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EFFECT OF FARMYARD MANURE ON THE AVAILABILITY OF $ZnSO_4$ IN TWO DIFFERENT TEXTURED SOILS

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A soil incubation study was conducted on two texturally different alkaline calcareous soils to note the effect of premixing of $ZnSO_4$ with farmyard manure on the Zn availability in soil. Premixing of $ZnSO_4$ with farmyard manure about 12 hr. before its incorporation into the soil had little effect on Zn availability in loamy sand soil. On loamy clay soil it increased Zn availability ($P < 0.01$) than $ZnSO_4$ added alone at 25 ppm Zn application. At a lower rate of 5 ppm Zn application it had little effect on Zn availability. In both soils, native Zn decreased drastically after four weeks' incubation. More than 50 and 70% of the applied Zn could not be extracted by 0.005 M DTPA in the loamy sand and loamy clay soils, respectively, after four weeks of incubation. Zinc addition had no effect on Cu availability in the loamy sand soil but it increased its availability in the loamy clay soil significantly.

INTRODUCTION

Widespread micronutrient dificiencies have been reported in Pakistan soils. Amongst the various micronutrient cations, Zn has been reported deficient in soils rather frequently and extensively [1-3, 14-15, 21, 29-30]. Due to intensive cultivation, the introduction of high yielding varieties and enhanced use of micronutrient free fertilizers, Zn deficiency might become a serious problem for crop raising [21]. Therefore, farmers might be using the fertilizer materials containing Zn. But significant amounts of applied Zn get fixed in the soil in a short period of time [13, 26]. So it is highly important to find the methods to use these costly materials efficiently and economically by saving them from fixation in the soil.

Various factors have been reported to enhance Zn availability. Organic compounds such as chelating agents are of great significance in this regard [8, 10]. Organic compounds may bind Zn and hence reduce its fixation and increase mobility in soils [10, 20]. Farmyard manure (FYM) contains a number of chelating agents and it has been reported to increase the availability of micro-and macronutrients when applied after mixing them with FYM [5, 18, 19, 23, 25, 28]. It was expected to exert a similar positive effect on the Zn availability in the soil. This study was undertaken to test this hypothesis.

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MATERIALS AND METHODS

Two bulk surface soil samples (0-15 cm) used in this study were collected from the experimental farm of the Nuclear Institute for Agriculture and Biology, Faisalabad and from Nankana town (Table 1). Soils were air-dried, ground and passed through 2 mm plastic sieve. Subsamples of 1 kg soil were filled in polythene lined plastic beakers. Zinc was applied at the rate of 5 and 25 ppm in the sulphate form with and without premixing with 200 mg of FYM at 15% moisture, 12 hr. before application. Treatments were imposed in triplicate according to randomised complete block design. Nitrogen and P as urea and KH_2PO_4 were applied at a uniform rate of 100 and 50 ppm, respectively, to all pots.

Subsequently the soils were incubated for four weeks at $30^{o} \pm 2^{o}$ and 60% relative humidity in the controlled environment chamber at 60% field capacity moisture level. Moisture was brought to and maintained at field capacity by daily additions of deionized water. After 4 weeks of incubation, 10 g of the soil sample were shaken with 20 ml of 0.005M DTPA + 0.1M $CaCl_2$ + 0.01M TEA (triethanolamine) extracting solution according to the method of Lindsay and Norvell [16]. The whole experimental apparatus were washed with deionized water, 0.1% Na-EDTA, deionized water, 10% HNO_3 and finally with deionized water as reported by Chaudhary and Loneragen [4]. Zn and Cu in the extract were determined by atomic absorption spectrophotometer (Beckman - 485).

Table 1. Physico-Chemical properties of the soils.

Property	Unit	Faisalabad soil	Nankana Soil
Clay	%	6.00	25.00
Texture	–	loamy sand	loamy clay
pH	–	7.70	7.90
EC_3	mmhos/cm	1.35	3.70
$CaCO_3$ equivalent	%	4.50	2.00
$NaHCO_3$ extractable P	ppm	10.00	15.00
DTPA extractable Zn	ppm	0.46	1.25
DTPA extractable Cu	ppm	1.08	2.62

Table 2. Effect of premixing $ZnSO_4$ and FYM on Zn availability in two soils

Treatment		DTPA extractable Zn after incubation in		
Dose	Methods of application	Faisalabad soil (loamy Sand)	Nankana Soil (loamy clay)	Mean
		ppm		
0	–	0.19	0.14	0.17
FYM	Alone	0.28	0.14	0.21
5 ppm Zn	Alone	2.29	1.35	1.82
	Unmixed	2.31	1.48	1.90
	Premixed	2.48	1.65	2.07
25 ppm Zn	Alone	11.40	6.81	9.11
	Unmixed	11.40	7.20	9.30
	Premixed	11.49	7.43	9.46
LSD	(for overall comparison)	0.05 = 0.25		
		0.01 = 0.34		
LSD	(for comparison within a soil)	0.05 = 0.36		
		0.01 = 0.49		

RESULTS AND DISCUSSION

(a) Effect of Premixing of $ZnSO_4$ with FYM on Zn availability. – Addition of FYM did not affect the availability of native Zn while premixing of $ZnSO_4$ with FYM increased its availability ($P < .05$) at 25 ppm application and had little effect at lower dose on overall basis. In the case of loamy sand soil, it had little effect on Zn availability: however, an increasing trend was noted at control and 5 ppm applied Zn due to premixing $ZnSO_4$ with FYM. In the case of loamy clay soil it increased Zn availability ($P < 0.01$) over Zn added alone at higher dose and had slight increasing effect at 5 ppm which was not significant. Increased Zn availability due to FYM mixing could be attributed to the formation of complexes through chelation because it contained a number of organic compounds such as aliphatic and amino acids and carbohydrates which are capable of forming complexes with heavy metals [8, 10, 28]. Other workers have reported higher uptakes of Cu and P when these were applied to soil after

premixing with FYM [5, 24, 25]. Little effect of FYM mixing on Zn availability in the loamy sand soil could be attributed to its lower clay contents and probably different type of clay which resulted in higher Zn extraction by DTPA and ultimately the elimination of difference in the treatments, if any. The other possible reason for the lower overall relative effect of premixing treatment on Zn availability could be the association of available Zn with soluble fractions of organic matter and poor relationship between soluble fractions of organic matter and total organic matter [11, 12].

(c) Effect of Zn Application on Cu Availability. Zinc applications at the rate of 5 and 25 ppm had no effect on Cu availability in the loamy sand soil while it increased from 2.74 to 3.24 ($P < 0.05$) and to 3.81 ppm ($P < 0.01$) respectively on the loamy clay soil. Increased Cu uptake due to Zn addition by wheat plants on many soils have been observed in our previous glasshouse studies [15]. These findings also confirm the increased Zn or Cu availability due to their addition by depressing their fixation competitively on soil components and may thus mask sometimes their physiological inhibition of absorption by plant [9]. However, short-term solution culture studies have indicated strong mutual Zn-Cu inhibition in their absorption by upland plant species [4, 23]. Workers have reported that Zn and Cu do not interact during translocation from roots to shoots [4]. The net effect of these elements on their uptake by plants growing on soils will, therefore, be governed by two opposing reactions operating simultaneously in soils and plant roots and will highly vary with the nature of soil and plant species.

Table 3. Effect of Zn application on Cu availability in two soils.

Dose	Method of application	DTPA extractable Cu after incubation in Faisalabad Soil (loamy Sand) ppm	Nankana Soil (loamy Clay) ppm	Mean
0	–	0.35	2.74	1.55
FYM	Alone	0.38	3.03	1.71
5 ppm Zn	Alone	0.38	3.24	1.81
	Unmixed	0.37	3.47	1.92
	Premixed	0.38	3.39	1.89
25 ppm Zn	Alone	0.38	3.81	2.10
	Unmixed	0.38	3.15	1.77
	Premixed	0.38	3.40	1.89
LSD	(for overall comparison)	0.05 = 0.31 0.01 = 0.71		
LSD	(for comparison within a soil)	0.05 = 0.49 0.01 = 0.66		

(b) Effect of Zn Addition on its Availability. Four weeks' incubation decreased native Zn availability from 0.46 and 1.25 to 0.19 and 0.14 ppm in the loamy sand and loamy clay soils respectively. These decreases could be attributed to enhanced microbial activities due to favourable moisture and temperature. Microorganisms have been reported to fix Zn in their bodies [13, 27]. Zinc application increased its availability in the order 25 ppm > 5 ppm > control. After 4 weeks of incubation only 47.2, 45.7% and 29.9 and 28.6% of the applied Zn was extracted by DTPA at 5 and 25 ppm applied Zn loamy sand and loamy clay soils respectively. The reduced availability of Zn can be attributed to its fixation by the two soils and increased microbial activities. Similar conclusions were reported by other workers [6, 13]. Higher Zn fixation by loamy clay soil was due to its higher clay contents than loamy sand soil.

CONCLUSIONS

Increased Zn availability due to mixing it with FYM prior to its application on loamy clay soil and little effect on the loamy sand soil necessitates further investigations on these lines involving different textured soils along with growing plants on them supported by simultaneous incu-

bation studies with more frequent sampling. Different types of manures with varied amounts, synthetic organic materials and improved mixing techniques could also be considered.

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