Annals of Arid Zone 30 (1) : 17-21, 1991

AVAILABLE COPPER, ZINC, MANGANESE AND IRON STATUS OF RAJASTHAN SOILS

R.K. MEHRA and B.L. BASER

Department of Soil Science & Agril. Chemistry
Rajasthan College of Agriculture, Udaipur 313 001

ABSTRACT

Soil samples representing Pellusterts, Chromusterts, Haplustalfs and Ustochrepts great groups of Rajasthan were collected and investigated for available content of micronutrient elements. Available (DTPA extractable) copper, zinc, manganese and iron were found to range between 0.18 ppm to 7.40 ppm, 0.20 ppm to 1.80 ppm, 2.05 ppm to 12.00 ppm and 1.5 ppm to 11.28 ppm respectively. Soils were adequate in available copper content, but deficient in available zinc followed by manganese and iron. Positive significant correlations were found between organic matter and available copper, zinc, manganese and iron. Available manganese and iron decreased significantly with calcium carbonate in some of the soil great groups under study. Available manganese decreased significantly with increase in pH only in Ustochrepts.

INTRODUCTION

Intensive cultivation of high yielding varieties and use of high analysis fertilizer disturb the nutrient balance in soil and micronutrients may become a limiting factor for increasing crop production. Thus, it is very essential to have a knowledge about available content of micronutrient elements in soils. The state of Rajasthan has widely different agro-climatic regions and wide variations in micronutrient content have been reported (Lal and Biswas 1974). The object of the present investigation was to assess the available copper, zinc, manganese and iron status of representative soils of Pellusterts, Chromusterts, Ustochrepts and Haplustalfs great groups of Rajasthan and to study relationship of some of the soil properties with their availability,

MATERIAL AND METHODS

Three hundred surface soil sample covering eight districts of four soil great groups of the state were collected. Available copper, zinc. manganese and iron were extracted with 0.005 M DTPA + 0.01 M $CaCl_2$ (Lindsay and Norvell 1978) and determined by Atomic Absorption Spectrophotometer. Soil properties were determined with usual standard laboratory procedures.

RESULTS AND DISCUSSION

Available copper, zinc, manganese and iron content in surface soil samples are presented in Table 1 and their correlation coefficient with pH, calcium carbonate and organic matter in Table 2.

Available copper : Available copper in these soils ranged from 0.18 ppm ot 7.40 ppm. On an average Chromusterts (Bundi) contained a minimum amount of available copper (0.68 ppm) while Haplustalfs (Udaipur) contained maximum amount (1.87 ppm). Based on average values, the following descending order of available copper content in different districts of Rajasthan was observed;

Banswara (3.05 ppm) > Udaipur (1.87 ppm) > Jhalawar (1.80 ppm) > Chittor (1.60 ppm) > Bhilwara (1.32 ppm) > Kota (1.29 ppm) > Dungarpur (1.09 ppm) > Bundi (0.68 ppm)

If the critical limits prescribed by Lindsay and Norvell (1978) i.e. 0.2 ppm is taken as criteria then all the soil samples under present study can be considered to have adequate quantity of available copper needed for plant growth. No consistent relationship between available copper and pH of soils was observed. In Chromusterts and Ustochrepts a negative non significant relationship was observed while in pellusterts and Haplustalfs, the relationship was positive non significant

The results show that available copper increased with increase in organic matter content in all the soils. Correlations were significant for pellusterts ($r=0.394^{**}$) and Haplustalfs ($r=0.663^{*}$). The results are in agreement with the findings of Gupta et al. (1980b) who made similar observation.

Available Zinc : Available zinc content ln these soils ranged from 0.20 ppm to 1.80 ppm. Soils of pellusterts group (Jhalawar) contained minimum amount (0.44 ppm) and Chromusterts (Kota) contained maximum amount (1.05 ppm) of available zinc. Based on the mean values, the following descending order of available zinc in different districts was obtained.

Kota (1.05 ppm) > Bhilwara (0.80 ppm) > Banswara (0.75 ppm) > Chittor (0.74 ppm) > Dungarpur (0.72 ppm) > Bundi (0.68 ppm) > Udaipur (0.48 ppm) > Jhalawar (0.44 ppm)

The variation might be due to differences in soil charactertics. If the critical limits of 0.6 ppm as prescribed by Takkar and Mann (1975) is taken as criteria it can be said that 40 per cent samples are deficient in zinc. In general zinc was negatively and non significantly related with pH and calcium carbonate. With organic matter a positive significant correlation was found in Chromusters ($r=0.381^{**}$) and

Table 1. Available copper, zinc, manganese and iron content of different soil groups of Rajasthan

Soil group	District	No. of Samples	pH	$CaCO_3$ (%)	OM (%)	Avl. Cu (ppm)	Avl. Zn (ppm)	Avl. Mn (ppm)	Avl. Fe (ppm)
Pellusterts	Jhalawar	40	7.5-8.5	2.08-8.00	0 47-2.95	0.63-4.10	0.28-0.98	4 05-8 98	2.30-9.80
			(8.15)	(6.10)	(0.88)	(1.80)	(0.44)	(5.25)	(4.28)
Pellusterts	Dungarpur	20	7.5-8.3	1.88-3.05	0.43-2.09	0.18-2.05	0.27-1.10	2.50-8.25	3.60-9.50
			(7.95)	(2.08)	(0.78)	(1.09)	(0.72)	(4.08)	(4.80)
Chromusterts	Kota	50	7.4-8.8	1.20-5.20	0.45-2.04	0.38-4.05	0.60-1.70	2.05-8.05	2.70-10.59
			(8.20)	(3.85)	(1.08)	(1.29)	(1.05)	(5.85)	(9.08)
Chromusterts	Banswara	40	7.8-8.5	2.34-5.01	0.78-7.40	0.88-7.40	0.37-1.38	2.88-12.00	1.80-3.95
			(8.20)	(4.00)	(3.09)	(3.05)	(0.75)	(6.05)	(2.50)
Chromusterts	Bundi	20	8.0-8.7	1.75-3.25	0.50-1.30	0.16-1.85	0.20-1.38	2.36-2.87	1.50-11.28
			(8.30)	(2.85)	(0.70)	(0.68)	(0.68)	(1.59)	(6.38)
Ustochrepts	Bhilwara	40	7.8-8.8	3.00-8.05	0.70-3.10	0.27-3.06	0.30-1.69	2.87-11.85	4.50-10.00
			(8.25)	(4.88)	(0.90)	(1.32)	(0.80)	(6.85)	(5.70)
Haplustalfs	Udaipur	50	7.5-8.9	1.15-10.08	0.70-2.40	0.75-2.95	0.27-1.80	2.80-7.50	1.85-5.09
			(8.30)	(3.88)	(1.01)	(1.87)	(0.48)	(4.87)	(3.08)
Haplustalfs	Chittor	40	7.4-8.8	4.15-10.08	0.65-2.80	0.88-1.95	0.38-1.65	2.89-5.59	3.25-9.88
			(7.95)	(6.80)	(0.95)	(1.60)	(0.74)	(3.85)	(5.75)

* Figures in the parentheses are average values for the district.

Table 2. Correlation coefficients among different factors and available micronutrient

Soil group	No. of samples	Available Cu Vs			Available zinc Vs			Available manganese Vs			Available iron Vs		
		pH	$CaCO_3$	OM	pH	$CaCO_3$	OM	pH	$CaCO_3$	OM	pH	$CaCO_3$	OM
Pellusterts	60	+0.09	−0.09	+0.39**	−0.18	−0.13	+0.24	−0.13	+0.14	+0.13*	−0.18	−0.48**	+0.12
Chromusterts	110	−0.11	+0.11	+0.12	−0.09	−0.10	+0.38**	+0.10	−0.19*	+0.27*	−0.03	−0.18*	+0.18
Ustochrepts	40	−0.31	+0.03	+0.28	−0.05	+0.09	+0.13	−0.43*	−0.13	+0.18	−0.10	−0.61**	+0.31
Haplustalfs	90	+0.08	+0.08	+0.66**	−0.13	−0.14	+0.44	+0.08	−0.20*	+0.64**	+0.13	−0.13	+0.45*

** Significant at 1 per cent level ; * Significant at 5 per cent level

Haplustalfs (r=0.440**) and also it was positive though non significant in pellusterts and Ustochrepts. These findings are in agreemeet with the findings of Gupta et al. (1980b),

Available manganese : Available manganese in these soils ranged from 2.05 ppm to 12.00 ppm. On an average, Chromusterts (Bundi) contained minimum (1.59 ppm) and Ustochrepts (Bhilwara) contained maximum amount (6.85 ppm) of available manganese. Based on average values, the following descending order of available manganese content in different district under present study was observed :

Bhilwara (6.85 ppm) > Banswara (6.05 ppm) > Kota (5.85 ppm) > Jhalawar (5.25 ppm) > Udaipur (4.87 ppm) > Dungarpur (4.08 ppm) > Chittor (3.85 ppm) > Bundi (1.59 ppm)

Nearly 13 per cent soil samples can be treated as deficient if critical limit of manganese is considered to be 3 ppm (Sakal et al. 1986). Available manganese was negatively correlated with pH and $CaCO_3$. A positive significant correlation between available manganese and organic matter was found in all soil great groups except Ustochrepts where also it was positive though non significant

Available Iron : Available iron in these soils ranged from 1.50 ppm to 11.28 ppm. Based on average values, the following descending order of available iron in different districts of Rajasthan was observed.

Kota (9.08 ppm) > Bundi (6.38 ppm) > Chittor (5.75 ppm) > Bhilwara (5.70 ppm) > Dungarpur (4.80 ppm) > Jhalawar (4.28 ppm) > Udaipur (3.08 ppm) > Banswara (2.50 ppm)

Considering 4.5 ppm DTPA extractable Fe as critical level (Lindsay and Norvell 1978; Gupta and Potalia 1987) 12 per cent samples fall in deficient category. A low content of available iron in some of the soils is attributed to low content of organic matter, sandy texture and high pH of the soils. No consistent relation was found between available iron and pH, though it was usually negative and non significant. The inverse relationship between soil pH and available iron has been reported by Gupta et al. (1980) and Sakal et al. (1986). $CaCO_3$ showed a negative relationship with available Fe. Reduction in availability of iron with an increase in pH may be attributed to conversion of Fe^{2+} ions to Fe^{3+} ions which are not absorbed by plants. At high pH iron is also precipitated as insoluble $Fe(OH)_2$ and reduces its availability.

A significant positive correlation of Fe with organic carbon was found in Ustochrepts (r=0.31) and Haplustalfs (r=0.45), while in other Groups it was positive non significant. Similar relationship has also been reported by Gupta et al. (1980a)

in arid brown soils of Haryana. The positive effect of organic matter on the availability of iron may be attributed to supply of chelating agents formed by the product of decomposition of organic matter that help in maintaining the solubility of micro nutrients.

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