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Effect of Saline Water Irrigation on Properties of Vertisols and Yield of Setaria

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Abstract : Effect of saline irrigation waters (1, 2, 4, 6, 8 and 12 dSm^{-1}) on soil properties, available nitrogen, water soluble cations and yield of setaria (*Setaria italica* L.) revealed that the soil EC_2 gradually decreased after sowing till 61 DAS (0.71 dSm^{-1}) and it increased till 75 DAS (0.93 dSm^{-1}) and thereafter, again decreased at harvest (0.58 dSm^{-1}). The available nitrogen and phosphorus were more in surface layer after harvest and were less affected due to salinity levels. Among the water soluble cations, the concentration of K, Mg and Na increased with increasing salinity and Ca increased upto 6 dSm^{-1} at both the soil depths after harvest. The grain yield increased upto 6 dSm^{-1} salinity level and decreased, thereafter.

Key words : Saline water, soil properties, nutrients, yield, vertisol, setaria.

Salinity is a problem of serious concern in arid, semi-arid and coastal zones of India. Due to non-availability of good quality waters from the secondary sources, saline underground waters are very often used for irrigation. This may increase concentration of Mg and Na in the soil solution and adversely affect the growth and yield of crops (Giridhar and Yadav, 1982). For profitable irrigated agriculture, an optimum salt balance has to be maintained in the soil. The salts to be leached beyond the root zone must exceed the salts being added. This paper presents the changes which have taken place in black soils where the setaria crop was irrigated with waters of varying salinity levels.

Materials and Methods

A field experiment was conducted at Agricultural College Farm, Dharwad, on a presalinized black soil (vertisols) in permanently laid out plots of 6.25 sq. m size during *kharif* 1987 in a randomized block design replicated thrice. Rainfall of about 808.6 mm was received during 1987, out of which, 305.4 mm was received during the cropping period.

Five salinity levels in irrigation water (2, 4, 6, 8 and 12 dSm^{-1}) along with control (1 dSm^{-1}) were artificially prepared by dissolving the salts of Na:Mg:Ca::4:1.7:1 and $Cl:SO_4:HCO_3$::2:1:1. The initial soil pH (prior to sowing) varied from 8.4 to 8.6 under control to 12 dSm^{-1} in treated plots, whereas, the soil EC_2 varied from 0.36 to 3.7 dSm^{-1} . Setaria (var. K 221-1) was irrigated four times during the cropping period. Composite soil samples were collected from 0-15 and 15-30cm depths before sowing and after harvest of the crop and analysed for various constituents.

Results and Discussion

Effect on soil properties : The results revealed that the continuous application of saline water reduced the build up of salts in the soil after 100 days compared to presowing level. This was mainly due to the rains received during *kharif* season. The total distribution and intensity of rain inturn governs the extent of salts leached. The EC_2 of soil was drastically reduced at sowing to after harvest at both the soil depths. The decrease was 38.9% in control and 74.3% in 12 dSm^{-1} plots in surface layer. The corresponding values in sub-surface layer were 42.9% and 59.1%. After harvest, the pH showed an increasing trend at both the soil depths at all salinity levels. The EC_2 of the soil decreased and the pH increased after third salinization at both the soil depths compared to EC_2 and pH before sowing.

Table 1. Status of water soluble cations and sodium adsorption ratio (SAR) in soil (1:2 soil water extract) as influenced by varying salinity levels in irrigation waters

Salinity level (dSm^{-1})	Na ($me\ L^{-1}$)		Ca ($me\ L^{-1}$)		Mg ($me\ L^{-1}$)		K ($me\ L^{-1}$)		SAR	
	BS	AH	BS	AH	BS	AH	BS	AH	BS	AH
0—15 cm depth (surface layer)										
Control	4.8	2.4	17.0	0.6	8.0	0.1	0.02	0.04	1.3	3.7
2.0	13.2	4.7	15.0	1.3	9.0	0.5	0.02	0.03	3.8	4.8
4.0	18.8	7.3	17.0	1.6	24.0	0.7	0.03	0.04	4.1	6.8
6.0	35.6	8.3	18.0	1.7	32.0	1.0	0.04	0.05	7.5	6.4
8.0	54.9	9.4	16.0	0.3	19.0	4.8	0.05	0.06	13.0	6.6
12.0	61.7	10.9	18.0	0.4	12.0	4.8	0.08	1.02	16.3	6.6
15—30 cm depth (sub-surface layer)										
Control	7.1	3.2	16.0	0.7	28.0	0.2	0.01	0.03	1.5	4.5
2.0	13.4	6.6	11.0	1.2	14.0	0.5	0.02	0.03	3.6	7.1
4.0	20.4	9.4	14.0	1.5	13.0	0.8	0.02	0.02	5.6	8.5
6.0	36.9	10.2	22.0	1.8	17.0	0.8	0.02	0.03	8.3	9.3
8.0	51.0	11.5	16.0	0.5	15.0	5.8	0.02	0.06	13.2	6.4
12.0	72.9	17.8	19.0	0.5	25.0	3.4	0.03	0.09	15.7	13.8

BS—Before sowing ; AH — After harvest.

After harvest, the increase in SAR was inconsistent at both the depths (Table 1), which might be due to low Na level (Sharma *et al.*, 1983). The SAR of the soil, however, decreased at higher salinity levels (Singh and Narain, 1980).

Effect on available N and P : The N and P contents increased after harvest and the surface layer accounted for higher N and P content compared to sub-surface layer (Gandhi and Paliwal, 1975). The increase in N content may be due to the lower N uptake by the setaria from soil than applied N (60 kg N ha^{-1}). Similar trend was also noticed in case of P (30 kg P_2O_5 ha^{-1}). Therefore, the N content in soil at harvest was more than the N content before sowing. Further, the decrease in EC and increase in pH at harvest compared to before sowing might have increased the P content in soil (Table 2).

Effect on water soluble cations : The water soluble K^+ and Na^+ increased due to increased salinity at both soil depths. However, Na^+ content decreased after harvest compared to before sowing and the reverse trend was observed in case of K^+. The soluble cations, viz., Na^+, Ca^{++}, and Mg^{++} accumulated more in sub- surface layer than in surface layer. Both Ca^{++} and Mg^{++} increased with increasing salinity levels, however, the increase was inconsistent (Sharma *et al.*, 1983).

Effect on grain yield : Maximum grain yield (3151 kg ha^{-1}) recorded with salinity level of 6 dSm^{-1} was at par with all other treatments except 12 dSm^{-1} (1709 kg ha^{-1}). Continuous rains upto 61 days after sowing of setaria (flowering period) might have helped in leaching of added salts from the root zone of the crop reducing their adverse effects on the crop growth and development. A dry spell of 21 days thereafter, increased the salinity in the upper soil layers. By this time the crop had already flowered. Thus, the salinity developed did not have the adverse effects on the yield of setaria even upto 6 dSm^{-1} salinity level.

Table 2. Available nitrogen and phosphorus in soil, their uptake and grain yield of setaria as influenced by salinity levels in irrigation water

Salinity level (dSm^{-1})	N ($kg\ ha^{-1}$)		N uptake after harvest ($kg\ ha^{-1}$)	P_2O_5 ($kg\ ha^{-1}$)		P uptake after harvest ($kg\ ha^{-1}$)	Grain yield ($kg\ ha^{-1}$)
	Before sowing	After harvest		Before sowing	After harvest		
			0—15 cm depth (surface)				
Control	101.3	110.6	39.2	16.2	18.5	2.29	2623
2.0	100.1	10.5.7	40.6	12.1	16.3	2.51	2865
4.0	98.5	103.7	44.9	12.6	13.8	2.39	3026
6.0	102.4	109.3	57.6	10.4	12.9	2.66	3131
8.0	89.4	103.5	33.2	11.0	20.1	2.54	2629
12.0	86.4	94.4	27.2	10.5	20.8	2.31	1790
			15—30 cm depth (sub—surface)				
Control	79.5	82.9	–	10.6	16.4	–	–
2.0	82.2	94.7	–	8.3	13.0	–	–
4.0	86.6	91.6	–	9.0	7.8	–	–
6.0	92.7	87.1	–	9.5	10.7	–	–
8.0	79.3	83.3	–	9.4	8.1	–	–
12.0	55.3	61.4	–	9.4	11.9	–	–

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