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Soil Properties Influenced by the effect of nutrient enriched compost and zinc application in Maize (Zea mays L.) Crop

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Abstract
A field experiment was conducted during kharif 2020 at the Instructional Farm (Agronomy), Rajasthan College of Agriculture, Udaipur to study the effect of nutrient enriched compost (NEC) and zinc application on nutrient on quality, nutrient uptake and profitability of maize (*Zea mays* L.) cultivar MP –9 in sub-humid southern plain and Aravalli hill region of Rajasthan. Treatments comprised of four levels of NEC i.e. control (NEC_0), 2.0 t NEC ha^{-1} (NEC_1), 4.0 t NEC ha^{-1} (NEC_2) and 6.0 t NEC ha^{-1} (NEC_3) and four treatment of zinc (Zn) application i.e. control (Zn_0), 10 kg $ZnSO_4$ ha^{-1} as basal + 0.5% $ZnSO_4$ foliar spray (Zn_1), 15 kg $ZnSO_4$ ha^{-1} as basal + 0.5% $ZnSO_4$ foliar spray (Zn_2) and 20 kg $ZnSO_4$ ha^{-1} as basal + 0.5% $ZnSO_4$ foliar spray (Zn_3) taken in a factorial combination in randomized block design with three replications. The increasing levels of nutrient enriched compost and zinc up to 4 t $ha^{-1}$and 15 kg $ZnSO_4$ + foliar spray of $ZnSO_4$ 0.5% ha^{-1} increased significantly found better nutrient and biological status in post harvest soil.and increased the availability of macronutrients (N and K), micronutrients (Zn and Cu), microbial population (bacteria, fungi and actinomycetes) as well as the dehydrogenase and acid phosphatase enzyme activity in post harvest soil of maize over control.Based on the statistical inference, application of nutrient enriched compost @ 4 t ha^{-1} along with basal application of 15 kg $ZnSO_4$ increased significantly found better nutrient and biological status in post harvest soil profitability of maize in sub-humid southern plain region of Rajasthan,

Keywords: Maize, quality, nutrient enriched compost, Nutrient ,foliar and zinc

I. INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal crops of the world and finds a place in the human food, animal feed, fodder and industrial raw material. The productivity of maize is very high because of its C_4 nature of plants and it is very efficient in converting solar energy into production of dry matter. The crop has high genetic yield potential and hence, it is called as Miracle crop and as the "Queen of cereals". In India occupying 9.03 m ha area with production of 28.64 million tones and productivity status of 3.07 t ha^{-1}, respectively (FAI, 2020). In the state of Rajasthan, it covers an area of 0.85 m ha and has a productivity of 2.24 t ha^{-1}(FAI, 2019-20).

Nutrient enriched composting is basically a microbiological process accomplished by the combined activity of bacteria, actinomycetes, fungi and protozoa which are either present in the composting material or are introduced externally to speed up composting and enrich the compost. As a result the substrate is broken down to form an amorphous brown to dark brown mixture known as compost. The waste material with adequate water content undergo intensive decomposition from low to high temperature in heaps or pits for around 4 to 8 months. It is considered a valuable organic fertilizer, supplying nutrients for the crop and hence saving substantial amount of mineral fertilizes (Erhart*et al*., 2005). Nutrient enriched compost is being used as a soil conditioner, as it contains organic matter, plethora of micro-flora, macro and micronutrients, which helps in improving the nutrient status, physico-chemical and biological properties of soil (Ingelmo*et al*., 2012).

Essentiality of zinc in the plant was first established by Maze (1915) in maize and subsequently in barley and sunflower (Sommer and Lipman, 1926). The critical limit of available zinc in the soil suitable for growth is 0.6 mg kg^{-1}. The available zinc in the Indian soils extracted with DTPA is less than 1 per cent of the total zinc content (Takkar and Mann, 1975). Analysis of DTPA extractable Zn in soils has shown that 40 per cent of soil samples were potentially zinc deficient (Shukla *et al*., 2014). It has been postulated that zinc deficiency is likely to increase from 49-63 per cent by the year 2025 as most of the marginal soil brought under cultivation are showing the symptoms of zinc deficiency (Arunachalam *et al*., 2013). Zinc is one of the essential micronutrient and plays an important role in various enzymatic and physiological activities of the plant. Most of the soils of Rajasthan have been found deficient in zinc and assigned low availability of zinc in coarse textured soils with medium organic carbon content (Singh and Singh, 1981). Therefore, if the soil is in short supply with respect to zinc, crop yields are further adversely affected. Hence, it becomes necessary to pay serious attention to the application and utilization of zinc.

II. Materials and Methods

The field experiment was conducted during kharif 2020 at the Instructional Farm (Agronomy), Rajasthan College of Agriculture, Udaipur situated at an altitude of 579.5 m above mean sea level (amsl) and at 24034' latitude and 73042' longitude. This region falls under agro-climatic zone-IVa (Sub-humid Southern Plain and Aravalli Hills) of Rajasthan. The experimental soil was alkaline (pH 8.26+0.16), non-saline (with electrical conductivity of 0.631+0.01 dS m^{-1}) clay loam; medium in organic carbon (0.63+0.01%); low in available N (272+5 kg ha^{-1}), and available P (17.97+0.32 kg ha^{-1}); high in available K (352+7 kg ha^{-1}); and low in available zinc (0.59+0.01 mg kg^{-1}).

Experiment was laid out in a factorial randomized block design and replicated thrice in a plot of 4.0 m x 3.0 m (12 m^2). Treatments comprised of four levels of nutrient-enriched compost (NEC) viz., control (NEC_0), 2.0 t NEC ha^{-1} (NEC_1), 4.0 t NEC ha^{-1} (NEC_2) and 6.0 t NEC ha^{-1} (NEC_3) and four levels of zinc (Zn) application i.e. control (Zn_0), 10 kg $ZnSO_4$ ha^{-1} as basal + 0.5% $ZnSO_4$ foliar spray (Zn_1), 15 kg $ZnSO_4$ ha^{-1} as basal + 0.5% $ZnSO_4$ foliar spray (Zn_2) and 20 kg $ZnSO_4$ ha^{-1} as basal + 0.5% $ZnSO_4$ foliar spray (Zn_3). Maize variety PM-9 was sown in lines 60 cm apart. As per the treatments, whole quantity of NEC was broadcasted at the time of sowing. Nitrogen dose of 120 kg ha^{-1} was applied in two equal splits the half was applied as basal and the remaining half was top-dressed at the time of first irrigation. The basal N dose was applied through urea after adjusting the quantity supplied through diammonium phosphate. The whole quantity of phosphorus (60 kg P_2O_5 ha^{-1}) through diammonium phosphate and potassium (30 kg K_2O ha^{-1}) through muriate of potash was basally applied. The basal zinc (10, 15 or 20 kg $ZnSO_4$) was applied through zinc sulphate heptahydrate at the time of sowing. Foliar spray of 0.5% zinc sulphate heptahydrate was given at 35 days after sowing.Crop was raised followingstandard package of practices recommended by theMPUAT. Observations of soil parameters wererecorded as per the standard methods.Data recorded for different parameters wereanalyzed with the help of analysis of variance(ANOVA) technique for a factorial randomized blockdesign as outlined by Panse and Sukhatme (1985).

III. Result and Discussion

Soil Properties

Effect of nutrient enriched compost

The pH and electrical conductivity of soil decreased whereas, organic carbon, available nitrogen, phosphorus, potassium and zinc content in soil after harvest of maize crop ware increased significantly with increasing levels of nutrient enriched compost (Table 1 and 2). The maximum pH (8.27) and electrical conductivity (0.638 dSm^{-1}) was obtained under the control (NEC_0) and minimum pH (8.13) and electrical conductivity (0.574 dSm^{-1}) was observed under NEC_3 (6 t nutrient enriched compost ha^{-1}) as given in Table 1.

The significantly highest organic carbon (0.756 per cent), available nitrogen (338.79 kg ha^{-1}), available phosphorus (23.88 kg ha^{-1}), available potassium (428.06 kg ha^{-1}), available Zn (0.791 mg kg^{-1}) content in soil after harvest of crop was observed under NEC_3 (Nutrient enriched compost @ 6 t ha^{-1}) over control (NEC_0). However, the difference between NEC_2 & NEC_3 treatment were also found to be statistically at par. The application of nutrient enriched compost @ 2, 4 and 6 t ha^{-1} increased the organic carbon, available nitrogen, available phosphorus, available potassium and available Zn content in soil to the extent of 6.46, 12.30 and 19.24 per cent, 9.93, 18.52 and 23.13 per cent, 7.50, 18.53 and 31.71 per cent, 8.72, 17.22 and 21.06 per cent, 10.32, 30.79 and 33.84 per cent, respectively as compared to control (NEC_0).

The decrease in pH and electrical conductivity of soil with the application of nutrient enriched compost is due to the fact that production of organic acids on decomposition of organic matter and improvement in soil aggregation. These results of present finding are in line with Nagar *et al.* (2016), Meena (2017) and Meena (2019) who also reported decreased pH and electrical conductivity of soil with the application of nutrient enriched compost. The higher availability of N, P, K and Zn with application of nutrient enriched compost might be due to inherent capacity of organic manure which hastens the process of mineralization of organically bound macro and micro nutrients present in the native soil. The availability of nutrients was increased due to formation of organics chelates of higher stability with organics legends, which have lower susceptibility to adsorption, fixation and precipitation in soil (Kanwal *et al*., 2011). The increased available nitrogen, phosphorus, potassium and zinc might be due to the addition of enriched compost and increased multification of soil microbes and as well as hastens chemical activities activities which enhanced the available nutrient pool of the soil (Meena, 2019).

Effect of zinc application

The data presented in Table 1 indicated that zinc application had no significant effect on soil pH and organic carbon at the harvest stage of the maize crop. The electrical conductivity of the soil after harvest of the maize crop increased significantly due to the application of zinc over control. The maximum value of electrical conductivity (0.628 dS m^{-1}) of soil was observed under the treatment of Zn_3 (20 kg $ZnSO_4$ + foliar spray of Zn 0.5% ha^{-1}) and minimum value of electrical conductivity (0.581 dS m^{-1}) of soil was observed with the control (Zn_0) (Table 1).

The effect of zinc application on available nitrogen, phosphorus, potassium and zinc content in soil after harvest of crop was found significant (Table 2). The significantly highest available N (337.71 kg ha^{-1}), K (429.22 kg ha^{-1}) and Zn (0.809 mg kg^{-1}) content in soil was observed under treatment Zn_3 (337.71 kg ha^{-1}) over control. Whereas, the maximum available P content in soil after harvest of crop was obtained under the treatment Zn_0 (21.45 kg ha^{-1}) and the minimum under Zn_3 (19.89 kg ha^{-1}). The application of Zn_1, Zn_2 and Zn_3 increased the available N, K and Zn content in soil to the extent of 10.46, 19.99 and 23.34 per cent, 9.06, 17.37 and 21.38 per cent, 6.27, 29.07 and 35.97 per cent respectively as compared to control (Zn_0).

The pH and organic carbon of soil remained unaffected even the use of zinc fertilizer due to inherent buffering capacity of the soil would resist small changes in soil reaction. The similar results were also reported by Jangir *et al.* (2017) and Todawat *et al.* (2017). The increased available nitrogen and potassium content with zinc application in soil after harvest of crop might be due to effect of zinc on microbial nitrogen fixation in soil which was also indicated (Hemalatha and Chellamuthu, 2013).

On the other hand zinc application significantly decreased available phosphorus content in soil might be due to antagonistic effect of zinc on availability of phosphorus, due to formation of insoluble zinc phosphate at higher concentration of zinc which reduces the availability of phosphorus. Such finding was also reported by Todawat *et al.* (2017) and Meena (2019). The experimental soil being low in available zinc might have resulted in increased available zinc with the increasing level of zinc application. There could be a ‘Priming effect’ which possibly caused solubilization of native zinc with increase in the rate of zinc application. The result was in conformity to those of reported by Kannan *et al.* (2014), Todawat *et al.* (2017) and Meena (2019).

Table 1: Effect of nutrient enriched compost and zinc application on pH, EC and organic carbon in soil at harvest

Treatments	pH	EC (dSm^{-1})	Organic carbon (%)
Nutrient enriched compost levels (t ha^{-1})			
Control (NEC_0)	8.27	0.638	0.634
2 (NEC_1)	8.19	0.631	0.675
4 (NEC_2)	8.17	0.594	0.712
6 (NEC_3)	8.13	0.574	0.756
S.Em$\pm$	0.03	0.002	0.010
CD (P=0.05)	0.07	0.005	0.029
Zinc application (kg ha^{-1})			
Control (Zn_0)	8.24	0.581	0.672
10 kg $ZnSO_4$ + foliar spray of Zn 0.5% ha^{-1} (Zn_1)	8.21	0.609	0.698
15 kg $ZnSO_4$ + foliar spray of Zn 0.5% ha^{-1} (Zn_2)	8.16	0.619	0.703
20 kg $ZnSO_4$ + foliar spray of Zn 0.5% ha^{-1} (Zn_3)	8.15	0.628	0.705
S.Em$\pm$	0.03	0.002	0.010
CD (P=0.05)	NS	0.005	NS

NS = Non-significant

Table 2: Effect of nutrient enriched compost and zinc application on available N, P_2O_5, K_2O and Zn in soil at harvest

Treatments	Available N	Available P_2O_5	Available K_2O	Available Zn
		(kg ha^{-1})		(mg kg^{-1})
Nutrient enriched compost levels (t ha^{-1})				
Control (NEC_0)	275.13	18.13	354.47	0.591
2 (NEC_1)	302.46	19.52	385.38	0.652
4 (NEC_2)	326.09	21.49	415.54	0.773
6 (NEC_3)	338.79	23.88	428.06	0.791
S.Em±	5.04	0.11	5.41	0.008
CD (P=0.05)	14.56	0.32	15.63	0.022
Zinc application (kg ha^{-1})				
Control (Zn_0)	273.79	21.45	353.59	0.595
10 kg $ZnSO_4$ + foliar spray of Zn 0.5% ha^{-1} (Zn_1)	302.45	21.26	385.64	0.635
15 kg $ZnSO_4$ + foliar spray of Zn 0.5% ha^{-1} (Zn_2)	328.53	20.43	415.01	0.768
20 kg $ZnSO_4$ + foliar spray of Zn 0.5% ha^{-1} (Zn_3)	337.71	19.89	429.22	0.809
S.Em±	5.04	0.11	5.41	0.008
CD (P=0.05)	14.56	0.32	15.63	0.022

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