USE OF MARGINAL QUALITY WATER AS ALTERNATE SOURCE OF IRRIGATION FOR WHEAT PRODUCTION IN SALT AFFECTED SOIL

M. Javaid Ahmad, M. Arif, S. Hussain, Z. Chishti, G. Yaseen, S. Nawaz and S .Riaz

Institute of Soil Chemistry & Environ. Sciences, Ayub Agricultural Research Institute, Faisalabad, Pakistan, ahmad.javaid62@gmail.com

ABSTRACT

Availability of good quality irrigation water for crop production is a great challenge in most parts of the world. In Pakistan, supply of canal water is in-sufficient to meet the agricultural demands. It is need of the day that marginal quality water may also be used with canal water to irrigate the field crops. Field studies were conducted to determine the effects on the use of brackish water with combination to canal water in wheat production under saline conditions. Soil was collected from the salt affected area and filled in the pots. Four treatments i.e., brackish water as control (T_1), 3 canals + 2 tube well irrigation (T_2), 2 canal + 3 tube well irrigation (T_3) and, canal + tube well water in the ratio of 1:1 (T_4) were selected in the study. NPK fertilizers were applied @ 120-90-60 Kg ha^{-1} as Urea, SSP and SOP, respectively. Normal agronomic practices were followed until maturity. The results revealed a significant increase in both biomass and grain yield in all the treatments over control where, only brackish water was applied for irrigation. Maximum grain yield of 3.35 t ha^{-1} was recorded in the treatment T_2, where 3 canal water and 2 brackish water irrigation was applied. The yield at T_3 was statistically at par with higher yield values. Post harvest soil analysis indicated a decrease in pH, ECe and SAR, while an increase in N and P content in all the treatments over control. It seems that marginal quality water can be used with canal water to irrigate the wheat crop.

Keywords: Water, Wheat, Quality, Salts.

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1. INTRODUCTION

Enhanced agricultural production and productivity are essential if we want to meet the world wide food demand of burgeoning population especially in developing countries. The inadequate attention to agriculture development may result in a shortage of food and feed for human beings. Besides many other factors, water is an essential prerequisite for the success of crop production in the field. The fresh water comprises only 3% of earth's water and its 1% is only available for man demands including agricultural requirements (Postal and Wolf) [12]. The crop demand for water varies with soil conditions, temperature and annual precipitation. Natural water resources play a vital role in plant growth on the contrary these are decreasing with the climatic changes throughout the world. The arid and semi arid areas with hotter and dry summer have a negative impact on these resources as well (Rustler and Thompson [14].

In Pakistan, out of 24 m ha cultivated area, 17 m ha is irrigated which plays an important role in the economy of the country (Anon [1]. About 6.3 m ha area is suffering salt problem (Khan [8], while rest is facing extreme shorting of water. The use of tube well water is increasing to overcome the shortage of canal water but most of tube wells water is not fit for irrigation because of high E.C., SAR and RSC (Ghafoor et al [6]. Cyclic use of this water on problem soils without proper strategy can result in accumulation of salts in the root zones, particularly in arid / semi-arid areas deemed with high evaporation rates (Patel at el. [11]. Salts in the soil are one of the major factors hampering the soil productivity. Salts affect the crop growth by inhibiting the cell division and enlargement in growing plant (Munns et al. [10]. The crop yield and fertilizer use efficiency in these soils can be improved mere by the use of low quality water along with the amendments like gypsum (Swarp [18]. Salts affected soils can be brought under normal growing environment through reclamation provided that plenty of irrigation water is available. So, where sufficient quantities of canal water are not available to cope the requirements, marginal quality water can be used for the purpose. Rhoades [13] observed from the field studies that for initial reclamation of salt-effected soils, low quality irrigation waters are more useful and even better than canal water due to favorable effect on infiltration rate and hydraulic conductivity. Relatively higher ratios of EC : SAR in drainage and ground water have been found to improve water conducting properties of soils which resulted in better and rapid amelioration of saline-sodic soils (Ghafoor et al. [5].

In Pakistan, most of the agricultural area has arid to semi arid climate with insufficient water supply to meet the irrigation requirement. More than half of the country receives less than 205 mm annual precipitation, which is insufficient to leach down the salts out of root zone (Khan [9]. It is major challenge for agriculture to meet the increasing demand of food and fiber with the rapid growing population. To meet this challenge, it is necessary to use marginal quality water in combination with canal water to irrigate the crops especially in salt affected soils (Zaka et al. [20]. Saeed et al. [15] reported increase in wheat grain yield, plant height and 1000 grain weight from his studies relevant to the use of brackish water on saline sodic soils.

2. MATERIALS AND METHODS

The experiment was conducted at District Faisalabad (Punjab Province) of Pakistan. The selected field's soil was saline sodic. The soil samples were collected from the field, mixed well and a composite sample was taken. After preparation and passing through 2mm sieve the physiochemical analysis was done, analysis detail is shown in table 1.

Table .1 Basic Characteristics of Soil

S. No.	Characteristic	Unit	Value
1	Textural Class	_	Sandy clay loam
2	pH	_	8.8
3	ECe	dS m^{-1}	5.2
4	SAR	(m mole $L^{-1})^{1/2}$	18.5
5	O.M.	%	0.56
6	Total N	%	0.038
7	Available P	mg Kg^{-1}	7.8
8	Extractable K	mg Kg^{-1}	194
9	Infiltration Rate	cm h^{-1}	2.10

Table .2 Basic Characteristics of Water

S. No.	Characteristic	Unit	Canal water	Tube well water
1	pH	_	7.80	8.30
2	ECe	dS m^{-1}	1.65	4.35
3	RSC	meq L^{-1}	1.10	7.60

The experiment was planned with four treatments which were

T_1 = brackish water (tube well water as control)

T_2 = 3 canal water +2 tube well water irrigation

T_3 = 2 canal water + 3 tube well water irrigation

T_4 = canal water + tube well water irrigation in the ratio of 1:1

3. EXPERIMENT PLAN

The field was prepared using routine agronomic practices. The trial was designed having four treatments and three repeats using Randomized Complete Block Design layout plan. NPK fertilizers were applied at the rate of 130-90-80 kg ha^{-1} in the form of Urea, SSP and SOP, respectively. The entire P and K doses and half N were applied at the time of sowing, while half N was applied at 1st irrigation. Wheat variety Inqlab was sown with 125 kg ha^{-1} of seed rate. The field was irrigated according to plan with canal and tube well water. Five irrigations were applied according to the recommendation by the Agriculture Department, Punjab, Pakistan. Weedicide Bromoxynil + MCPA 40 EC was applied after 1st Irrigation to control the weeds. At maturity, data regarding biomass production and grain yield was recorded. Plant and soil samples were taken for analysis purpose. Soil and plant samples were analyzed according to methods given in U.S. Salinity Laboratory Staff [19]. Infiltration rate was calculated according to the method of Aronovici [2] after the harvest of each crop. The data collected was subjected to statistical analysis according to Steel and Torrie [17]. The treatment means were compared at 5% probability by applying the Duncan's multiple range tests (Duncan [4].The data for two consecutive crops were collected and presented in results.

4. RESULTS AND DISCUSSION

The results collected from the study are discussed as under:

4.1. EFFECT ON WHEAT GRAIN YIELD

The data regarding the grain yield of wheat resulted from the experiment is indicated in Figure 1.

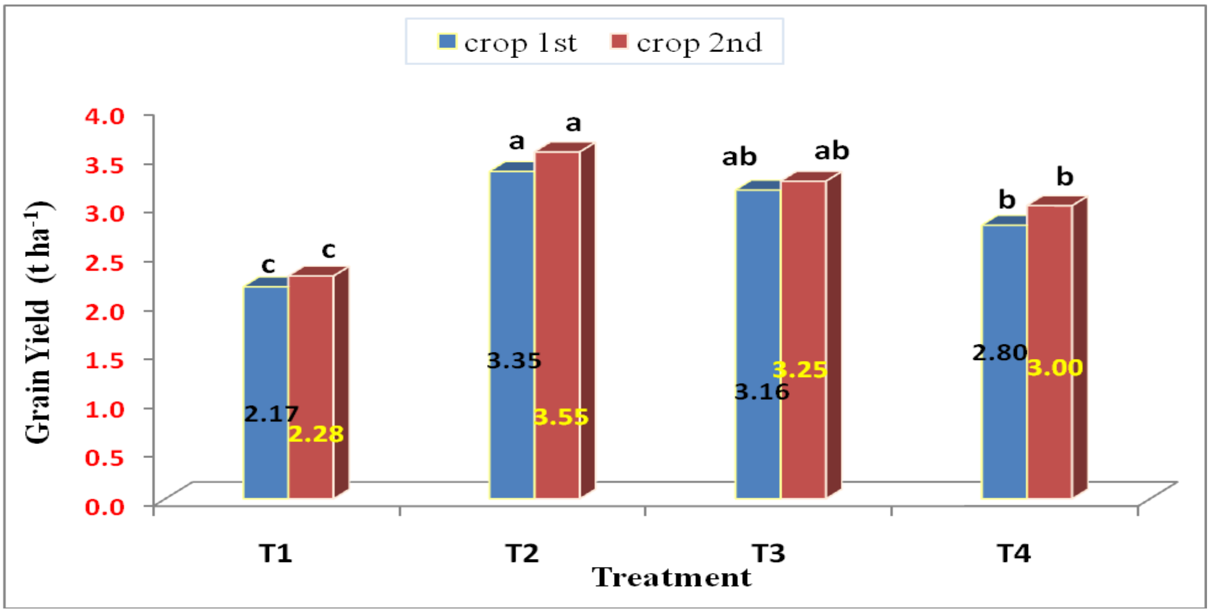

Fig. 1: Effect of brackish and canal water irrigation on wheat grain yield (t ha^{-1})

LSD Crop 1st 0.3215, Crop ^{2nd}.3532
*Means sharing the same letter (s) do not differ significantly at $P < 0.05$ according to Duncan'sMultiple Range Test.

It is evident from the data that grain yield increased significantly in all the treatments over control. The yield of control plot was 2.23 t ha^{-1}, while maximum return of 3.35 t ha^{-1} was obtained by the treatment where crop was supplied with three canals and two brackish water irrigations. It was close to the yield obtained from the treatment having three brackish and two canal water irrigation.

The results obtained from the study thus favor the use of blending us of brackish water with canal water for production of wheat crop in salt affected fields. The results are in line with the findings of Singh et al. [16] and Gomes et al. [7] who reported the increase in wheat yield with the use of brackish water. Saeed et al. [15] also reported the similar results of improvement in wheat grain yield in salt affected soils with combined application of canal and brackish water.

4.1. EFFECT ON INFILTRATION RATE OF SOIL

Infiltration refers to the vertical movement of water in the soil. It is generally high in the soils having high permeability and wide pore spaces. In the fields with high infiltration rates, rain water does not go waste and runoff is low with less erosion. Infiltration rate of soil was measured after each harvest of wheat crop both the years. It revealed the role of different treatments on the improvement of soil permeability. In all the treatments including control, infiltration rate was improved in the1st year and 2nd year crops where as it was 2.10 cm h^{-1} at the start of experiment (Table 3).

Table .3 Effect of brackish and canal water irrigation on infiltration rate of soil (cm h^{-1})

Treatment	**1st crop**	**2nd crop**	**Average**
T_1	2.20c	2.33c	2.27c
T_2	2.70a	2.85a	2.78a
T_3	2.60ab	2.72ab	2.66ab
T_4	2.45b	2.58b	2.53b
LSD	0.1215	0.1510	0.1304

*Means sharing the same letter (s) do not differ significantly at $P < 0.05$ according to Duncan's Multiple Range Test.

However maximum increase of 5.5% was observed in the treatment where two brackish plus three canal irrigations were applied. The improvement in infiltration rate by all the treatments may be due to improvement in soil structure resulted in the penetration of plants roots. The results were favored by Rhoades [13] and Chaudhry et al. [3] who found an increase in infiltration rate of soil by using brackish water in salt affected fields.

4.2. EFFECT ON SALINITY STATUS OF SOIL

The data presented in Figure 2 showed the effect of different treatment on the electrical conductivity (ECe) of soil.

The ECe of a soil indicates the presence of soluble salts and level of salinity in the ploughing layer. These salts may affect the plant growth adversely but can be leach down through frequent irrigations. It is evident from the data that ECe value of soil decreased in all the treatment. The decreasing trend was also noted in control plots that might be due to leach down of salts with the application of water as well as improvement of water penetration in soil. The maximum decrease to 3.40 dS m^{-1} was noted in T_2 from the initial reading of 5.18 dS m^{-1} after the harvest of 2nd crop. It depicted that cyclic use of canal and brackish water did not affect the ECe of soil. Similar results have been reported by Singh *et al*. [16] and Saeed et al. [15].

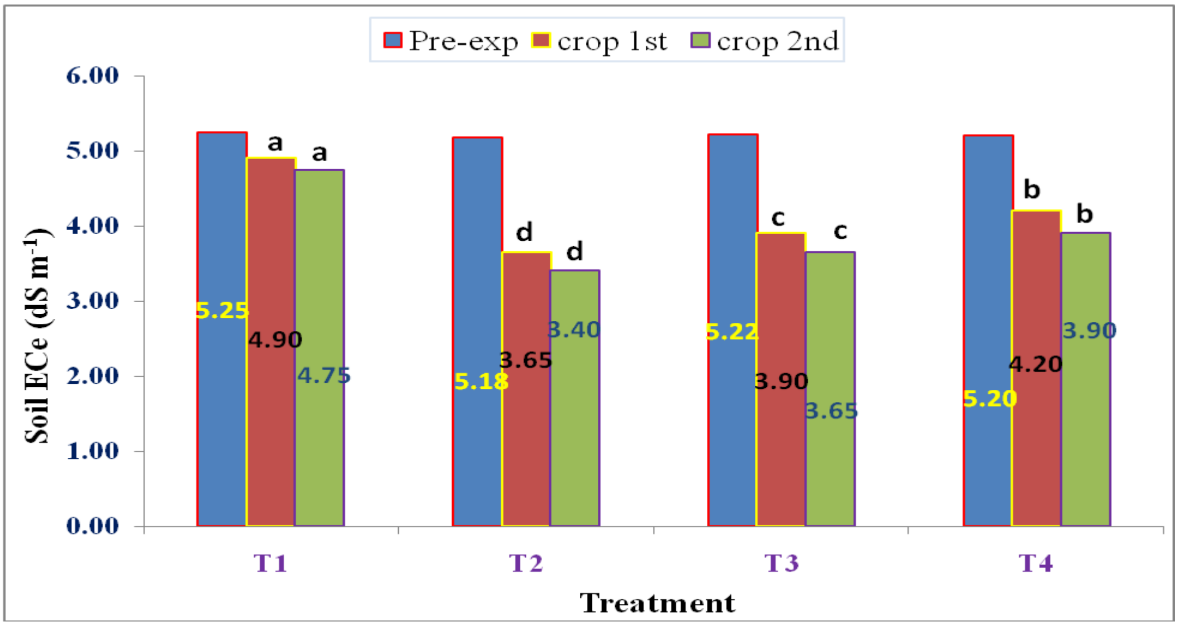

Fig. 2: Effect of brackish and canal water irrigation on soil ECe

LSD Crop 1st 0.2825, Crop 2nd 0.2530
*Means sharing the same letter (s) do not differ significantly at $P < 0.05$ according to Duncan's Multiple Range Test.

4.3. EFFECT ON pH OF SOIL

Soil pH in salt affected soils is an indicator of presence of sodium salts with carbonates/ bicarbonates in excessive amounts. Its value is generally high in soils having high levels of sodicity. The data in Table 4 depicted a slight decrease in pH with crop production.

Table. 4 Effect of brackish and canal water irrigation on soil pH

Treatment	Pre experiment	1st crop	2nd crop
T_1	8.90	8.75n.s.	8.65n.s
T_2	8.80	8.65	8.32
T_3	8.83	8.62	8.45
T_4	8.80	8.60	8.50

*Means sharing the same letter (s) do not differ significantly at $P < 0.05$ according to Duncan's Multiple Range Test.

It is obvious from the results that application of brackish water in combination with canal water irrigation had beneficial effect in terms of decrease in pH of soil. Although the difference in pH among the treatment means was non significant yet maximum decrease (8.32) from 8.80 was recorded in T_2, where maximum grain yield was obtained as well. A decrease in pH values was also noted in all treatments in contrast to control, where only brackish water was used to irrigate the crops. Saeed et al. [15] observed a decrease in soil pH after harvest of wheat crop irrigated with combined application of canal and brackish water.

4.4. EFFECT ON SAR OF SOIL

The results regarding the SAR of soil after crop harvest is mentioned in Table 5.

Table. 5 Effect of brackish and canal water irrigation on soil SAR

Treatment	Pre experiment	1st crop	2nd crop
T_1	18.20	17.00a	16.50a
T_2	18.50	14.12c	12.80c
T_3	18.20	15.30b	13.32bc
T_4	18.70	16.50ab	14.35b
LSD	-	1.182	1.110

*Means sharing the same letter (s) do not differ significantly at $P < 0.05$ according to Duncan's Multiple Range Test.

The data indicated a slight decrease in sodium adsorption ratio in all the treatments except the treatment where brackish water was applied alone. This clears that use of brackish water blending with canal water did not affect soil properties adversely. The decrease in SAR of soil may be due to leach down of excessive sodium from the clay particles in the form of sodium sulphate along with bicarbonates removal from soil solution. As sodium is removed from the soil, SAR lowers down to that limit which may be favorable for plant growth .The results corresponds to the findings of Saeed et al. [15]. Rhoades [13] concluded that for initial reclamation of salt-effected soils, low quality irrigation waters are more useful or even better than the canal water.

CONCLUSION

1, It is evident from the study that brackish water can be used on saline-sodic soils in combination with canal water for wheat production.
2. The cyclic use of canal and brackish water significantly improved the wheat grain yield and infiltration rate of soil, on the other hand reduced the salinity and sodicity over the brackish water application alone.
3. Further studies are required to confirm the findings.

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