Madras Agric J. 68. (10) : 680-682, October 1981

Influence of Phosphorus Fertilization on Zinc Adsorption by Calcareous Soil of Northern Algeria*

Zinc deficiency disorder occurs in calcareous soils with pH more than 7.4. This adverse effect is due to the interaction of soil pH and $CaCo_3$ with zinc compounds in the soil. The zinc content of calcareous soils is not of ten low but may exceed the amount that is present in non-calcareous soils (Thorne, 1942). Moreover, the distribution of Zn in soil is likely to be affected by depth of the soil, pH, $CaCO_3$, organic matter and CEC. Miller *et al.* (1964) observed that Zn deficiencies are common in plants grown under alkaline soil conditions. In addition, Udo *et al.* (1970), Trehan and Sekhon (1977) and Saeed (1977) have reported that in calcareous soils Zn may be adsorbed by $CaCo_3$.

It has been observed that Zn deficiency occurs in soils that received heavy or frequent P applications (Bingham and Martin, 1956). However, some authors (Boawn and Leggett, 1964) have reported evidence to the contrary. The mechanism and conditions involved in the development of P induced Zn deficiency are not fully agreed upon. Pauli *et al.* (1960) reported that $CaCO_3$ influenced the P-Zn relationship within the plant and also affected P-Zn compounds in the growing medium. The present investigation was undertaken to evaluate Zn adsorption characteristics of a calcareous soil fertilized with different levels of P.

Surface soil samples were collected from an experimental plot which was fertilized with different P levels (0, 25, 50 and 100 Kg P_2O_5/ha; designated as P_0, P_1, P_2 and P_3 respectively). The pH of the soil was 8.2, DTPA extractable Zn 1.8 ppm and $CaCO_3$ 11%. The samples were air dried, seived through a 2 mm seive and stored in plastic containers till the adsorption studies. Adsorption isotherms were determined by equilibrating in 50 ml plastic centrifuge tubes, a series of 1 g soil samples with 25 ml of different amounts of Zn ranging from 3.6 and 44.5 ppm in 0.01 M $CaCl_2$. Two drops of toluene were added to retard microbial growth and the tubes were shaken for one hour twice each day. The equilibration was continued for one week at 25 ±0.5°C and after this period, the samples were centrifuged followed by the determination of the Zn remaining in solution by an atomic absorption spectrophotometer (Pye Unicam 190SP). The amount of Zn adsorbed was calculated as outlined by Saeed (1977) Viz.

$$\text{Zn adsorbed} = A - \frac{R \times S}{g}$$

where,
A = amount of Zn added μg/g of soil
R = Zn remaining in solution μg/ml
S = total equilibrating solution, and
g = grams of soil taken for adsorption study.

The amount of Zn adsorbed at different levels of P is given in the Table. It was observed that Zn adsorption progressively increased with increasing solution concentration of Zn in the aquilibrating solution. It is evident from the results observed in this study

that the ability of the soil to adsorb Zn was gradually diminished with higher P application. At a given Zn concentration (44.5 ppm), the reduction in Zn adsorption was 20.23% for the soil fertilized with P_2O_5 at the rate of 100 Kg/ha. It is evident that $CaCO_3$ and P fertilization played a dominant role in the Zn adsorption characteristics of the soil studied. The results suggest that P induced Zn deficiency could not necessarily be attributed to the precipitation of Zn as insoluble Zn-P compounds in soils. The studies conducted by Lindsay (1972) had shown clearly that $Zn_3(PO_4)_2.H_2O$ is relatively more soluble than soil Zn, and this compound could be an excellent source of Zn as well as P. Increased solubility of Zn with P application has also been reported by other workers (Bingham and Garber 1960; Boawn and Viets, 1954; Brown *et al.*, 1970). However, the present results do not agree with the findings by Spencer (1960) who reported that Zn is immobilized in the soil by phosphats and lime, but substantiate the conclusions by most of the authors that the Zn–P interaction problem is not in the soil external to plants (Pauli *et al.* 1960; Saeed, 1977).

A. J. RAYAR

Department of Soil Science
Faculty of Agriculture
University of Maiduguri P. M. B
1069, Maiduguri NIGERIA

REFERENCES

BINGHAM, F. T. and M. J. GARBER. 1960. Solubility and availability of micronutrients in relation to phosphorus fertilization. Soil Sci. Soc. Am. Proc. 24: 209-213.

BOAWN, L. C. and G. E. LEGGETT. 1964. Phosphorus and Zinc concentration in Russett Burbank poteto tissues in relation to development of Zinc deficiency symptoms. Soil Sci. Soc. Am. Proc. 28: 229-232.

BOAWN, L. C., F. G. VIETS, and C. L. CRAWFORD. 1954. Effect of phosphate fertilizers on zinc nutrition of field beans. Soil Sci 78: 1-7.

BROWN, A. L. B A. KRANTZ, and J. L. ENDINGS. 1970. Phosphorus-Zinc interactions as measured by plant response and soil analysis. Soil Sci 110: 415-420,

LINDSAY, W. L. 1972. Zinc in soils and plant nutrition Adv Agron. 24: 147-186.

MILLER, W. J., W.E. ADAMS. R. NUSSBAUMER R. A, McCRERY and H. F. PERKINS. 1964. Zinc content of ccastal bermudagrass as infiuenced by frequency and season of harvest, location and level of N and lime Agron J. 56: 198-201.

PAULI. A. R, R ELLIS, and H C. MOSER. 1960 Zinc uptake and translocation as influenced by phosphorus and $CaCO_3$. Agron. J. 60 394-396.

SAEED, A. 1977. Phosphate fertilization reduces Zinc adsorption by calcareous soils Plant and Soil 48: 641-649.

SPENCER, W. F. 1960. Effects of heavy application of phosphate and lime on nutrient upteke, growth, freeze injury, and root distribution of grape fruit trees. Soil Sci. 89: 311-318.

THORNE, D. W., W. D. LAWS and A. WALLACE. 1942. Zinc relationship of some Utah soils. Soil Sci. 54: 463-468.

TREHAN, S. P. and G. S. SEKHON. 1977. Effects of clay, organic matter and $CaCO_3$ on Zinc adsorption by soils. Plant and Soil 46: 329-336.

UDO, E. J., H. L. BOHN, and T. C. TUCKER, 1970. Zinc adsorption by calcareous soils Soil Sci. Soc. Am. Proc. 34: 405-407.

TABLE : Effect of P levels on Zn adsorption.

P levels	Zn concentration used for adsorption studies (ppm)					
	3.60	6.40	10.41	24.00	38.00	44.50
	........Zn adsorbed $\mu g/g$ of soil (Mean of four replications)........					
P_0	87.70	155.00	248.63	566.05	900.00	989.44
P_1	85.60	152.80	244.20	555.90	862.78	915.33
P_2	84.20	150.10	238.33	535.20	827.35	853.36
P_4	80.30	141.70	222.03	490.45	722.30	789.20
Percent decrease over	8.44	8.58	10.70	13.36	19.74	20.23
S. Ed.	1.196	2.256	1.770	4.940	6.930	4.080
C. D. (P= 0.05)	2.71	5.10	4.01	11.17	15.67	9.23