EFFECTS OF SALT LEACHING ON SOIL UNDER DIFFERENT IRRIGATION AMOUNTS & INTERVALS

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ABSTRACT

An experiment was conducted from at Latif Farm, Sindh Agriculture University Tandojam for assessing the leaching effects on soil. The treatments consisted three quantities of irrigation water (7.62cm, 10.16cm and 12.70cm) and three interval periods (7, 14 and 21 days). All the treatments were replicated four times in Randomized Complete Block Design (RCBD). Irrigation water was applied to the field from Rohri Canal. The results of salt leaching experiment showed that in top soil (0-30cm) and middle soil profile (30-60cm) salts have leached more than 40 percent by consuming 45.72cm 60cm and 76cm water within 7 and 14 days interval while in 21 days interval the salt leaching results with all three irrigation amounts were non significant because of long interval of irrigation application, warm climates and silty clay to silty clay loam soil. It is concluded that salt leaching technique in clay dominated soil 14 days interval with depths water 10.16cm may be used for reducing salts to lower horizon.

Key words: Salt leaching, Irrigation Interval, Irrigation amount.

1. INTRODUCTION

The sustainability of agriculture of Pakistan is mainly dependant on better management of available water resources because due to poor management, water logging and salinity have posed a serious threat to agriculture. The groundwater monitoring of this country in early fifties indicated that in 25 percent of irrigated area, water table had reached within 150cm below the ground surface and 22 percent irrigated area developed moderate to severe salinity conditions. The continuous rising of water table and groundwater salinity are considered to be among the most important issues affecting agricultural productivity and sustainability in the Indus Basin Shah et al. [1].

According to estimates by FAO and UNESCO nearly 50 percent of the irrigated land in the arid and semi-arid regions of the world has some degree of soil salinization problems. It is estimated that the world as a whole is losing at least 3 hectares of fertile land every minute due to salinization / sodification Abrol et al [2]. The declining growth rates in crop land area in Pakistan observed since 1980 are due in part to the degradation of land and water resources caused by inappropriate management of resources on Farms and throughout irrigated areas Murgai, et. al., [3].

To day the availability of new land is limited, while on the other hand, due to over irrigation, high water tables and poor water management practices, fertile and productive soils are turning into non-productive soils which results in less crop production and eventually abundant. Thus reclamation of existing saline soil is of primary importance. Leaching is the only effective way to decrease excessive salts

from root zone of the salt affected soils. This is the process of dissolving and transporting soluble salts by down ward movement of water by applying excessive water onto soil surface. The economical means of controlling soil salinity was to ensure a net downward flow through crop root zone Hoffman [4]

The main objectives of this research were to: (i) determine effects of salt leaching on saline soil and (ii) determine the effects of irrigation intervals and irrigation depths on leaching.

2. MATERIALS AND METHODS

The salt leaching experiment was conducted at Latif Farm of Sindh Agriculture University Tandojam. The experimental land was selected after survey of abandoned saline cracked land, which was a fallow land for about ten years due to shortage of irrigation water. The experiment was laid out with variable factors (interval and amount of water) replicated four times in a Complete Randomized Block Design (RCBD). The treatment consisted three quantities of irrigation water 7.62cm, 10.16cm and 12.70cm at 7, 14, 21 days of intervals of irrigation. The experimental field was divided into four blocks. Each block was further divided into sub plots with 1m x 1m (1m) and was separated by levees and undisturbed land brought under salt leaching experiment.

The irrigation system in the country permits water supply on rotation basis (warabandi) with the interval of 7 days, thus, the intervals were so selected that water should be available to farmers in accordance with the irrigation intervals selected for the experiment. The field experiment was conducted on silty clay to silty clay loam saline soil. After layout of the experiment, composite soil samples were collected from each plot for 0-30cm, 30-60cm, and 60-90cm depth. Each treatment was considered according to design of the experiment in each block. Irrigation water was delivered to field from Rohri Canal. Due to high deficit of water and unreliability, the irrigation water was stored in pond. Before starting the field experiment of salt leaching, land preparation was done according to plan layout. The observation began after the selection of site for study and that was done after the preparation of plots.

Table 1 summaries some physical and chemical properties of the soil in this study. Soil texture was determined using Bouyoucos hydrometer method [5]. EC, pH, soluble Na^{+}, Ca^{2+} +Mg $^{2+,}$ were determined saturated paste extract using method of Rhoades [6]. Sodium adsorption ratio (SAR) and Exchangeable sodium percentage (ESP) were calculated from the values of soluble Na^{+}, Ca^{2+} Mg^{2+} according to the methods described by Rowell [7]. The first irrigation with all three quantities was applied to all plots, subsequent water applied according to interval design. During leaching experiment no any rainfall in the area. Water table in the experimental area was recorded 7.6m below ground surface. Total five irrigations were applied at 7, 14 and 21 days intervals respectively. Salt leaching effects determined on soil by taking the soil samples after completion of experiment from all three depths. The samples collected from each treatment plot were analyzed by standard methods described by U.S.Salinity Staff [8].

3. RESULTS AND DISCUSSION

Table 2 and Fig. 1 shows comparison values of Electrical Conductivity (EC) of soil saturation extract before and after salt leaching with three different irrigation amounts with 7 days interval. All three graphs follow almost same pattern of salt decrease in all three soil profiles. All three irrigation applications (7.62cm, 10.16cm and 12.70cm) produced very close results of leaching in all three profiles. The over all change of EC of soil profile (0-90cm) indicate that all three irrigation application suppressed more than 44 percent of salts and turned the saline soil as non saline. Analysis of variance shows interval of irrigation was highly significant and depth and their interaction was non significant.

Table 3 and Fig. 2 shows comparison values of EC before and after salt leaching with three different irrigation applications with 14 days interval. Figs. 1-3 of three soil profiles have also same trend of salt leaching. Maximum EC was found suppressed by 10.16cm irrigation application. Experimental results reveal that all three irrigation depths also turned the saline soil at normality. The irrigation depth 12.70 cm could not produced better results as compared to 10.16 cm might be cracked soil. The over all change in EC of soil profile (0-90cm) indicate more than 56 percent salt reduction in 14 days interval was recorded and make soil productive. The result of irrigation interval was highly significant.

Table 4 and Fig. 3 Shows comparison values of EC before and after salt leaching with three different irrigation applications with 21 days interval. The results indicate that all three irrigation applications were not effective in decreasing EC in all three soil profiles in 21 days interval. The EC in lower horizon (60-90cm) increased because of long interval and warm climate. The results are in accordance to Minhas and Khosla [9] they reported that in warm climates the salts that are leached to shallow depths may move back to surface by capillary forces during rest periods due to high evaporation.

The over all data of three soil depths (0-30cm, 30-60cm, 60-90cm) showed that all three irrigation applications produced significant results of EC reduction with 14days irrigation interval followed by 7 days interval. These results are in agreement with Devrajani [10] who reported that electrical conductivity decreased with increased irrigation amount. Further he reported that frequent irrigation application of more depth leached down the soluble salts to leaching horizon. Kern [11] also states that salt leaching with irrigation application is the usual way to reclaim salt affected soils. It is suited to areas where leaching water is available.

The results of salt leaching experiment showed that in all three un structured soil profiles (0-30cm, 30-60cm, 60-90cm) salts have leached more than 56 percent by consuming 45.72cm, 60cm, and 76cm water within 14 days interval. Tanton, et. al.., [12] showed that for leaching 80 percent salts from the top 100cm of the restructured clay soil 200 to 300cm of water were consumed as compared to 60cm of water used by Verma and Gupta [13] for leaching unstructured clay soil. The leaching experimental results clearly indicates that applying leaching water to the root zone of the soil is one of the main practice to keep profile salinity below harmful level for crop production. The success of the application is also depending on the quality of the leaching water used Yurtseven [14] Biligic [15].

4. CONCLUSION

It is concluded that leaching technique with 14 days (frequent) irrigation application and irrigation depths may be advantageous for silty clay salt affected soil. However, its applicability for other soil textures needs to be evaluated.

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Table 1. Physical and Chemical properties of the experimental soil.

Analysis	Amount		
	0 - 30 cm	30 - 60 cm	60 - 90 cm
Sand (%)	16.61	19.30	11.50
Silt (%)	42.23	42.20	51.90
Clay (%)	41.16	38.50	36.60
Textural Class	Silty Clay	Silty clay loam	Silty clay loam
Moisture Content (%)	7.00	10.00	15.00
Bulk density(gm/cc)	1.13	1.16	1.19
pH	7.65	7.66	7.63
EC (dS/m)	6.29	6.75	5.50
Exchangeable Ions			
Co_3+ H CO_3 (Meq/lit)	2.73	2.49	2.33
Cl_3 (Meq/lit)	71.71	48.16	35.30
SO_4 (Meq/lit)	39.73	23.63	18.12
Ca^+ + Mg^+ (Meq/lit)	38.12	31.96	24.69
Na^+ (Meq/lit)	69.86	50.12	29.22
SAR (%)	16.75	11.40	9.23
ESP (%)	18.41	12.47	10.96
Remarks	Saline sodic	Saline soil	Saline soil

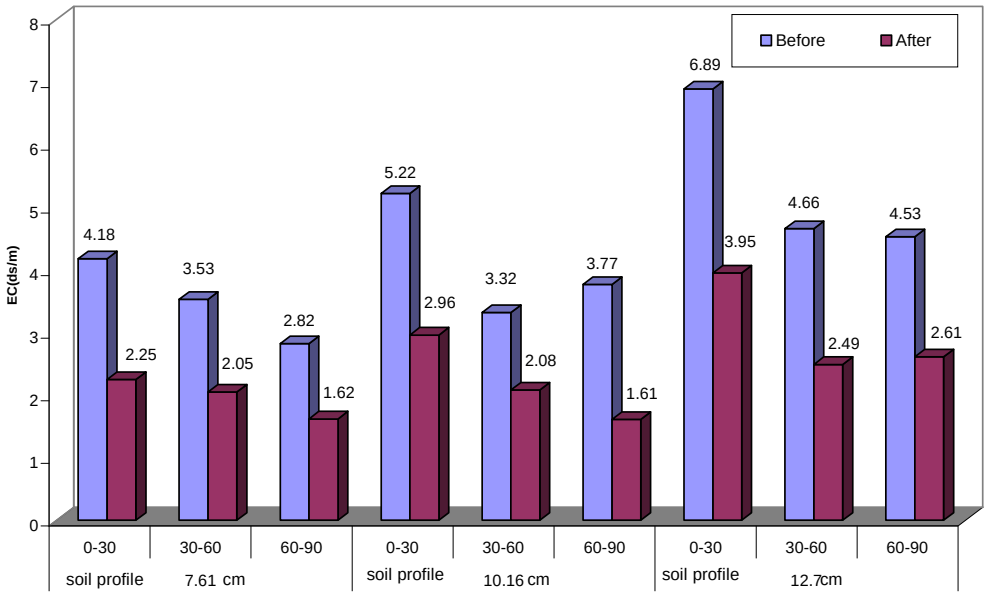

Figure:1. Mean values of salt leaching with diffeent irrigation amouints in 7 days interval

Source	**F-value**	**P-value**
Interval	34.870	**
Depth	0.331	NS
Interval*Depth	0.768	NS

** = Significant at 5% probability level
NS = Non-Significant

Table 2 Over all reduction in EC in 7 days irrigation interval

Soil Depth (Cm)	Water Depth (Cm)	Decrease in EC (%)
0-90	7.61	43.5
0-90	10.16	46
0-90	12.70	43.8
Mean	10.15	44.43

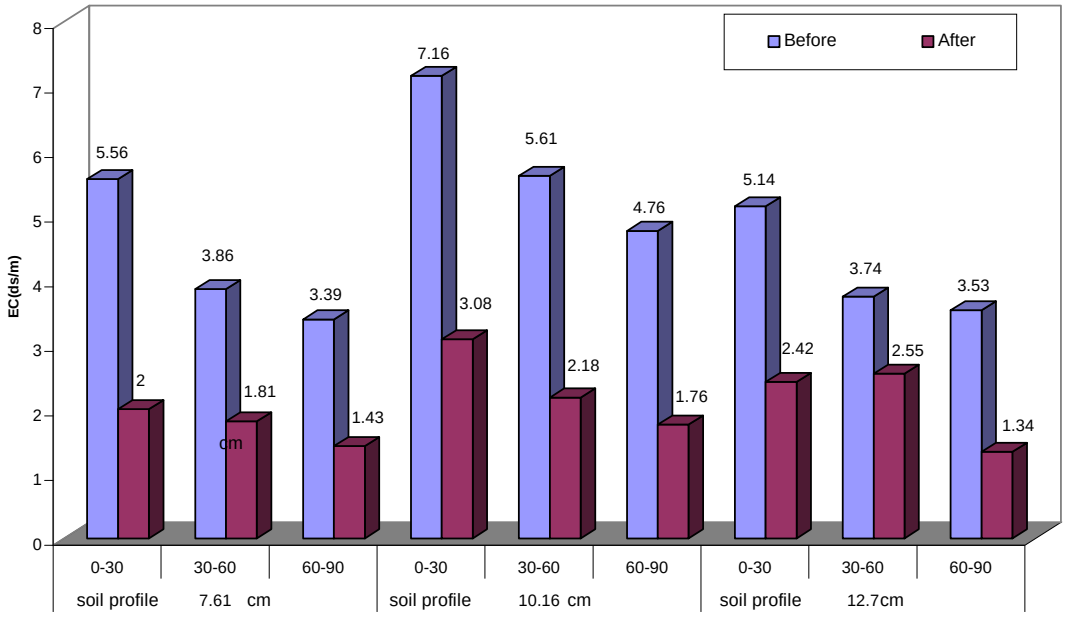

Figure:2. Mean values of salt leaching with diffeent irrigation amouints in 14 days interval

Source	**F-value**	**P-value**
Interval	15.03	**
Depth	0.426	NS
Interval*Depth	0.351	NS

** = Significant at 5% probability level
NS = Non-Significant

Table 3 Over all reduction in EC in 14 days irrigation interval

Soil Depth (Cm)	Water Depth (Cm)	Decrease in EC (%)
0-90	7.61	58.33
0-90	10.16	62.16
0-90	12.70	49.93
Mean	10.15	56.47

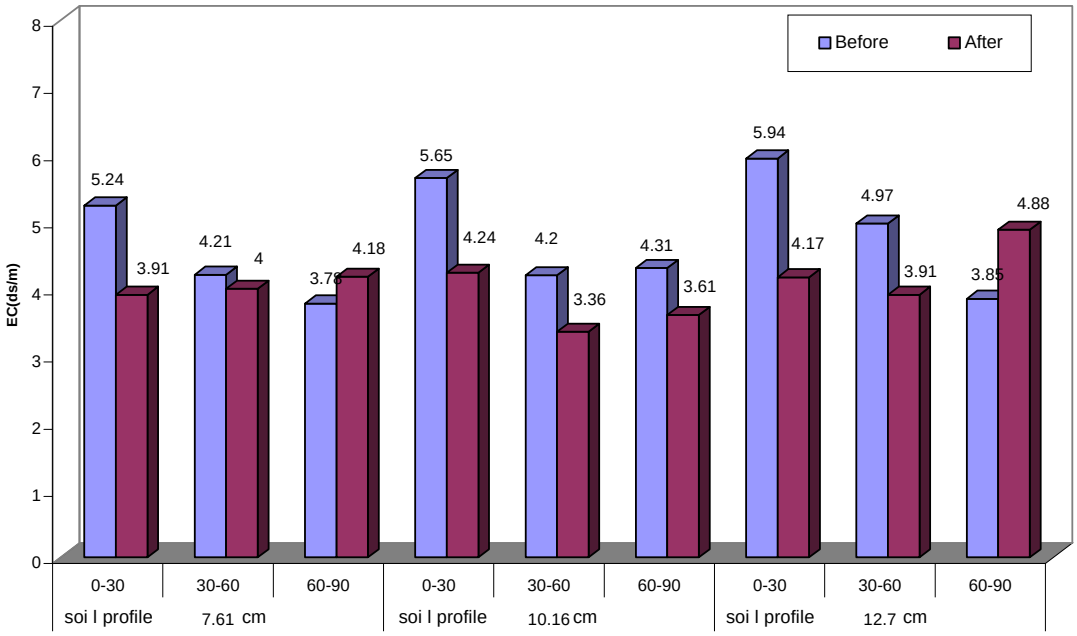

Figure:3. Mean values of salt leaching with diffeent irrigation amouints in 21 days interval

Source	**F-value**	**P-value**
Interval	12.44	**
Depth	4.98	**
Interval*Depth	1.05	NS

** = Significant at 5% probability level
NS = Non-Significant

Table 4 Over all reduction in EC in 21 days irrigation interval

Soil Depth (Cm)	Water Depth (Cm)	Decrease in EC (%)
0-90	7.61	6.00
0-90	10.16	20.38
0-90	12.70	8.13
Mean	10.15	11.50