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COMPARISON OF METHODS OF AVAILABLE MICRONUTRIENTS (COPPER, ZINC AND MANGANESE) FROM SOIL

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Extraction efficiency of four solutions, DTPA (diethylene triamine pentaacetic acid), EDTA (ethylene diamine tetraacetic acid), HCl and NH_4OAC in respect of Cu, Zn, Mn was evaluated from three soils (clay, loamy sand and sandy clay loam) in a pot culture using rice as indicator crop. The results showed that for Zn and Cu extraction, the efficiency was in the order of HCl > EDTA > DTPA > NH_4OAC. The correlation co-efficient between plant Zn and Cu and soil Zn and Cu extracted with NH_4OAC remained the highest, i.e. 0.93 and 0.50 respectively. For Mn the order being HCl > NH_4OAC > DTPA > EDTA, however correlation co-efficient was not promising with any of the extractants.

Key words: Micronutrients, Extractants, Texture and availability.

INTRODUCTION

Micronutrients i.e. Zn, Cu and Mn play an important role in plant growth, so that it is necessary that the availability of these should be determined in the soil. Various workers tested and devised many methods under variable soil conditions for the determination of available content of any single micronutrient element. Zietecks [8] reported that the amount of Cu extracted by four methods showed the following order:

$$1N\ HCl > 2\%\ HNO_3 > 0.02M\ EDTA > 1N\ NH_4\ OAC$$

and also observed that amount of Cu extracted was increased with increase in the content of clay and organic carbon. Tiwari and Pathak [6] observed that neutral 1N NH_4 OAC + dithiozone was a better extractant for the determination of available Zn than 0.1 N HCl, 2N $MgCl_2$, 1N NH_4OAC and EDTA. In spite of the vital role of trace elements in plant life little attention has been paid to the evaluation of the available content of these elements in our soil conditions. Keeping this in view, the study was designed for the extraction of available contents of micronutrients from soil with various extractants and to select the best extractant for practical use.

MATERIALS AND METHODS

Three soils varying in texture i.e. loamy sand, sandy clay loam and clay (Table 1) under natural conditions were filled in glazed pots lined with ployethylene sheet in order to avoid leaching and contamination. Then three plants of rice IRRI-6/pot transplanted and nitrogen, 50 Kg/ha, as urea, was applied to each pot except to those kept as control. After 60 days, plants were harvested and saved for the determination of Cu, Zn, and Mn by using standard methods of Jackson [4] and soil analysis was accomplished by the methods of U.S. Salinity Lab. Staff [7]. Four extractants were studied for the extraction of above referred elements from soils. Correlation co-efficients between soil extractable and plant Cu, Zn and Mn were calculated using standard statistical procedures.

Preparation of extracting solution. (i) *DTPA:* Solution was prepared by mixing 0.005M DTPA, 0.1M TEA (triethanol amine) and 0.01M $CaCl_2$, adjusted to pH 7.3. 30 g. soil was shaken mechanically with 60 ml of extractant solution for about 2 hr. Filtrate was used for the estimation of Cu, Zn and Mn.

(ii) *EDTA:* 0.02M EDTA and 1.0M $(NH_4)_2CO_3$ solutions were mixed. 30 g soil shaken mechanically with 60 ml of extracting solution for about half an hour. Clear filtrate was used for the estimation of nutrient concentration by atomic absorption spectrophotometer.

(iii) *HCl:* 6 g. soil was mixed with 60 ml of 0.1M HCl. After standing overnight, the mixture was shaken mechanically for 30 min. Filtrate was used for analysis.

(iv) *NH_4OAC:* 15 g. soil was shaken mechanically with 60 ml of 1.0 M NH_4OAC adjusted to pH 4.8 for one hour. Filtrate was analysed by atomic absorption sepectrophotometer.

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RESULTS AND DISCUSSION

Mean value of available Zn as extracted by various solutions are lower (Table 2) compared to those estimated before the start of the experiment (Table 1). This decrease seems to be due to plant absorption. However, quantitatively the values are identical to those obtained by Chaudhry *et al.* [2] in respect of calcareous soils. Based on the quantity of Zn extracted from the soil, the decreasing order of extractant efficiency was HCl > EDTA > DTPA > NH_4 OAC. NH_4 OAC yielded the highest correlation coefficient (0.93) between plant uptake and concentration in soil extract followed by DTPA (r=0.87), EDTA (r=0.81) and HCl (r=0.23). Similarly, Tiwari and Pathak [6] concluded that neutal normal NH_4 OAC + Dithiozone was the best extractant for soil Zn estimation.

The data in Table 3 reveal that the concentration of Cu in the extract increased over the original soil value (Table 1). This increase seems due to flooding which has caused release of bound Cu (organically and chemically) into the soil solution. Chaudhry *et al.* [2] observed a similar trend of Cu in their studies. However based on the capacity to extract the element, the order of decreasing efficiency was HCl > EDTA > DTPA > NH_4 OAC. It is

Table 1. Physico-chemical analysis of soils.

(a) *Textural class*

S. No.	Clay (%)	Slit (%)	(Sand (%)	Class
1.	12	8	80	Loamy sand
2.	21	19	60	Sandy clay
3.	49	24	27	Clay

(b) *Physico-chemical characteristics*

S. No.	pH	Ece dsm^{-1}	S.P.	CEC me/100	Exchangable cations Na me/100 g	K me/100 g	Ca+Mg me/100 g
1.	7.3	1.6	27	6.75	0.5	1.55	4.7
2.	7.8	1.8	37	8.50	1.2	1.70	5.6
3.	7.5	3.0	48	17.20	2.5	0.90	13.8

(c) *Micronutrients status of soils*

S. No.	DTPA	EDTA	HCl	NH_4OAC
		Zn ppm		
1.	1.42	2.58	5.1	1.18
2.	1.00	2.04	4.8	0.48
3.	0.72	1.68	4.3	0.25
		Cu ppm		
1.	1.2	1.6	3.1	0.32
2.	2.4	3.6	3.7	0.60
3.	4.0	5.6	6.6	0.76
		Mg ppm		
1.	28.14	20.12	90.0	45.24
2.	62.56	29.54	187.6	73.20
3.	35.54	28.64	166.4	40.00

Table 2. Relation of zinc uptake by rice with soil zinc extracted by four methods.

		Soil zinc				Plant zinc
		Zn extracted by four methods				Zn uptake
S. No.	Treatment	DTPA (ppm)	EDTA (ppm)	HCl (ppm)	NH_4OAC (ppm)	by rice plant (ppm)
1.	S_1F_o	1.00	2.25	5.2	1.25	56.6
2.	S_1F_1	0.91	2.22	5.0	1.22	60.6
3.	S_2F_o	0.91	2.19	5.6	0.67	48.3
4.	S_2F_1	1.19	2.30	7.5	0.75	55.3
5.	S_3F_o	0.40	1.58	4.9	0.40	42.3
6.	S_3F_1	0.50	1.60	5.7	0.33	49.0
	r* values	0.87	0.88	0.23	0.03	

S_1 = Loamy sand soil; S_2 = Sandy clay loam soil; S_3 = Clayey soil; F_o = No fertilizer; F_1 = N fertilizer applied at the rate of 50 kg/ha.; *Correlation coefficient of zinc uptake by rice with soil zinc as extracted by various methods.

Table 3. Relation of copper uptake by rice with soil copper extracted by four methods.

		Soil copper				Plant Copper
		Cu extracted by four methods				Cu uptake by
S. No.	Treatment	DTPA (ppm)	EDTA (ppm)	HCl (pmm)	NH_4OAC (ppm)	rice plants (ppm)
1.	S_1F_o	2.5	3.4	5.0	0.92	45.6
2.	S_1F_1	2.3	2.9	4.8	0.77	50.0
3.	S_2F_o	3.6	4.9	5.1	0.53	40.3
4.	S_2F_1	3.8	5.2	5.0	0.77	39.6
5.	S_3F_o	4.9	6.4	7.1	0.63	37.9
6.	S_3F_1	5.0	6.4	7.1	0.83	40.3
	*r value	– 0.86	– 0.87	– 0.55	0.50	

S_1 = Loamy sand soil; S_2 = Sandy clay loam soil; S_3 = Clayey soil; F_o = No fertilizer; F_1 = N fertilizer applied at the rate of 50 kg/ha; * = Correlation coefficient of copper uptake by rice with soil copper as extracted by various methods.

Table 4. Relation of manganese uptake by rice with soil manganese extracted by four methods.

		Soil manganese				Plant manganese
		Mn extracted by four methods				Mn uptake by rice plants
S. No.	Treat-ment	DTPA (ppm)	EDTA (ppm)	HCl (ppm)	NH_4OAC (ppm)	(ppm)
1.	S_1F_o	31.11	21.52	91.2	59.29	1152.6
2.	S_1F_1	28.96	20.47	92.9	54.61	1139.3
3.	S_2F_o	63.29	34.47	187.0	88.95	999.0
4.	S_2F_1	64.50	32.19	188.9	92.61	1053.0
5.	S_3F_o	59.56	36.93	189.1	74.48	766.0
6.	S F	56.75	31.55	186.8	74.60	738.0
	*r value	–0.57	– 0.74	– 0.74	– 0.24	

S_1 = Loamy sand soil; S_2 = Sandy clay loam soil; S_3 = Clayey soil; F_o = No fertilizer; F_1 = N fertilizer applied at the rate of 50 Kg/ha., * = Correlation coefficient of manganese uptake by plant with soil manganese as extracted by various methods.

clear from the computed r values that only NH_4 OAC (r = 0.50) was a suitable extractant while the others failed to predict reasonable correlation. Singh *et al.* [5] also found NH_4 OAC to be the best extractant for soil Cu. It appears that the amount removed by the latter three extractants did not fit within the complete solubility of the Cu containing materials because of complexing and solubilizing mechanisms. The Mn value contained in Table 4 are almost identical to those of the original soil (Table 1).

The amount of extracted Mn by the four extractants was in the decreasing order of HCl > NH_4 > OAC > DTPA > EDTA. However, none of the extractants was significantly corelated with the Mn taken up by rice plants. The sufficiently higher Mn content in soil may explain the reason for poor correlation coefficients. It is not out of place to mention that flooding the soil results in slight decrease in pH [3] due to which the concentration of Cu, Mn, HCO_3, Mg, Fe, Zn, P, and TSS may be increased.

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