Annals of Arid Zone 49(2): 137-140, 2010

Short Communication

Micronutrients Status of Soils Irrigated with High Residual Sodium Carbonate Water in Jhunjhunu District of Rajasthan

Mahesh Kumar* and B.K. Sharma
Central Arid Zone Research Institute, Jodhpur 342 003, India

Accumulation of excess salts in soils and consequent development of salinity and sodicity in soils is common in arid and semi-arid regions. In Rajasthan, where nearly 0.2 million sq. km area is under arid climate, salinity and sodicity in soils have posed a big problem (Roy and Kolarkar, 1977). Ground water irrigation is also deteriorating soil quality, especially where ground water is rich in soluble salts and residual sodium carbonate (RSC). According to Minhas and Gupta (1992) about 84% of the ground water in western Rajasthan is of poor quality. Often the water has EC >2.2 dS m^{-1} and up to 10 dS m^{-1}, coupled with high RSC (up to 20 me L^{-1}). Irrigation with such waters leads to secondary salinization, deterioration in physical and chemical properties, restricted availability of major and micronutrients and reduction in crop yields (Gupta *et.al.*, 2000; Joshi and Bohra, 2009). Micronutrient deficiency occur all over the world, but type of soils, climate and management practices are the key factors, governing the variations in extent and status. Deficiency and status of micronutrients have been reported in soils of India (Takkar and Randhawa, 1978; Rattan and Sharma, 2004), and in the arid soils of Rajasthan (Sharma *et al.*, 1985). Micronutrient deficiency in salt affected soils have been reported in different parts of the country (Bhumbla and Dhingara, 1964) and particularly in arid soils of Rajasthan irrigated with high RSC waters (Joshi, 1990; Mathur *et al.*, 2006). In Jhunjhunun District water contains high amount of RSC. Continuous irrigation with these waters leads to development of sodicity/salinity in soils resulting in deterioration of soil properties. Soils irrigated with such waters become hard and compact and some times land is taken out of agricultural production. The present investigation was taken up to asses the status of micronutrients in soils irrigated ,with high RSC water.

*E-mail: maheshcazri@gmail.com

Soil (5 samples at each location) and water samples from the area where soils are irrigated with high RSC water were collected for detailed laboratory investigation. The soils of different sites either belong to Chomu Series (Typic Torripssaments) or Chirai Series (Typic Haplocambids). Surface soil samples (0-20 cm) were analyzed for pH, EC, $CaCO_3$, organic carbon, available phosphorus and potassium using standard procedures as described by Jackson (1973). The soils were extracted with DTPA-$CaCl_2$ solution for the estimation of available iron (Fe), manganese (Mn), copper (Cu) and zinc (Zn) (Lindsay and Norvell, 1978) and concentrations of these micronutrients were determined with atomic absorption spectrophotometer. Water samples were also analyzed for pH, EC, exchangeable cations and anions, residual sodium carbonate (RSC) and sodium absorption ration (SAR).

The soils at different sites were very deep and varied in texture from fine sand to loamy fine sand with 5-9% clay and 3-6% silt. The soils were alkaline in reaction (pH 8.4-9.5) and had low EC (0.065 to 0.859 dS m^{-1}). Soils were low in organic carbon (0.18-0.35%), medium in available phosphorus (12-25 kg ha^{-1}) and medium to high in available potassium (155-375 kg ha^{-1}). The soils from different sites showed wide variation in available Fe (5.5-9.3 mg kg^{-1}), Mn (10.0-22.2 mg kg^{-1}), Zn (0.38-1.5 mg kg^{-1}) and Cu (0.44-4.5 mg kg^{-1}). Taking the critical limits as 4.5, 3.5, 0.60 and 0.20 mg kg^{-1} for Fe, Mn, Zn and Cu, respectively, the soils under study appeared to be adequate in these micronutrients, barring Zn deficiency at places (Table 1). About 45% of the soil samples were found to be deficient in Zn (<0.60 mg kg^{-1}). However, soils from all the sites irrigated with high RSC water had Zn concentration less than 1 mg kg^{-1}, except Tain village where it was 1.5 mg kg^{-1}. Thus, these soils are marginal in Zn content and need immediate attention. Deficiency of Zn in sodic soils is quite common due to high

Table 1. Texture, pH, EC and micronutrients in the soils irrigated with RSC water

Location	Site No.	pH (1:2)	EC ($dS\ m^{-1}$)	Texture	Micronutrients ($mg\ kg^{-1}$)			
					Fe	Mn	Zn	Cu
Sisiyan	1	8.7	0.150	fs	6.2	12.8	0.60	2.6
Sameshpur	2	9.0	0.106	fs	6.6	17.2	0.58	0.70
Khajpurnaya	3	8.6	0.092	lfs	7.9	17.7	0.38	0.76
Bidana	4	8.5	0.068	ls	5.5	15.9	0.54	0.44
Maraqsar	5	8.5	0.245	fs	6.7	11.8	0.50	0.50
Tain	6	9.5	0.078	lfs	8.6	22.2	1.50	1.38
Kamalsar	7	8.5	0.087	ls	8.6	15.9	0.90	0.82
Bidasar	8	8.5	0.087	fs	9.3	14.5	1.00	0.56
Dabri	9	8.7	0.082	fs	5.6	10.0	0.74	0.62
Togiyawas	10	9.5	0.171	l	7.6	17.5	0.74	1.80
Nalwa	11	8.8	0.086	ls	6.5	13.5	0.75	4.40

pH, high carbonate and bicarbonate ions (Lindsay, 1972).

The DTPA extractable Fe and Mn in the soils at all the sites ranged from 5.5 to 10.8 and 9.5 to 24.2 mg kg^{-1} soil, respectively. The deficiency of Fe and Mn at study sites are not very common and none of the soil sample was found deficient in Fe and Mn as per the critical limits (<4.5 mg kg^{-1} for Fe and <3.5 mg kg^{-1} for Mn) as suggested by Takkar and Randhawa (1978). The high content of available Fe and Mn at study sites may be due to continuous weathering of Fe and Mn bearing minerals, since the soils under study are rich in Fe and Mn bearing minerals. Earlier also higher concentrations of these micronutrients in arid soils were reported (Joshi and Dhir, 1989; Joshi, 1990; Sharma *et al.*, 1985) In addition to this farmers are also adding these micronutrients through organic manures/micronutrient mixtures to soils and the cropping pattern is so that these micronutrients are required in very small quantities.

Irrigation water in the area contained high sodium and predominance of carbonates and bicarbonates in comparison to Ca and Mg. On irrigation with such waters Ca in soil gets precipitated as $CaCO_3$ leaving excessive sodium in soil solution and ultimately leading to high pH and ESP. These conditions adversely affected soil physical and chemical properties. The EC of water samples ranged from 1.1 to 4.2 dS m^{-1} with a mean value of 2.3 dS m^{-1} (Table 2). The pH of water varied from 8.5 to 9.1. All the samples had pH above 8.5, indicating high sodicity in water. Among the cations Na was by far the dominant followed by Mg and Ca. Whereas, K content in all the samples was very low. The anions were present in the order of chloride>bicarbonate> carbonate. Almost all the water samples fell under high chloride class (Table 2). The RSC values ranged from 1.82 to 14.80 me L^{-1}, out of these about 80% samples had more than 5 me L^{-1} RSC. However, irrigation with these waters for a long period led to sodicity in soils, as reflected by the pH values of soils. Several other workers also suggested that prolonged use of such waters (with high RSC and SAR values) create sodicity problem and induced severe nutritional disorder that adversely affected the crop yield (Minhas and Bajwa, 2001).

Simple correlation studies were computed relating micronutrient content with other physico-chemical properties (pH, EC, $CaCO_3$, SOC, RSC, SAR and clay content) of the soils as suggested by Panse and Sukhatme (1961). The significant and positive correlation of Fe, Mn, Zn and Cu with SOC in soils (r=0.496, r=0.654, r=0.697, r=0.287, respectively) were observed. The clay content in these soils was also positively correlated with DTPA extractable micronutrients. Similar kind of relationship between these micronutrients and SOC was reported by several other workers (Sharma *et al.*, 1985). Soil pH and $CaCO_3$ content was negatively correlated with Fe (-0.378 and-0.135), Mn (-0.653 and-0.131) and Zn (-0.098 and-0.019) but did not show such relationship with Cu. In the soils irrigated with high RSC water the negative correlation between available Fe and soil pH suggested limiting effect of alkalinity on availability of Fe. An inverse relationship of pH and $CaCO_3$ with available micronutrients has also been reported by several other workers (Mathur *et al.*, 2006; Joshi, 1990; Katyal and Agarwala, 1982). The correlation studies between DTPA micronutrients

Table 2. Chemical characteristics of water used for irrigation

Site No.	pH (1:2)	EC (1:2)	Cations (me L^{-1})				Anions (me L^{-1})			RSC (me L^{-1})	SAR
			Ca	Mg	Na	K	CO_3^{-2}	HCO_3^{-1}	Cl		
1	8.9	1.2	0.20	1.68	12.2	0.04	2.20	8.1	3.0	8.6	9.2
2	8.6	1.2	0.36	0.76	11.7	0.03	1.20	4.8	5.4	5.0	15.6
3	8.5	1.1	0.56	1.02	10.9	0.05	0.60	4.65	6.0	3.7	5.8
4	8.5	2.7	1.12	3.66	23.3	0.05	1.2	5.5	18.1	1.8	15.0
5	9.0	2.0	0.54	1.68	24.6	0.04	2.2	14.1	6.7	14.0	24.4
6	9.0	2.6	0.14	2.54	26.9	0.08	4.2	11.6	11.4	13.2	23.2
7	9.1	2.7	0.37	1.63	29.1	0.04	4.4	12.4	8.6	14.8	29.1
8	8.7	1.8	0.56	2.18	16.9	0.04	1.0	7.35	6.3	5.6	14.4
9	9.0	3.0	0.20	2.84	30.4	0.04	3.0	12.0	9.8	11.9	24.7
10	8.8	2.4	0.37	2.87	23.9	0.04	2.4	8.0	12.1	7.2	18.8
11	9.0	4.2	0.22	5.02	39.1	0.06	4.2	9.4	18.7	8.3	24.1

in soils and RSC and SAR values of irrigation water at corresponding sites were carried out. Negative correlation of Mn with SAR (r=-0.146) and RSC (r=-0.160) was observed. However, Fe and Zn in the soils showed positive correlation and this positive correlation between SAR and RSC with micronutrients in tree-based systems was attributed to the continuous addition through organic matter into the soil as well as through micronutrient mixtures available in the market.

Despite the sodicity, induced mainly due to continuous use of irrigation water with high RSC, the soils were adequate in Fe, Mn and Cu. The status of these micronutrients is comparable with those reported for arid zone soils of Rajasthan (Joshi and Dhir, 1983; Anonymous, 2006). Use of such waters for irrigation requires application of gypsum in the soil and cyclic management of lands keeping fallow in the rainy season and cultivation in alternate years with the judicious use of these waters.

References

Anonymous 2006. *Annual Progress Report*. Central Arid Zone Research Institute, Jodhpur, Rajasthan.

Bhumbla, D.R. and Dhingara, D.R. 1964. Micronutrient status of saline alkali soils of Punjab. *Journal of the Indian Society of Soil Science* 29: 453-461.

Gupta, J.P., Joshi, D.C. and Singh, G.B. 2000. Management of arid agro-ecosystem In *Natural Resource Management for Agricultural Production in India* (Eds. J.S.P. Yadav and G.B. Singh), pp. 557-668. New Delhi.

Jackson, M.L. 1973. *Soil Chemical Analysis*. Prentice Hall of India. Pvt. Ltd., New Delhi.

Joshi, D.C. 1990. Available micronutrients status of soils degraded due to irrigation with residual sodium carbonate/saline water. *Annals of Arid Zone* 29: 9-13.

Joshi, D.C. and Bohra, P C. 2009. Conservation technology for sustainable crop production under saline water irrigation in arid region of Rajasthan. *Current Agriculture* 33: 17-24.

Joshi, D.C. and Dhir, R.P. 1983. Distribution of micronutrients forms along duny landscape. *Annals of Arid Zone* 22: 135-141.

Joshi, D.C. and Dhir, R.P. 1989. Management of loamy sand soils irrigated with high RSC water. In *Proceedings of International Symposium on Managing Sandy Soils*, pp. 474-487. CAZRI, Jodhpur.

Katyal, J.C. and Agarwala, S.C. 1982. Micronutrient research in India. *Fertilizer News* 27: 66-70.

Lindsay, W.L. 1972. *Micronutrients in Agriculture* (Eds. W.L. Lindsay, J.J. Mortvedt and P.M. Giordano) Soil Science Society of America, Madison, Wisconsin. USA.

Lindsay, W.L. and Norvell, W.A. 1978. Development of DTPA soil test for zinc, iron, manganese and copper. *Soil Science Society of America Journal* 42: 421-428.

Mathur, G.M., Ram Deo and Yadav, B.S. 2006. Status of zinc in irrigated north west plain soils of Rajasthan. *Journal of the Indian Society of Soil Science* 54: 359-361.

Minhas, P.S. and Bajwa, M.S. 2001. Use and management of poor quality water in rice wheat production system. *Journal of Crop Production* 4: 273-306.

Minhas, P.S. and Gupta, R.K. 1992. *Quality of Irrigation Water: Assessment and Management*. ICAR, New Delhi, 123 p.

Panse, V.G. and Sukhatme, P.V. 1961. *Statistical Methods for Agricultural Workers*, ICAR, New Delhi.

Rattan, R.K. and Sharma, P.D. 2004. Main micronutrients available and their method of use. In *Proceedings,* *IFA International Symposium on Micronutrients* pp. 1-10.

Roy, B.B. and Kolarkar, A.S. 1977. Saline and sodic soils of Rajasthan: A review. In *Natural Resources of Rajasthan* (Eds. M.L. Roonwal), pp. 1011-1021. Pub. University of Jodhpur, India.

Sharma, B.K., Dhir, R.P. and Joshi, D.C. 1985. Available micronutrient status of some soils arid zone. *Journal of the Indian Society of Soil Science* 33: 50-55.

Takkar, P.N. and Randhawa, N.S. 1978. Micronutrients in Indian agriculture: A review. *Fertilizer News* 23: 3-26.