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EXTENDED ABSTRACT

Effect of Conjunctive Irrigation on Soil Salinity and Herbal Elements of Sorghum and Simulation of Output Salt Using SWAP Model

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Introduction

Reduction of water resources in arid and semi-arid areas requires the application of management methods to achieve optimal performance. With the logical application of saline water as a source of irrigation water, we can supply a part of the crop water requirement (Hamdy, A., Abdel-Dayem, S. and Abu-Zeid, M., 1993), using various applicable management techniques. The optimal management is, in turn, considered as the use of conjunctive irrigation. Two commonly used solutions include mixing salty and fresh water to obtain water with the optimal salinity; and also the periodic application of fresh and salty water (Amer, 2010; Aslam, & Prathapar, 2006). In effect, salt mainly enters the surface layers of the soil through irrigation and the solute moves vertically from the unsaturated to the saturated zone and towards the groundwater. In turn, the SWAP model is often used to simulate the solute transfer in soil. However, field measurement of the solute concentration changes is very difficult in soil profiles. A simulation model can, thus, be used to estimate the accumulation of solutes in the soil profiles. (Van Dam, Huygen, & Wesseling, 1997)

Methodology

This study was conducted to investigate the effect of conjunctive irrigation on the amount of cation and anion in the soil saturation extract in a research farm at Isfahan University of Technology. The soil texture was sandy loam and the dimension of the farm was 13.5*15 m including fifteen 2.4*3 m plots. To conduct the study, grain sorghum was cultivated as a row crop with 60*10 cm spacing with a density of 20 plants per square meter on June 14, 2014. The experimental design was a completely randomized design with three replications. Five irrigation treatments were used including irrigation with saline water (salinity of 5 dS / m), irrigation with fresh water (municipal water with salinity of 0.4 dS/m), alternate irrigation, conjunctive irrigation, and irrigation with fresh water to the raceme stage followed by irrigation with saline water. To measure the chemical properties of soil, the samples were taken at the depths of 0-20 and 20-40 cm. Sodium and potassium concentration of the saturated extract was, then, measured by Flame Photometer. Calcium and magnesium concentration was, in turn, measured using titration with EDTA, chloride concentration

was measured by sedimentation titration with silver nitrate, and bicarbonate concentration was measured by titration with sulfuric acid. In turn, to measure the sodium and potassium concentration of the plant, plant ash samples were prepared and after mixing with nitric acid, their concentration was determined by Flame Photometer. The analysis of variance and the mean comparison test with LSD method was performed using SAS software.

Results and discussion

Table 1 shows the variation of average salinity of soil ECe 50 days after planting and at the end of the season, and its comparison with the beginning of the season at two depths of 0-20 and 20-40 cm. ECe in each irrigation management had a significant difference in 50 days after planting and at the end of the season at two depths of 0-20 and 20-40 cm.

Table 1- Average soil EC and its variation ratio 50 days after planting and at the end of the growth season compared to the beginning of the season at two depths of 0-20 and 20-40 cm

Irrigation management treatment	Depth 0-20 cm				Depth 20-40 cm			
	50 days after planting	*Variation ratio	End of season	**Variation ratio	50 days after planting	Variation ratio	End of season	Variation ratio
fresh water	0.84^{c}	-40.1 %	0.8^{c}	-43.6 %	0.88^{b}	-81.4 %	1.1^{c}	-76.8 %
saline water	3.89^{a}	169 %	4.18^{a}	194 %	3.65^{a}	-23.1 %	8.90^{a}	78.3 %
alternate irrigation	1.59^{bc}	12.0 %	2.94^{b}	107 %	2.79^{a}	-41.2 %	5.53^{b}	2.50 %
conjunctive irrigation	4.43^{b}	71.1 %	2.94^{b}	107 %	3.27^{ab}	-50.1 %	4.63^{b}	-16.4 %
Salinity the end of the season	0.85^{c}	-40.0 %	3.59^{a}	178 %	0.90^{b}	-81.0 %	4.38^{b}	-7.70 %

*Variation ratio = (ECe 50 days after planting – initial ECe)/ initial ECe
**Variation ratio = (ECe end of season–initial ECe)/ initial ECe
initial ECe_{0-20} = 1.47 dS/m and initial ECe_{20-40} = 4.75 dS/m

The effect of irrigation management treatments on the concentration of potassium in the shoot at a 5% probability level and the potassium concentration of grain at the probability level of 1% were statistically significant. The effect of irrigation treatments on the sodium concentration of shoot and grain at a 1% probability level was statistically significant. The results of mean comparison test showing the concentration of sodium and potassium of the crop under the influence of different irrigation management can be seen in Table 2.

Table 2- Comparison of the mean crop sodium and potassium concentration under the influence of different irrigation managements

Irrigation management	Sodium concentration (mg/g DW)		Potassium concentration (mg/g DW)	
	shoot	Grain	shoot	Grain
fresh water	18.1^{c}	12.5^{b}	0.744^{a}	0.468^{bc}
saline water	23.8^{a}	21.2^{a}	0.515^{c}	0.381^{d}
alternate irrigation	20.8^{a}	13.5^{b}	0.582^{bc}	0.569^{a}
conjunctive irrigation	19.9^{bc}	11.3^{b}	0.636^{abc}	0.394^{cd}
Salinity the end of the season	19.6^{bc}	12.1^{b}	0.684^{ab}	0.508^{ab}

The measured and calculated ECe at the end of the root zone can be seen in Figures 1 and 2 in the middle and at the end of the season. The model estimates ECe more than its actual value. Thus, the

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coefficients were 0.75 and 0.81 50 days after planting, and at the end of the season. Besides, the NRMSE were 0.092 and 0.058 50 days after planting, and at the end of the season, respectively. MAE were 0.35 and 0.23 50 days after planting, and at the end of the season, respectively.

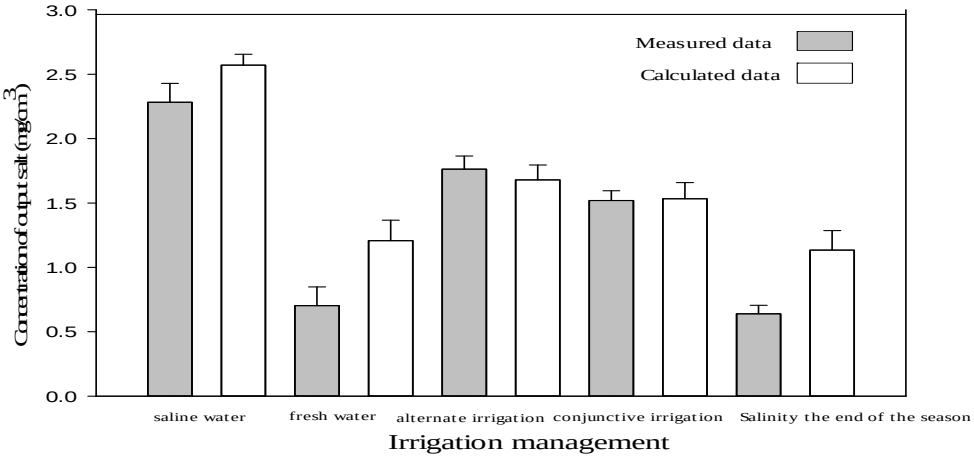

Fig. 1- Comparison between the mean and standard error of the measurement and calculated salt concentration at the end of the root zone 50 days after planting

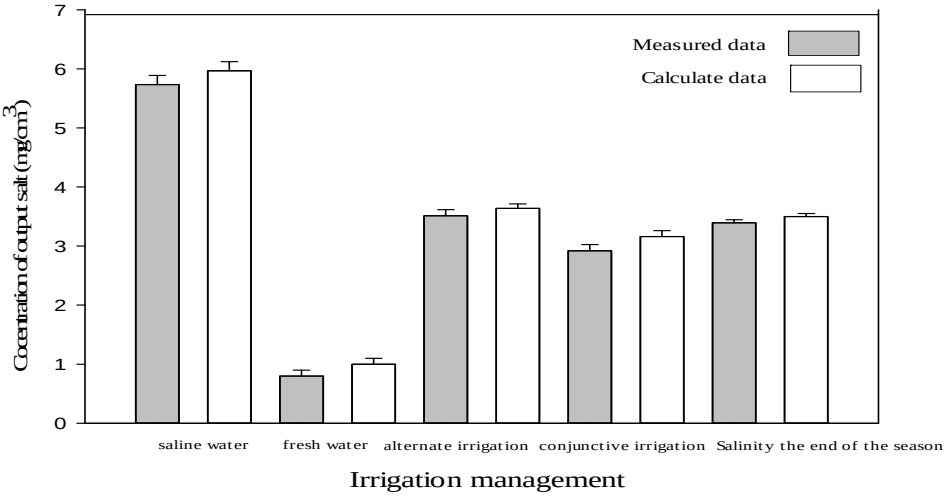

Fig. 2- Comparison between the mean and standard error of the measurement and calculated salt concentration from the end of the root zone at the end of growth season

Conclusion:

The results showed that among irrigation management treatments, the lowest and the highest variation in soil ECe were observed in alternate irrigation and saline irrigation treatments, respectively. Moreover, it was found that the simulation of the model at the end of the growth season was more accurate than in the middle of the growth season. Further, the statistical indices showed that the model could simulate the output salt originated from the root zone.

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References

1-Amer, K.H., 2010. Corn crop response under managing different irrigation and salinity levels. *Agricultural water management*, *97*(10), pp.1553-1563.

2-Aslam, M., Prathapar, S.A., Aslam, M. and Prathapar, S.A., 2006. *Strategies to mitigate secondary salinization in the Indus Basin of Pakistan: a selective review* (Vol. 97). IWMI.

3-Hamdy, A., Abdel-Dayem, S. and Abu-Zeid, M., 1993. Saline water management for optimum crop production. *Agricultural water management*, *24*(3), pp.189-203.

4-Van Dam, J. C., J. Huygen, J. G. Wesseling, R. A. Fedds, P. Kabat, P. E. V. Van Walsum, P. Groenendijk and C.A. Van Diepen, 1997. SWAP version 2.0, Theory. *Simulation of water flow, solute transport and plant growth in the Soil-Water-Atmosphere-Plant environment,* Department Water Resources, Wageningen Agricultural University. 167p.