil pH of brown top millet was recorded in this study.

Electrical Conductivity (EC)

The data on soil electrical conductivity didn't differ significantly with the variation in fertilizer levels, however, it trends increasing with increase in fertilizer doses. Similar findings were reported by Deekshitha *et al.*, (2017). The mean values of soil electrical conductivity due to fertilizer levels were ranging between 0.07 to 0.09 dS m⁻¹.

The data clearly showed that row spacing of brown top millet had no significant effect on soil electrical conductivity in an *Entisol* at Bastar plateau region of Chhattisgarh. No significant combined effect of fertilizer doses and row spacing in brown top millet on soil electrical conductivity was recorded in this study.

Organic Carbon (OC)

The data reveals that levels of fertilizer didn't create significant variation in the soil organic carbon content. Kang *et al.*, (2005) reported that the application of chemical fertilizers had no effect on the soil organic carbon content, whereas, organic manures significantly increased the soil organic carbon. However, the results are not in accordance with the findings of Deekshitha *et al.*, (2017); who find out that the fertilizer doses had significant effect on OC content in soil.

The soil organic carbon content as influenced by fertilizer levels are ranged from 0.54 to 0.55% in the *Entisol* under study. The range of OC content was in accordance with the several workers. Nearly 50.4 % soil samples of Dabhra block of Janjgir-Champa district with *Entisols* were reported medium in organic carbon content (Joshi,S. 2012). Similar results were reported in case of soils of Amritsar by Sharma *et al.*, 2008. The soils of Sakti block (*Entisols*) are low to medium in

organic carbon status and ranged from 0.21 to 0.68 % with a mean value of 0.51% (Wany, 2012). The data clearly showed that row spacing of brown top millet, in an *Entisol* at Bastar plateau region of Chhatisgarh, had no significant effect on soil organic carbon. The interaction effect of levels of fertilizers with row spacing on soil organic carbon content is found significant but their simple effects are non significant hence it has no importance.

Table.1 Initial soil properties and nutrient status of experimental soil

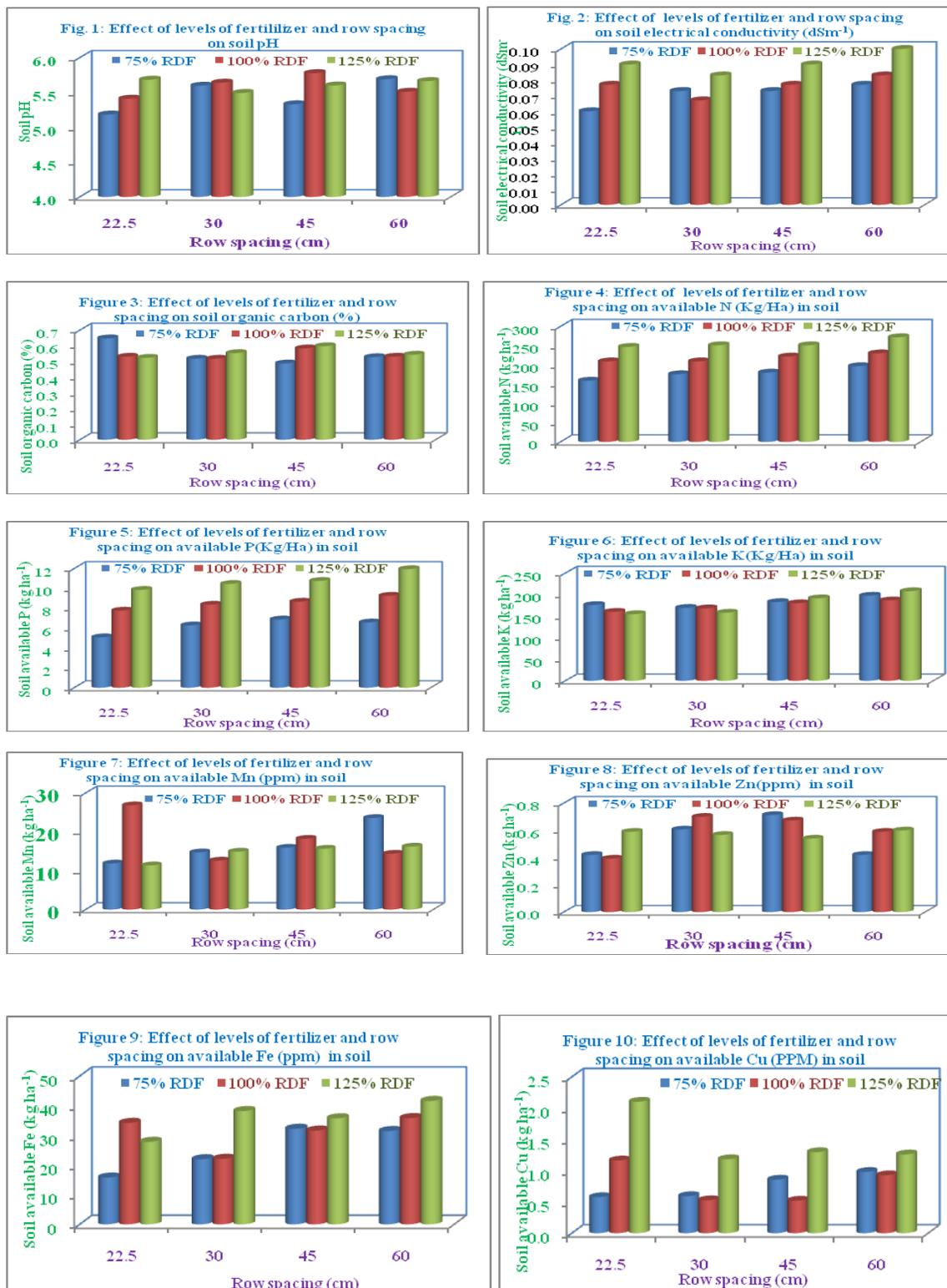
Soil properties	Initial status	Rating	Method
pH	5.86	Slightly acidic	pH meter
EC (dS m ⁻¹)	0.10	Normal	EC meter
OC (%)	0.55	Medium	Walkley and Black (1934)
N (kg ha ⁻¹)	163.07	Very low	Subbiah and Asija, 1956.
P (kg ha ⁻¹)	10.75	Medium	Olsen <i>et al.</i> (1954) and Watnabe and Olsen (1965)
K (kg ha ⁻¹)	204	Medium	Muhr <i>et al.</i> (1965) using flame photometer
Mn (mg kg ⁻¹)	24.21	Sufficient	Lindsay and Norvell (1978) using AAS
Fe (mg kg ⁻¹)	11.15	Sufficient	Lindsay and Norvell (1978) using AAS
Zn (mg kg ⁻¹)	1.2	Sufficient	Lindsay and Norvell (1978) using AAS
Cu (mg kg ⁻¹)	1.58	Sufficient	Lindsay and Norvell (1978) using AAS

Table.2 Effect of levels of fertilizers and row spacing on soil parameters of brown top millet in *Entisols* of Bastar plateau

S. No.	Soil properties	Fertilizer levels (% of RDF)			CD (P=0.05)	Row spacing (cm)				CD (P=0.05)
		75	100	125		22.5	30	45	60	
1.	pH	5.5	5.6	5.6	NS	5.4	5.6	5.6	5.6	NS
2.	EC (dS/m)	0.07	0.08	0.09	NS	0.08	0.07	0.08	0.09	NS
3.	OC (%)	0.54	0.54	0.55	NS	0.57	0.53	0.56	0.53	NS
4.	N (kg ha ⁻¹)	178	217	255	22.5	205	212	218	233	12.6
5.	P (kg ha ⁻¹)	6.2	8.5	10.8	1.0	7.6	8.4	8.8	9.3	0.7
6.	K (kg ha ⁻¹)	181	174	178	NS	164	165	185	198	20.3
7.	Mn (ppm)	16.5	18.0	14.5	NS	16.7	14.1	16.6	18.0	NS
8.	Zn (ppm)	0.54	0.59	0.57	NS	0.47	0.63	0.64	0.54	NS
9.	Fe (ppm)	25.3	30.9	35.8	4.6	25.9	27.4	33.2	36.3	NS
10.	Cu (ppm)	0.75	0.78	1.46	NS	1.28	0.77	0.89	1.06	NS

CD=Critical difference, P=Probability level of significance, NS=Not significant, RDF=Recommended dose of fertilizer, cm=centimeter

Fig.1



Available N in soil

The results reveal that the treatment 125% recommended dose of fertilizer had the highest available N (255 kg ha^{-1}) in soil which was significantly higher than 75 and 100% recommended dose of fertilizer. The available N in soil increased significantly with each successive level of fertilizer. This was in accordance with the results obtained by Deekshitha *et al.*, (2017) who reported 229 kg ha^{-1} highest and 163 kg ha^{-1} lowest available N in soil in case of Bt Cotton. Similarly findings were also reported by Gogoi *et al.*, (2010) in the case of soils of Jorhat. Wany (2012) reported the available N in *Entisols* ranging between 100 to 364 kg ha^{-1} .

The results reveal that the row spacing of 60 cm had the highest (233 kg ha^{-1}) available N in soil which was significantly higher than 45, 30 and 22.5 cm row spacing. The row spacing of 45 cm had significantly higher available N in soil than the 22.5 cm row spacing. The available N showed a general increasing trend with the increase in row spacing. Deekshitha *et al.*, (2017), Gogoi *et al.*, (2010) and Wany (2012) were also reported similarly. No significant combined effect of fertilizer doses and row spacing in brown top millet on soil available N was recorded in this study.

Available P in soil

The results reveal that the treatment 125% of recommended dose of fertilizer had the highest (10.8 kg ha^{-1}) available P in soil which was significantly higher than the 75 and 100% of recommended dose of fertilizer. The available P in soil was increased significantly with each successive level of fertilizer. These results are in accordance with the findings of Reddy *et al.*, (2006). The available P content increased with increase in fertilizer application (Deekshitha *et al.*, 2017). Nirawar *et al.*, (2009) reported the available

phosphorous in the soils of Ahmedpur which was 16.15 kg ha^{-1} . Gorgoi *et al.*, 2010 also reported available P as 12.1 kg ha^{-1} . Wany (2012) reported the available P in *Entisols* which was varying between 17.24 to 38.85 kg ha^{-1} . The results reveal that the row spacing of 60 cm. had the highest available P (9.3 kg ha^{-1}) in soil which was significantly higher than 30 and 22.5 cm row spacing and on par with 45 cm row spacing. The available P in soil was found at par with 45 and 30 cm row spacing and both were significantly higher than 22.5 cm row spacing. Reddy *et al.*, (2006), Deekshitha *et al.*, (2017), Nirawar *et al.*, (2009), Gogoi *et al.*, (2010) and Wany (2012) also reported similarly. No significant combined effect of fertilizer doses and row spacing in brown top millet on soil available P was recorded in this study.

Available K in soil

The result reveals that the effect of levels of fertilizer on available K in soil was found non-significant. It was ranging from 174 to 181 kg ha^{-1} . Sharma *et al.*, (2006) reported that the available K ranged from 135 to 350 kg ha^{-1} in soils of Molasar series (Typic Torripsaments) of Jaisalmer district of Rajasthan. Wany (2012) reported the available K in *Entisols* which was ranging between 90 to 264 kg ha^{-1} . The result reveals that the row spacing of 60 cm was recorded the highest available K in soil which was significantly higher than 30 and 22.5 cm row spacing and statistically at par with 45 cm row spacing of brown top millet. The available K in soil was found significantly higher under the row spacing of 45 cm as compared to 22.5 cm row spacing and statistically at par with 30 and 60 cm row spacing of brown top millet. No significant combined effect of fertilizer doses and row spacing in brown top millet on soil available K was recorded in this study.

Available Mn in soil

The result reveals that the effect of fertilizer levels on the available Mn (ppm) in soil was found non significant. The range of available Mn (ppm) in soil was between 14.5 to 18.0 ppm. Kumar *et al* (2009) reported that available Mn range between 26.2 to 180.0 mg kg⁻¹. Singh *et al.*, (2009) reported 3.2 to 8.5 mg kg⁻¹ of Mn from Ghazipur, UP. Wany (2012) reported the available Mn in soil in the range of 37.7 to 31.7 mg kg⁻¹.

The result reveals that the effect of row spacing on the available Mn (ppm) in soil was also found non significant. No significant combined effect of fertilizer doses and row spacing in brown top millet on soil available Mn was recorded in this study.

Available Zn in soil

The results reveal that the effect of levels of fertilizer on the available Zn (ppm) in soil was found non significant. The available Zn in soil due to levels of fertilizer was ranging from 0.54 to 0.59 ppm and the Zn deficiency was not found in this study. This was in accordance with the finding that the application of fertilizer had no significant effect on Zn content in soil (Deekshitha *et al.*, 2017).

Several workers reported the Zn availability between 0.1 to 1.7 mg kg⁻¹ in the soils of Nagpur, 0.32 to 1.40 mg kg⁻¹ in the soils of Fatehgarh Sahib, Punjab, and 0.38 ppm in the soils of Rajgarh, MP (Sharma *et al.*, 2003 and Sharma *et al.*, 2001). Wany (2012) reported the available Zn in *Entisols* between 0.6 to 2.8 mg kg⁻¹. The result reveals that the effect of row spacing on the available Zn (ppm) in soil was also found non significant. No significant combined effect of fertilizer doses and row spacing in brown top millet on soil available Zn was recorded in this study.

Available Fe in soil

The results reveal that the treatment 125% of recommended dose of fertilizer had the highest (41.6 ppm) available Fe in soil which was significantly higher than the 75% and 100% of recommended dose of fertilizer. The available Fe in soil was increased significantly with each successive level of fertilizer. This might be either due to the acidifying effect during the nitrification of urea or through replacement of Fe²⁺ from exchangeable site on clay by the NH₄⁺ ion formed after its hydrolysis; this was in agreement with findings of Tarafdar *et al.*, 2011. The result reveals that the effect of row spacing on the available Fe (ppm) in soil was also found non significant. No significant combined effect of fertilizer doses and row spacing in brown top millet on soil available Fe was recorded in this study.

Available Cu in soil

The results reveal that the fertilizer doses and spacing had no significant effect on availability of Cu in soil. The results were in accordance with the findings of Deekshitha *et al.*, (2017) and Singh *et al.*, (2009). Wany (2012) reported the availability of Cu in *Entisols* to the tune of 1.2 mg kg⁻¹. The result reveals that the effect of row spacing had no significant effect on availability of Cu in soil. No significant combined effect of fertilizer doses and row spacing in brown top millet on soil available Cu was recorded in this study.

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