Evaluation of Effect of Irrigation by Saline -sodium Water and freshwater as a combination on physical and chemical properties of soil with silt loam texture

Ehsan Salehi[1]*, Saeed Boroomand Nasab[2], Amir Soltani Mohammadi[3]

[1.] MSc student in Irrigation and draining, water science engineering Faculty, Shahid Chamran University
[2.] Professor of Irrigation and Drainage Department, water science engineering Faculty, Shahid Chamran University
[3.] Assistant Professor of Irrigation and Drainage Department water science engineering Faculty, Shahid Chamran University
*-Corresponding author: (E-Mail: ehs_salehi69@yahoo.com)

Abstract: During the deficit water, one of the irrigation management techniques is saline- sodium water in combination with freshwater. In order to study the effect of saline- sodium and freshwater ratios on some soil properties such as porosity, average speed of penetration and electrical conductivity, an experiment in a completely randomized design with three replications in Research Station of water Science engineering Faculty, Shahid Chamran University of Ahwaz was done. The test duration was three months starting from mid-April 2014 and 20 times irrigation was performed. Treatments consisted of control (C): treatment that has been irrigated with fresh water, 1/3 salt treatment, 2/3 freshwater (M1), treatment as a third of irrigation water was saline water and the remaining two-thirds, Immediately after the intrusion of salt water is completed by fresh water, the treatment of 1/2 salt, 1/2 freshwater (M2), 2/3 saline water treatment, 1/3 freshwater treatment (M3), mixed treatment: In this treatment, the saline water and freshwater were mixed in a same ratio and then were used (M4). The results showed no significant difference between treatments in terms of soil acidity. M1 and M2 treatments after control treatment (C) had the lowest electrical conductivity and the closest result in the control (C) in terms of sodium adsorption ratio was related to M1. The M4, after the control (C), had the highest average speed of penetration and there was no difference between treatments in terms of porosity.
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Keywords: irrigation management; saline- sodium water; use integration; porosity; electrical conductivity; soil acidity; sodium adsorption ratio.

Introduction and Literature review

Currently agriculture plays vital role in national economy and food production so that 27.9 percent of GDP, 23% of the workforce and 80 percent of the food supply are associated with this section [1, 3]. Over 93% of volume of used water is allocated to agriculture that according to freshwater sources shortage and because of that Iran is in range of countries with water crisis, it seems to if water expenditure in this section can be controlled, we can control water crisis, But does not mean that agricultural production decreases, on the contrary, these productions should be increased by using management techniques in addition to crisis controlling.

Despite the large volume of right or wrong works in recent years in the face of water crisis, using unconventional waters overlooked or considered ineffective, However, in developed countries, the vast majority of agricultural water is provided by unconventional water sewage, water drainage, the water is salty sources. If you want that water crisis don't exert any tension on agriculture, food security and social welfare, use of unconventional waters (especially usage saltwater resources) in agriculture is on the agenda and managers and planners development plans by education and promote good management practices in the use of saline water lead farmers to use these water. In recent years, many researches was done in regarding this subjects but only have research aspect and don't use this method in water crisis control and restore of freshwater resources [11].

In Iran, about 6 thousand of m3 per year of saline water flows in rivers or there is huge saline water resources with low depth of water table in majority of region that these resources don't be used only because of saline [9, 10], But during frequent irrigation with salty water and over time, a large amount of salt added, to soil and finally because of this, the soil becomes saline and useless [8]. Salts affect some of physical and chemical properties of soil that in turn affect soil as an environment for plant growth. Due to plant growth directly affects the amount of pH and salt concentration such as sodium ions and chloride and other salts in the soil solution. Increased sodium in the soil solution, cause damage to aggregate, swelling and

dispersion of clay particles, and reduce porosity and permeability [8, 12].

There is one question that in regions with freshwater shortage and have saline-sodium water sources, by using of which one of irrigation management methods can have maximum use of saline-sodium water, but modest changes in physical and chemical properties of the soil?

In these situations, one of the management methods is irrigation by saline-sodium water in combination freshwater. By doing so, farmers are pushed to use of lower quality water so that the least concern over crop reduction and soil degradation.

So far a lot of experiments and researches in the world and in Iran in the use of unconventional waters especially about the effect of salinity on plant parameters and Parameters of land have been made. In the realm of fresh and saline water management as integrated, researches had been performed in terms of the effect of plant yield and soil parameters and also, economy that a few of them include: Emdad and colleagues were tested the effects of different water quality (salinity and sodium) on the final permeability soil in furrow irrigation. This trial was performed in randomized complete block design with three water quality treatment. The results showed that by increasing the sodium adsorption ratio, the final permeability rate of the soil at the end of the period was reduced significantly in compared to control treatment [2]. Khattar evaluated the effect of salinity and alkalinity of irrigation water on hydraulic characteristics and physical quality of the soil. The results showed that increasing salinity increased contestation particles which increased soil porosity [4]. Also Mansouri studied using of SWAP model on the effect of management of irrigation with saline water on soil permeability of Rudasht region in Esfahan. His results showed that salinity led to permeability reduction [12]. Feizi studied effect of quality and management of water on the chemical properties of soil. He said salt distribution in soil in long term is result of combination of interaction between the salt of irrigation water, amount of washing or deduct ratio and water and salt redistribution is due to evapotranspiration. Also he said in totally salinity increases soil salinity changes during the season [6].

Pearson and Buader evaluated the effect of salinity and sodium of irrigation water on soil physical properties. The results showed three important effect of soil particles dispersion due to sodium of irrigation water are permeability reduction and hydraulic conductivity and also creation surface Crust in soil. He was concluded that by calcium and magnesium increasing can reduce the effect of sodium irrigation water on dispersing the soil particles [14].

Tedeschi and Menenti studied the effect of different treatments of water quality in terms of salinity and sodium. The results showed that the penetration rate in control treatment (non-salty), was 10 mm per hour, while penetration, reduced to 1 millimeter per hour in high salinity treatment [15].

Choudhary et al. examined the effect of irrigation with sodium and non-sodium water on soil properties and sunflower yield. Their results showed that continuation of irrigation by sodium water for six years led to increase pH and ESP soil and also, final penetration rate reduction of soil and sunflower seed and concentration of sodium in soil and depends on number of irrigation by sodium water in season [13].

According to these statements, purpose of this study is to evaluation of the effect of irrigation management by saline-sodium and freshwater as integration on some physical properties.

Materials and Methods

In order to investigate the effect of saline-sodium and fresh water ratios on some physical properties of soil, an experiment in a completely randomized design with three replications in Research Station Water Science Engineering Department, Shahid Chamran University was done. This test was performed without plant cultivation and the criteria for assessing were the amount of corn irrigation water.

Studied treatments included:

- Control: treatment where irrigation was performed with fresh water throughout the growing season (C)
- 1/3 saline,2/3 freshwater treatments: in this treatment in each irrigation one third of irrigation water is saline water and two third remaining was completed by freshwater (M1).
-1/2 saline, 1/2 freshwater treatments: in this treatment half of irrigation water was saline and another half, immediately after saline water intrusion, completed by freshwater (M2).
- 2/3 saline, 1/3 freshwater treatments: in this treatment two third of irrigation water was saline and one third, immediately after saline water intrusion, completed by freshwater (M3).
- Mix treatment: in this treatment saline water and freshwater were pooled in a same ratio and then was used (M4).

The amount of irrigation water was calculated according to equation (1):

(1) $Dn = (\theta_{FC}-\theta_{PWP}) \times \rho b \times Drz \times MAD$

Dn =The amount of irrigation water, θ_{FC} = mass moisture at field capacity point, θ_{PWP} = mass moisture at permanent wilting point, ρb = Bulk density, Drz = depth of root development and MAD = water depletion coefficient that was considered 50%.

Irrigation was done in each plot and plots with dimensions of 1.5 x 2 meters with 1.5 meter intervals in treatments and 1 meter per replication were available. Stacks height was about 20 cm. Irrigation was done by means of tanker and output water was measured by counter. The test duration was three months from mid-April to mid-July 2014 and 20 times irrigation was performed. Data collection took place in two stages with 45 days intervals. Permeability was done using doubled cylinders and Kastyakof equation coefficients were determined. Porosity was measured by preparing samples intact. For this, special cylinders were used and then the samples were transferred to the laboratory. Saturated samples were weighed, and then were put in the oven for 24 hours at 105 ° C. Dried samples were measured. Also, the weight difference between dry and wet sample weight is water weight that with respect to water bulk density was equal to volume of water and pore volume. Electrical conductivity (EC), sodium adsorption ratio (SAR) and soil pH samples in the field using the depths of 0-30, 30-60 and 60-90 and then saturated extraction will be measured in the laboratory. EC and pH will be measured using EC and pH meters. For SAR measurement total calcium and magnesium by titration and sodium using of flame photometer will be achieved. It should be mentioned that in this treatment, fresh water irrigation was done by Karun River water with salinity of 2.5 dS/m and saline water irrigation with salinity of 5.6 dS/m. in this investigation, NaCl was used for saline water preparation in this way that first, saline water solution was prepared in a smaller tank and this solution was added to irrigation tank graduate and in each stage EC was measured by using EC meter portable devices up to the EC to be desired. Obtained data were analyzed by using SPSS software.

Results and Discussion

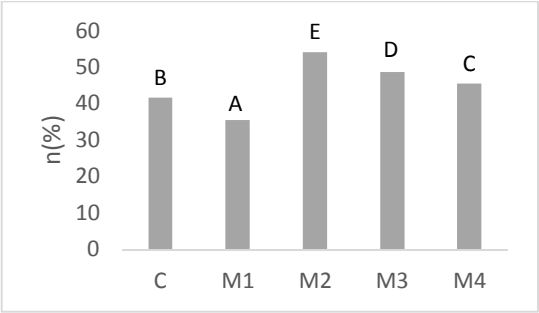
Average speed penetration, porosity, pH, electrical conductivity and sodium adsorption ratio values (in depth 0-30, 30-60, 60-90 cm) in the middle and the end of the season for different treatments were analyzed using SPSS software. In table (1) results of analysis of variance of experimental design for measured physical traits in mid-season were shown. In table (2) results of analysis of variance for measured chemical properties were shown in the middle of the season.

Results in table 1 show that the effect of different irrigation treatments at five percent level in both traits (average speed of penetration and porosity) is significant. Evaluation of results in table 2 show that the effect of different irrigation treatments at five percent level for electrical conductivity and sodium adsorption ratio of soil (in the three depth) is significant and non-significant for soil acidity. In order to evaluate the effect of treatments on soil properties mean comparison was done by Duncan test that results were shown in graphs (1) to (8) for the mid-season. Graphs (1) and (2) show the amount of average infiltration rate and porosity in mid-season respectively.

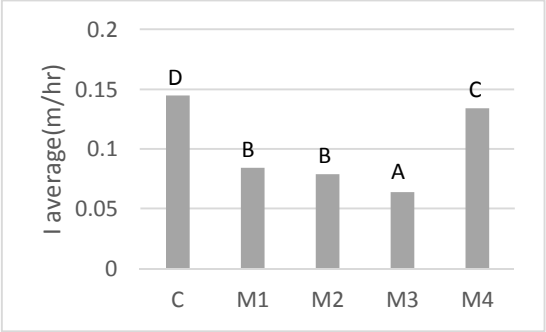
Table 1- Results of analysis of variance of effect of treatment on physical properties in the mid-season

S.O.V	df	MS	
		porosity	average speed of penetration
treatment	4	149.336*	0.004*
error	10	0.943	0.00000946
total	15		

(*)Significant in five percent probability level



Graph 1- Porosity values in mid-season



Graph 2- average infiltration rate in mid-season

Treatments with same letters are placed in one class and there is no significant difference between them and have the same effect on soil properties. Treatments in the Class A had lowest values and in Class E treatments have highest values. Mansouri (2007) in a study base on use of SWAP model to investigate the effect of irrigation with saline water on soil permeability and concluded that saline irrigation water has led to reduced permeability. Emdad et al (2007) also stated reason of this is destructive properties of sodium.. The use of sodium salt water causing damage and swelling of soil aggregates and can change large pores to small pores, this can be due

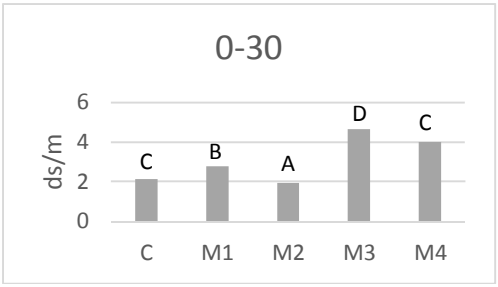
to increased porosity of some of treatments compared to the control. Khattar (2007) evaluated the effect of salinity and alkalinity of irrigation water on soil physical quality and hydraulic properties. The results showed that with increasing salinity, contestation particles is increased which increases soil porosity.

Table 2- Results of analysis of variance of effect of treatments on chemical properties in mid-season.

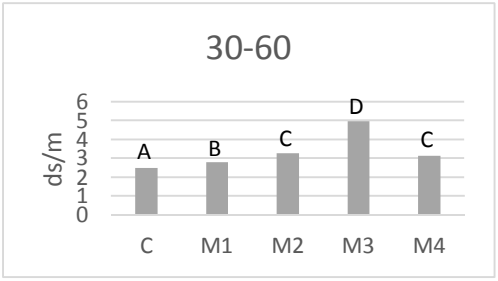
S.O.V	df	MS								
		Soil acidity			EC			SAR		
		0-30	30-60	60-90	0-30	30-60	60-90	0-30	30-60	60-90
treatment	4	.038	.039	.010	3.686*	2.825*	1.468*	640.548*	571.874*	300.117*
error	10	.060	.056	.061	.025	.020	.012	1.495	1.207	3.052
total	15									

(*) Significant in five percent probability level

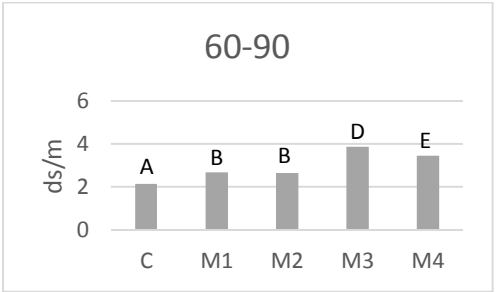
According to the effect of different irrigation on treatment on soil acidity was not significant. Mean comparison test was not done for this trait. Figures no (3), (4) and (5) show the amount of soil electrical conductivity in the depths of 0-30, 30-60 and 60-90 cm for mid-season.



Graph 3- EC in depth of 0-30cm



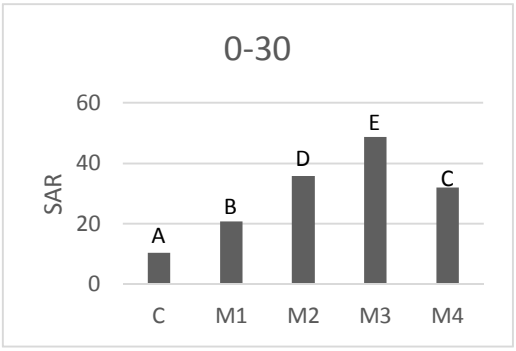
Graph 4- EC in depth of 30-60cm



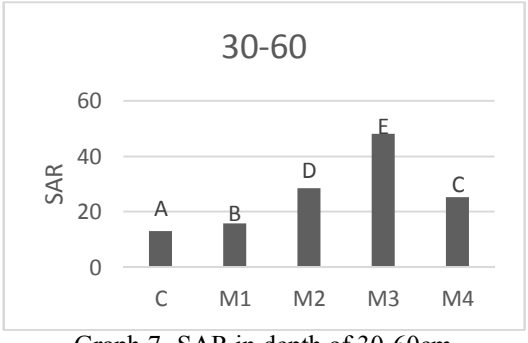
Graph 5- EC in depth of 60-90cm

Since M1 and M2 treatments than other treatments have received less saline water as expected, has less EC and allocate the closest results to control, to themselves. M3 treatment due to receiving more saline, the water highest had values in compared to control treatment. Ghaedi (2014) performs based on an experiment of combination of saline and non-saline water used in cultivation of sorghum and sunflowers in Sistan plain. He showed that treatment with one third had saline water had the best results after control treatment.

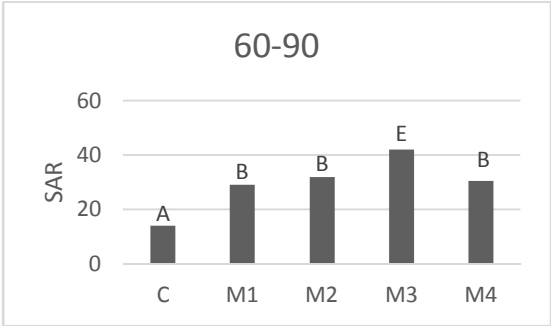
Charts No. (6), (7) and (8) show soil sodium adsorption ratio at depths of 0-30, 30-60 and 60-90 cm for mid-season, respectively.



Graph 6- SAR in depth of 0-30cm



Graph 7- SAR in depth of 30-60cm



Graph 8- SAR in depth of 60-90cm

Roughly trend of absorption sodium ratio in different treatments, is like as changing of electrical conductivity of the treatment. Here M1, treatment due to receiving less saline water in accordance in compered to other treatments with the expected had less electrical conductivity and had, and the closest results to control. M3 treatment due to receiving more saline water had the highest values in compared to control treatment. The results of M4 are also close to M2.

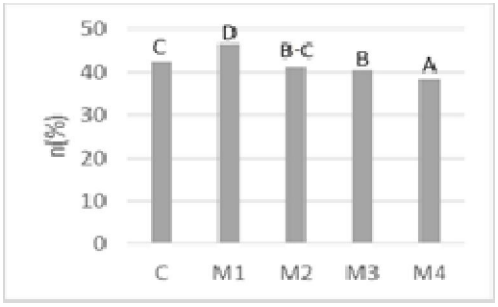
In Table (3) showed analysis of variance of measured physical properties at the end of season. Table (4) show results of analysis of variance of measured chemical properties at the end of season. At the end of season as well as the mid-season evaluation results of Table 3 shows that effect of different irrigation treatments at five percent level on average speed of penetration and porosity is significant. Results Table 4 shows that effect of different irrigation treatments at five percent level on electrical conductivity and sodium adsorption ratio of soil (in the three depth) is significant and is not significant for soil acidity. In order to evaluate the effect of treatments on soil properties mean comparison was done by Duncan test that results were shown in graphs (9) and (16) to the middle of the season. Graphs (9) and (10) show values of porosity and average speed at the end of season.

Table 3- Results of analysis of variance of effect of treatments on Physical properties at the end of season

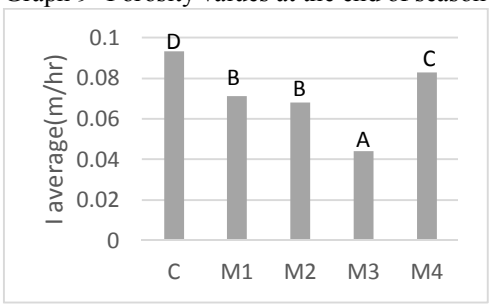
S.O.V	DF	MS	
		porosity	average speed of penetration
treatment	4	27.941*	0.001*
error	10	0.809	0.0000087
total	15		

(*) Significant in five percent probability level

Statistical analysis (Table 3) showed that the mean difference in treatments over control in 5 percent level in both specification (average speed of penetration and porosity) is significant, i. c. The treatments on these two factors have significantly different over control.



Graph 9- Porosity values at the end of season



Graph 10- average speed of penetration at the end of season

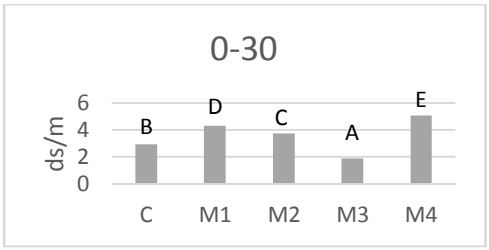
At the end of season because of the greater effect of saline water on soil properties, porosity values and average speed penetration values was less than mid-season.

Table 4- Results of analysis of variance of effect of treatments on chemical properties at the end of season

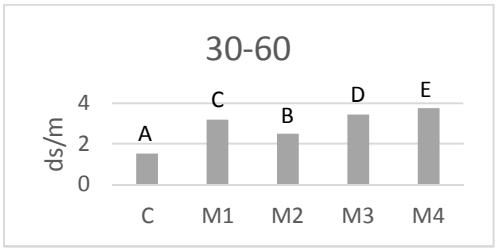
S.O.V	df	MS								
		Soil acidity			EC			SAR		
		0-30	30-60	60-90	0-30	30-60	60-90	0-30	30-60	60-90
treatment	4	.063	.004	.036	4.627*	2.442*	5.683*	475.643*	252.468*	514.803*
error	10	.026	.028	.028	.024	.015	.021	1.548	1.577	5.320
total	15									

(*) Significant in five percent probability level

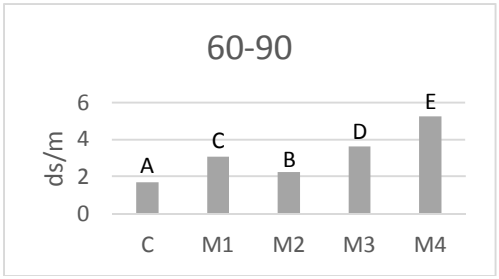
Charts No. (11), (12) and (13) show the values of soil electrical conductivity in the depth of 0-30, 30-60 and 60-90 cm at the end of season.



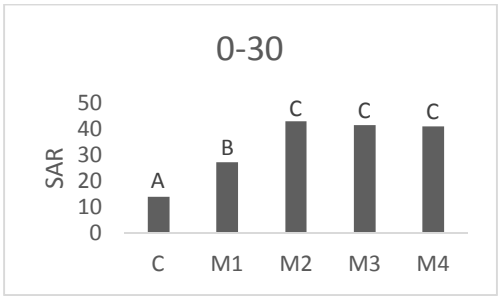
Graph 11- SAR in depth of 0-30cm



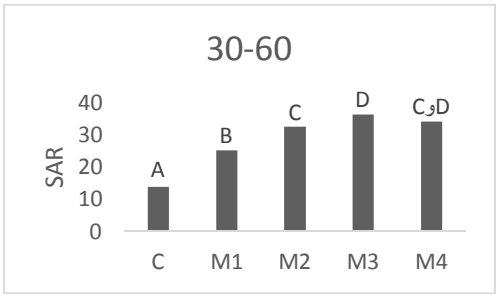
Graph 12- SAR in depth of 30-60cm



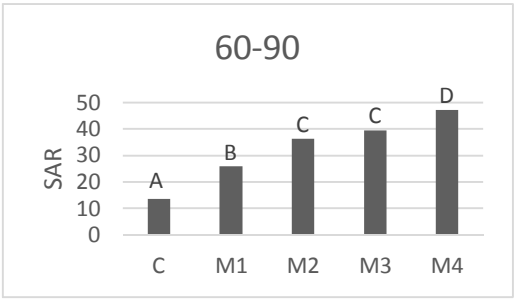
Graph 13- EC in depth of 60-90cm



Graph 14- SAR in depth of 0-30cm



Graph 15- SAR in depth of 30-60cm



Graph 16- SAR in depth of 60-90cm

Generally, the results showed that M1 and M2 treatment (one third salt and two third salt treatments in terms) of the EC had the closest results to control treatment and these treatments can be used instead of control. Liaghat and Ismaili (2003) by doing an experiment to evaluation of effect of combination of salt water and fresh water on corn yield and concentration of salts in the root zone concluded that one half saline treatment had similar results to control. Chart (14), (15) and (16) show the amount of soil sodium adsorption ratio in the depth of 0-30, 30-60 and 60-90 cm at the end of season.

At the end of season, like as the mid-season M1 treatment was the closest result to control. This treatment after control (class A) was in the next class (class B). Also, M2, M3 and M4 Treatments had close results to each other and were in maximum distance over control treatment, but we can say that in generally mix treatment had maximum distance over control. This result can indicate that time had more effect on mix treatment (M4) in compared to the other treatments.

Conclusion

Also, M1 and M2 treatments because of alternation of large volume of non-saline water by saline water showed acceptable results. Therefore, due to less non-saline water use in M1 and M2 treatments, under certain conditions and limitations of non-saline water, usage of these treatments is recommended.

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