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Effect of Organic Materials With or Without NPK Fertilizers on Yield Uptake of Zinc by Maize (*Zea mays* L.) and DTPA-Zn Status in Soil

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Abstract

A field experiment was conducted on a sandy clay loam Paleustalf to assess the effect of different organic materials with or without recommended dose of NPK fertilizers on grain and stover yield and uptake of zinc by maize and also to know the changes that take place in DTPA-Zn status of soil. The experiment consisted of an absolute control, recommended dose of NPK fertilizers and FYM, city compost, vermicompost and pressmud at 12.5 t/ha with or without NPK fertilizers. Grain and stover yields of maize significantly increased due to the addition organic materials along with NPK fertilizers or NPK fertilizers alone. However, a maximum of 10.50 t/ha^{-1} grain and 6.95 t/ha stover yield of maize were recorded by the treatment that received FYM plus NPK fertilizers. Total zinc uptake was also high (569.15 g/ha) in the treatment which received FYM with NPK fertilizers. Further DTPA-Zn status in soil significantly increased due to the application of organic manures with or without fertilizers. The magnitude of increase was proportionate to the zinc content of these organic materials. Accordingly, the highest DTPA-Zn (1.15 mg/kg) was observed in the treatment which received city compost at harvest of the crop because of its high zinc content.

Key words : Organic materials, NPK fertilizers, Yield, Uptake of Zinc, Maize.

Intensive cultivation of high yielding varieties, increased use of high analysis NPK fertilizers free from micronutrients, decreased use of organic manures and lack of crop residue recycling created a situation that the inherent pools of most of the micronutrients in soils were exhausted. This caused a wide spread deficiency of micronutrients in soils, which become critical for obtaining high and sustainable production. Among the micronutrients, zinc deficiency has been observed in Indian soils on a large scale. More than two lakhs soil samples were analyzed by different centers of ICAR projects and other organizations for evaluation of micronutrients status in Indian soils. The results revealed that more than 45% of the samples analyzed indicated zinc deficiency which is considered to be most serious constraint to the productivity and sustainability in many soils of India (1). Recently, Prasad et al. (2) emphasized the use of organic manures for amelioration of zinc and iron deficiencies in soils. Organic manures, besides improving the deteriorated soil structure and supply of nutrients required by plants, react with native reserves of micronutrients in soil rendering them available to the plants. Hence, an attempt was made to assess the impact of organic manures with or without fertilizers on yield and uptake of zinc by maize and also to understand the changes that takes place in available zinc status in soil.

Methods

A field experiment was conducted on a sandy clay loam Paleustalf at Agricultural Research Station, Kathalagere, Channagiri taluk of Davanagere district, UAS, Bangalore using maize as a test crop. The treatments consisted of an absolute control, recommended dose of NPK fertilizers (RDF), and FYM, city compost (CC), vermicompost (VC) and pressmud (PM) at 12.5 t/ha with or without recommended dose of NPK fertilizers (RDF). The chemical composition of the or-

Table 1. Chemical characteristics of organic materials used in the investigation.

Parameters	FYM	City com-post	Vermi-com-post	Press-mud
pH (1 : 10)	7.90	7.64	7.72	6.72
EC (dS/m at 25C)	1.64	2.02	2.28	2.82
Organic carbon (%)	7.06	8.82	18.00	33.20
Nitrogen (%)	0.90	1.12	1.82	1.34
P_2O_5 (%)	0.40	0.56	0.61	2.10
K_2O (%)	0.60	0.59	0.48	0.53
Total Zn (mg/kg)	100.00	325.00	197.50	180.00

ganic materials used for the experiment is given in Table 1. These treatments were triplicated and tried in randomized complete block design. At maturity the grain and stover samples of maize were collected from each plot after recording their yields. The collected samples were dried at 70 C, pulverized and digested using diacid mixture containing HNO_3 and $HClO_4$ in the proportion of 10 : 4 and zinc concentration in the digest was determined by atomic absorption spectrophotometric method (3). Soil sample collected from experimental plot before start of the experiment was analyzed for its physicochemical properties. The proportion of sand, silt and clay in soil was determined by international pipette method (4). The pH and electrical conductivity (EC) of the soil were determined by potentiometric and conductometric methods, respectively (5). Organic carbon was estimated by Walkley and Black's method as outlined by Jackson

Table 2. Effect of organic materials with or without fertilizers on grain and stover yield of maize.

Treatments	Yield (t/ha) Grain	Stover	Test weight (g)
Absolute control	4.61	4.63	23.49
Recommended dose of NPK (RDF)	9.30	6.33	33.96
FYM 12.5 t/ha	7.02	6.79	32.29
City compost 12.5 t/ha	5.01	5.79	28.56
Vermicompost 12.5 t/ha	5.79	5.25	27.36
Pressmud 12.5 t/ha	5.31	4.86	27.31
FYM 12.5 t/ha + RDF	10.05	6.95	36.51
City compost 12.5 t/ha + RDF	9.65	6.48	36.24
Vermicompost 12.5 t/ha + RDF	9.31	6.95	35.97
Pressmud 12.5 t/ha+ RDF	9.85	6.25	35.97
SE ±	0.29	0.22	0.52
CD at 5%	0.86	0.64	1.53

Table 3. Effect of organic materials with or without fertilizers on concentration and uptake of zinc by maize.

Treatments	Concentration (mg/kg) Grain	Stover	Uptake (g/ha) Grain	Stover
Absolute control	43.17	22.17	213.00	102.70
Recommended dose of NPK (RDF)	34.50	22.50	320.56	141.78
FYM 12.5 t/ha	45.00	22.67	315.89	153.39
City compost 12.5 t/ha	44.67	27.67	222.02	160.19
Vermicompost 12.5 t/ha	44.50	27.50	255.40	144.37
Pressmud 12.5 t/ha	48.17	27.50	256.34	124.11
FYM 12.5 t/ha + RDF	38.67	22.50	412.67	156.48
City compost 12.5 t/ha + RDF	36.00	24.83	346.64	160.72
Vermicompost 12.5 t/ha +RDF	35.83	22.50	332.90	156.09
Pressmud 12.5 t/ha+ RDF	34.33	23.00	338.34	143.52
SE ±	1.79	0.80	16.93	5.97
CD at 5%	5.33	2.38	50.31	17.72

Table 4. Effect of organic materials with or without fertilizers on DTPA-Zn status in soil at different growth stages of maize. DAS = Days after sowing.

Treatments	DTPA-Zn (mg/kg) 30 DAS	60 DAS	At harvest
Absolute control	0.60	0.61	0.57
Recommended dose of NPK (RDF)	0.55	0.79	0.69
FYM 12.5 t/ha	0.74	0.88	0.78
City compost 12.5 t/ha	1.39	1.53	1.15
Vermicompost 12.5 t/ha	0.92	1.09	0.91
Pressmud 12.5 t/ha	0.74	0.81	0.84
FYM 12.5 t/ha + RDF	0.72	0.84	0.71
City compost 12.5 t/ha+RDF	1.19	1.39	1.07
Vermicompost 12.5 t/ha+RDF	0.83	0.99	0.87
Pressmud 12.5 t/ha+RDF	0.67	0.83	0.77
SE ±	0.06	0.05	0.06
CD at 5%	0.16	0.14	0.16

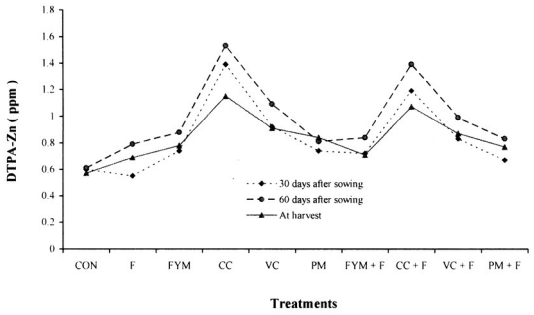

Figure 1. Effect of organic materials with or without fertilizers on DTPA-Zn status in soil at different growth stages of maize.

(5). CEC by NH_4 ion saturation method (3) and total Zn content in soil was determined by a method as described by Sridhar and Jackson (6).

During the crop growth period, soil samples collected at 30 and 60 days after sowing, and also at harvest of the crop were analyzed for DTPA extractable zinc status. Soil was extracted with DTPA extractant (0.005 M diethylene triamine penta acetic acid + 0.1 M triethanolamine + 0.01 M calcium chloride, pH 7.30) at 1 : 2 soil to extractant ratio, shaken for two hours and filtered (7). Zinc concentration in the filtrate was determined by using atomic absorption spectrophotometer under suitable measuring conditions as given in the manual of the instrument (3). Total nitrogen of manures was estimated by Kjeldahl's method (3). After digesting the manures with diacid mixture, total phosphorus and potassium concentrations in the digest were determined by vanadomolybdate yellow color and flame photometric methods, respectively (5) and zinc by atomic absorption spectrophotometric method (3).

Results and Discussion

Soil of the experimental field was sandy clay loam (24% clay) with slightly acidic pH (6.44) and medium in organic carbon status (0.66%). The CEC of the soil was 16.80 cmol (p^+)/ kg and contained 3.60% of $CaCO_3$. Total and DTPA extractable Zn contents were 200 and 0.62 mg/kg, respectively.

Application of recommended dose of NPK fertilizers significantly increased the grain yield of maize (9.30 t/ha) compared to that of absolute control (4.61 t/ha), and treatments which received only organic materials (Table 2). But, when these organic materials applied along with NPK fertilizers significantly increased the grain yield of maize compared to the corresponding treatments, which received only these organic materials. However, the treatment, which received FYM plus fertilizers recorded a maximum of 10.05 t/ha grain yields. Similarly, stover yield also significantly increased due to the applied fertilizers or organic materials along with NPK fertilizers compared to that of control (4.63 t/ha). An increase in grain and stover yield of maize by the application of organic materials in combination with NPK fertilizers could be due to optimum supply of nutrients to plants and also the added organic materials might have created favorable physical conditions in soil for plant growth (8, 9).

Zinc concentration in grain and stover of maize obtained from the treatments which received only organic materials was slightly higher compared to those obtained from the treatments which received NPK fertilizers or organic materials plus fertilizers (Table 3). This may be due to dilution effect wherein the increase in grain and stover yield of maize due to the addition of fertilizers or fertilizers in combination organic materials might have caused the dilution of zinc in grain and stover of maize. Zinc uptake by grains significantly increased due to the addition of fertilizers or organic materials when applied along with fertilizers compared to that of control (213 g/ha) and the treatments, which received only city compost vermicompost and pressmud (Table 3). A maximum of 412.67 g/ha of zinc uptake by grains was recorded by the treatment which received FYM plus NPK fertilizers. A similar observation was also noticed in case of zinc uptake by stover. Here also FYM plus NPK fertilizers added treatment recorded a maximum uptake (160.72 g/ha). An increase in zinc uptake by grain and stover due to the applied organic materials or organic materials in combination with fertilizers could be attributed to the increased availability of zinc in soil (Table 4) and increase in grain and stover yields of maize (Table 2). These results are conformed the observations reported by Sakal et al. (10) and Sharma and Singh (11).

Table 4 indicated the effect of organic materials with or without fertilizers on DTPA-Zn status in soil during crop growth period and revealed that application of FYM, City compost, vermicompost and

pressmud at of 12.5 t/ha or these materials in combination with fertilizers significantly increased the DTPA-Zn in soil at 30 and 60 days after sowing and after harvest of the maize crop (Table 5 and Fig. 1). Whereas, NPK fertilizers alone did not increase the DTPA-Zn in soil except at 60 days after sowing wherein the increase was significant compared to that of absolute control (0.61 mg/kg). The level of DTPA-Zn recorded by all treatments except control at 60 days after sowing of maize was found to be high compared to other two stages, which indicates that rate of transformation seems to be more at this stage as a result of high rate of absorption of zinc by plants. But, the available zinc status at harvest of maize was found to be low in all treatments compared to other two stages probably due to crop removal. Similarly, the treatments, which received organic materials plus fertilizers recorded lower values of DTPA-Zn, compared to that of corresponding organic material added treatments. This could be attributed to the more uptake of zinc by maize due to the increase in the yield of both grain and stover of maize (Table 3). An increase of DTPA-Zn in soil due to the addition of organic materials with or without fertilizers could be explained by release of zinc by these materials and also the chelating substances which released during their decomposition could have prevented the zinc from precipitation or fixation by soil or soil constituents. Swarup (12), Katyal and Sharma (13), Chitdeshwari and Krishnasamy (14) and Nayak et al. (15) reported similar findings.

Therefore, it was concluded that applying organic manures with or without fertilizers could increase available zinc status in soil. But, the magnitude of increase was proportionate to the zinc content of the organic manures.

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