



Effect micro-nutrients and farm yard manure on soil properties and yield of maize (*Zea mays* L.) in lower Indo-Gangetic Plain of Uttar Pradesh

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Abstract: The objective of the study to find the suitable treatment combination between the combination of compaction, micronutrients and farm yard manure, which enhanced physical, chemical properties of soil and yield for alluvial soil. The maximum particle density (3.01g/cc), water holding capacity (58.23 %) and pore space (63.40 %) were observed in the treatment T₃ (C₃I₃M₃), whereas maximum bulk density (1.09 g/cc) was observed in the treatment T₁ (C₁I₁M₁). The maximum EC (0.58dS m⁻¹), Organic carbon (0.66 %), available nitrogen (279.76 kg/ha), phosphorous (19.62 kg P₂O₅/ha) potash (194.90 kg K₂O/ha), zinc (0.65 ppm) and sulfur (14.89 ppm) were found in treatment T₃ (C₃I₃M₃). The electrical conductivity gradually increased from control (C₀I₀M₀-0.45) to T₃ (C₃I₃M₃-0.58) dSm⁻¹. The maximum dry weight, test weight and yield were found in the treatment T₂ (C₂I₂M₂) viz., 154.43, (230.33 and 50.50 qha⁻¹ respectively for alluvial soil.

Keywords: Farm yard manure (FYM), Maize yield, Micronutrients, Soil compaction

INTRODUCTION

Maize is the most widely distributed crops of the world. It is cultivated in tropics, sub-tropics and temperate regions. India ranks fourth in the world and it shared area (4.88%) and production (2.55%) in 2012 (FAO 2012). The area of maize in India has been increased from 7.8 to 8.8 (1.1 Mn Hectare) and production from 15 to 22 (7 Mn Mt) during 2006-07 to 2011-12. In Uttar Pradesh, the production and area of maize is 1.1 Mn tonne and 0.8 Mn hectares, respectively (India Maize Summit 14). The Upper Indo-Gangetic Plain of Uttar Pradesh is an important producer of maize in the state. Maize is grown in as many as 25 districts in Uttar Pradesh, but Bulandshahar, Jaunpur, Ghaziabad, Bahraich, Farrukhabad and Gonda are the main producing districts. Maize utilized for direct consumption over the year and increasing commercial demand, presently poultry and cattle feed 61 percent starch and food processing 19 percent in 2012-13 (India maize summit, 2014).

Soil compaction has a severe problem in mechanized agriculture and it influence on many soil properties and on crop yield. The soil is compacted by an intensive use of machinery during the wheat, barley and second crop maize production. It increases bulk density and penetrometer resistance while it reduces penetrability of roots to soil (Unger and Kaspar, 1994) and crop yield (Husnjak *et al.*, 2002). Soil compaction may

significantly impair maize productivity by decreasing the aeration, soil water storage and crop water use efficiency (Kumar *et al.*, 2012a; 2012b). The effect of soil compaction on maize yields has been study comprehensively due to decrease soil productivity associated with mechanization. Farm Yard Manure (FYM) is a good source of nutrients and contributed towards build up of organic matter in soil. It helps to improve and conserve the fertility of soil. Maize responded markedly to graded levels of FYM and showed spectacular response to integration of FYM and fertilizer, plausibly through the activity and population of beneficial soil organisms in the soil. The main objective of the study was how to improved yield of maize through soil manipulation and nutrient management.

MATERIALS AND METHODS

Study area: An experiment was conducted at Research Farm, Department of Soil Science, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, U.P. It is situated 25°24'08.71"-N latitude and 81° 50' 16.95" E longitude, and along the Yamuna River catchment and 98 meter above the mean sea level.

Treatment combination:

T₀ - Control (C₀I₀M₀)

T₁- (C₁I₁M₁) @125 kg Roller 3 times + @25% RDF

(NPK+ZnSO₄) + FYM@2.5 t ha⁻¹

T₂- (C₂I₂M₂) @125 kg Roller 6 times+@50 % RDF (NPK+ZnSO₄)+FYM@5 t ha⁻¹

T₃ - (C₃I₃M₃) @125 kg Roller 9 times + @100 % RDF (NPK+ZnSO₄) + FYM@10 t ha⁻¹

Mechanical and chemical analysis: Mechanical analysis was done by “Bouyoucous hydrometer method”. The bulk density, particle density and percentage pore space determined by cylinder method. Chemical analysis of soil viz., pH, EC, organic carbon, available nitrogen, available phosphorous, available potassium, sulfur and zinc of soil were determined using pH and Ec meter as described by Jackson (1958), Walkley and Black (1934) method, Alkaline permanganate method Subbiah and Asija (1956), Olsen’s colorimetric method (Olsen *et al.*, 1954), Flame photometric method Blancher (1986), Lindsay and Norvell (1978).

Statistical analysis: Randomized block design was used in experiment with three replications. The different plant and soil parametric data recorded at the field were used for statistical analysis method as given by Fisher (1960). The significant and non significant of treatment effect was judged with the help of ‘F’ variance ratio test calculated ‘F’ at 5% level of significance.

RESULTS AND DISCUSSION

Effect micro-nutrients and farm yard manure on soil physical properties: The maximum particle density (3.01 g/cc), water holding capacity (58.23 %) and pore space (63.40 %) were observed in the treatment T₃ (C₃I₃M₃). The maximum bulk density (1.16 g/cc) was observed in the treatment T₁ (C₁I₁M₁) as compared to control (1.15 g/cc). It might be due to the greater level of organic C content maintained as a result of applications of FYM. Level of compaction, micro-nutrient and FYM did not significantly changed bulk density (g/cc). It was also observed the bulk density (g/cc) in soil was gradually decreased with application of the FYM, NPK and micro-nutrient (Laiho *et al.*, 2004; Schjonning *et al.*, 1994). The presence of FYM improved the water holding capacity (%) of soil. It’s contains higher amount of organic matter, silt and clay particle. As these indicated an enrichment of fine fractions i.e. Silt and clay a part from the retention of dissolved organic matter (OM) leading to change in physical properties of soil. Mulholland *et al.* (1999) reported that water holding capacity (%) of soil was increased by moderate

degree of compaction and decreased by heavy compaction.

Effect of micro-nutrients and farm yard manure on soil chemical properties: Soil chemical properties viz. EC, organic carbon, available NPK and sulfur showed a significant change whereas pH and available zinc showed non significant changes. The pH values showed gradually decreases with increase soil compaction, micronutrient and farm yard manure application (Aphale *et al.*, 2005; Tracy and Zhang, 2008). The maximum EC (0.58dS m⁻¹), Organic carbon (0.66 %), available nitrogen (279.76 kg/ha), phosphorous (19.62 kg/ha) potash (194.90 kg/ha), zinc (0.65 kg/ha) and sulfur (14.89 kg/ha) were found in treatment T₃ (C₃I₃M₃). The electrical conductivity was gradually increased from treatment control (C₀I₀M₀) 0.45 to C₃I₃M₃ 0.58 dS m⁻¹. It might be attributed to the addition of salts through application of increase dose of inorganic fertilizers. The maximum available Nitrogen (kg ha⁻¹) of soil was found in the T₃ (C₃I₃M₃) 279.76 followed by T₂ (C₂I₂M₂) 258.82 and minimum values was found in control (C₀I₀M₀) 211.65, respectively. Available NPK of soil was found significantly affected by the application of different level of compaction and micro-nutrient. It was also observed NPK of soil was gradually increased with an increase in different levels of compaction and micro-nutrient (Sarwar *et al.*, 2010). The maximum available zinc in parts per million (PPM) of soil was found in treatment T₃ (C₃I₃M₃) 0.65 followed by T₂ (C₂I₂M₂) 0.56 (PPM) and minimum values were found in control 0.33 (PPM). The availability of Zinc in soil was found Non-significant due to different level of compaction (Soil and Applied Zinc 2004).

Effect of micro-nutrients and farm yard manure on yield attributes of Maize: The dry weight of cob (g) at 90 DAS, test weight (g/1000 grains) and yield (q/ha) were showed significant effect. The maximum dry weight of cob (g) at 90 DAS, test weight (g/1000 grains) and yield (q/ha) were found in the treatment T₂ viz., 154.43, 230.33 and 50.50, respectively. It was observed, the weight of cob were gradually increased with an increases in rate of compaction and micro-nutrient and farm yard manure. This improved growth was mainly due to increased soil nutrient supplying capacity and uptake by plants. Syed *et al.*, (2009) reported that composite varieties differed significantly in dry weight of cob of maize. This might be due to the availability of N required for plant growth

Table 1. Effect of micro-nutrients and farm yard manure on soil physical properties.

Treatment	Bulk density (g/cc)	Particle density (g/cc)	Water holding capacity (%)	Pore space (%)
T ₀	1.15	2.733	50.39	57.35
T ₁	1.16	2.356	53.06	53.10
T ₂	1.07	2.523	55.83	57.22
T ₃	1.09	3.010	58.23	63.40
S. Em. (±)	-	-	0.33	-
C.D. at 5%	-	-	0.93	-

Table 2. Effect of micro-nutrients and farm yard manure on chemical properties of soil.

Treatment	pH	Soil EC (dSm ⁻¹)	O.C (%)	A. N (kg ha ⁻¹)	A. P (kg ha ⁻¹)	A. K (kg ha ⁻¹)	A. Zn (ppm)	A. S (ppm)
T ₀	7.17	0.45	0.43	211.65	16.71	154.30	0.33	11.48
T ₁	7.13	0.51	0.48	246.83	17.43	169.21	0.44	12.69
T ₂	7.10	0.55	0.55	258.82	17.87	177.92	0.56	13.72
T ₃	7.10	0.58	0.66	279.76	19.62	194.90	0.65	14.89
S. Em. (±)	-	0.02	0.02	14.59	0.14	1.54	-	0.22
C.D. at 5%	-	0.07	0.04	21.70	0.24	3.11	-	0.44

Note. A- (Available)

Table 3. Effect of micro-nutrients and farm yard manure on yield attributes of Maize.

Treatment	Dry weight of cob (g) at 90 DAS	Test weight (g/1000 grains)	Yield (q ha ⁻¹)
T ₀	50.53	122.67	33.10
T ₁	102.97	222.00	42.15
T ₂	177.53	267.67	55.10
T ₃	154.43	230.33	50.50
S. Em. (±)	28.37	3.88	1.23
C.D. at 5%	56.58	9.33	2.55

and development (Ahmad *et al.*, 2001). Application of organic matter showed increased DTPA-extractable concentrations of Zn, Fe and Mn. Micro nutrients (Fe, Mn and Zn) of grain corn that ranged from (36–65 mg kg⁻¹). These results were in agreement with Ali (2009). This study illustrated that the applied OM in to soil increased the concentration of Zn and Mn in grains and straw of maize plants. This might be due to the lowering in both pH and soil salinity values.

Conclusion

Integrated nutrient management is one of the best options for apply organic, inorganic fertilizers and mechanical practices to adapt higher in maize production. It not only enhances quantitative values of crop and also qualitative values of crop. The results from the study showed an important treatment combination for good soil health and higher yield in maize crop in alluvial soil at Allahabad region. On the basis of findings, the treatment combination (C₂I₂M₂) @125 kg Roller 6 times+@50 % RDF (NPK+ZnSO₄)+FYM@5 t ha⁻¹ (T₂) showed the best treatment for maize production. Therefore, we recommend to apply a combination (T₂) for higher maize production (the maximum dry weight of cob (g) at 90 DAS, test weight (g/1000 grains) and yield (q/ha) viz., 154.43, 230.33 and 50.50, respectively) in alluvial soil.

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