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EVALUATION OF SOIL TESTS FOR ZINC IN SEMI ARID SOILS FOR MAIZE

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ABSTRACT

A greenhouse experiment was conducted with 20 soils representing semiarid soils of Coimbatore district to peredict the most reliable soil test method for determining the available Zn status in the soil. Therewere four levels of Zn (0, 2.5, 5.0 and 7.5 ppm) and each treatment was replicated two times. Maize (Ganga 5) was used as the test crop and the crop was allowed to grow for seven weeks. The results showed that among the six extractants tried, EDTA + $(NH_4)_2 CO_3$ and DTPA were found to be the most reliable soil test methods as compared to the other four methods employed. Between the two methods, DTPA soil test method could be recommended for determining the available Zn status in the soils of Coimbatore district as it had given higher relationship with the actual yield, Bray's per cent yield, Zn content in leaves and leaf sheath and stem.

KEY WORDS : Soil Test, Evaluation, Zinc Status, Maize, Coimbatore District

Deficiency of Zn usually appears early in the growing season. For soils of diversified physical and chemical characteristics, the same extractant may not be suitable. Therefore, a reliable soil test is needed to determine the Zn fertiliser requirement prior to planting. The present study was contemplated to fix the most reliable soil testing method with suitable extractant for assessing the available Zn status in four great soil groups *viz* chromusterts, ustorthent, ustivertept and Rhodustalf of the Coimbatore district.

MATERIALS AND METHODS

Soils

Twenty surface soils, representing the major maize growing areas of the Coimbatore district of Tamil Nadu, were Collected. Both Zn deficient and sufficient soils were included. The soils had the following characteristics; texture sandy loam to clay loam; pH 7.6 to 8.7; organic matter 1.34 - 3.10 per cent; available Zn (DTPA) 0.26-3.90 ppm. Available Zn was extracted using different extractants, viz: 0.1 NHC1 (wear and Sommer, 1948), 0.05 N HC1 + 0.025 N H_2SO_4 (Lea *et al.*, 1980) 2N $MgCl_2$ (Stewart and Berger, 1956, 0.01 M EDTA + 1.0 $M(NH_4)_2 CO_3$ (Trierweiler and Lindsay, 1969) and 0.005 M DTPA + 0.01 M $CaCl_2$ + 0.1 M Triethanolamine (TEA) adjusted to pH 7.3 (Lindsay and Norvell, 1978).

Green house study

A green house study was conducted employing 20 test soils to determine the suitable extractant for extracting available Zn. Four levels of Zn (0, 2.5, 5.0 and 7.5 ppm) were used as treatments and each treatment was replicated two times. Zinc sulphate was used to supply different level of Zn.

Four kg in each of the air dried 2 mm sieved soils were transferred to polythene lined pots. Basal applications of N, P and K were applied in solution form to provide 54 ppm N, 27 ppm $P_2 O_5$ and 18 ppm K_2O in the form of urea, diammonium phosphate and muriate of potash respectively. Half of the N was top dressed at knee-high stage (30 days after sowing).

Eight seeds of maize (Ganga 5) were sown in each pot. The soil was brought to field moisture capacity daily by the addition of de- ionized water.

Table 1. Evaluation of soil test procedures for estimating available zinc from soils (Critical level approach)

Name of extractant	Soil extractant ratio	Shaking time minutes	Graphic method		Statistical method	
			Critical soil test level (ppm)	Percent predictability	Critical soil test level (ppm)	Percent predictability
0.1 N HCl	1:10	60	4.50	80	4.30	75
0.05 N HCl	1:10	60	2.38	65	1.90	70
0.05 N HCl + 0.025 N H_2SO_4	1:4	15	NS	NS	NS	NS
2 N $MgCl_2$	1:10	60	NS	NS.	NS	NS
0.01 M EDTA + IM $(NH_4)_2 CO_3$ P.H.8.6	1:2	120	1.40	90	1.74	90
0.005 M DTPA + 0.01M $CaCl_2$ + 0.1M T.E.A. pH 7.3	1:2	120	1.00	80	0.99	80

Five days after emergence, the plants were thinned to four plants per pot. After seven weeks of the growth, shoot of the plants were removed, separated into leaves, sheath and stem washed for thirty seconds on 0.1 N HCl rinsed and dried at 60^0C in an oven. Leaf sheath and stem were added together and was called as leaf sheath and stem (LSS).

Yield were determined by weighing oven dried plants. The plants were then ground to pass a 20 mesh screen in a wiley mill with stainless steel cutting blades. One gram in each of the plant materials was weighted and digested in triacid

Table 2. Available zinc extracted by different extractants.

Soil No	Extractants						
	Bray's per cent yield	0.1N HCl	0.05N HCl	0.05N HCl + 0.0245N H_2SO_4	2N $MgCl_2$	0.01M EDTA + IM $(NH_4)_2 CO_3$	0.005M DTPA + 0.01M $CaCl_2$ + 0.1M T.E.A. pH 7.3
1	63.5	4.5	3.5	2.0	1.3	0.6	0.53
2	66.9	3.0	1.5	1.2	1.0	0.4	0.40
3	71.1	2.3	1.5	0.8	1.5	0.7	0.60
4	94.7	6.5	5.5	2.2	1.4	3.0	3.90
5	67.2	2.5	1.0	0.4	1.0	0.4	0.73
6	74.3	6.5	0.5	0.3	1.5	0.2	0.86
7	64.3	1.0	0.5	0.2	1.3	0.2	0.26
8	71.1	4.0	3.0	1.7	1.0	0.4	0.60
9	63.7	5.0	4.0	2.8	1.5	0.5	0.53
10	56.3	1.0	0.5	0.4	1.0	0.3	0.73
11	4.0	1.0	0.5	0.5	1.3	0.7	0.46
12	58.8	2.0	0.5	0.4	1.5	0.4	0.79
13	81.9	3.5	1.0	0.5	1.3	0.9	1.12
14	107.6	4.5	3.0	2.4	1.5	2.2	1.91
15	55.4	4.0	1.5	1.4	1.3	0.6	0.40
16	68.7	6.0	0.5	0.8	1.5	1.3	0.73
17	64.3	3.5	3.0	0.4	1.5	0.8	0.60
18	64.7	5.0	1.5	3.0	1.5	0.9	0.86
19	84.8	5.0	4.3	0.4	1.5	1.3	1.91
20	82.4	3.5	2.3	1.8	1.5	0.8	0.79
Mean		3.7	1.9	1.2	1.4	0.83	0.94

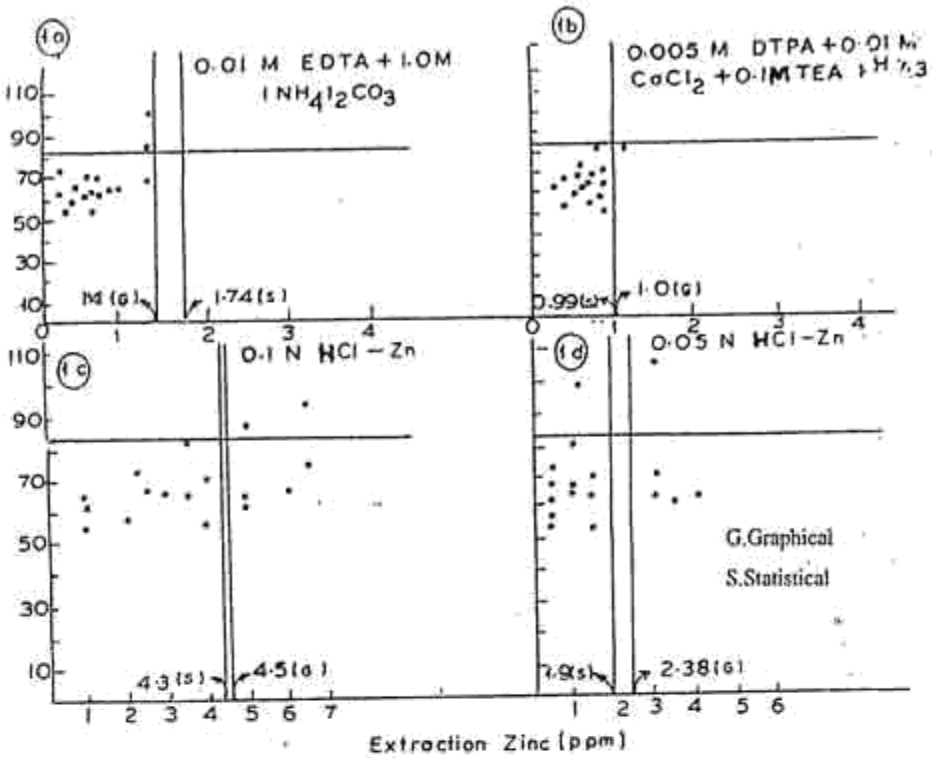

Fig. 1. Evaluation of soil test procedures for available zinc

mixture. Zinc was determined in triacid extract of the plant samples using Atomic Absorption Spectrophotometer.

Soil extractions

Half a kg of processed soil from each of the test soils was preserved for extracting available Zn with above six extractants. Other details of the extraction are given in Table 1.

RESULTS AND DISCUSSION

Zinc extracted by different extractants

The amount of Zn extracted by the different extractants decreased in the order: 0.1 N HCL>0.05 N HCL>2N $MgCL_2$>0.005 N HCL + 0.025 N H_2SO_4>0.005M DTPA 0.01 M EDTA + 1.0 M $(NH_4)_2CO_3$ and the corresponding ranges and mean values were 1.0 - 6.5, 3.7; 0.05 - 5.5., 1.9; 1.0-1.5, 1.4; 0.2-3.0, 1.2; 0.26-3.9, 0.94; 0.2-3.0, 0.83 ppm Zn respectively (Table 2).

Among the six methods tried for predicting available Zn status of soils for maize, the methods of Trierweiler and Lindsay (1969) and Lindsay and Norvell (1978) appeared to be most promising. Zinc extracted by 0.01 M EDTA + 1.0 M $(NH_4)_2$ CO_3 in control pot soils was positively correlated with Bray's per cent yield (r=0.777 **), actual yield (r=0, 572 **), Total Zn uptake (r=0.681 **), Zn content in leaves (r=0.781 **) and Zn content in stem (r=0.613 **). Trierweiler and Lindsay (1969) obtained positive and significant relationship between EDTA extractable Zn and maize yield (Table 3).

Similarly Zn extracted by 0.005 M DTPA method in control pot soils was also correlated significantly with Bray's per cent yield (r=0.744 **), actual yield (r=0.659 **), Total Zn uptake (r=0.704**), Zn content in leaves (r=0.744**) and Zn content in stem (r=0.685**) (Table 3). The plausible reason attributed for the results obtained in the present study is that, in alkaline soils, a part of Zn combines with chelating agent and remains in available form. Joshi *et al* (1983) obtained similar relationship between DTPA extractable Zn and maize yield.

Critical level of Zn in soils

The plot of per cent yield against 0.01 M EDTA + 1.0 M $(NH_4)_2$ CO_3 and 0.005 M DTPA extractable Zn indicated 1.74 and 0.99 ppm Zn respectively as the critical level of Zn of these soils for demarcating the Zn responsive from non-responsive soils based on statistical method of cate and Nelson (1971) (Fig.1). Eventhough EDTA + $(NH_4)_2$ CO_3 extractant exhibited highest per cent

Table 3. Relationship between soil zinc and yield and zinc content and its uptake (n = 20)

Extractants	'r' values at T_1 level				
	Actual	Brays percent yield	Total Zn uptake	Zn content in leaves	Zn content in stem
0.1 N HCl	0.481*	0.444*	0.436	0.264	0.224
0.05 N HCl	0.297	0.498*	0.338	0.345	0.303
0.05 N HCl + 0.025 N H_2SO_4	0.009	0.278	0.071	0.205	0.022
2 N $MgCl_2$	0.250	0.348	0.294	0.303	0.339
0.01 M EDTA + IM $(NH_4)_2 CO_3$ P.H.8.6	0.572**	0.777**	0.681**	0.781**	0.613**
0.005 M DTPA + 0.01M $CaCl_2$ + 0.1M T.E.A. pH 7.3	0.659**	0.744**	0.704**	0.744**	0.685**

*, ** denotes significant at 5% and 1% levels respectively.

predictability (Table 1), this could be used for only one nutrient. This aspect restricts the use of this method in rapid soil analysis.

As the DTPA is mild chelating agent, this extractant, can be used for determining the status of soil for available Cu, Fe and Mn simultaneously. This method can be, recommended for obtaining more precision since it has also given higher relationship not only with Bray's per cent yield (r=0.744**) but also with soil properties like organic matter (r=0.570**) available phosphorus (r=0.469*) and available Cu (r=0.798**).

Therefore the simulteneous extraction of Zn as well as Cu, Fe and Mn by the DTPA is another added advantage in rapid soil testing for the evaluation and recommendation of Zn fertilisation for maize growing soils.

Critical level of Zn in maize plant

Plant analyses as well as appropriate soil test are also essential features of a good soil test programmes. Zinc concentration in leaves (r=0.618**) and leaf sheath and stem (r=0.546**) were positively correlated with Bray's per cent yield.

The plot of per cent yield against plant tissue Zn concentration by the graphical and statistical methods of cate and Nelson (1965, 1971) revealed 21 ppm Zn in leaves of seven weeks old well established maize plant from both methods as critical concentration below which responses to Zn application can be expected.

Critical concentration of Zn in LSS of maize plant was also determined. The results revealed that 19.75 and 19.5 ppm zn as critical concentration in LSS by graphical and statisical methods of cate and Nelson (1965, 1971) respectively. The results from the present study are in agreement with those of Anon. (1980) who reported 22 ppm Zn as critical level in seven weeks old maize plant leaves for the soils of Punjab State. Sakal *et al.* (1981) reported similar results of 23 ppm Zn as critical level in maize leaves for the soils of Bihar state.

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