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Conjunctive Use of Saline Water for Raising Arable Crops on Fluventic Eutrochrept and Vertic Ustochrept Soils

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ABSTRACT

Field experiments conducted from 1992 to 1995 at Khanpur farm of regional centre of C.S.S.R.I., Anand, Gujarat revealed that increasing salinity levels of irrigation water progressively decreased the seed yield and plant height in both Vertic Ustochrept and Fluventic Eutrochrept soils, the reduction being more under the former soils. In case of fennel crop, significant yield reduction was observed with the saline water of 16 dS/m EC value in Fluventic Eutrochrept and with 4 ds/m EC value in Vertic Ustochrept. In safflower significant yield reduction was observed when saline water with EC value of 8 dS/m was applied for both the soils.Study also revealed that castor can be grown successfully with 8 to 12 dS/m EC water on coarse textured soils and it can not be grown on fine textured saline soils even with good quality of irrigation water.In case of mustard,significant yield reduction was observed with water of 8 dS/m E C value in Fluventic Eutrochrept whereas in Vertic Ustochrept the significant reduction was observed even at 4 dS/ m EC of water.In dill crop the lowest yield was observed with saline water of 12 dS/m and 4 dS/m EC values in the Fluventic Ustochrept and Vertic Ustochrept ,respectively. In case of rajagira the seed yield was less with the water of salinity level 8 dS/m in Fluventic Eutrochrept and with 4 dS/m in Vertic Ustochrept soils.

Introduction

Extensive saline ground water aquifers occur in many arid and semi-arid regions and remain unutilized .The use of saline ground water for irrigation can increase the quantity of water available for agricultural production, if suitable management strategies for their utilization are evolved. A common practice for the combined use of saline underground water and good quality water is to blend both water in appropriate proportion for irrigation. Another practice consists of applying fresh water at sensitive growth stages and making use of saline water at comparatively tolerant stages. Germination and crop establishment are the most critical stages in crop. Therefore, if a pre-sowing irrigation with good quality water is given, the crop may be able to tolerate salinity build-up resulting from the subsequent irrigations with saline blend water at later stages. The same technique was used for the present study to evaluate the response of salinity water of different levels on growth and yield of fennel (*Foeniculum vulgare* Miller), safflower (*Carthamus tinctorius* L.), Indian mustard (*Brassica juncea* L.), castor (*Ricinus communis* L.), dill (*Anethum graveolens* L.) and rajagira (*Amaranthus paniculatus* L.) and resultant soil salinity build up in fine (Vertic Ustochrept) and coarse (Fluventic Eutrochrept) textured soils.

Materials and Methods

The experiments were conducted from 1992 to 1995 on two types of soils viz., Vertic Ustrochrept (Khanpur clay) and Fluvenic Eutrochrept (Khanpur sandy loam) at the farm of regional research centre of C.S.S.R.I., Anand, Gujrat (Lat. 21^{0} 45' to 22^{0} 55' N, Long. 71^{0}15' E and 12 m above mean sea level). The average annual rainfall was 650 mm and there was net saturation deficit from September to June.The experimental field was barren for the past several years.The physico - chemical characteristics of the soils were determined by standard methods as described in U.S.D.A. Hand Book No. 60 and are presented in Table 1.

The crops, safflower (*Carthamus tinctorius* L.) var. Bhima, Indian mustard (*Brassica juncea* L.) var. Pusa Bold, castor (*Ricinus communis* L.) var. GCH-4, dill (*Anethum graveolens* L.) var. sowa, rajagira (*Amaranthus paniculatus* L.) var. local were sown and fennel (*Foeniculum vulgare* Miller) var. Gujrat -1 was transplanted in October each year and 50 mm good quality irrigation water was applied as pre-sowing irrigation followed by irrigation with water of different salinity levels The pond water having electrical conductivity (EC) 0.4 dS/m was considered as best available water. The five categories of water with the EC values of 0.4 , 4.0 ,8.0,12.0 and 16.0 dS/m were applied for Vertic Ustochrept and six categories of water having EC values of 0.4, 4.0, 8.0 , 12.0, 16.0 and 24.0 dS/m were used for the Fluventic Eutrochrept soils for raising the above mentioned crops. Water of different qualities were prepared by mixing available ground water with pond water. Two irrigations in safflower, mustard, castor, dill and rajagira and six in fennel (50 mm of water in each irrigation) were

Table 1. Physico chemical properties of soils

Properties	0-15 cm	15-30 cm	30-60 cm	60-90 cm	90-120 cm
(a) Khanpur clay (Vertic Ustochrept)					
Sand %	34.8	34.7	36.6	31.2	38.6
Silt %	22.0	21.5	20.4	24.2	27.6
Clay %	43.2	43.8	43.0	44.6	33.8
BD(Mg/m^3)	1.62	1.62	1.64	1.68	1.60
Org. carbon	0.62	0.41	0.33	0.26	0.15
pH	7.8	7.6	7.5	7.7	7.7
(b) Khanpur sandy loam (Fluventic Eutrochrept)					
Sand %	74.9	76.4	73.4	72.4	71.2
Silt %	11.0	10.2	10.0	9.2	12.4
Clay %	14.1	13.4	16.6	18.4	16.4
BD(Mg/m^3)	1.48	1.50	1.51	1.52	154
Org. carbon	0.42	0.34	0.32	0.20	0.13
pH	7.7	7.7	7.6	7.5	7.5

applied throughout the growing season in both the soils.The crops were harvested during late February and early March.The soil samples before sowing and after harvesting were collected for measuring their salt content and electrical conductivity of saturation extract (ECe).

Plant heights were measured at the time of full plant growth .All the crops were grown with recommended doses of fertilizers and other normal agronomic package and practices.

Results and Discussion

Saline water, plant height and crop yield

Increasing salinity levels of irrigation water progressively decreased plant height and seed yield in both the soils. The reduction in plant height was more under Vertic Ustochrept than under Fluventic Eutrochrept in all the treatments. In fennel, saline water with the EC values of 4, 8, 12, 16, and 24 dS/m reduced the seed yield by 1.3%, 2.4%, 3.1%, 4.1% and 13.7%, respectively in the Fluventic Eutrochrept soils. In Vertic Ustochrept soils the seed yields were reduced by 8.7%,17.8%,26.9% and 36.8% with water of having EC values of 4,8,12,16, dS/m , respectively when compared with pond water. The plant height also showed similar trends.Significant yield reduction was observed with water of 12 dS/m EC value in Fluventic Eutrochrept soils,whereas in Vertic Ustochrept soils, significant yield reduction occurred even with 4 dS/m EC water. (Table 3).

In safflower the highest yield was observed in the Vertic Ustochrept soils when pond water was applied.Use of salt water of 4.8,12 and 16 dS/m EC values reduced the seed yield by 9.0%,25.4%,34.6% and 45.0%,respectively when compared with best available pond irrigation water. In Fluventic Eutrochrept soils the seed yield decreased by 2.8% to 37.8% with increase in EC from 4 to 24 dS/m. Significant reduction in yield was observed at EC of 8 or more dS/m in both the soils . Plant height also showed significant reduction as EC of irrigation water exceeded 8 dS/m (Table 2).

In case of mustard, the significant yield reduction was observed with water of 8 dS/m EC value in Fluventic Eutrochrept soils, whereas in Vertic Ustochrept soils this was observed even with 4 dS/m EC water.In Fluventic Eutrochrept soils,application of saline blend water reduced seed yield of mustard by 8.8%, 11.9%, 21.2%, 33% and 43%,respectively with water of 4, 8, 12, 16 and 24 dS/m EC .In case of a Vertic Ustochrept soils the seed yield decreased by 19.6, 39.1, 52.2 and 65.2 per cent with water of 4,8, 12 and 16 dS/m ,respectively when compared with pond water (Table 2). In case of castor crop application of saline blended water reduced seed yield by 86.5,

Table 2. Effect of different salinity water on plant height of different crops

EC of irrigation water (ds/m)	Fennel	Safflower	Mustard	Castor	Dill	Rajagira
(a) Khanpur clay (Vertic Ustochrept)						
0.4	1.03	0.63	0.90	0.57	0.81	0.96
4.0	0.98	0.58	0.82	0.42	0.76	0.86
8.0	0.87	0.54	0.76	0.36	0.74	0.73
12.0	0.78	0.52	0.74	0.30	0.69	0.51
16.0	0.69	0.42	0.61	0.23	0.58	0.36
CD(0.05)	0.05	0.06	0.06	-	0.10	0.10
(b) Khanpur sandy loam (Fluventic Eutrochrept)						
0.4	1.36	0.64	1.53	1.82	1.30	1.89
4.0	1.29	0.63	1.44	1.67	1.25	1.62
8.0	1.27	0.60	1.36	1.56	1.20	1.58
12.0	1.21	0.58	1.32	1.46	1.16	1.46
16.0	1.19	0.55	1.26	1.36	1.15	1.36
24.0	1.13	0.50	1.14	1.12	1.06	1.33
CD(0.05)	0.055	0.035	0.10	0.17	0.08	0.13

78.7, 67, 56.7, and 41.4 per cent with water of 4,8,12,16 and 24 dS/m EC values,respectively in Fluventic Eutrochrept soils.In case of Vertic Ustochrept soils the seed yield decreased by 72.7, 46.6, 35.2 and 21.6 per cent with the water of 4, 8, 12, 16, dS/m,respectively when compared with pond water. The results indicated that castor crop failed to grow on saline Vertic Ustochrept soils with good quality of water. Therefore, it is suggested that castor crop can be grown with 8 to 12 dS/m EC water on coarse textured soils (Table 3).

Dill showed very good performance on both the soils with saline water. In Fluventic Eutrochrept soils 92.2, 87.0, 83.0, 75.5 and 65.3 per cent yield (in comparison to yield with pond water)could be achieved with water of 4,8,12,16,and 24 dS/m EC values, respectively while in Vertic Ustochrept soils with same quality of water 77.5, 70.2,59.6 and 49.4 per cent yield was achieved.The reduction in seed yield was more in Vertic Ustochrept than that of in Fluventic Eutrochrept soils (Table 3).

Rajagira showed very good performance on Fluventic Eutrochrept than that on the Vertic Ustochrept. Use of saline blended water in Fluventic Eutrochrept soils reduced seed yield by 38.3 to 84.3 per cent with water of 4 to 24 dS/m EC, respectively. In case of Vertic Ustochrept seed yield decreased by 21.1 to 69.2 per cent, respectively with water of 4 to 16, dS/m as compared to pond water.

The crops fennel,mustard,castor, dill and rajagira showed best performance with good and poor quality water on Fluventic Eutrochrept soils, while performance of safflower was good on Vertic Ustochrept. Results also indicated that poor quality water can be utilized successfully for growing arable crops on light textured soils (Table 2 and 3). Our observations in this experiment are in close agreement with those of Sharma *et al.* (1990), Naresh *et al.*, (1993) and Singh *et al.*(1995).

Soil salinity status

The initial EC of saturated extract (ECe) of Fluventic Eutrochrept soils was 0.78 to 1.2 dS/m, where as in Vertic Ustochrept soils, it was 4.2 to 10.0 dS/m. Application of water of increasing salinity and number of irrigations increased soil salinity upto a depth of 120 cm in both the soils but the increase was more in the top 60 cm soil depth.The patterns of soil salinity build up in upper half and lower half portion of soil profile of both the soils differed; more salts were accumulated in the Vertic Ustochrept than in the Fluventic Eutrochrept soils. The ground water table in Vertic Ustochrept

Table 3. Effect of different salinity water on crop yield (t/ha) of different crops

EC of irrigation water (dS/m)	Fennel	Safflower	Mustard	Castor	Dill	Rajagira
(a) Khanpur clay (Vertic Ustochrept)						
0.4	0.416	0.763	0.460	0.088	1.78	1.33
4.0	0.380	0.700	0.370	0.064	1.38	0.92
8.0	0.342	0.569	0.280	0.041	1.25	0.54
12.0	0.304	0.499	0.220	0.031	1.06	0.38
16.0	0.263	0.420	0.160	0.019	1.88	0.28
CD(0.05)	0.016	0.066	0.040	-	0.170	0.150
(b) Khanpur sandy loam (Fluventic Eutrochrept)						
0.4	1.081	0.600	1.93	5.03	3.31	5.72
4.0	1.067	0.583	1.76	4.35	3.05	4.82
8.0	1.055	0.563	1.70	3.96	2.88	3.16
12.0	1.048	0.529	1.52	3.37	2.75	2.81
16.0	1.037	0.458	1.29	2.85	2.50	2.44
24.0	0.933	0.373	1.10	2.08	2.16	2.19
CD(0.05)	0.040	0.036	0.15	0.56	0.14	0.26

remained between 1.10 and 1.35 m depth during the cropping season and its average EC ranged between 18 to 23 dS/m. Rains *et al.*, (1987) and Sharma *et al.*, (1990) also reported similar phenomenon.The initial 50 mm irrigation of good quality water sufficiently deceased the salt content during germination, but latter the upward flux was very high and caused salt accumulation within the root zone.To avoid the salinity build-up, crops having low water requirements should be grown on fine textured soil and the crops having more water requirements should be grown on coarse textured soil.

Response of different crops to soil salinity

Seed germination was found to be inversely related to soil salinity. In safflower more than 90% germination was observed in the soil having salinity less than 3 dS/m ,but only 50 % occurred at 18 dS/m soil salinity and no germination was found when EC of water exceeded 30 dS/m. In dill crop, 100% seed germination was observed at soil salinity less than 3 dS/m and only 50% at soil salinity more than 5 dS/m. It was more than 20% at soil salinity more than 20 dS/m and no germination was found at above 30 dS/m.

Dill crop did not show significant reduction in seed yield up to 5 dS/m salinity, but a sharp reduction in seed yield was observed from 5 to 14 dS/m EC values. Further increase in soil salinity upto 28 dS/m gradually decreased the seed yield. No yield was obtained when EC value exceeded 28 dS/m. The response curve of dill indicated that the threshold value was at 5 dS/m soil salinity. Whereas for safflower it was at soil salinity value of 4dS/m EC. Very low yield was observed at high soil salinity (>10 dS/m). Only 50% yield was obtained at or above 8.5 dS/m and no yield was obtained at or above 28 dS/m on Vertic Ustochrept soils.

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