IRRIGATION OF CROPS WITH BRACKISH WATER USING ORGANIC AMENDMENTS

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Brackish water can be made productive through the addition of various chemical and organic amendments. In this experiment we used three organic amendments to reduce the deleterious effect of brackish water (EC = 3.24 dS m^{-1}, SAR = 14.8 $(mmol\ L^{-1})^{1/2}$, RSC = 4.6 $mmol_c\ L^{-1}$) following a rice-wheat crop rotation on nonsaline-nonsodic, silt loam soil (EC = 3.1 dS m^{-1}, SAR = 6.26 $(mmol\ L^{-1})^{1/2}$, pH_s = 7.8). Four treatments, i.e. brackish water, brackish water + pressmud, brackish water + poultry manure and brackish water + FYM were arranged in randomized complete block design with three replications. The composite soil samples from 0-15, 15-30, 30-45, 45-60 and 60-100 cm depths were collected first at the start of experiment then after the harvest of each crop. After first crop (rice 2003) the percent increase in EC_e was 17 to 54 throughout the soil profile. Minimum increase in EC_e was found when brackish water was used with pressmud. Treatments differed non-significantly to reduce the ill effect of brackish water in terms of SAR. Again pressmud remained most effective compared to others. After wheat harvest (2003 – 2004) EC_e was increased to 5.6 dS m^{-1} and SAR 15.50 $(mmol_e L^{-1})^{1/2}$ at 0-15cm depth. However when amendments were applied, the increase was within safe limit. The growth and yields of rice and wheat were significantly decreased with brackish water which was improved by the application of various organic amendments. All the three organic amendments were highly effective but poultry manure showed superiority over others in improving crop growth under brackish irrigation water.
Key words: Brackish water, Amendments, Irrigation

INTRODUCTION

Agriculture in arid and semiarid region is threatened with acute shortage of irrigation water. According to Ansari (1995) in Pakistan canal net work could supply only one cusec of water for 350 acres compared to 70 acres in U.S.A. To make up the gap canal water resources can be supplemented by ground water but unfortunately 70-75% of total water being pumped out in the country is of brackish nature (Ahmed and Chaudhry, 1988) and unscientific use of this water is deteriorating the soil health and crop yields (Khan et al. 1991 ; Hussian et al. 1991). Soil properties undergo drastic changes when soil is irrigated with brackish water (Aslam, 1988). The soluble salts present in the rhizosphere as a result of saline irrigation affect the crop growth by reducing ability of plant roots to absorb water due to osmotic pressure effect (Maas and Nieman,1978).

However, brackish water can effectively be used for irrigation if proper management practices are followed (Ghafoor et al., 2001; Qadir et al., 2001). Addition of organic materials such as farm yard manure and crop residues are of utmost importance in improving the soil properties (Hormick and Parr, 1987), which are otherwise deteriorating when brackish water is being used. According to Murtaza et al. (2002) brackish water can be used for irrigation with proper management practices without considerable loss to soil health and crop productivity.

Keeping in view the possibility of using brackish water, present study was planned with following objectives:

I. To study the effect of brackish water on the growth and yield of rice and wheat crops.
II. To evaluate the effectiveness of various organic amendments in rectifying the deleterious effects of brackish water.

MATERIALS AND METHODS

The study was conduced during 2003-04 following a rice-wheat rotation at Haveli Reclamation Research Farm Shorkot Cantt. The experiment was laid out according to Randomized Complete Block Design (RCBD) with four treatments and three replications. The treatments were:

T_1 = Brackish water (control)

T_2 = Brackish water + pressmud @ 4t ha^{-1}

T_3 = Brackish water + poultry manure @ 4 t ha^{-1}

T_4 = Brackish water + FYM @ 10 t ha^{-1}

After laying out the experiment, composite soil samples from 0-15, 15-30, 30-45, 45-60, and 60-100 cm depths were collected and analyzed for physical characteristics (Textural class and saturation percentage) and chemical properties (pH_s, EC_e and

SAR) according to U.S. Salinity Lab. Staff (1954). Pre-sowing characteristics of experimental field (To) were given in Table 1. Brackish water (EC = 3.24 dS m^{-1}, SAR=14.8 $(mmol_c L^{-1})^{1/2}$, RSC=4.6 (mmol L^{-1}) was used for irrigation. The organic amendments were applied to only rice crop and their residual effects were studied in following wheat crop. After well incorporation of amendments in plots, forty days old rice seedlings (Basmati-385) were transplanted in the last week of June 2003 maintaining line to line and plant to plant distance 20 cm x 20 cm. Recommended dose of fertilizers ($N:P_2O_5$ and Zn @ 225:125 and 15 kg/hectare respectively) was applied. Half of N as urea and full dose of P_2O_5 as SSP were applied at the time of transplanting and remaining urea was applied in two splits after 35 and 55 days of transplanting, while Zn was applied as zinc sulfate after 25 days of transplanting. Crop growth characteristics such as plant height, number of tillers per plant, number of kernels per panicle, paddy yield and 1000-grain weight were recorded and statistically analyzed. After the harvest of rice, composite soil samples were collected from each plot similar to that at the start of experiment. The field was prepared for wheat 2003-04 and Inqlab-91 was sown by maintaining 20 cm row to row distance. Recommended dose of fertilizer ($N:P_2O_5$ @ 225 and 125 kg ha^{-1} respectively) was applied. Plant growth parameters were recorded and analyzed statistically (Steel and Terrie, 1980). After the harvest of wheat, again soil samples were collected and analyzed chemically.

RESULTS AND DISCUSSION

Soil characteristics

The electrical conductivity of soil extract is an indicative of salinity hazard of applied water. Data presented in Fig. 1 & 2 revealed that brackish water increased 17–80% salt concentration in soil solution throughout the soil profile. At the start of experiment EC of soil at 0-15 cm depth was 3.1 dS m^{-1} which increased to 4.8 after rice 2003 and 5.6 dS m^{-1} after wheat 2003-04 with the use of brackish water. Similar trend was found in other soil layers. However where organic amendments were applied although EC_e was increased but still below the critical limit. This was possibly due to the reason that organic amendments contained high concentration of ions like Ca^{2+}, k^+ which mitigate the ill effects of brackish water. Moreover these amendments helped to maintain the hydraulic conductivity, resulting in leaching of salts. Among various organic amendments, pressmud showed its supremacy over others. The increase in EC_e with the use of brackish irrigation water was also reported by Rhoades (1993) and Ghafoor et al. (1997). It was obvious from the data (Fig. 1) that salt build up in all soil layers continued to be increased but effects were being more pronounced in upper layers (0-30 cm) in case of rice crop. This was perhaps due to the swelling and partial dispersion of clay particles by the excessive concentration of sodium in brackish water (Ghafoor et al., 1997). Moreover rice was sown under puddled conditions which restricted the movement of water and salts to lower layers. In wheat crop somewhat reverse trend was observed where more salts accumulated in lower layers (Fig. 2). This was due to leaching of salts as organic amendments counteract the deleterious effect of Na and did not allow the dispersion of soil (Jilani et al., 1990).

Sodium adsorption ratio (SAR) of soil extract is associated with the sodic hazard of irrigation water. The effect of various organic amendments on the soil SAR was shown in Fig. 3 & 4. The data revealed that there was an increase of about 65 to 147 percent in SAR throughout the soil profile compared to the original values when brackish water was used without amendments. However when organic amendments were applied although SAR was increased but values were still below the critical limit of 13 $(mmol_e L^{-1})^{1/2}$. Singh (1969) reported that organic manures contained Ca^{2+} which helped in the removal of exchangeable sodium from soils.

Table 1. Chemical and physical characteristics of soil at the start of experiment

Soil depth (cm)	Textural Class	Saturation Percentage	pH_s	EC_e (dS m^{-1})	Soluble cations ($mmol_c L^{-1}$)			Soluble anions ($mmol_c L^{-1}$)			SAR
					Ca^{2+}	Na^+	K^+	HCO_3^-	Cl^-	SO_4^{2-}	
0-15	Silt loam	45	7.8	3.1	16	17.7	0.3	4	8	22	6.26
15-30	Silt loam	38	7.5	2.7	13	16.2	0.3	6.5	8.5	14.5	6.35
30-45	Silt loam	30	7.4	2.3	11	13.1	0.4	5.5	7	12	5.59
45-60	Silt loam	36	7.7	1.8	7.5	10.9	0.3	4	6	8.7	5.63
60-100	Silt loam	40	7.6	1.7	7.5	9.8	0.2	6	4.5	7	5.06

Fig.1. Effect of brackish water on EC after rice

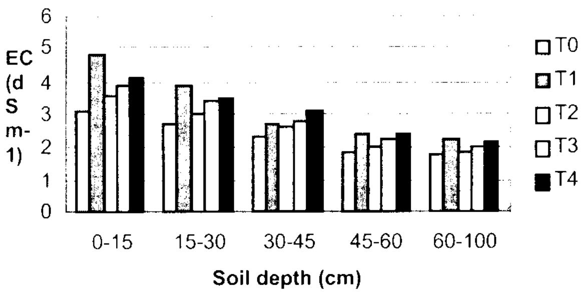


Fig. 2. Effect of brackish water on EC after wheat 2003-

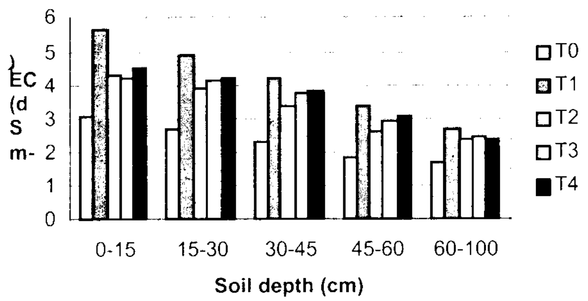


Fig. 3. Effect of brackish water on soil SAR after rice 2003

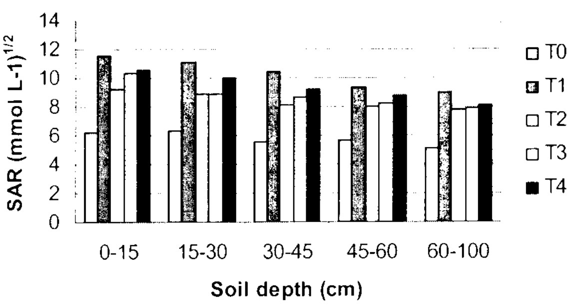


Fig 4. Effect of brackish water on Soil SAR after 2003-04

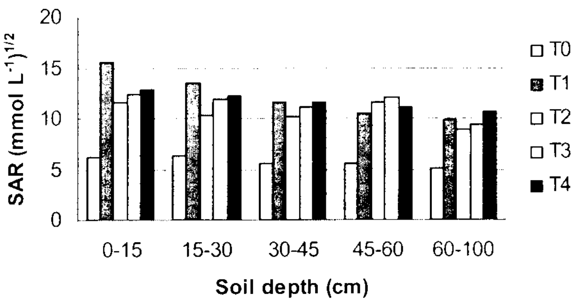


Fig 5. Effect of brackish water on pH after rice

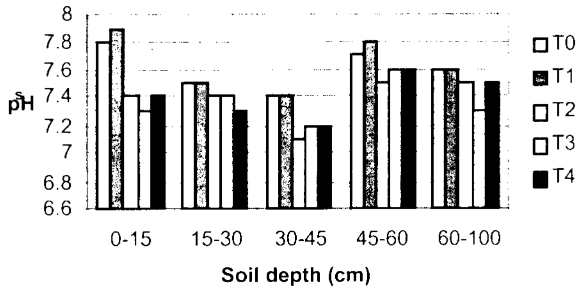
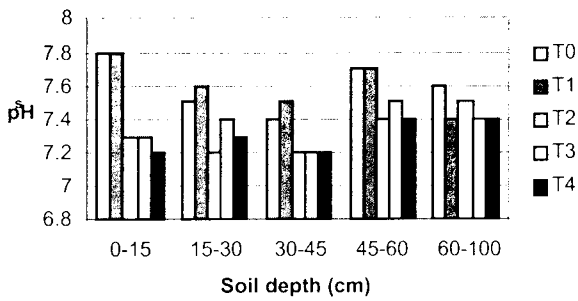


Fig. 6. Effect of brackish water on pH after wheat 2003-



The data on soil reaction indicated that there was no appreciable change in soil pH by the use of brackish water (Fig. 5 & 6). Application of organic amendments lowered the soil pH from original values particularly in upper soil layers because organic amendments on their decomposition release CO_2 and organic acids which in turn decrease the soil pH (Hussain et al., 1994).

Plant growth characteristics

The crop yields were significantly decreased by the use of brackish water which might be associated with water and nutritional imbalance resulting from salt stress (Maas and Grieve, 1987). However yield and its components might be improved with the use of organic amendments. In the first crop, i.e. rice 2003 the maximum response of plants in terms of yield, height, tillers count etc. was observed in poultry manure and pressmud respectively which resulted in significantly higher yields over the control (Table 2). The application of organic manures not only improve yields by providing adequate nutrition under salt stress conditions but also ameliorate soil chemically and physically (Shukla and Pandey, 1988 and Singh et al., 1992). The lower yield response from FYM might be attributed to its low solubility and slow release of nutrients. The beneficial effect of poultry manure and pressmud similar to this was reported by Shukla and Pandey (1988).

Table 2. Effect of organic amendments on growth characteristics of rice 2003 irrigated with brackish water

Treatments	Plant height (cm)	Number of tillers ($plant^{-1}$)	Number of kernels $panicle^{-1}$	Paddy yield ($t\ ha^{-1}$)	1000-grain weight (g)
Control	106c	8c	134c	3.33b	19c
Pressmud	126a	14a	217a	4.87a	21ab
Poultry manure	125a	15a	204a	5.10a	22a
Farm yard manure	118b	11b	181b	4.85a	20bc

Table 3. Effect of organic amendments on growth characteristics of wheat 2003-04 irrigated with brackish water

Treatments	Plant height (cm)	Number of tillers ($plant^{-1}$)	Number of grains $spike^{-1}$	Paddy yield ($t\ ha^{-1}$)	1000-grain weight (g)
Control	82c	5c	36c	2.04c	33d
Pressmud	90a	13a	52a	2.64a	37b
Poultry manure	86bc	13a	52a	2.72a	39a
Farm yard manure	88ab	9b	44b	2.26b	35c

After the harvest of rice crop, wheat (2003-04) was sown. A similar trend of results, as observed in rice crop was noted in follow-up wheat crop (Table 3) where poultry manure and pressmud again got lead over FYM in terms of the yield responses. The differential response of various organic amendments might be attributed to their different decomposition rates and decomposition products (Hussain et al., 1994).

Conclusion

Brackish water can be used to irrigate crops with less risk of soil deterioration and yield reduction by the application of various organic amendments like pressmud, poultry manure and farm yard manure.

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