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INFLUENCE OF ADDING GYPSUM ON DTPA-EXTRACTABLE ZINC, COPPER, IRON AND MANGANESE IN TWO UPLAND SOILS

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Increased crop yields have resulted in more attention being given to micronutrients. In Pakistan their disorders have been reported in various crops. More research efforts have been concentrated on Zn fertilization than on all other micronutrient problems because of the widespread incidences of Zn disorders.[1] Micronutrient deficiencies have generally been attributed to their low availability from soils and several soil conditions have been reported to promote these deficiences in plants.[2] The effects of various factors which contribute to micronutrient deficiency in plants are still not well understood and considerably more information is needed.

Gypsum, one of the least expensive sources of Ca, has been used as a fertilizer for a long time in many areas of the world.[3] Single superphosphate which contains a significant amount of gypsum is being liberally used as a phosphatic fertilizer. Gypsum among soil amendments has been considered an effective mean of reclaiming alkali soils.[4, 5] Placement of gypsum fragments in watercourse has been found to be an effective measure for amending saline-sodic water for raising crops.[6]

Gypsum incorporation to the soils in one form or the other stimulated the need to know its effect on the solubility of micronutrients in soils. Little information in this connection is published. The present work was designed to evaluate the effect of adding gypsum on DTPA-extractable Zn (native plus applied) and Cu, Fe and Mn (native).

Materials and Methods

Two surface soils (0-15 cm) of varying texture were collected from Thikriwala and Kamalia, Faisalabad district. They were air dried and passed through a 2-mm mesh plastic sieve. Physico-chemical characteristics of the soils used have been detailed elsewhere.[7] Before performing the actual incubation study, 4 kg of each soil received 4 rates of analytical grade gypsum (0, 5.5, 11.0 and 22.0 tonnes/ha) as pretreatment. After the addition of gypsum the soils were thoroughly mixed and incubated at their respective field capacities and room temperature for 2 weeks so that the added gypsum may get equilibriated with the soils. Twenty-five g portions of air-dried and 2-mm-sieved soil samples of these pretreated soils were taken in flat-bottomed plastic vessels. Samples in triplicate were superimposed with 4 rates of Zn (0, 2.5, 5.0 and 10.0 ppm) as $ZnSO_4 \cdot 7H_2O$ solution and the amount of water in the soil of each vessel was brought to its 75% field capacity. Soils were incubated at $30 \pm 1°$ for 13 days, a period found sufficient for the maximum fixation of Zn (data not shown). Moisture level of the soils was maintained at 75% field capacity during the experimental period. After a 13-day incubation, the soil samples were extracted with 0.005 M DTPA (diethylenetriaminopentaacetic acid) and Zn, Cu, Fe and Mn in the soil extracts were determined by atomic absorption spectrophotometery.[8] The data were processed by standard statistical procedures.

Results

Effect of gypsum on DTPA-extractable Zn (native plus applied). Irrespective of the gypsum level, increasing rate of Zn increased DTPA-extractable Zn of both the soils ($P<0.01$, Table 1). Increasing level of gypsum gradually decreased the extractable Zn of the Kamalia soil ($P<0.01$). Gypsum additions to Thikriwala soil, however, exhibited little effect on the extractability of this metal.

Effect of gypsum on DTPA-extractable Cu, Fe and Mn (native). Gypsum application considerably decreased extractable Cu of both Thikriwala and Kamalia soils ($P<0.05$ and $P<0.01$ respectively). Even the lowest level of gypsum studied had a marked effect on the solubility of this metal. But no further decrease in Cu extractability was noticed with an increase in the level of gypsum application.

A marked effect of gypsum addition was noticed on extractable Fe of both soils ($P<0.01$). Substantial decrease in extractable Fe occurred in the Thikriwala soil with increasing level of gypsum up to 11 tonnes/ha. This decrease in the Kamalia soil was of a much greater magnitude, the maximum decrease being at the highest level of gypsum used.

A drastic decrease in extractable Mn of both soils occurred with gypsum application ($P<0.01$). An increase in the level of gypsum progressively decreased Mn solubility in both soils, the maximum decrease being at the highest level of gypsum applied.

Discussion

The results of the present study indicated that gypsum addition to the soils caused a reduction in the extractability of all the metals studied except that Zn remained unaffected in the Thikriwala soil. A sudden and drastic drop in the extractable Mn of both soils with the application of gypsum was quite surprising. Calcium donated by gypsum obviously does not appear to have played any role in causing reduction in metal extractability. Moreover, gypsum

TABLE 1. DTRA-EXTRACTABLE MICRONUTRIENTS AS INFLUENCED BY VARIOUS LEVELS OF GYPSUM AND ZINC IN TWO SOILS INCUBATED FOR 13 DAYS AT 30±1° AND 75% FIELD CAPACITY.

Applied		0.005 M DTPA-extractable micronutrients							
Zn (ppm)	Gypsum (tonnes/ha)	Thikriwala soil				Kamalia soil			
		Zn	Cu	Fe	Mn	Zn	Cu	Fe	Mn
		ppm							
0	0	0.25	0.51	1.61	3.03	0.59	1.40	6.70	3.24
	5.5	0.31	0.45	1.47	2.13	0.51	1.25	4.47	2.46
	11.0	0.30	0.46	1.39	1.92	0.46	1.22	4.47	2.01
	22.0	0.26	0.49	1.54	1.65	0.46	1.25	4.17	1.74
2.5	0	1.89	0.52	1.61	3.03	2.12	1.43	6.70	3.21
	5.5	1.95	0.51	1.54	2.04	1.97	1.29	4.62	2.34
	11.0	1.88	0.46	1.32	1.83	2.01	1.25	4.47	2.01
	22.0	1.89	0.49	1.39	1.74	1.99	1.29	4.17	1.71
5.0	0	3.48	0.49	1.47	2.97	3.72	1.57	6.99	3.30
	5.5	3.48	0.46	1.39	2.10	3.54	1.29	4.47	2.19
	11.0	3.48	0.46	1.32	1.80	3.60	1.33	4.17	1.95
	22.0	3.48	0.45	1.39	1.71	3.42	1.25	4.02	1.68
10.0	0	6.54	0.42	1.61	2.97	6.70	1.47	6.25	3.03
	5.5	6.50	0.43	1.47	2.28	6.46	1.40	4.47	2.28
	11.0	6.48	0.42	1.39	1.89	6.60	1.36	4.47	1.98
	22.0	6.48	0.42	1.39	1.68	6.42	1.29	4.02	1.71
LSD (0.05) (Gypsum means)		NS	0.03	0.11	0.09	0.05	0.05	0.18	0.09
LSD (0.05) (Zn means)		0.04	0.03	NS	NS	0.05	0.05	NS	NS
LSD (0.05) (Gypsum × Zn means)		NS	NS	NS	NS	0.14	NS	0.50	NS

has little effect on soil reaction. Such interferences in solubility, therefore, may be ascribed to some other cause.

As $CaSO_4.2HO_2$ is a sparingly soluble compound, certainly a significant portion of added gypsum remains in crystalline form in the soil. All crystalline phases of matter in the soil capable of existing in a finely divided state, when dispersed in solution, inherently possess an adsorption potential because of the unsaturated forces which exist at all interfaces.[9] Crystalline gypsum, in a finely divided state, may also constitute a potential adsorptive phase for certain metals. In the present study, possibly the fixation of these metals on solid phase gypsum, in part, seems a plausible explanation for the reduction in their extractability. Comparatively, more decrease in the extractable metals of the Kamalia soil with a greater percentage of clay shows the possibility of the occurrence of some additional mechanism rather than mere adsorption on solid-phase gypsum. But again the real mechanisms are not understood and such postulations warrant further investigations. However, whatever the mechanism, the present study seems to be of a considerable academic importance since it clearly indicates that the incorporation of gypsum to soils may induce or aggravate the deficiencies of Zn, Cu, Fe and Mn in soils.

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