Egypt. J. Soil Sci. **45**, No. 1, pp. 1 – 14 (2005)

Effect of Saline Irrigation Water and Leaching Fraction on Soil Salinity, Wheat Yield and Water Use

E. H. El-Haddad, A.A. Aboushal and M. El-S. Mohamed
Soil Salinity Department, Soil, Water and Environment Research Institute, Agricultural Research Center (A.R.C.), Cairo, Egypt.

A GREENHOUSE experiment was conducted to study soil salinity changes, wheat growth, and water use as affected by different salinity levels (EC_i) and leaching fractions (LF). Eighteen large columns (20 cm in diam. and 120 cm depth) were packed with sandy clay loam soil and after that were planted with wheat (*Triticum aestivium* L. var. Sakha 69). Three salinity levels having electrical conductivity values of 4,6, and 8 dS/m were used in this study with an amount to provide two leaching fractions (0.20 and 0.30). After each irrigation, the drainage water from each column was collected and its volume and electrical conductivity were measured. Salt balance was performed by comparing the total amount of salts drained into the drainage water and the total amount of salts contributed by irrigation water during the experimental time. At the time of maturity wheat plants were harvest and soil samples were taken at different depths for analyses. The results indicated that soil salinity (EC_e) and sodium adsorption ratio (SAR_e) were increased as EC_i increased or LF decreased. The salt balance data indicated that salt accumulation (salt input- salt output) increased by 67.20 % as ECi increased from 4 to 8 dS/m., while increasing LF from 0.20 to 0.30 decreased salt accumulation by 9.9 %. The results also indicated that 67.9 and 54.3% of the salts added during the experimental period were stored by the soil for 0.20 and 0.30 LF, respectively, regardless of salinity levels. Grain yield of wheat were not affected neither by EC_i nor by LF treatments. Although, water use was decreased significantly by 21% as EC_i increased from 4 to 8 dS/m, it was not influenced by LF. Straw yield the vegetative vigor parameter and water use-efficiency were decreased significantly only at 8 dS/m., while they were not varied due to LF variations. Water use- efficiency for 0.20 LF was significantly higher compared with that of 0.30 LF, indicating that the same grain yield of wheat can be produced with lower amount of water.

Keywords: Saline water, Leaching fraction, Wheat yield.

Low quality of irrigation water such as drainage and well water has been used in some Egyptian lands for irrigation whenever the Nile water not available. Such irrigated lands are being subjected to salt accumulation, because plants absorb and transpire water from soils, leaving salts of the irrigation water to build up in the soil. Low quality waters used in irrigation contain appreciable quantity of salts up to several tons of dissolved salts per acre are applied in the arid regions (Rhodes, 1968; Rhodes & Bernstein, 1971 and Kaddah & Rhodes, 1975). These salts frequently accumulate in soil to the point that plant growth is reduced unless it is removed by leaching (Rhodes *et al.*, 1973). Rain fall is generally insufficient in arid climates to leach salts. Management of saline water must be oriented to minimize the potential pollution of the ground water as well as to provide an adequate environmental for plant roots. The salt contribution to ground water or a river system from irrigated land in dry climates could be reduced to zero by eliminating any leaching of the root zone (Jury *et al.*, 1978b). Several recent studies have indicated that decreasing the leaching fraction may reduce the amount of salt in the irrigation return flow because (i) it maximize the precipitation of carbonate and gypsum, (ii) it minimize soil mineral weathering, and (iii) it maximized the amounts of soluble salts stored in the soil profile and not returned in the drainage water (Rhodes *et al.*, 1973 and Oster & Rhodes, 1975). An association between irrigation water quality and soil chemical properties such has been demonstrated by various researchers (Bingham *et al.*, 1979; Zartman & Gichuru, 1984; Costa *et al.*, 1991 and Wienhold & Trooien, 1995). They concluded that ECe, SARe, and Na- hazards were increased as a result of using poor quality water in irrigation. The aim of the present work was to a quantitative study of soil salinity changes as a result of irrigation with water of different salinity levels and applied at different leaching fractions. The design of the experiment allowed as well to investigate water use of wheat as affect by treatments.

Material and Methods

A greenhouse experiment was conducted during 2001/2002 growing season in eighteen large columns (20 cm in diam. and 120 cm depth). A 10 cm layer of sand gravel was placed at the bottom of each column. The columns were then packed to field bulk density (1.28 g/cm^3) with sandy clay loam soil (22% clay, 12% silt and 66 % sand) represents an alluvial soil. Water content of the soil at 0.3 and 15 bars of matric suction were about 34 and 16 %, respectively. The soil had a pH value of 7.6, an electrical conductivity of the saturation extract (EC_e) of 1.2 dS/m, and a sodium adsorption ratio (SAR_e) of 6.9. Drainage outlets in the gravel sand layer of each column were connected by tubing to 2- L bottles for drainage collection. After soil packing all columns were fertilized with supper-phosphate (15% P_2 O_5) at the rate of 30 Kg/ faddan each. The columns were then planted with wheat (*Triticum aestivium* L. var. Sakha 69). After emergence the plants were thinned to 5 plants / column. Nitrogen fertilizer was added at the rate of 90 kg N/ fed. in two splitting doses. The first dose was added three weeks after sowing, the second dose was added one month later. All columns were irrigated with none-saline water during the first two weeks after germination. Then, the none- saline water was replaced with saline- water treatments. Three salinity levels were constructed from dilution of sea water to give electrical conductivity values (EC_i) of 4,6, and 8 dS/m (Table 1). The irrigation water treatments have SAR values between 13.6 and 22.9 and classified as C_4-S_2 waters for 4 and 6 dS/m and as C_4-S_3 waters for 8 dS/m according to U.S. Salinity Staff (1954).

TABLE 1. Composition of irrigation waters used in the experiment.

EC dS/m	pH	Soluble cations, meq/l				Soluble anions, meq/l			SAR*
		Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	Cl^{-}	HCO_3^-	SO_4^{2-}	
4.0	7.25	2.5	6.41	30.0	0.27	35.0	1.30	3.7	13.6
6.0	7.55	3.0	9.65	43.8	0.50	53.4	1.67	4.9	17.0
8.0	7.76	4.0	12.3	66.2	0.96	71.3	2.20	6.4	22.9

* $SAR = Na^{+} / [(Ca^{2+} + Mg^{2+})/2]^{1/2}$, all concentrations are expressed in meq/l .

The experimental arrangement permitted to weigh the columns freely using an electronic scale of 20 g accuracy. Column weights at field capacity, wilting point; 50 % and 60% available water were then reported. Irrigation was imposed whenever the column available moisture reached the range 50-60%. The quantity of irrigation water for each column exceeded than the measured evapo-transpiration (ET) to establish two different leaching fractions (LF); 0.20 and 0.30. Evapo-transpiration was estimated using the conventional equation:

$$ET = Iv - Dv \quad (1)$$

Where: Iv **= volume of irrigation water, and**
Dv **= volume of drainage water**

After each irrigation, the drainage water from each column was collected and its volume and electrical conductivity (EC_d) were measured. The amount of water applied as irrigation (reported as cm/unit area) and the leaching fraction attained during the experimental period are shown in Table 2. The irrigation water depths ranged from a high of 79.63 cm for treatment (4 dS/m, 0.30 LF) to 54.11 cm for treatment (8 dS/m, 0.20 LF). The average leaching fraction achieved over the experimental period for each column is also given in Table 2. Treatments designed for a leaching fraction of 0.20 averaged 0.193 and those for 0.30 averaged 0.327. Salt balance was performed by comparing the total amount of salts drained into the drainage water and the total amount of salts contributed by irrigation water during the experimental time. At the time of maturity wheat plants were harvest and soil samples were taken to a depth of 90 cm by dividing the soil column into six 15- cm sections. Sub-samples were taken and brought back to the laboratory to obtain the saturation extracts. All major cations and anions were analyzed along with the electrical conductivity (EC_e) according to procedure outlined by U.S. Salinity Staff (1954). The experiment was laid out in a randomized complete block design with three replications. Data were statistically examined for treatments with the analysis of variance and multiple linear regression (SAS Institute, 1990).

TABLE 2. The amount of water applied as irrigation and leaching fractions attained during the experimental period.

Leaching fractions	Irrigation salinity, dS/m		
	4	**6**	**8**
	Water applied , cm		
0.20	70.95	65.64	54.11
0.30	79.63	68.32	65.36
	Leaching fractions attained		
0.20	0.19	0.19	0.20
0.30	0.33	0.33	0.32

Results and Discussion

Salt distribution

Electrical conductivity of the paste extracts (EC_e) was considerably affected by salinity of irrigation water and leaching fraction used (Fig. 1). The EC_e values had increased in the upper 15 cm of the soil profile to levels exceeding salinity of irrigation water (EC_i) and uniformly distributed with soil depth down to 75 cm. Thereafter, they were increased near bottom and being greater in magnitude for 8 dS/m water. At equal salinity level, EC_e tended to increase as the leaching fraction decreases from 0.30 to 0.20. This pattern suggests that leaching remove salts from the surface and from the root zone deposing them lower in the soil profile and was most evident for 8 dS/m water. The results were agreement with those obtained by pervious workers (Bower *et al.*, 1969; Bower *et al.*, 1970; Oster & Schroer, 1979 and Costa *et al.*, 1991). The linearly averaged salt concentrations (C) for the 0 to 90 cm depth were calculated using Eq. (2), which is the definite integral of EC_e from 0 (soil surface) to Z (lower depth).

$$C = \frac{1}{Z}\int_{0}^{90} ECe\,\partial Z \quad \text{------------} (2)$$

The relationship between the average of soil salinity (C) and irrigation water salinity (EC_i) and leaching fractions (LF) was found as follows:

$$C = 3.1 + 1.09\,EC_i - 7.9\,LF\,, \quad \text{------------} (3)$$

Where $4 \leq EC_i \leq 8$ and $0.20 \leq LF \leq 0.30$

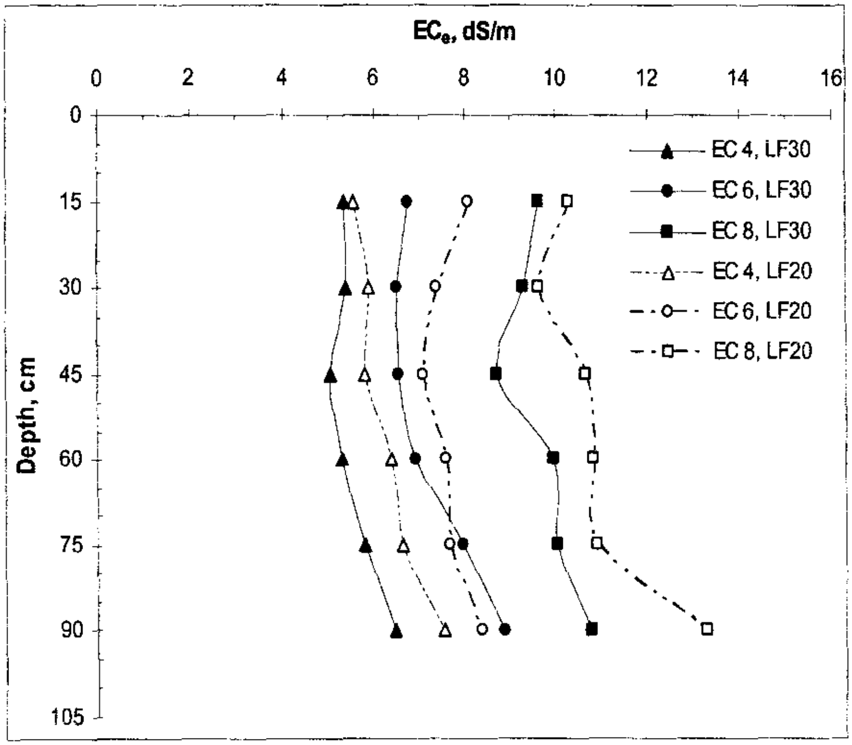

Fig. 1. Soil salinity (EC_e) with soil depth as a function of salinity of irrigation water and leaching fraction.

The partial regression coefficients of EC_i and LF, as seen above, are positive and negative, respectively, indicated that C increased with increasing EC_i and decreasing LF. The high R^2 value (R^2=0.97**) indicates that 97 % of variability in the average of soil salinity (C) was due to variation in irrigation water salinity and leaching fractions.

Sodium adsorption ratio (SAR_e) of the paste extracts was appreciably influenced by salinity of irrigation water and leaching fraction (Fig. 2). SAR_e values increased as salinity of irrigation water increased and uniformly distributed with soil depth. At salinity of irrigation water of 4 and 6 dS/m, SAR_e increased as the leaching fraction decreased from 0.30 to 0.20, while at EC_i of 8 dS/m the effect of leaching fraction was not obvious. The linearly averaged sodium adsorption ratio in soil paste (S) were calculated at the end of the experiment using Eq.(2) by substituting SAR_e for EC_e Multiple linear regression of EC_i and LF against S is given by the following equation:

$$S = 5.50 + 2.56\,EC_i - 14\,LF \quad (4)$$

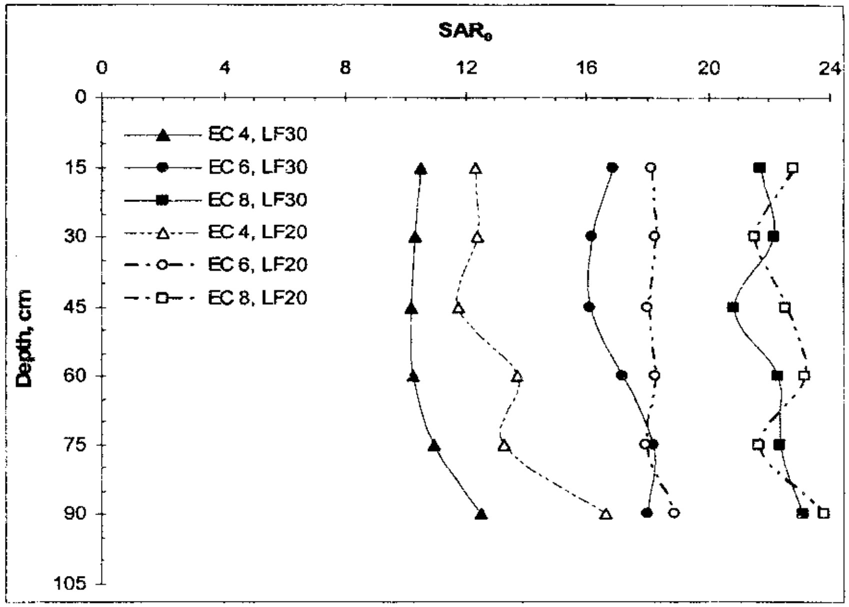

Fig. 2. Sodium adsorption ratio (SAR_e) with soil depth as affected by salinity of irrigation water and leaching fraction.

Equation (4) showed that 98% of variability (R^2=0.98**) in the averaged S was related to both ECi and LF. As salts in the irrigation water are added to the soils, the concentration of Na, Ca, and Mg increase, resulting in an increase in EC_e. However, as in the present study, SAR_i values increased widely with increasing EC_i (Table 1) since the main cation is Na. Jury *et al.* (1978a), Jury *et al.* (1978b), Costa *et al.* (1991) and Wienhold & Trooien (1995) in their studies found that when the salt concentration becomes great enough, minerals such as gypsum and calcite will begin to form. As additional salts are added, the concentration of Ca no longer increases while that of Na and Mg continue to increase due to minerals precipitation, resulting in an increase in EC_e and SAR_e.

Ions distribution

The distribution patterns of soluble ions in the soil were controlled primarily by salinity of irrigation water and leaching fraction. This is readily seen in Fig.3, where Na^+, Ca^{++}, Mg^{++}, Cl^- and SO_4^{--} followed a distribution patterns similar to that of EC_e. Moreover, the concentration of soluble of constituents generally increased with decreasing LF. This effect is greatest with those solutes whose solubility is normally exceeded in the soil solution, namely Na and Cl. Apart from the stated trend of soluble ions, K showed a different distribution trend, where K concentration at 15 cm depth were relatively higher than those found at greater depths. This pattern suggests that K distribution very dependant on the physico-chemical properties of the soil, and differs greatly with soil type (Rhodes *et al.*, 1973 and Blake *et al.*, 1999).

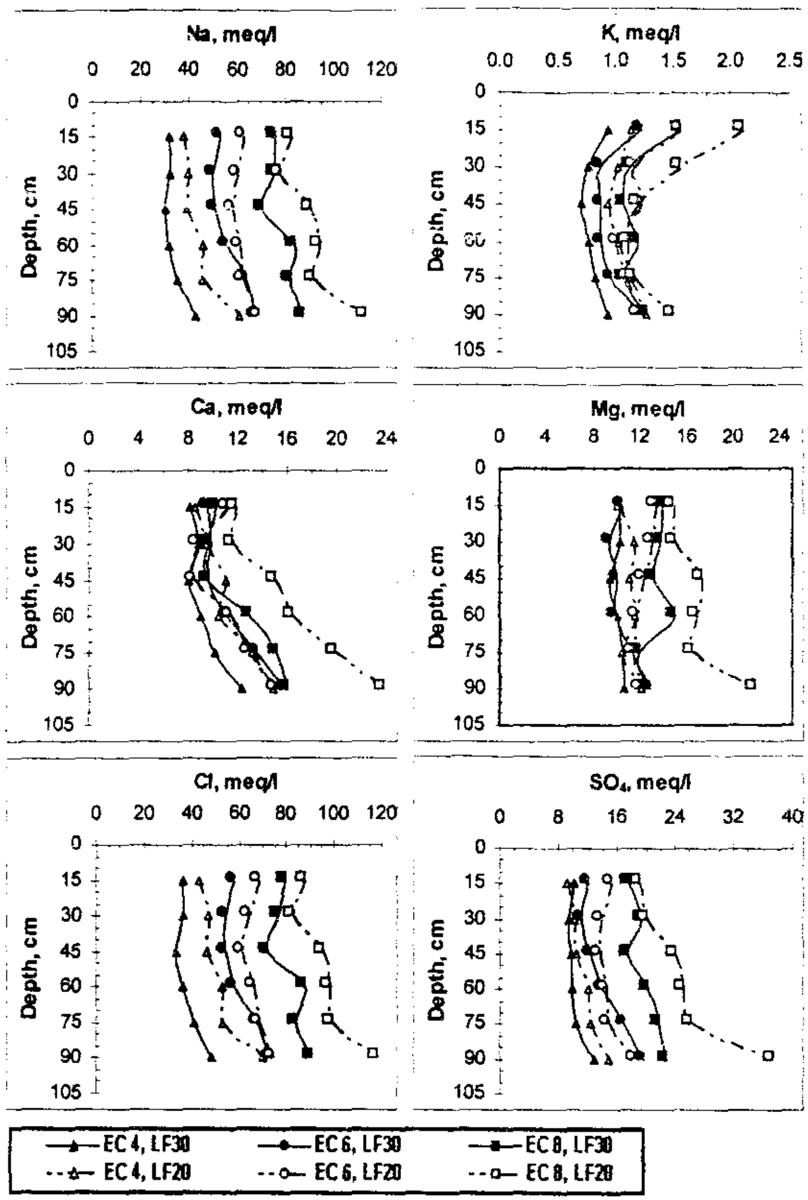

Fig. 3. Concentrations of sodium potassium, calcium, magnesium, and sulfate with soil depth as affected by salinity of irrigation water and leaching fraction.

Salinity of drainage water

Salinity of drainage water (EC_d) was generally higher at 8 dS/m than that found at 4 or 6 dS/m, and being greater for 0.20 compared with 0.30 treatment

(Table 3).By looking to EC_d values towards the end of the experiment, they are still far below the steady state value estimated from salinity of the irrigation water and the leaching fraction (LF) by using the conventional steady- state salt balance equation:

$$EC_d = EC_i / LF \quad (5)$$

Where

$$LF = D_v / I_v \quad (6)$$

EC_i is the salinity of irrigation water. D_v and I_v are the volume of drainage and irrigation water, respectively. The measured salinity values were less than those predicted, indicating that the steady state was not achieved and that further irrigations would have been eventually raised the EC_d values. The results coinciding with the earlier observations of Jury *et al.* (1978b) and Devitt *et al.* (1989).

TABLE 3. Salinity of drainage water measured and that predicted from the steady-state salt formula over the experiment*.

Leaching fractions	Irrigation salinity, dS/m			Mean
	4	6	8	
Salinity of drainage water, dS/m				
0.20	8.30	13.05	17.00	12.78
0.30	7.70	9.08	14.50	10.42
Mean	8.00	11.07	15.75	
Salinity of drainage at steady state, dS/m				
0.20	20.00	30.00	40.00	30.00
0.30	13.33	19.98	26.64	19.98
Mean	16.67	24.99	33.32	

* Values are mean of three replicates.

Salt balance

Salt balance was calculated for each column based on EC and volume measurements for water applied via irrigation and that collected in the drainage. The components of salt balance for each treatment are given in Table 4 for the study period. The major of salt input for this balance, of course, from irrigation water. It was high as salinity of irrigation water and leaching fractions increased. The same trend was observed for salt output in drainage water, which increased by 47 % as salinity increased from 4 to 8 dS/m and increased by 60 % as LF increased from 0.20 to 0.30. As shown in Fig. 4, salt accumulated in the soil, expressed as the difference between salt input by irrigation water and salt output by drainage water ($Salt_{ac}$), increased gradually with repeated irrigation and with a magnitude being dependent on salinity and leaching fraction used. Furthermore, increasing salinity of irrigation water from 4 to 8 dS/m increased $Salt_{ac}$ in soil by 67.20 %, while increasing LF from 0.20 to 0.30 decreased it by 9.9 % (Table 4). Similar results were reported earlier (Jury *et al.*, 1978b; Hoffman *et al.*, 1983; Costa *et al.*, 1991 and Bustos *et al.*, 1996). The percentage of salts added in irrigation water accumulated in the soil was calculated from Table 4 as follows:

$$Salt_{ac}\,\% = [(Salt\ input - Salt\ output)\ 100 / Salt\ input] \text{ ------------(7)}$$

TABLE 4. Salt balance data as affected by salinity of irrigation water and leaching fractions at the end of the experiment*.

Leaching fractions	Irrigation salinity, dS/m			Mean
	4	6	8	
	Salt input by irrigation water, g/column			
0.20	57.04	79.14	86.99	74.39
0.30	64.00	82.37	105.05	83.81
Mean	60.52	80.76	96.02	
	Salt output by drainage water, g/column			
0.20	19.08	23.92	28.75	23.92
0.30	32.54	35.21	47.20	38.32
Mean	25.81	29.57	37.98	
	Salt accumulated in soil, g/column			
0.20	37.96	55.23	58.24	50.48
0.30	31.46	47.16	57.84	45.49
Mean	34.71	51.20	58.04	

* values are mean of three replicates.

Multiple linear regression of EC_i and LF against $Salt_{ac}$ % at the end of the experiment is represented by the following equation:

$$Salt_{ac}\,\% = 91 + 0.78\ EC_i - 139\ LF \text{ --------------------------------(8)}$$

where $4 \leq EC_i \leq 8$ and $0.20 \leq LF \leq 0.30$

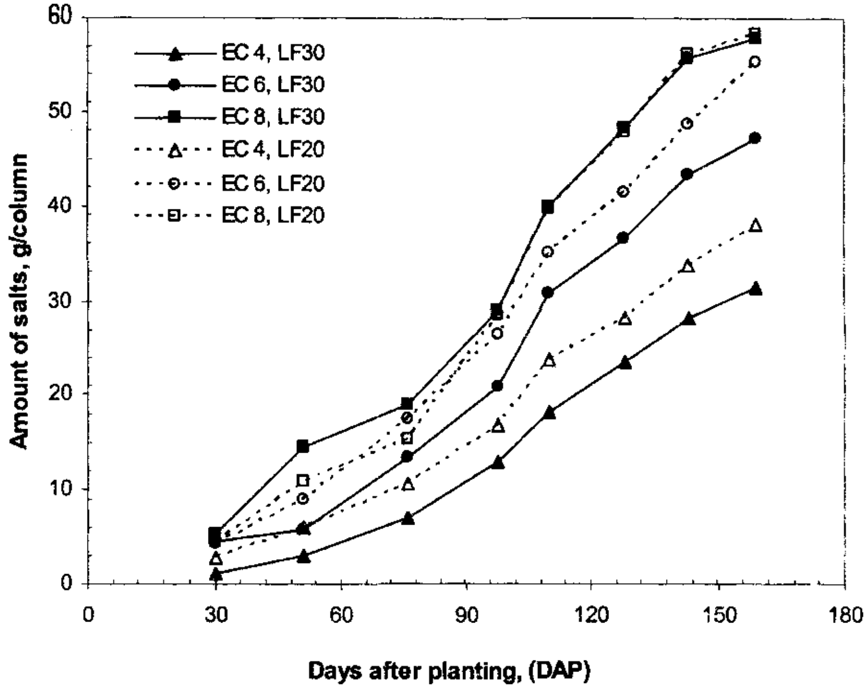

Fig. 4. Salts accumulated in soil as a function of time as affected by salinity of irrigation water and leaching fraction.

The equation indicated that the *LF* was the dominating factor (R^2=0.91**) in dictating value of percentage salt added in irrigation water that accumulated in soil. From the above equation, the results indicate that 67.9 and 54.3% of the salts added during the experimental period were stored by the soil for 0.20 and 0.30 LF, respectively, regardless of salinity of irrigation water. Despite the differences in salt concentration in the irrigation waters, $Salt_{ac}$ % was basically the same. Under the conditions of the experiment, results illustrate that the fractional salts accumulation in soils through irrigation practices may be showed a different trend than those suggested by the total salt concentration in irrigation water.

Yield of wheat

Grain yield of wheat were not affected neither by salinity of irrigation water nor by leaching fractions used. Increases of salinity in the columns were not sufficient to cause a reduction in wheat yield. In the columns receiving the 8 dS/m irrigation water, the average ECe at the end of the experiment was exceeded the ECe threshold for wheat reduction which is 8.6 dS/m (Francois *et al.,* 1986 and Mass, 1986). Therefore, it appears that salt tolerance of the wheat variety (Sakha 69) in this experiment was considerably greater or salts did not accumulate in the soil to harmful extent, especially in the early stages of growth. Relative grain yield (Y/ Y max) was very high (0.81-1) suggesting that wheat crop was able to successfully adjusted to the range of salinity – leaching treatments imposed on the plants over the study without major restrictions in grain yield. If the experiment had been continued for longer period to obtain steady state salt conditions in all columns a more dramatic impact on grain yield would probably have been observed. Straw yield the vegetative vigor parameter, was not differed as salinity increased up to 6 dS/m . Further increasing in salinity of irrigation water to 8 dS/m, resulted in decreasing straw yield by 10.5 % (Table 5). Vegetative growth was sensitive to salinity than that found for grain. Straw yield damaged, perhaps, at the expense of grain. The results are agree with those found by Francois *et al.* (1986), who found that straw yield was sensitive to salinity than grain yield, with thresholds varied between 2.3 and 4.5 dS/m according to the cultivar used.

TABLE 5. Grain yield, straw yield, water use and water use- efficiency of wheat plants as affected by salinity of irrigation water and leaching fraction used.

Leaching fractions	Irrigation salinity, dS/m			Mean
	4	6	8	
	Grain yield, g/ column			
0.20	23.17	22.42	22.84	22.81
0.30	21.00	18.77	20.74	20.17
Mean	22.09	20.60	21.79	
	Straw yield, g/ column			
0.20	25.62	24.60	21.40	23.90
0.30	24.20	21.80	23.20	23.10
Mean	24.90 **a**	23.20 **a**	22.33 **b**	
	Water use, cm			
0.20	56.76	52.52	43.28	49.29
0.30	55.74	47.84	45.56	51.27
Mean	56.25 **a**	50.18 **b**	44.42 **c**	
	Water use- efficiency, g grains/ cm water			
0.20	0.41	0.43	0.53	0.46 **a**
0.30	0.38	0.39	0.46	0.41 **b**
Mean	0.40 **b**	0.41 **b**	0.50 **a**	

* Values within a column or a row followed by the same letter are not significantly different at P $\leq$ 0.05 by Duncan's multiple range test.

Water use (WU) and water-use efficiency (WUE)

Water use quantities reported as the average depths of water per unit of surface are given in Table 5. Water use significantly decreased (21% reduction) as salinity of irrigation water increased from 4 to 8 dS/m, regardless of LF, while it was not varied on base of LF. WUE did not vary with salinity of irrigation water up to 6 dS/m. Raising EC_i

to 8 dS/m, however, increased WUE clearly. Irrespective of EC_i, WUE for 0.20 LF was significantly higher compared with that of 0.30 LF, indicating that the same grain yield of wheat can be produced with lower amount of water.

The data presented here give information about concentration and distribution of salts and ions in soil resulting from irrigation with saline water with different amounts. Such data can be used to estimate soil and drainage water salinity, assessing the fraction of applied salt that must be removed in drainage water to achieve near maximum crop yield.

References

Blake, L.; Mercik, S.; Koerschens, M.; Goulding, K. W. T.; Stempsen, S.; Weigel, A.; Poulton, P.R. and Powlson, D.S. (1999) Potassium content in soil, uptake in plants, and the potassium balance in three European long- term field experiments. *Plant and Soil* **216,** 1.

Bingham, F.T.; Mahler, R.J. and Sposito, G. (1979) Effect of irrigation water composition on exchangeable sodium status of a field soil. *Soil Sci.* **127**, 248.

Bower, C.A.; Ogata, G. and Tuker, J.M. (1969) Rottzone salt profiles and alfalfa growth as influenced by irrigation water salinity and leaching fraction. *Agron. J.* **61**, 783.

Bower, C. A.; Ogata, G. and Tuker, J. M. (1970) Growth of sudan and tall fescue and leashing fraction. *Agron. J.* **62**, 793.

Bustos, A.; Roman, R.; Cabllero, R.; Diez, J.A.; Cartagena, M.C.; Vallejo, A.; and Caballero, A. (1996) Water and solute movement under conventional corn in central Spain. II. Salt Leaching. *Soil Sci. Am. J.* **60**, 1536.

Costa, J.L.; Prunty, L.; Montogomery, B.R.; Richardson, J.L. and Alessi, R. S. (1991) Water quality effects on alfalfa: II. Soil physical and chemical properties. *Soil Sci. Soc. Am. J.* **55**, 203.

Devitt, D. A. (1989) Bermudagrass Response to leaching fractions, irrigation salinity, and soil types. *Agron. J.* **81**, 893.

Francois, L.E.; Mass, E.V.; Donvan, T.J. and Youngs, V.L. (1986) Effect of salinity on grain yield and quality, vegetative growth, and germination of semi-dwarf and durum wheat. *Agron. J.* **78**, 1053.

Hoffman, G.J.; Jobes, J.A. and Alves, W.J. (1983) Response of tall fescue to irrigation water salinity, leaching fraction, and irrigation frequency. *Agr. Water Management* **7**, 439.

Jury, W.A.; Frankel, H. and Stolzy, L.H. (1978a) Transient changes in the soil water system from irrigation with saline waters. I. Thoery. *Soil Sci. Soc. Am. J.* **42**, 579.

Jury, W. A.; Frankel, H. and Stolzy, L.H. (1978b) Transient changes in the soil water system from irrigation with saline waters. II. Analysis of the experimental data. *Soil Sci. Soc. Am. J.* **42**, 585.

Kaddah, M.T. and Rhodes, J.D. (1975) Salt and water balance in valley, California. *Soil Sci. Soc. Am. J.* **40**, 93.

Mass, E.V. (1986) Salt tolerance of plants. *Appl. Agric.Res.* **1**, 12.

Oster, J.D. and Schror, F.W. (1979) Infiltration as influenced by irrigation water quality. *Soil Sci. Soc. Am. J.* **43**, 444.

Oster, J.D. and Rhodes, J.D. (1975) Calculated drainage water compositions and salt burdens resulting from irrigation with river waters in the western United States. *J. Environ. Quality* **4**,73.

Rhodes, J. D. (1968) Mineral- weathering correction for estimating the sodium hazard of irrigation waters. *Soil Sci. Soc. Amer. Proc.* **32**, 648.

Rhodes, J.D. and Bernstein, L. (1971) Chemical, physical, and biological characteristics of irrigation water and soil water. In : *"Water and Water Pollution Handbook"*, L. Ciaccio (Ed.), pp. 141-222, Leonard Marcel Deckker. Inc., New York.

Rhodes, J.D.; Ingvalson, R.D.; Tucker, J.M. and Clark, M. (1973) Salts in irrigation Drainage waters: I. Effects of irrigation water composition, leaching fraction, and time of the year on the salt composition of drainage waters. *Soil Sci. Am. Proc.* **37**, 770.

SAS Institute. (1990) SAS/STAT guide for personal computers. Version 6 ed., SAS Inst., Cary, NC.

US Salinity Laboratory Staff. (1954) *"Diagnosis and Improvement of Saline and Alkaline Soils"*, L. A. Richrds (Ed.), 160p., US Dep. Agr., Handbook 60.

Wienhold, Brian and Trooien, T.P. (1995) Salinity and Sodicity changes under irrigated alfalfa in the Northern Great Plains. *Soil Sci. Soc. Am. J.* **59**, 1709.

Zartman, R. E., and Gichuru, M. (1984) Saline irrigation water. Effects on soil chemical and physical properties. *Soil Sci.* **138**, 417.

(*Received* 10/2004;
accepted 1/2005)

تأثير ملوحة مياه الرى ومعاملات الغسيل على ملوحة الأرض ومحصول القمح والأستهلاك المائى

السيد حسن الحداد ، أحمد عبد الرازق أبوشال و محمد السيد محمد
قسم بحوث الأراضى الملحية – معهد بحوث الأراضى والمياه والبيئة – مركز البحوث الزراعية – القاهرة – مصر.

أجريت هذه الدراسة باستخدام أعمدة من البلاستيك (قطرها ٢٠سم ، ارتفاعها ١٢٠سم) ملئت بتربة ذات قوام رملى طينى لومى وزرعت قمحا صنف سخا ٦٩ وذلك لدراسة التغير فى ملوحة الأرض ونمو محصول القمح والأستهلاك المائى تحت مستويات مختلفة من ملوحة مياه الرى ومعاملات الغسيل وأشتملت المعاملات على ثلاث تركيزات من ملوحة المياة ذات قيم توصيل كهربائى تساوى ٤ ، ٦ ، ٨ ديسيسمنز/م و مستويين من معاملات الغسيل تساوى ٠,٢٠ ، ٠,٣٠ .

بعد كل رية تم تجميع مياه الصرف لكل عمود على حده وتم قياس حجمه ومعامل التوصيل الكهربى له وحسب الاتزان الملحى بمقارنة الكمية الكلية للأملاح فى مياه الصرف والكمية الكلية للأملاح التى أضيفت فى مياه الرىخلال فترة التجربة. وتم ضم القمح بعد مرحلة النضج وأخذت عينات أرض ممثلة للمعاملات ولأعماق مختلفة للتحليل الكيماوى.

أوضحت النتائج أن ملوحة الأرض (EC_e) ونسبه الصوديوم القابل للادمصاص (SAR_e) قد أزدادت مع ازدياد قيم ملوحة مياه الرى (EC_i) أو نقص معامل الغسيل. وأوضحت بيانات الاتزان الملحى أن تراكم الأملاح (كمية الأملاح المضافة – كمية الأملاح المنصرفة مع مياة الصرف) ازداد بنسبة ٦٧,٢٪ عند زيادة ملوحة مياه الرى من ٤ الى ٨ ديسيسمنز/م ، بينما زيادة معامل الغسيل من ٠,٢ إلى ٠,٣ أدت الى نقص فى تراكم الأملاح بنسبة ٩,٩٪ . كما بينت النتائج أن ٦٧,٩ ٪ ، ٥٤,٣٪ من الأملاح الكلية المضافة خلال فترة التجربة قد خزنت فى الأرض عندما كانت معاملات الغسيل ٠,٢ ، ٠,٣ على التوالى بصرف النظر عن مستويات الملوحة المستخدمة. لم يتأثر محصول حبوب القمح سواء بمستويات ملوحة مياه الرى أو بمعاملات الغسيل. أيضا كان انخفاض استهلاك المياه معنويا وبنسبة ٢١٪ عندما ازدادت ملوحة مياه الرى من ٤ إلى ٨ ديسيسمنز/م ، بينما لم يكن هناك تأثيرا معنويا لمعاملات الغسيل. انخفض معنويا كل من محصول القش وكفاءة استخدام مياه الرى عند مستوى ملوحة ٨ ديسيسمنز/م فقط بينما لم يتأثرا بالتغير فى معاملات الغسيل. كانت كفاءة استخدام المياه لمعامل الغسيل ٠,٢ معنويه بدرجة كبيرة بالمقارنة بمعامل الغسيل ٠,٣ بما يبين أن نفس محصول حبوب القمح يمكن إنتاجه باستخدام كمية أقل من المياه.