J. Agric. Sci. Mansoura Univ., 28(8): 6517 - 6530, 2003

EFFECTS OF SALINE WATER FLUX ON CHANGES IN EFFLUENT QUALITY, LEACHING FRACTION, EVAPORATION AND SALT LOAD IN COARSE – TEXTURED SOIL

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ABSTRACT

Two laboratory experiments were conducted on sandy soil columns to quantify the dynamic changes of effluent salinity (EC) and sodium adsorption ratio (SAR) as well as leaching fraction (LF) and salt load as a result of using water with EC 0.5, 1.2, 1.8, 2.37, and 3.6 $dS.m^{-1}$. Downward flux simulates normal surface irrigation while upward flux simulates subsurface irrigation. The results indicated that there were polynomial relationships between EC and SAR of leachate and (LF) and time when the EC values of applied mixing water were > 0.5 $dS.m^{-1}$. Exponential relations between EC, SAR and LF with time were obtained when the EC of applied water was 0.5 $dS.m^{-1}$. Linear regression equations between the cumulative evaporation and the time of upward flux were obtained under different salinity levels of applied water. The contribution of upward and downward saline water to build up salt load in soil columns was clear. The maximum values of osmotic potential in the surface layer were 0.83 and 0.58 bar as a result of upward and downward flux of saline water (3.6 $dS.m^{-1}$), respectively. Thus the adverse effects on soil properties as a result of increased salt concentration can be minimized by controlling the mixing ratio. It was concluded that the use of poor quality water in irrigation, particularly in coarse - textured soil, becomes an efficient means in a scare resource without risks due to mismanagement this requires appropriate salinity by mixing agricultural drainage water with canal water. Best soil and water management practices and adequate leaching are also required to keep suitable salt balance in a given soil depth.

Keywords: Saline water, Leaching, Evaporation, Salt load, Sandy soil.

INTRODUCTION

As a result of the increase of the human population and the shortage water resources the conjunctive use of saline and fresh (canal), reuse of drainage water, and/or use poor quality water became urgent necessity to reclaim more new lands to overcome food shortage.

The main problem in semi arid regions, is that the salts left behind from irrigation water will be accumulated in the soil. So, irrigation schemes in semi-arid areas must be managed to remove these salts out the root zone of the crop at regular intervals. This can be achieved by adopting successful water management that keep the ground water level far enough away from the soil surface, a suitable leaching requirement should be applied to leach out the accumulated salts from the soil profile. Modern irrigation technique should be applied to improve and increase the efficiency of surface irrigation systems, maximizing the crop water - use from the shallow and saline water tables, besides their use for conjunctive irrigation, and appropriate choice of promising cultivars of crops selected for commercial cultivation in saline/sodicity environment (Minhas and Khosla, 1987 and Minhas and Gupta, 1992).

The Egyptian policy allows to reuse drainage water directly for irrigation if its salinity is less than 700 $mg.l^{-1}$. If the salinity of drainage water ranged between 700 and 1500 $mg.l^{-1}$ it should be mixed 1:1 with the Nile water (180 to 250 mg. l^{-1}). The reuse of drainage water should be avoided if its salinity exceeds 3000 mg.l^{-1} (ABU-Zeid, 1988).

Rhoades (1982) reported that both the salinity and SAR of the applied water must be considered simultaneously when assessing the potential effect of water quality on soil physical properties.

There is a relationship between the displacement of salts and the volume of the effluent (Gardner and Brooks 1957). In this regard Balba and El-Laithy 1968 and Balba and Bassiuny 1977 found that the intermittent leaching was less efficient way than continuous leaching and if the amount of applied water is equal to the water holding capacity, the salts accumulate in the lower end of the soil column and with further increments of water, the salts are displaced further to the bottom and leached out with the portion leached water.

Tokuchi *et al.* (1993) reported that the flux of NO^{-3}, Ca^{2+} and Mg^{2+} through soil profile was highly correlated with the EC of soil solution.
Zaitseva, *et al.* (1997) reported that the distribution of Ca^{2+}, Mg^{2+} and Na^{+} was related to the pore size along the soil columns where, they found that the concentration of Na^{+} was higher in large pores than in fine pores while the concentration of Ca^{2+} and Mg^{2+} was some what lower in large pores than fine pores.

Kelleners, *et al.* (1999) used the soil hydraulic properties to quantify salute transport in a fallow field over a 214- day period as a function of water table depth with the one-dimensional, vertical, transient SWAP 93 model. For the sandy loam soil, simulated cumulative soil evaporation and cumulative bottom flux showed large special variability. Solute transport for sandy loam and loam soils proved insensible to spatial variability of the porosity.

Saad *et al.* (2001) found that there were high significant exponential regression equations between EC and SAR of leachate and the depth of applied water during the process of leaching of a salt affected sandy clay loam soil.

The reduction of porosity in the upper layer seems to be due to the pressure wave generated by the impacts of raindrops at he soil surface (Rousseval, et. Al. 2002).

Al-Ajmi et al (2002) developed an irrigation management model for soil salinity control IMAGE based on the salt balance of the profile assuming that the soil water salinity is in equiliberium with the irrigation water. This model showed that the soil water salinity was highly sensitive to the size of irrigation basin and the amount and scheduling of irrigation, and so provides a tool for optimizing salinity management.

However, integration of the interactive and interdependent process of different water quality indices with soils is required to obtain comprehensive knowledge of the system as a whole. Hence, the aim of this study was to understand the dynamic changes of leachate quality, evaporation and salt accumulation in soil resulting from downward and upward flux of different saline water supply and find out mathematical models for providing quantitative descrption of this changes during the period of applied saline water in sandy soil.

MATERIALS AND METHODS

Two laboratory experiments were conducted and repeated three runs under the same conditions and treatments to assess the effect of down and upward flux of saline water.(mixed water) on leachate quality and chemical characteristics of coarse textured soil. The soil sample was air dried, passed through 2mm sieve, and stored in plastic bags. The main chemical and physical properties of soil sample are shown in Table 1-a. Ten columns (12.5 cm diameter and 35cm length) were prepared from PVC tubes in the lab. The columns were sealed using thick plastic sheets and central orifice was made in each sheet to drain the leached water out. Five centimeters were filled with the washed, small and uniform gravels and covered by thin layer of glasswool (Filter) then, 25 cm length of these columns were filled with 5.4kg sand (ρb = 1.76 $Mg.m^{-3}$). Five columns were used for surface supply of water, downward flux, (First exp.) as shown in Fig.1 and the others used for subsurface supply of water, upward flux, (second exp.) as shown in Fig. 2.

Drainage water and irrigation canal water were collected and transfered to lab. The drainage and canal water were mixed to obtain water with different EC 1.2, 1.8, 2.37 and 3.6 $dS.m^{-1}$ as well as the control with 0.5 $dS.m^{-1}$. The chemical analysis of these mixing water are shown in Table 1-b.

Table(1-a):Main chemical and physical analysis of the experimental soil.

EC, $dS.m^{-1}$	PH	Cations, meq. L,				Anions, meq. l^{-1}			
		Na^+	K^+	Ca^{+2}	Mg^{+2}	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{-2}
1.2	8.13	5.6	0.2	4	2.2	--	5.0	6.0	1.0
Dry Sieve analysis									
Diameter, mm	> 2	2-1	1-0.5	0.5-0.25	0.25-.125	0.063	<0.063		
Soil fraction %	6.45	15.82	32.38	29.9	13.7	1.23	0.52		
K_s, cm sec^{-1}	ρb, $Mg.m^{-3}$	FC, %	W.H.C, %	MWD, mm					
0 013	1.76	3	7	0.82					

Table 1-b : chemical analysis of applied water.

No. of samples	EC, $dS.\ m^{-1}$	pH	Cations, meq. l^{-1}				Anions, meq. l^{-1}			SA R
			Na^+	K^+	Ca^{+2}	Mg^{+2}	CO_3^{2-},	HCO^-,	CL^-,	
1	0.5	7.95	2.2	0.1	1.7	1.0	-	2.6	2.0	1.89
3	1.2	8.08	3.9	0.6	5.1	2.4	-	3.7	8.0	2.06
3	1.8	8.27	4.5	1.0	8.5	4.0	-	8.3	9.1	1.8
4	2.37	8.29	7.2	1.3	9.0	6.2	-	10	12.8	2.6
5	3.6	8.20	10.1	2.1	12.8	11	-	10	24	2.9

Ks = Saturated hydraulic conductivity, WHC = water holding capacity
ρb = bulk density, F.C.= Field capacity, MWD = mean weigh diameter

In the first experiment water was added by fixing 500 ml polyethylene bottles, at 130 cm above soil surface in soil columns (Fig 1). The flow rate was adjusted with regulator to be 0.25 l hr^{-1}. The soil columns were initially saturated by capillary with distilled water at the begining of the experiment, then the soil columns were subjected to 20 intermittent wetting and drying cycles using the different prepared mixtures of drainage and canal water. At each cycle the leachates were collected, EC was measured, soluble Ca^{2+} and

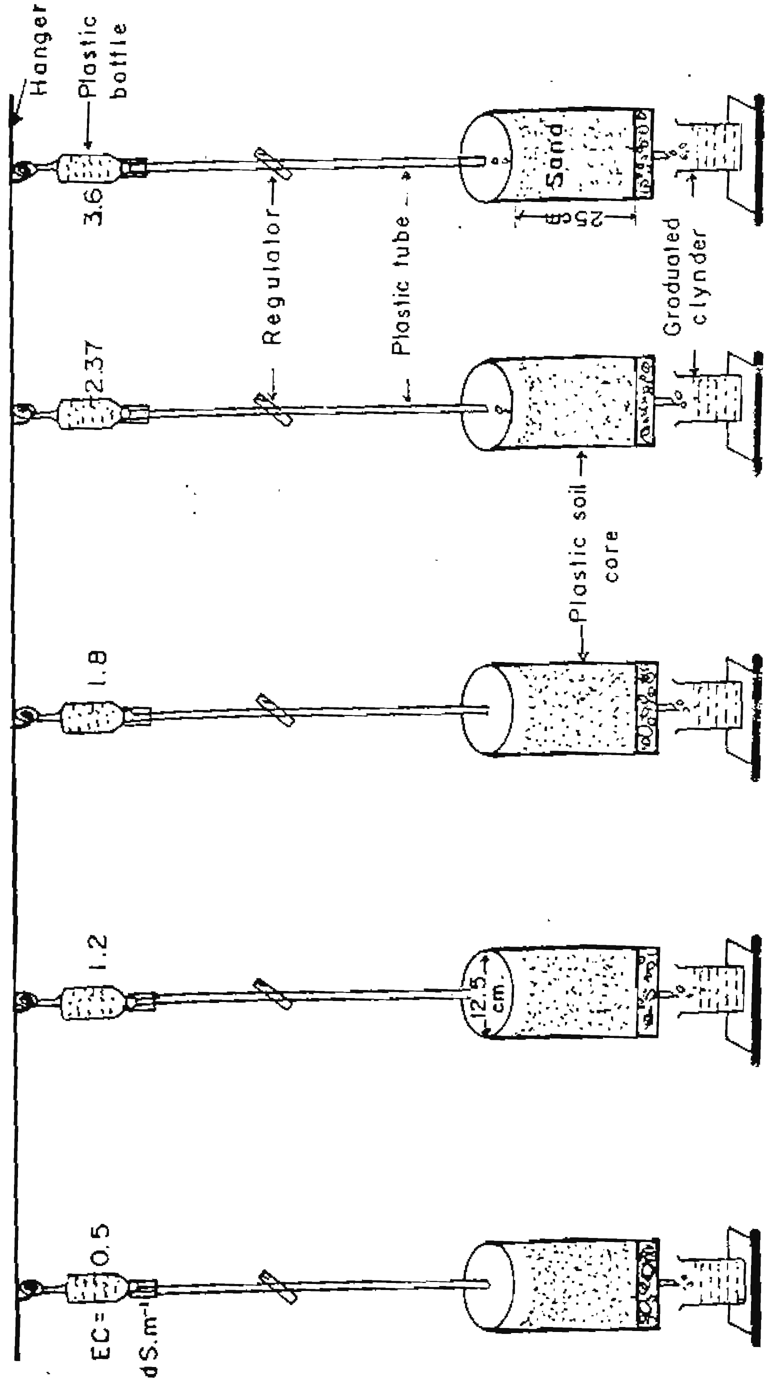

Fig. 1 : Sketch of downward flux of saline water through sand soil columns (1st experiment).

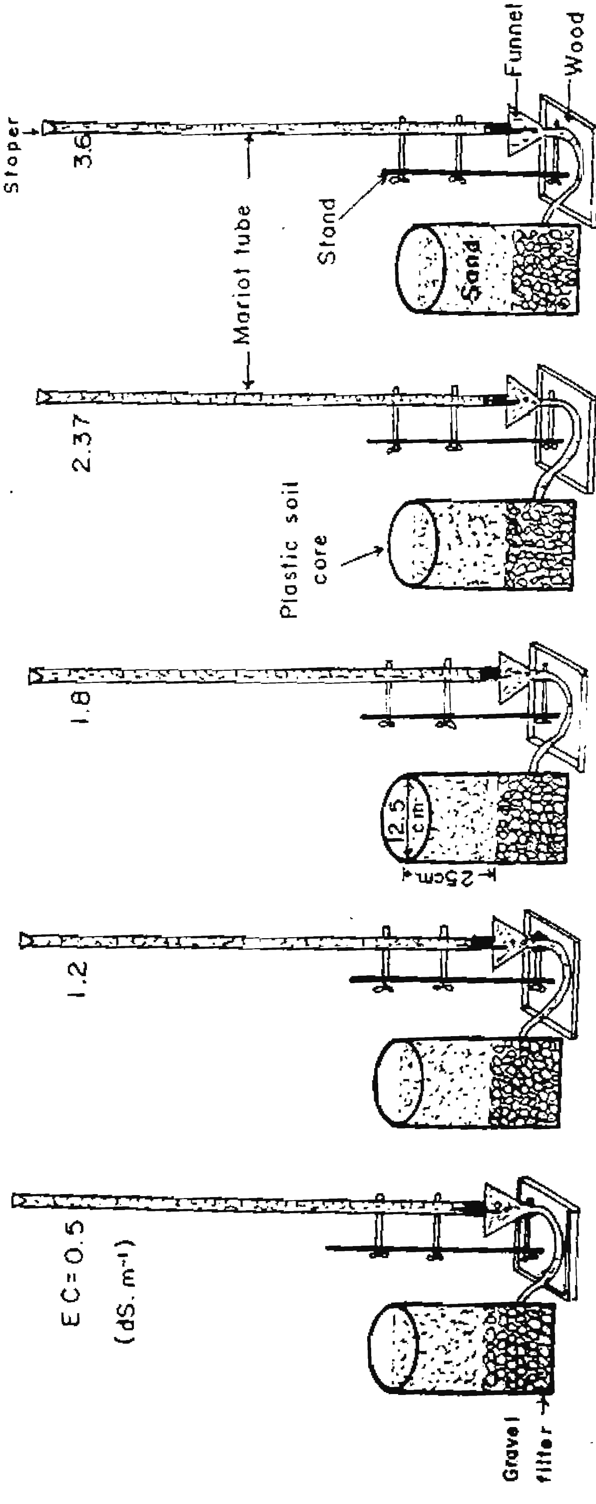

Fig. 2 : Sketch of upward flux of saline water through sand soil columns (2nd experiment)

Mg^{2+} were determined by titration method, and Na^+ was measured by flame-photometer. At the end of the experiment the soil columns were left to air dry, then soil in each column was divided to five layers from 0-5, 5-10 10-15 cm, 15-20, and 20-25cm depth. EC, Na^+, Ca^{2+}, and Mg^{2+} were determined in 1:1 soil extract. Exchangeable soduim percent (ESP) was calculated using Bower equation (1959) as follows:

$$ESP = \frac{100\ (0.0057 + 0173\ SAR)}{1 + (0.0057 + 0.0173\ SAR)}$$

Where, SAR is soduim adsorption ratio and was calculated as follows:

$$SAR = Na^+ / \sqrt{(Ca^{++} + Mg^{++})/2}$$

The second experiment aimed to study the evaporation rate and salt accumulation under different salinity of water supply by upward flux (capillary rise). Five PVC columns were used and the underground water level was fixed at 25 cm from soil surface using graduated Marriott tube (Fig. 2). The different salinity water used were similar to those used in the first experiment. The decrease of water level in Marriott tube were monitored, then the evaporation rate was rate was calculated. At the end of experiment each column was divided into 5 cm depths then EC, Ca^{+2}, Mg^{2+} and Na^+ were determined in 1:1 soil extract. Osmotic potential (Ψ_o) in bar is equal (EC * 0.36) and ESP was calculated from Bower equation (1959).

The salinity (EC) and sodium adsorption ratio (SAR) are the most important water quality parameters. The study of changes in leaching fractions, EC and SAR of Leachate during the process of leaching soil columns particuraly, when saline water used in irrigation, is essential for controling the salt balance in a certain depth of soil profile (Minhas and Gupta, 1992 Grattan and Roades, 1993).

The regression analysis was performed on a computer in order to obtain equations relating the EC, SAR of leachate and leaching fraction (LF) with the time of water supply process, Also, regression analysis between evaporation and the time was done.

RESULTS AND DISCUSSION

The changes of electrical conductivity (EC) of leachate at each irrigation intervals (3.5 days) of sandy soil columns using different saline water supply are shown in Figure 3. During the first 15 days of process the EC of leachate increased with time then it was decreaced up to 30 days and constant rate of changes in EC of leachate during irrigation were noticed after one month of leahing process intervals, when the EC_{iw} was 0.5 $dS.m^{-1}$. The EC values of leachate during irrigation intervals showed deviation during the first 20 days then it seemed to be close most of the remained time when EC_{iw} were 1.2 and 1.8 $dS.m^{-1}$. The salinity of leachate for EC_{iw} 3.6 $dS.m^{-1}$ treatment decreased during the first 35 days then it was flactuated between 4.0 and 5.0 $dS.m^{-1}$ up to 66 days. When water with EC_{wi} 2.37 $dS.m^{-1}$ was applied the EC of leachate gradually decreased with time.

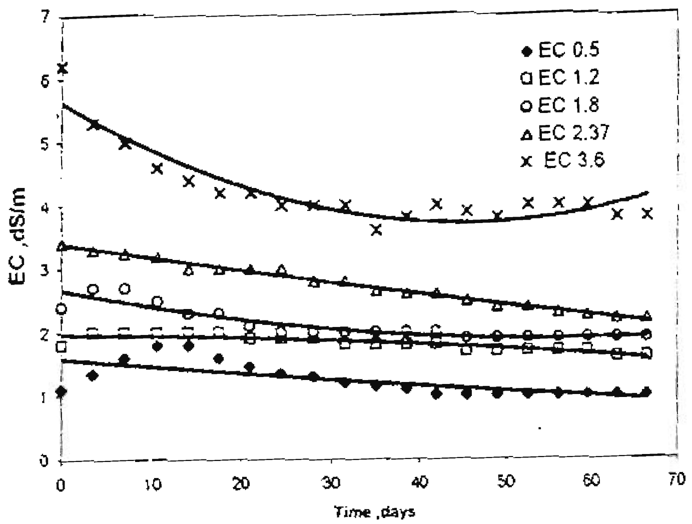

Fig3 EC of leachate vs . time of downward flux of saline water in sandy soil columns .

The correlation between EC of leachate and time of downward flux processes are shown in the following regression equations. It is clear that there were polynomial ralationship between EC of leachate and time of leaching process when EC of applied water was more than 0.5 dS.m^{-1} while it gave exponential relation, when EC was 0.5 dS.m^{-1} :

$EC_{0.5} = 1.5804\ e^{-0.0079\,t}$ $R^2 = 0.6072$
$EC_{1.2} = -7 \times 10^{-5}\ t^2 + 0.001\ t + 1.9636$ $R^2 = 0.8295$
$EC_{1.8} = 3 \times 10^{-5}\ t^2 - 0.0284\ t + 2.8862$ $R^2 = 0.8652$
$EC_{2.37} = 4 \times 10^{-5}\ t^2 - 0.0215\ t + 3.3904$ $R^2 = 0.9874$
$EC_{3.6} = 9 \times 10^{-4}\ t^2 - 0.0848\ t + 508339$ $R^2 = 0.8721$

The relations between leaching fraction (LF) and time during irrigation intervals showed little differences as a result of changes in saline irrigation water from 1.8 to 3.6 dS.m^{-1}. In the control treatment (EC_{iw} = 0.5 dS.m^{-1}) the LF values increased during the first two weeks due to the decrease of EC of leachate then it decreased. Also, there was no change in LF after 42 days as shown in Fig.4. The LF values in case of 1.2 dS. m^{-1} treatment along the period of 66 days were located between the changes of LF in case of 1.8 to 3.6 dS. m^{-1}.

The regression analysis between LF vs time released the same trend of equations as those EC vs. time. So, polynomial equations were obtained except in the case of control treatment (EC = 0.5 dS.m^{-1} this relation was exponential.

$LF = 3.1476\ e^{-0.0079t}$ for EC = 0.5 dS.m^{-1} $R^2 = 0.6078$
$LF = -4E{-}05\ t^2 - 0.0013\ t + 1.6411$ for EC = 1.2 dS.m^{-1} $R^2 = 0.7676$
$LF = 0.0001\ t^2 - 0.0157\ t + 1.481$ for EC = 1.8 dS.m^{-1} $R^2 = 0.8607$
$LF = 1E - 05\ t^2 - 0.0086\ t + 1.4232$ for EC = 2.3 dS.m^{-1} $R^2 = 0.9851$
$LF = 0.0003\ t^2 - 0.0237\ t + 1.5661$ for EC = 3.6 dS.m^{-1} $R^2 = 0.8798$

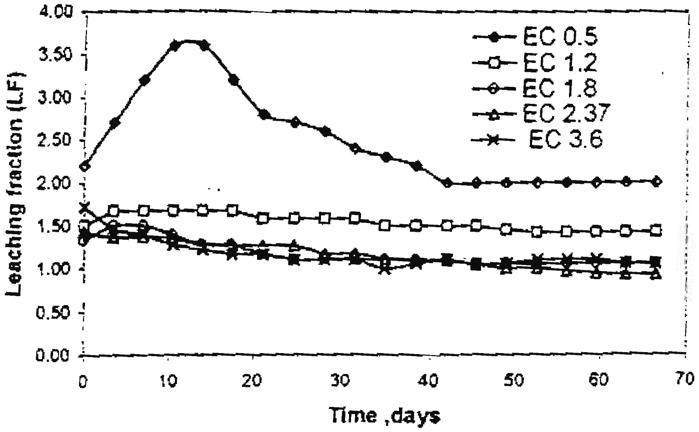

Fig 4 leaching fraction (LF) vs . time of downward flux of saline water in sandy soil columns

The relationship between the sodium adsorption ratio (SAR) of leachate and the time of leaching process in sandy soil columns are depicted in Fig 5. The results show that general decrease in SAR values with time. The SAR values were increased with increasing EC_{iw} where it ranged between 5.82 to 1.37, 9.53 to 4.45 and 11.07 to 4.71 for EC_{iw} 0.5, 1.2 and 2.37 $dS.m^{-1}$, respectivity.

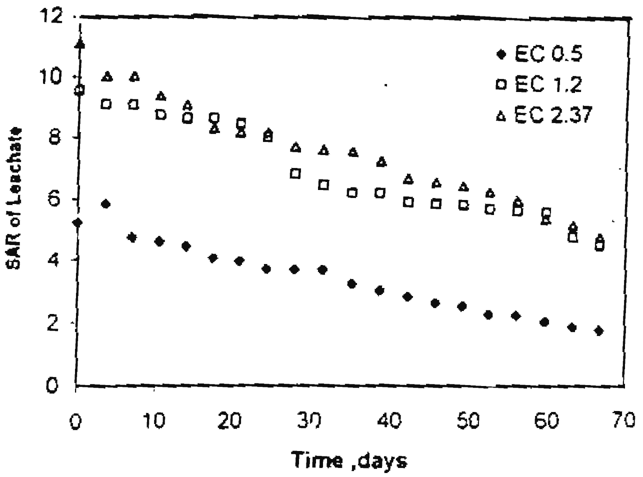

Fig :5 SAR of leachate vs . time of downward flux of saline water in sandy soil columns

The relationships between SAR and time were polynomial when the EC of applied water was 1.2 and 2.37 dS. m^{-1} and it was exponential when EC_{iw} was 0.5dS.m^{-1}.

$SAR = 5.6538\ e^{-0.0172\ t}$ for EC = 0.5 dS.m^{-1} $R^2 = 0.9832$

$SAR = 0.0004\ t^2 - 0.100\ 5t + 9.7204$ for EC = 1.2 dS.m^{-1} $R^2 = 0.9514$

$SAR = 0.0003\ t^2 - 0.1059\ t + 10.548$ for EC =2.37 dS.m^{-1} $R^2 = 0.9788$

In the second experiment the cumulative evaporation during upward flux periods of sandy soil columns are illustrated in Figure (6). The results showed that the maximum cummulative evaporation was 77.9 mm in 1.8 dS.m^{-1} treatment during the 65 days period of capillary process. The cummulative evaporation was minimum (55.5 mm) when EC_{iw} was 0.5 dS.m^{-1} (control) followed by 1.2 dS.m^{-1} treatment. It is noticed that the cummulative evaporation was 66.8 mm when the EC of applied water was 3.6 dS.m^{-1} which was less than that of 1.8 dS.m^{-1} treatment (77.9 mm). This might be due to the decrease of total porosity, volume drainable pores, quickly drainable pores and hydraulic conductivity as a result of increase of SAR of applied water (El-Samanoudi, 1992). Also, Figure 6 shows that one well-defined stage of evaporation can be observed during the time of drying process at constant evaporation potential in sandy soil column. During this stage the relation between evaporation and time was Linear and evaporation rate is characterized by a rapid and steady loss of water comparable to that from free water surface in bulk. Hence, the flow of water from the soil surface, might also be fast enough to meet the evaporative demand of the atmosphere. This stage was 65 days of drying and still the soil can longer transmit water to the surface to meet the atmospheric evaporative demand. There is no any distinct reduction in the evaporation rate.

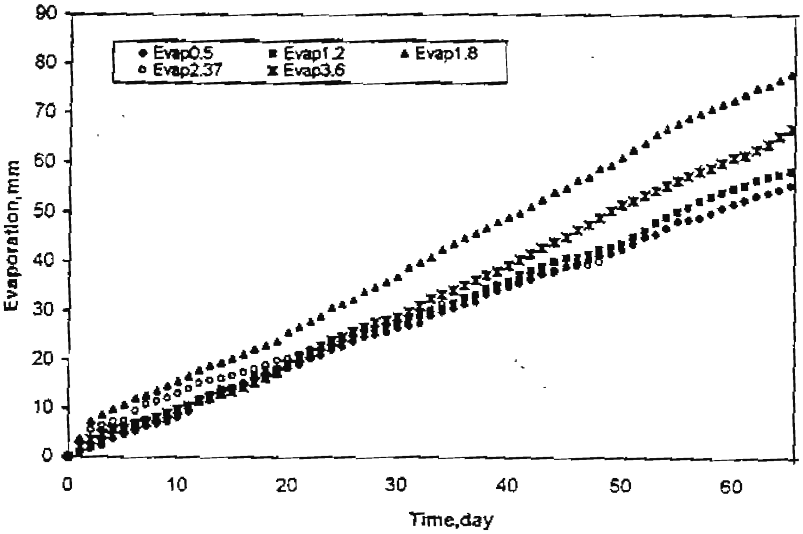

Fig 6 Cummulative evaporation,mm. vs. time,day

The rate of evaporation in this stage can be very well predicted from the empirical relations developed to quantify the evaporation from the free water surface. So, the relationships between cumulative evaporation (E),mm and time of continuous upward flux process(T_d), day obtained were as follows:

$E = 0.8689\ T_d$ for $EC = 0.5\ dS.m^{-1}$ $R^2 = 0.9984$
$E = 0.9084\ T_d$ for $EC = 1.2\ dS.m^{-1}$ $R^2 = 0.9975$
$E = 1.2288\ T_d$ for $EC = 1.8\ dS.m^{-1}$ $R^2 = 0.9924$
$E = 0.9168\ T_d$ for $EC = 2.37\ dS.m^{-1}$ $R^2 = 0.9458$
$E = 1.0074\ T_d$ for $EC = 3.6\ dS.m^{-1}$ $R^2 = 0.9976$

The above linear relation between E and T_d with very high R^2 showed that the 94.6% to 99.8% of evaporation depends upon the period of upward flux (i.e. the contribution of capillary water to supply the loss of water by evaporation from the surface layer of soil). These highly linear correlation between E and T_d might be controlled by saturated hydraulic conductivity and depth of water table (El-Samanoudi, 1992).

Table 2 shows the results of chemical analysis of soil columns at the end of the experiment (downward flux process). The EC values of the top 5cm soil samples in 1:1 soil extract were 0.6, 0.8, 1.0, 1.35, 1.6dS.m-1 when EC of irrigation water Eciw was 0.5, 1.2, 1.8, 2.37 and 3.6 dS.m-1, respectively. Hence, the osmotic potential (ψo) of soil extract was 0.22 and 0.57 bar at top 5 cm of soil column for Eciw 0.5 and 3.6 dS. m-1, respectively. The sodium adsorption ratio (SAR) of the top 5 cm was 1.78 and 10.37 for ECiw 1.8 and 1.2 dS.m-1 , respectively. In general, the values of EC of subsurface layers were less than that of the top 5 cm soil layer. This might be due to the surface salts accumulation during period of high rate of evaporation when the leached salts tended to move upward between successive water applications. Also, it is noticed that the EC values of sub-layers were close and the maximum value of osmotic potential (ψo) for subsurface layers did not exceese 0.25 bar. This means that the alternative application with suitable leaching fraction can keep a suitable salt balance in a certain depth of soil column and valuable fraction of the pores contribute to the leaching process (Minhas and Khosla, 1987).

The results depicted in Table 2 show also, the migration of Ca^{2+}, Mg^{2+} and Na^{+} after 65 days of forming salt load in sandy soil columns supplied with different saline water. Concentration of Ca^{2+} and Mg^{2+} were increased, with depth and then decreased at the end of soil columns. The maximum concentration of Na^{+} was in the top 5 cm of soil column then it decreased with depth. The concentration of Ca^{2+}, $Mg^{++}$and Na^{+} through soil columns might be controlled by the EC of soil solution, continuity of macropores, spatial variability of the porosity, reduction of porosity in upper layer due to the impact of applied surface water with time and increase evaporation rate from this layer and size of soil columns, amount and scheduling of irrigation (Tokuchi *et al.* 1993, Zait seva, et al 1997, Kelleners, *et al.* 1999, Rousseval, *et al.* 2002, and Al-Ajmi, *et al.* 2002).

Tabel 2: Chemical analysis of 1:1 soil extract for different depthes of sandy columns at end of downward flux process.

Soil depth, Cm	E.C, $dS.m^{-1}$	ψ_o, bar	Na^+, Meq L^{-1}	Ca^{++}, Meq L^{-1}	Mg^{++}, Meq L^{-1}	ESP, %
Ec_{iw} = 0.5 $dS.m^{-1}$						
0-5	0.6	0 216	01.30	03.0	02.0	1.95
5-10	0 4	0.144	00.43	04.0	01.0	1.15
10-15	0.4	0 144	00.48	07 0	02.0	0 828
15-20	0.6	0.216	01.22	03.0	03.0	1.757
20-25	0.4	0.144	00.70	02.0	02.0	1.406
Ec_{iw} = 1.2 $dS.m^{-1}$						
0-5	0.8	0.288	04.35	02.0	03.0	5 06
5-10	0.4	0.144	00.83	03.0	03.0	2 25
10-15	0 4	0.144	01 22	05.0	04.0	1 54
15-20	0.4	0.144	00.87	07.0	06.0	1.14
20-25	0.4	0.144	01.22	05.0	03.0	1.60
Ec_{iw} = 1.8 $dS.m^{-1}$						
0-5	1.0	0.360	05 70	05.8	02 5	5.13
5-10	0.6	0.216	01.50	04.1	03.5	1.87
10-15	0.6	0.216	01.70	05.8	04 2	1.88
15-20	0.6	0 216	02 00	06.3	05.4	1.96
20-25	0.6	0.216	01 70	05.4	03.7	1.91
Ec_{iw} = 2.37 $dS.m^{-1}$						
0-5	1.4	0.486	06.80	10.5	04.0	4.71
5-10	0.6	0.216	02.50	09.5	08 0	1.99
10-15	0 6	0.216	02.80	08.0	07.0	2.29
15-20	0.6	0.216	01.70	08.5	03.5	1.74
20-25	0.6	0.216	03 20	12.5	03.0	2.49
Ec_{iw} = 3.6 $dS.m^{-1}$						
0-5	1.6	0.576	11.30	13.0	03.0	6.96
5-10	0.7	0.252	03.50	05.0	12.0	2.58
10-15	0.6	0.216	02.40	08.0	07.0	2.04
15-20	0.6	0.216	02.30	14.0	05.0	2.00
20-25	0.5	0.180	02.30	13.0	08.0	1.77

The results in Table 3 show the effect of saline water and upward flux on salinity distribution of soil columns after 66 days of continuous process of capillary rise. In general, the EC_e decreased with the depth of soil columns but it was high in upward compared to the down ward flux.

The EC_e values of 1:1 soil extract for top 5 cm soil was 1.2, 1.9, 2.2, 2.3 and 2.6 $dS.m^{-1}$ when the salinity of supply water were 0.5, 1.2, 1.8, 2.37, and 3.6 $dS.m^{-1}$, respectively. So, the osmotic potential (ψ_o) of this surface layer ranged between 0.43 to 0.83 bar. It is clear that the EC^e and ψ_o of top soil layer attributed to upward flux increased by 40% compared to Ec_e and ψ_o attributed to downward flux due to the significant difference in values of cumulative evaporation in two cases. This means in the first experiment the cumulative evaporation might not be was equal to the evaporativedemand between the irrigation interval (3.5 days). This led to the moisture content of soil column reaching to threshold values and evaporation ceased while in second experiment there was steady evaporation rate equal to potential evaporation because of continuous upward supply of capillaris water. Also, the results in table 3 show that the maximum value of ESP was 13.89% when EC_{iw} was equal to 1.2 $dS.m^{-1}$.

Tabel 3: Chemical analysis of 1:1 soil extract for different sandy columns at end of upward flux process.

Soil depth, Cm	E.C, Ds.m^{-1}	ψ_o, bar	Na^{+}, Meq L^{-1}	Ca^{++}, Meq L^{-1}	Mg^{++}, Meq L^{-1}	ESP, %
Ec$_{iw}$ = 0.5 dS.m^{-1}						
0-5	1.2	0.432	9.57	4.0	2.00	9.20
5-10	0.4	0.144	0.96	8.0	5.00	1.21
10-15	0.4	0.144	0.74	7.0	1.00	1.20
15-20	0.4	0.144	0.78	3.0	1.00	1.50
20-25	0.4	0.144	0.78	2.0	3.00	1.40
Ec$_{iw}$ = 1.2 dS.m^{-1}						
0-5	1.9	0.684	16.96	3.0	4.00	13.89
5-10	0.4	0.144	1.39	2.0	2.00	1.74
10-15	0.4	0.144	1.39	3.0	2.00	2.05
15-20	0.4	0.144	1.30	3.0	3.00	1.83
20-25	0.4	0.144	1.39	3.0	1.00	1.74
Ec$_{iw}$ = 1.8 dS.m^{-1}						
0-5	2.2	0.792	18.54	7.0	7.00	6.82
5-10	0.7	0.252	3.50	5.0	13.00	.46
10-15	0.7	0.252	3.30	4.0	9.00	0.64
15-20	0.7	0.252	3.40	5.0	9.00	0.64
20-25	0.5	0.180	1.70	5.0	6.00	0.14
Ec$_{iw}$ = 2.37 dS.m^{-1}						
0-5	2.3		24.71	6.0	9.00	10.94
5-10	0.6		3.30	5.0	16.00	2.28
10-15	0.7		2.70	7.0	17.00	1.88
15-20	0.7		4.00	5.0	07.50	2.46
20-25	0.8		3.50	12.5	3.50	2.64
Ec$_{iw}$ = 3.6 dS.m^{-1}						
0-5	2.6	0.828	44.83	6.0	12.00	5.67
5-10	0.7	0.252	4.00	8.0	18.00	0.38
10-15	0.8	0.288	4.30	6.0	21.00	0.46
15-20	0.8	0.288	4.30	6.0	8.00	1.13
20-25	0.6	0.216	3.10	13.0	8.00	0.41

It could be concluded that the relation between the evaporation rate and leaching fraction must be taken into consideration when saline irrigation water used for surface or subsurface supply for keeping a suitable salt balance, preventing build up of secondary salinization in root zone and avoiding the plant water stress or select the promissing cultivars for commercial cultivated with using saline water supply, having a high yield potential and a high-salt tolerance. Therefore, the mathematical models are important for understanding the dynamic changes of soil - water system and salt accumulation in root zone associated using poor quality water in irrigation of sandy soil.

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تأثيرات حركة المياه الملحية على التغيرات فى نوعية المياه المنصرفه ومعامل الغسيل والبخر والحمل الملحى فى أراضى خشنة القوام

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أجريت تجربتان معمليتان فى أعمدة أرض رملية لتحديد التغيرات الديناميكية لملوحة الماء المنصرف (EC) ونسبة الصوديوم المدمص (SAR) إضافة الى معامل الغسيل (LF)والحمل الملحى نتيجة لأستخدام مياه ملوحتها ٠,٥، ١,٢، ١,٨، ٢,٣٧، ٣,٦ ديسى سيمنز/م . وأضيفت هذه المياه بطريقتين الأولى تعبر عن الحركة الرأسية لأسفل لتمثيل الرى السطحى (التجربه الأولى). والثانية تعبرب عن الحركة الرأسية لأعلى والتى تمثل الرى تحت سطحى (التجربة الثانية) وأوضحت النتائج فى التجربة الأولى أنه هناك علاقات متعددة الحدود (Polynomial) بين كل من LF , SAR , EC وزمن إضافة المياه عندما كانت ملوحة المياه المضافه أكبر من ٠,٥ ديسى سيمنز/م بينما كانت العلاقات السابقة معادلات أسية (exponential) عندما كانت ملوحة المياه المضافه ٠,٥ ديسى سيمنز/م. كما أوضحت النتائج فى التجربة الثانية أن هناك علاقات إرتباط خطية (Linear) بين البخر التجميعي والفترة الزمنية التى تظل فيها الحركة الرأسية لأعلى مستمرة بإختلاف ملوحة المياه المضافة.

والحمل الملحى الناشئ سواء من الحركة الرأسية لأسفل أو لأعلى للمياه المالحه كان واضحا حيث أن أقصى قيم للضغط الأسموذى فى الطبقة السطحية للتربه كانت ٠,٨٣، ٠,٥٨ بار عند إستخدام مياه ملوحتها ٣,٦ ديسى سيمنز/م فى الحركة الرأسية لأعلى ولأسفل على الترتيب ومن ثم فإن التأثيرات السلبيه على خواص التربه والناتجه من زيادة الملوحة يمكن تدنيتها عن طريق التحكم فى نسب خلط المياه العذبه والمالحه. ويمكن تلخيص ذلك بأن إستخدام مياه رديئة النوعية فى الرى خاصه فى الأراضى خشنه القوام أصبحت من الوسائل الفعاله فى حالات ندرة المياه دون المخاطرة الناتجه عن سوء الإدارة وهذا يتطلب نسب خلط مناسبه لمياه الصرف الزراعى مع مياه الرى فى الترع ويتطلب أيضا إدارة عملية.جيدة للتربه والمياه كما تتطلب أيضا أحتياجات غسيلية مناسبة للحفاظ على التوازن الملحى فى قطاع التربه.