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CHANGES IN THE AVAILABLE MICRONUTRIENT STATUS DURING AMELIORATION OF SOILS IRRIGATED WITH HIGH RSC/SALINE WATER

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ABSTRACT

Studies on the changes in available micronutrient status during amelioration of soils irrigated with high RSC/ saline water have been reported. In soils irrigated with high residual sodium carbonate water, reducible Mn had significant positive influence on DTPA extractable Zn and significant negative effect on Cu. In saline - water irrigated amended soils, positive influence of reducible Mn on DTPA extractable Mn was further improved.

INTRODUCTION

Saline/sodic soils are often deficient in available micronutrients, especially the Zn (Takkar and Randhawa, 1978). Lindsay (1972) reported that the solubility of Zn was highly dependant on pH: a 100- fold decrease in solubility of Zn occurred with each unit decrease of pH. On the Contrary, salt affected soils of Guhiya catchment of Luni basin Rajasthan, were reportedly sufficient in available Fe, Mn, Zn and Cu status. (Joshi et al, 1987; 1988) Besides, Joshi (1987) further observed that soils irrigated with saline water were adequate in available Fe, Mn, and Cu though the status of Zn was marginal in some cases. Amongst soils irrigated with high residual sodium carbonate (RSC) waters, 50% were deficient in Zn, 5% were deficient in Mn and 15% were marginal in Cu content.

Soils in Balotra-Siwana area of arid western Rajasthan have developed sodicity/salinity due to irrigation with high RSC/saline water. These soils are being ameliorated with the use of gypsum/(gypsum+ leaching) on the farmers fields. The treatment effects on physico-chemical characteristics and physical conditions of soils have been reported earlier (CAZRI, 1985). In this paper, changes in the available micronutrient status as a result of amelioration of saline/sodic have been discussed.

MATERIAL AND METHODS

Nine sites irrigated with high RSC waters and 8 sites irrigated with saline waters were selected in different villages of Balotra-Siwana area. Soils were very deep and loamy fine sand in texture. At each site, four plots (each of 1600 m^2) were laid out, of which two were ameliorated and two were kept as control. At high RSC - water irrigated sites, quantity of gypsum applied was equal to 50% of soil requirement + gypsum required to neutralise RSC of irrigation water.

At saline - water irrigated sites, gypsum @ 50% of soil requirement was applied and then leaching done with 50 cm water. In both control and treatment plots, wheat crop was raised. After harvesting the crop, surface (0-20 cm) and sub-surface (20-40 cm) soil samples were collected. Soil pH and EC for 1 : 2 soil/water extract (pH_2 and EC_2, respectively). were determined. Reducible Mn and Fe were extracted with 1N NH_4 OAC + 0.2% hydroquinone (Jackson, 1967). Available Fe, Mn, Zn and Cu were extracted by DTPA (Lindsay and Norwell, 1978). In the extracts, Fe, Mn, Zn and Cu were estimated on the atomic absorption spectrophotometer. Students 't' test and multiple regression analysis were carried out to differentiate changes in the micronutrient status due to amelioration.

RESULTS AND DISCUSSION

High RSC water irrigated soils

At all the nine sites, the soils were highly sodic (pH_2 9.2-9.8) as they were irrigated with high RSC (6-20 me/1) waters. Micronutrient status of ameliorated and control soils are reported for surface (Table-1) and sub-surface (Table 2) soils. There

Table 1. Soil parameters and available micronutrient status (ppm) of surface soils irrigated with high RSC waters

Site	pH_2	EC_2	Reducible		DTPA extractable			
No.		mmhos/cm	Mn	Fe	Fe	Mn	Zn	Cu
			Gypsum treated					
I	8.82	0.93	19.4	23.1	9.7	6.8	2 00	0.29
II	8.90	0.95	19.4	22 2	8.5	7.2	1.50	0.27
III	8.76	1.20	24.9	32 5	8.4	8.7	0 80	0.25
IV	8.65	1.03	27.8	35.6	9.3	9.9	0.69	0.26
V	8.87	1.23	30.5	17.8	9.7	11.5	1.19	0.42
VI	8.97	1.62	24.9	26.5	11.1	14 2	1.30	0.48
VII	9.05	0.63	33.3	9.9	7.6	11.1	0.70	0.32
VIII	9 42	1.04	33.3	9.6	9.7	12.2	2.50	0.38
IX	8.59	0.72	22.2	35.6	8.8	5.7	0.66	0.22
Mean	8.89	1.04	26.41	23.64	9.20	9.7	1.26	0.32
			Control					
I	9.37	0.66	19.4	24.9	8.8	8.8	2.00	0.35
II	9.35	0.47	19.4	26.7	10.2	7.7	2.00	0.26
III	9.06	1.00	19.4	31.2	10,2	7.8	0.63	0.26
IV	9 05	0.71	24.9	27.8	9.7	8.9	0.40	0.22
V	9.26	0.88	30.5	17.8	8.9	10.9	1.50	0.35
VI	8.97	2.27	44.4	24.0	13.3	15.7	1.69	0.64
VII	9.36	0.63	33.3	11.2	8.4	10.4	1.06	0.80
VIII	9.55	0.69	20.2	9.5	8 4	5.7	0.80	0.74
IX	8.95	0.65	22.2	36.0	9.7	4.9	0.50	0.22
Mean	9.21	0.88	25.97	23.23	9.73	9.09	1.18	0.43
't'	-2.97*	0.75	0.128	09.25	-0.879	0.442	0.278	1.26

* Significant at 1% level

Table 2. Soil parameters and available micronutrient status (ppm) of sub-surface soils irrigated with high RSC waters

Site	pH_2	EC_2	Reducible		DTPA extractable			
No.		mmhos/cm	Mn	Fe	Fe	Mn	Zn	Cu
			Gypsum treated					
I	8.87	0.62	27.8	16.9	9.8	7.3	1.19	0.32
II	8.82	0.93	22.4	20.2	8.8	7.2	1.30	0.27
III	9.05	0.97	22.2	36.5	8.9	8.9	1.50	0.38
IV	8.72	1.10	32.2	33.6	8.8	8.2	0.50	0.32
V	9.09	1.42	41.6	23.4	7.9	7.3	1.81	0.70
VI	8.93	1.37	36.1	29.6	11.9	14.6	1.30	0.61
VII	9.42	0.58	55.5	5.9	7.1	9.8	0.69	0.74
VIII	9.42	1.04	45.4	8.5	7.8	9.4	0.57	0.50
IX	8.67	0.59	22.2	37.5	11.5	6.9	0.56	0.35
Mean	8.99	0.96	33.9	23.6	9.17	8.84	1.04	0.47
			Control					
I	9.46	0.54	22.2	22.2	9.8	9.6	2.10	0.51
II	9.37	0.47	22.2	20.7	9.3	6.2	1.38	0.23
III	8.95	1.41	16.7	32.9	8.8	7.8	1.06	0.32
IV	9.03	0.83	30.5	25.8	8.4	9.6	0.44	0.26
V	9.09	1.26	41.6	23.1	9.7	11.5	1.81	0.76
VI	9.02	1.48	58.5	23.1	11.5	13.3	0.75	0.58
VII	9.41	0.69	47.2	13.9	8.9	9.1	0.56	0.57
VIII	9.59	0.91	30.5	8.4	9.3	9.9	1.00	0.93
IX	8.29	0.65	27.2	39.2	10.2	6.7	0.50	0.28
Mean	9.13	0.92	32.9	23.2	9.54	9.29	1.06	0.49
't'	0.852	0.26	0.17	.0672	-0.60	-0.42	-.0789	0.28

was a significant decrease in the pH_2 value of the surface soil but in sub-surface soil, such influence on soil pH_2 was not apparent. This indicated that effective amelioration remained restricted to the top layer (0-20 cm) of the soils.

Reducible Mn and Fe content in the surface layers varied from 19.4 to 33.3 and 9.6 to 36 ppm, respectively, with slightly higher amount in sub-surface soils. The DTPA extractable Fe, Mn, Zn and Cu ranged from 7.6 to 11, 5.7 to 14.2, 0.4 to 2.5 and 0.22 to 0.80 ppm, respectively, with marginal variation in surface and sub-surface soils. Student's 't' test did not reveal significant difference in the micronutrient contents of surface and sub-surface soils.

Simple correlation coefficients (Table 3) revealed that in the control soil DTPA-Fe was related positively with EC_2; and DTPA-Mn positively with EC_2 and reducible Mn. The DTPA-Cu was related positively with reducible Mn and negatively with reducible Fe. Due to amelioration, changes in the physico-chemical characteristics affected the equilibrium between forms of Mn and Fe. Some of the correlations observed did not persist and positive correlation of pH with reducible Mn appeared. This indicated that consequent to amelioration, higher oxides of Mn were converted to lower valences and which increased in soil solution (Ponnamperuma, 1972).

Table 3. Simple correlation coefficients between soil parameters and the available micronutrient content of soils irrigated with high RSC waters

	EC_2	Reducible		DTPA Extractable			
		Mn	Fe	Fe	Mn	Zn	Cu
			Gypsum treated				
pH_2	0.032	0.721*	-0.785*	-0.370	0.383	0.311	0.639*
EC_2	—	0.006	0.196	0.292	0.526**	0.329	0.296
Reducible Mn	—	—	-0.601**	-0.423	0.313	-0.179	0.811*
Reducible Fe	—	—	—	0.438	-0.235	-0.212	-0.378
			Control				
pH_2	-0.296	-0.096	-0.816*	-0.379	-0.018	0.383	0.439
EC_2	—	0.526**	0 089	0.669*	0.752*	0.0790	.291
Reducible Mn	—	—	-0.277	0.449	0.750*	0.113	0.480**
Reducible Fe	—	—	—	0.304	-0.225	-0.158	-0.752*

* Significant at 1% level

** Significant at 5% level

Multiple regression of DTPA extractable micronutrients on soil parameters (Table 4) revealed that in control soils there was significant influence of EC_2 on DTPA Fe and of both EC_2 and reducible Mn on DTPA-Mn. Reducible Fe exerted negative effect on DTPA Cu. As the result of amelioration, significant effects of reducible Mn negative on DTPA-Zn and positive on DTPA Cu were observed.

Table 4. Multiple regression coefficients relating soil parameters with the available micronutrients in high RSC water irrigated soil

	Intercept	pH_2	EC_2	Reducible		R^2
	(a)			Mn	Fe	
			Gypsum treated			
DTPA Fe	8.58	0.009	1.117	-0.043	0.026	0.292
		2.304	1.103	0.045	.051	
DTPA Mn	-12.83	1.957	4 695**	0.023	-0.033	0.421
		4.063	1.945	0.081	0.089	
DTPA Zn	-12.43	1.637	0.655	-0.048*	-0.010	0.541
		0.791	0.378	0.016	0.017	
DTPA Cu	-1.72	0.173	0.119	0.012*	0.004	0.7698
		0.153	0.074	0.003	0.003	
			Control			
DTPA Fe	-6.28	1.252	1.430**	0.038	0.085	0.601
		1.477	0.578	0.026	0.053	
DTPA Mn	-16.83	2.114	3.181*	0.112**	0.020	0.774
		2.369	0.928	0.0427	0.086	
DTPA Zn	-16.99	1.839	0.430	-0.002	0.039	0.301
		0.961	0.376	0.017	0.035	
DTPA Cu	3.18	-9.242	0.145	0.0003	-0.027**	0.725
		0.235	0.092	0.0043	0.008	

* Significant at 1% level ** Significant at 5% level

Saline water irrigated soils

Soils irrigated with the saline waters (Ec 2–4 mmhos/cm) were saline (EC_2 0.78 to 4.28 mmhos/cm) with moderate sodicity (pH_2 7.5 - 8.8). In surface soils of both gypsum amended and control fields (Table 5, 6) initially due to leaching, salinity of surface soils decreased but with subsequent irrigation there was salinity build up and at harvesting stage significant difference in EC_2 and pH_2 values of the amended and control soils was not indicated by student's 't' test. The reducible Mn and Fe varied from 27.7 to 94.4 and 2.5 to 14.5 ppm with slightly higher values in the sub-surface soils and there was no significant difference due to the treatments. DTPA extractable Fe, Mn, Zn and Cu ranged between 4.4 and 9.3, 8.7 and 20, 0.88 and 2.6 and 0.54 and 1.14 ppm, respectively. The treatments did not reveal significant differences.

Table 5. Soil Parameters and available micronutrient status (ppm)of saline water irrigated surface soils

Site	pH_2	EC_2	Reducible		DTPA extractable			
No.		(mmhos/cm)	Mn	Fe	Fe	Mn	Zn	Cu
			Gypsum + leaching					
I	8.61	1.35	86.0	6.2	4.9	15 6	1.70	0 83
II	8.57	1.41	91.6	7.1	5.3	14.2	2.20	1.06
III	8.02	13,92	61.1	7.8	7.1	15.6	1.20	0.89
IV	7.58	31.82	83.3	6.2	9.3	20.2	2.00	1.34
V	8.19	5.20	30.5	7.1	7.1	8.7	1.50	0.80
VI	8.64	1.71	30.5	14.1	5.3	8.7	1.63	0.54
VII	8.12	5.35	47.2	5.9	4.8	16.8	2.16	0.96
VIII	8.44	2.56	38.7	4.7	4.4	10.4	0.88	0.86
Mean	8.27	7.92	58.6	7.4	6.0	13.8	1.66	1.91
			Only leaching					
I	8.45	1,34	94.4	2.5	4.4	10.5	1.00	0.96
II	8.69	0.78	94.4	3.1	7.1	18.9	1.30	1.41
III	8.01	23.65	72.2	6.8	6.7	19.2	1.80	1.18
IV	8.04	6.01	66.6	5.3	6.2	17.4	2.60	1.09
V	8.55	1.49	27.7	8.1	6.6	9.6	1.25	0.64
VI	8.07	11.90	27.8	11,5	9.3	8.9	2.13	0.67
VII	8.87	0.09	38.8	4.7	4.4	12.0	0.88	0.86
VIII	8.52	2.62	66.6	7.8	4.9	12 4	1.54	0.86
Mean	8.39	6-09	61.1	6.2	6.2	13.6	1.56	0.96
't'	-0.745	-0.391	-0.186	-0.799	-0.211	0.776	.0364	-0.365

saline and sodic soils was of different nature. In high RSC water irrigated soils, during amelioration with gypsum, reducible Mn showed significant positive influence on DTPA Zn and significant negative on DTPA Cu. In saline-water irrigated soils amended with gypsum + leaching the positive influence of reducible Mn on DTPA Mn was improved.

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