

# AVAILABLE MICRONUTRIENT STATUS OF SOILS DEGRADED DUE TO IRRIGATION WITH RESIDUAL SODIUM CARBONATE/SALINE WATER

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## ABSTRACT

Soils irrigated with saline water were adequate in iron, manganese and copper but marginal in zinc. Amongst soils irrigated with high residual sodium carbonate water zinc and manganese were deficient respectively in 50 and 5 per cent samples while copper was marginal in 15 per cent samples. Regression of salinity parameters on the available micronutrients has been discussed.

## INTRODUCTION

Micronutrient deficiency in salt affected soils has been reported in different parts of country (Bhumbla and Dhingara, 1964; Vinayak et al., 1964; Gupta et al, 1970). In arid region of Rajasthan, studies with the soils of Guhiya catchment (Joshi et al. 1988,89) have not revealed differences in the micronutrient status of the salt affected and associated normal soils. In Barmer district the ground water potential zone occur along the river *Luni* in Balotra and Siwana panchayat samities. This water is saline and frequently contains higher amounts of residual sodium carbonate (RSC). Continuous use of these waters for irrigation under intensive cropping has resulted in soil deterioration and drastic reduction in crop yields. Soils have become hard and compact and crops are patchy (Joshi and Dhir 1989). Present studies were taken up to examine whether this soil degradation process is also associated with decrease in available micronutrient status.

## MATERIAL AND METHODS

Soil and water samples were collected from different sites in Balotra-Siwana panchayat samities, where soils have degraded due to development of sodicity/salinity. Soils of different sites belong either to series Mokalsar (Typic camborthids) or Balotra series (Typic calciorthids). Soil samples were analysed for  $\text{CaCO}_3$  (calci-meter), gypsum requirement (GR), pH and electrical conductivity (1:2 soil water extract) according to Richard (1954) and Piper (1950). In these soil available Fe, Mn, Zn and Cu were extracted with DTPA- $\text{CaCl}_2$  solution (Lindsay and Norvell 1978) and reducible Mn and Fe with 1N  $\text{NH}_4\text{OAC}$  (pH7)+0.2% hydroquinone (Jackson, 1967). Concentration of micro-nutrients in the extracts were estimated with atomic absorption spectrophotometer.

## RESULTS AND DISCUSSION

Salinity attributes of irrigation water and soils at respective sites are reported in Table 1. Micronutrient content in high RSC and saline water irrigated soils are reported in Table 2 and discussed below.

Table 1. Salinity attributes of soils and irrigation water

Village	Site No.	Irrigation water				Soil		Textural Class*
		EC dSm <sup>-1</sup>	RSC meL <sup>-1</sup>	SAR	pH <sub>2</sub>	EC <sub>2</sub> dSm <sup>-1</sup>	GR me100 <sup>-1</sup>	
<b>A. RSC water irrigated</b>								
Khakharlai	1	5.8	14.6	37.4	9.5	0.6	0.5	lfs
	2	3.5	6.2	21.5	9.5	0.8	1.6	lfs
Meli	3	7.3	7.8	37.4	9.0	1.1	1.3	lfs
	4	7.9	5.0	28.9	9.2	1.6	1.8	sl
	5	5.6	8.8	27.3	8.6	0.7	0.1	lfs
	6	6.6	12.0	37.8	9.2	0.6	1.6	lfs
	7	5.1	16.5	38.4	9.4	0.6	0.3	lfs
Kuship	8	4.4	7.9	30.0	8.9	0.7	0.9	lfs
	9	2.5	14.6	25.8	9.6	1.3	0.6	lfs
	10	4.7	10.4	44.5	9.1	0.5	0.6	lfs
	11	4.7	12.0	40.0	9.3	0.7	1.3	lfs
Buriwara	12	1.9	8.0	24.0	9.3	1.4	2.8	sl
<b>B. Saline water irrigated</b>								
Balotra	13	4.5	0.0	14.8	8.7	2.1	1.2	l
	14	4.9	0.0	15.8	8.3	3.8	8.4	l
	15	2.8	0.0	12.7	8.4	2.2	4.4	sil
Janiana	16	4.5	0.0	40.0	8.4	4.8	3.9	sil

\*lfs-loamy fine sand, sl-sandy loam, l-loam, cl-clay loam, sil-silt loam.

**High RSC water irrigated soils :** The ranges in the attributes of RSC waters being used for irrigation at different sites were : EC 1.9 to 6.6 dSm<sup>-1</sup>, SAR 21.5-44.5, RSC 6.2-16.5 meL<sup>-1</sup>. The soils at different sites were very deep and varied in texture from fine sand to loamy fine sand with 3 to 6% silt and 5 to 7% clay. These soils are alkaline (pH<sub>2</sub> 8.8-9.9) and have low values of EC<sub>2</sub> (0.14 to 2.47 dSm<sup>-1</sup>). These were slightly calcareous with wide variations in gypsum requirement (nil to 5.6 me 100g<sup>-1</sup>). Gypsum requirement was positively related with pH and EC (r=0.399, 0.434).

Among the soils of different sites, there were wide variations in the available Fe (3.5 to 13.3 ppm), Mn (3.9 to 24.4 ppm), Zn (0.30 to 3.44 ppm) and Cu (0.22 to 1.56 ppm) with the mean values of 7.7, 8.9, 0.9 and 0.5 ppm respectively. Available Zn and Cu were more variable (CV 62.4 and 53.8%) than the available Fe and Mn (CV 30.2 and 43.3). There was significant relationship of available Fe, negative with pH (r=0.317, P=0.05) and positive with EC values (r=0.282, P=0.05) while Cu was

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Table 2. Available micronutrient content of soils (mean values in ppm) irrigated with high RSC/ saline water

Site No.	Fe	Mn	Zn	Cu
<b>A. RSC water irrigated soils -Mokalsar soil series</b>				
1	9.5	7.9	1.8	0.37
2	8.9	8.1	1.3	0.75
3	9.3	8.7	1.9	0.27
4	11.1	13.2	1.3	0.56
5	9.9	6.3	0.5	0.25
6	8.5	10.4	1.2	0.72
7	3.9	11.9	0.7	0.44
8	9.9	16.9	1.1	0.72
9	7.4	20.6	1.4	1.38
10	3.5	7.7	0.6	0.72
11	5.6	8.4	0.7	0.40
<b>Kaluri soils series</b>				
12	6.9	7.7	0.8	0.57
<b>B. Saline water irrigated soils -Balotra soils series</b>				
13	6.1	15.0	2.3	1.23
14	6.1	16.9	2.3	1.05
15	6.0	18.2	1.6	1.19
16	8.0	12.8	1.3	1.12

positively related with soil pH, EC, CaCO<sub>3</sub> and gypsum requirement values of the soils (r=0.262, 0.470, 0.290, 0.548). Available Mn and Zn were also positively related with EC values (r=0.264, 0.292, P=0.05). Multiple regression analysis (Table 3) revealed that with the studied salinity parameters the available Cu and Fe could be better predicted (38 and 21%) than the available Mn and Zn (13 and 3.9%).

**Saline water irrigated soils :** The attributes of saline water were in the ranges EC 2.8 to 4.9 dSm<sup>-1</sup>, SAR 12.7 to 40.0 and RSC nil. The soils irrigated with these water are very deep, sandy loam to clay loam having 11 to 20% silt and 15 to 20% clay. These soils had variable salinity (EC<sub>2</sub> 1. to 8 dSm<sup>-1</sup>, and pH (8.1 to 8.9). Mean values of CaCO<sub>3</sub> and GR were 7.48% and 4.02 me 100g<sup>-1</sup>.

Saline water irrigated soils showed wide variations in the content of available Fe (4.4-10.7 ppm), Mn (8.8-23.9 ppm), Zn (0.79-3.69 ppm) and Cu (0.64-1.34 ppm) with the mean values of 8.6, 15.3, 1.6 and 1.1 ppm, respectively. Available Zn was more variable (CV. 48.3%) than the available Mn, Cu, and Fe (CV 28.6, 27.9, 19.3%). Available Fe was negatively related with soil pH (r= -0.827) and available Mn and Cu related positively with CaCO<sub>3</sub> content (r=0.452 and 0.503, P=0.05). Multiple regression of different soil salinity parameters (Table 3) accounted better for variation in available Cu and Mn (35.7% and 33.3%) than for Zn and Fe (24.7% and 16.7%).

**Appraisal of the soils :** Compared to the high RSC water irrigated soils, the saline water irrigated soils were slightly better in available micronutrient status. When

Table 3. Multiple regression analysis relating available micronutrients with soil parameters

Available micro-nutrient	Intercept (a)	Coefficients for the independent variables (X <sub>1</sub> , X <sub>2</sub> ..... etc)				R <sup>2</sup>
		pH	EC	CaCO <sub>3</sub>	G.R.	
<b>(A) RSC water irrigated soils</b>						
Fe	20.06	-1.44	2.02	-0.02	-0.41	0.21
Mn	4.99	0.29	2.82	-1.13	0.20	0.13
Zn	0.03	0.09	0.33	0.04	0.01	0.03
Cu	-0.84	0.11	0.18	0.02	0.06	0.38
<b>(B) Saline water irrigated soils</b>						
Fe	27.97	-1.94	0.01	-0.26	0.01	0.16
Mn	24.83	3.13	4.29	1.49	0.57	0.33
Zn	2.03	-0.16	-0.03	-0.08	0.13	0.24
Cu	0.28	0.02	0.01	0.09	-0.03	0.35

NB : Equation of the type  $Y = a + bx_1 + cx_2$

viewed with the critical limit of 2 and 0.2 ppm for Fe and Cu (Takkar and Randhawa 1978), 5 ppm for Mn and 1 ppm for Zn (Dangarwala et al. 1983) the soils irrigated with saline water, barring a few samples, marginal in zinc, appeared adequate in available Fe, Mn and Cu. In case of high RSC water irrigated soils, available Fe was not below the critical limit but respectively 50 and 5 per cent samples were deficient in Zn and Mn and available Cu was marginal in 15% samples. Lindsay (1972) have reported that Zn deficiency in sodic soils is quite common due to high ESP, high pH, carbonate and bicarbonate ions. In both saline and high RSC water irrigated situations negative correlation of available Fe with soil pH indicated depressing influence of alkalinity on the availability of Fe. Similar results have also been reported by Khera and Pradhan (1980) and Saha et al (1982).

Thus inspite of high sodicity/salinity most of the soils appeared to have adequate levels of available Fe, Mn, Zn and Cu which are comparable with those reported for other arid zone soils (Joshi and Dhir 1983, Joshi et al 1981, Dhir et al 1983).

#### ACKNOWLEDGEMENT

Technical assistance by Shri P.C. Bohara is gratefully acknowledged.

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