Pakistan J. Sci. Ind. Res., Vol. 21, Nos. 3-4 June - August 1978

ZINC - COPPER INTERRELATIONS IN CALCAREOUS SOILS

A. RASHID and F. HUSSAIN

Soil Science Division, Nuclear Institute for Agriculture and Biology, Faisalabad

Zinc and copper deficiency has increasingly been observed in recent years in several field crops growing on calcareous soils of Pakistan [1–3] and their fertilizers will be commonly applied in the near future [2]. It is possible that the soils, deficient in one element and receiving its fertilizer, may contain marginal contents of the other. In such cases, application of one element may have only a limited benefit to the crop or in certain cases, may even be harmful due to the well known Zn-Cu antagonism in their uptake by crops [1–4]. Solution culture studies have frequently shown plant roots to be one possle site of such antagonism [2,5–7]. Their interaction within soils affecting their availability has never been reported.

The present studies were conducted on two alkaline calcareous soils of the Punjab to understand the effect of Zn and Cu additions on th soil availability of each other.

MATERIALS AND METHODS

The soil incubation study was conducted in the laboratory on two surface soils (0–15 cm) of different textures collected from Thikriwala and Kamalia towns of Faisalabad district (Punjab). The soils were air dried and crushed to pass through a 2-mm mesh plastic sieve. Their physicochemical properties have been reported elsewhere [8].

Twenty-five g of each soil was taken in flat-bottomed plastic vessels. Four levels of Zn and Cu, each at 0, 2.5, 5.0 and 10.0 ppm, were applied to both the soils. Zinc and Cu were applied as aqueous solutions of their sulphate salts. The treatments were applied in a completely randomized block design and the experiment was replicated thrice. The soils were maintained at 75% of their respective field capacities throughout the period of the study. They were incubated at 30±1°C for 13 days, a period found sufficient for maximum fixation of Zn (data not shown). At the end of the incubation period, the soils were extracted with 0.005*M* DTPA and their Zn and Cu contents determined by atomic absorption spectroscopy [9] All the experimental apparatus used were washed by s special technique: first with 0.2*M* EDTA, deionized water, 10% nitric acid and again with deionized water [10]. The data were analysed using standard statistical procedures.

RESULTS AND DISCUSSIONS

The influence of varying levels of Zn and Cu on the 0.005M DTPA-extractable Zn and Cu of two soils are

Table 1. Analyses of the soils treated with various levels of Zn and Cu and incubated for 13 days at 30±1°C and 75% field capacity.

Applied		Thikriwala soil		Kamalia soil	
Zn	Cu	Zn	Cu	Zn	Cu
0.0	0.0	0.32	0.63	0.68	1.69
	2.5	0.32	1.37	0.72	2.38
	5.0	0.34	2.17	0.72	3.15
	10.0	0.34	7.70	0.67	7.97
2.5	0.0	2.06	0.70	2.32	1.63
	2.5	1.98	1.36	2.40	2.36
	5.0	1.94	2.21	2.32	3.17
	10.0	1.98	7.59	2.32	8.07
5.0	0.0	3.96	0.63	4.16	1.69
	2.5	3.96	1.37	4.24	2.36
	5.0	3.96	2.24	4.32	3.12
	10.0	3.96	7.32	4.24	8.12
10.0	0.0	7.00	0.54	7.44	1.80
	2.5	7.08	1.29	7.50	2.38
	5.0	7.06	2.10	7.38	3.17
	10.0	7.00	7.54	7.38	8.34
LSD (Zn means)					
	0.05	0.08	NS	0.08	NS
	0.01	0.11	NS	0.11	NS
LSD (Cu means)					
	0.05	NS	0.14	NS	0.12
	0.01	NS	0.20	NS	0.16
LSD (Zn × Cu means)					
	0.05	NS	NS	NS	NS
	0.01	NS	NS	NS	NS

given in Table 1. Increasing rate of their application increased the DTPA-extractable Zn and Cu on both the soils (P 0.01). The average extractability of applied Zn was 66.4, 72.6 and 67.1% in light textured Thikriwala soil and 65.6, 70.8 and 67.3% in heavy textured Kamalia soil for 2.5, 5.0 and 10.0 ppm Zn levels, respectively. The average extractability of applied Cu was 29.2, 31.0 and 69.1% in Thikriwala soil and 26.8, 29.0 and 64.3% in Kamalia soil for 2.5, 5.0 and 10.0 ppm Cu levels, respectively. These results may help to explain high availability of Zn and Cu fertilizers for upland crops on calcareous soils of Pakistan [1].

Copper additions upto 10 ppm did not affect DTPA–extractable Zn in both the soils. Zinc additions upto 10 ppm similarly exhibited little effect on Cu availability. Application of Zn and Cu to alkaline calcareous soils thus appears to have little adverse effect on the soil availability of each other. A Zn-Cu interaction on plant root during absorption process [2,5–7] therefore, seems to be mainly responsible for Zn-Cu antagonism in various crops reported earlier on calcareous soils of Pakistan [1–4].

Acknowledgements. The authors are indebited to Dr. S.H. Mujtaba Naqvi, Director, Nuclear Institute for Agriculture and Biology, Faisalabad, for providing necessary facilities to carry out this study.

REFERENCES

1. M.A. Kausar, F.M. Chaudhry, A. Rashid, A. Latif and S.M. Alam, Plant Soil, **45**, 397 (1976).
2. F.M. Chaudhry and M. Sharif, *In* Isotope-aided Micronutrient Studies in Rice Production with Special Reference to Zinc Deficiency. Proc. Combined Panel Res. Coordination Meeting, Vienna, Sept. 23–27, 1974, IAEA-172, p.1. (1975).
3. A. Rashid, Rahmatullah, F. Hussain, A. Latif and M. Sharif, Pakistan J. Sci. Ind. Res. (submitted 1978).
4. F. M. Chaudhry, M. Sharif, A. Latif and R.H. Qureshi, Plant Soil, **38**, 573 (1973).
5. F.M. Chaudhry and J.F. Loneragan, Aust. J.Agr. Res., 21, 865 (1970).
6. W.E. Schmid, H.P. Haag and E. Epstein, Physiologia Pl., **18**, 860 (1965).
7. T.C. dunne, Proc. Aust. Conf. Plant Nutr. Melborne, 1956, Vol. 1, p. 278 (CSIRO, Aust., Melborne, 1956).
8. F. Hussain and A. Rashid, Pakistan J. Sci. Ind. Res. (in press 1977).
9. W.L. Lindsay and W.A. Norvell, Agron, Abstr., 84 (1969).
10. F.M. Chaudhry and J.F. Loneragan, J.Expt. Bot., **23**, 552 (1972).