IRRIGATION WATER SALINITY EFFECTS ON SOME SOIL WATER CONSTANTS AND PLANT

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ABSTRACT

Germination and pot experiment were conducted to study the influence of irrigation water salinity on yield and chemical composition of wheat (*Triticum vulgare* L.) plant grown in sandy and calcareous soil. Water salinity levels were, 0.43 (control), 4.85, 6.60 and 8.86 dS m^{-1}, S_1, S_2, S_3 and S_4, respectively.

Results concluded that, the lower germination percentage and rate in calcareous soil at any salinity level compared to sandy soil and also, decreased the mean daily germination in both soils. Soil salinity increased as a result of increasing salinity levels of irrigation water. Easily available water was negatively correlated with increasing water salinity from S_1 to S_4, especially in case of calcareous soil. Same trend was observed in case of soluble cations and anions; especially Na^+ which increased by 121, 285, 610 % and 94, 267, 531 % for S_2, S_3 and S_4 relative to the control, for sandy and calcareous soils, respectively. Increasing water salinity in sandy soil up to 4.85 dS m^{-1} reduces the grain yield by 23 %, while 16 % reduction is found in calcareous soil. The yield reduction increases by increasing salinity of irrigation water and reaches its maximum at 8.86 dSm^{-1} salinity level. Grain yield, was highly significant negative correlated with hardly available water, water salinity and soil EC, while the relations were highly positive with easily available water.

Keywords: Germination, calcareous, water salinity, water constants, yield

INTRODUCTION

Water is one of the limiting factors for agricultural development in developing countries in order to meet the growing demand of the increasing population. So, sea water as sea a potential source could be used for irrigation purposes. Irrigation water varies widely in both salt concentration and the availability of irrigation water depends on the characteristics of both water and soil. **El-Boraie (1997)** found that soil EC values increased with increasing salinity of irrigation water and decreased soil moisture depletion in calcareous soil of Maryut, Egypt. **Dosoky (1999**) found that the increasing of irrigation salinity from 0.58 to 3.67 dS m^{-1} increased total soil salinity from 1.87 to 24.83 dS m^{-1}. Thus the salts accumulation in soil was closely related to the salt concentration of irrigation water. **Zein El-Abedine *et al*. (2004)** found that the soil salinity and alkalinity parameters relatively increased by 195.54 and 360.49 % for EC_e, 174.73 and 280.11 % for SAR as a result of the use of mixed and drainage waters, respectively as compared to those of soils irrigated from canal water. **El-Boraie (1997)** found that soluble Ca^{+2}, Mg^{+2} and Na^{+} increased with increasing salinity level of irrigation water, while soluble K^{+} decreased with increasing salinity levels. But soluble Ca^{+2} and Na^{+} increased with decreasing irrigation frequency, while increasing salinity levels and irrigation frequency decreased the hazardous effects. **Ragab (2001)** studied the use of irrigation water qualities on chemical properties of soil. He observed that, there was a progressive and significant increase in soil salinity values as the salinity of irrigation water increases. Drainage water produced the highest soil salinity values compared to soil of irrigated with canal water.

Padole (1991) studied that, in pot experiment, irrigation with highly saline water (electrical conductivity, EC, 4.2 dS m^{-1}) or highly saline sodic water (EC 4.0 dS m^{-1}) and sodium absorption ratio (SAR, 8.6) significantly reduced yields of wheat. The combined effects of salinity and sodicity were greater than salinity alone. Uptake of N, P, K, Ca, Mg, Zn, Mn, Cu and Fe were reduced by salinity and/or sodicity of soil and irrigation water. Uptake of Na was increased by salinity and/or sodicity except at very high levels.

Wheat, the most important cereal crop, can be classified as a semi tolerant crop to salinity. **Chauhan and Singh (1993)**, in a field experiment studied that on sandy loam of wheat was irrigated with water having salinity levels of 2-16 dS m^{-1}. Seed germination was decreased by salinity levels > 6 dS m^{-1}, while DM and grain yields were decreased by salinity levels of 12 dS m^{-1}. **Soliman *et al*. (1994)**, in a greenhouse experiment, wheat plants in calcareous soil were watered with tap water (0.5 dS m^{-1}) or saline water (4.0, 8.2 and 12.5 dS m^{-1}). All salinity levels reduced straw and grain yields, leaf soluble proteins and grain protein content. Under saline conditions, plant growth is usually reduced by reducing the rate of leaf elongation, enlargement and the division of the cells in the leave **(Allen *et al.,* 1998)**. **Samiha (2006)** concluded that using saline water for irrigation reduced wheat yield by 4.14 and 4.38 % for Sakha 93 and Giza 168 and decreased water consumptive use by 15.02 and 11.93 % for both growing varieties, respectively.

The main objective of this work is to study the effect of irrigation water salinity on some soil properties of the calcareous and sandy soils and to limit the suitable concentration to obtain satisfactory yield of wheat under saline conditions.

MATERIALS AND METHODS

Two experiments were carried out on the soils of two different reclaimed extension areas for two growing seasons at the green house of Agricultural Research Centre. The first one is Torripsamments, sandy with a low calcium carbonate content (1.0 %), from

Nobarya. The second one is a Colciorthid calcareous, sandy loam and highly calcareous ($CaCO_3$ 21.4 %) from Maryout sector. Plastic pots of 25 cm diameter and 30 cm height were used. The bottom of the pots was provided with an out let to discharge the excess water. The pots were filled with 8 kg of soil collected from the upper (30 cm) layer of sandy and calcareous soils.

Germination experiment of wheat grains *Triticum vulgare* L. cv Sakha 8 was carried under different salinity levels of irrigation water in the both soils. Twenty grains were sown in each pot. The saline sea water at 50.8 dS m^{-1} was diluted with tap water to reach the desired concentration. Three salinity levels of irrigation water were prepared (tap water (0.43), 4.85, 6.60 and 8.86 dS m^{-1}, S_1, S_2, S_3 and S_4). Germination response to salinity levels was monitored visually at 24 hr intervals for duration of the germination test. A grain was considered to have germinated if the radical exceeded 2 mm length. Germination period lasted 15 days and soil moisture content was maintained at field capacity by weighting twice a week. During germination test, the total number of germinated grains counted and divided by total number of grain planted into hundred to give final germination percentage and the grains emergence was measured in relation to time. Germination rate was calculated as follows:

$$\text{Germination rate} = N_1 /T_1 + N_2 /T_2 + \ldots\ldots \ldots\ldots N_n/T_n. \qquad (1)$$

Where: N_1 is the number of plant geminated in 1^{st} day,
N_2 is the number of plant geminated in 2^{nd} day,
T_1 is the number of grains emergence in the 1^{st} day,
T_2 is the number of grains emergence in the 1^{st} and 2^{nd} day and
T_n is the number of grains emergence in the all days before.

Pot experiment was carried out to asses the aim mentioned above on the yield and chemical composition of wheat plant. Twenty grains were sown in each pot and the treatments were triplicates. After 15 days, the pots were thinned to 10 seedlings. Irrigation was monitored at 60 % of WHC and leaching requirements was taken place. Nitrogen, Phosphorus and potassium fertilizer was added as per recommendation of Ministry of Agriculture. Throughout the harvest period (growing stage was 137 days); grains and straw yield per pot and seed index (weight of hundred grains) were measured. The characteristics of soil and water used were shown in Tables (1 and 2) and determined after **Rebecca (2004).** N, P, K and Na were estimated in the plant digest after **Cottenie *et al*. (1982)**.

Soil water constant (air volume, storage water, easily available water hardly available water and non-useful water) was measured after **Klute (1986)** as follows:

Air volume (AV) = Saturation % – Field capacity,
Storage water (SW) = Field capacity – wilting point,
Easily available water (EAW) = Field capacity – water content at tension 5 bar,
Hardly available water (HAW) = water content at (tension 5-15 bar) and Non-useful water (NUW) = water content at wilting point.

Table (1): Some physico-chemical characteristics of the studied soil before planting

Physical properties										
Soil types	Particle size distribution (%)				Texture class	OM	$CaCO_3$	SP	FC	WP
	Coarse sand	Fine sand	Silt	Clay		(% wb)				
Sandy	38.36	53.66	3.78	4.20	Sand	0.52	1.00	13.4	9.95	3.20
Calcareous	8.34	59.18	13.78	18.70	Sandy loam	1.32	21.40	31.2	24.21	11.3

Chemical properties									
	EC dS m^{-1}	pH	Soluble ions (meq l^{-1})						SAR
			Ca^{++} + Mg^{++}	Na^{+}	K^{+}	$HCO3^{-}$	Cl^{-}	$SO4^{=}$	
Sandy	0.49	7.86	2.64	1.34	0.43	1.04	1.11	2.26	1.60
Calcareous	2.52	8.27	19.44	6.45	1.22	1.73	2.40	22.98	2.07

OM: organic matter, SP: saturation percent, FC: field capacity, WP: wilting point, EC: in soil paste extract, SAR: sodium adsorption ratio, wb: weight basis

Table (2): Chemical composition of water used for irrigation

EC (dS m^{-1})	**pH**	**Soluble ions (meq l^{-1})**						**SAR**
		Ca^{++} + Mg^{++}	**Na^{+}**	**K^{+}**	**HCO_3^{-}**	**Cl^{-}**	**$SO4^{=}$**	
S_1: 0.43	7.05	3.85	0.73	0.16	1.53	1.92	1.29	0.53
S_2: 4.85	7.27	17.49	25.3	0.42	1.21	39.47	2.53	8.55
S_3: 6.60	7.50	28.76	46.0	0.48	1.31	58.20	15.73	12.14
S_4: 8.86	7.63	39.35	61.2	0.60	1.73	78.65	20.77	13.78

Experiments designs was randomize complete block under one factor (water salinity) and mean values of the obtained data were compared using LSD at 5 % level after **Sndecor and Cochran (1989)**. All obtained data were subjected to statistically analysis according to **SAS program (1995).**

RESULTS AND DISCUSSION

Germination Experiment

Concerning the germination percentage, data presented in Table (3) showed that the increase of irrigation water salinity decreases the final germination percentage in both sandy and calcareous soils. It was higher in sand soil than in calcareous one regardless the salinity level. The statistical analysis indicated that a significant difference between the control treatment (S_1) and three salinity levels used (4.85, 6.60 and 8.86 dS m^{-1}) in sandy and calcareous soil, but there is no significant difference between S_2 and S_3 in both soils.

Considering the number of days required to reach the final germination, the obtained data showed that the salinity levels has no effect in the calcareous soil as well as the final germination percentage was after 15 days from sowing in all treatments. In calcareous soil, 90 % from planted grains were germinated after 12 days (7d) under control treatment, while this percentage varied between 80 % (d6), 80% (d9) and 76 % (d10) at S_2, S_3 and S_4, respectively. This may be due to toxic effect of Na^+ and Cl^- which increases in soil solution with increasing salinity.

Table (3): Effect of water salinity and soil types on germinated percent of wheat plant

Counting days (d)	Water salinity (dS m^{-1})							
	S_1: 0.43	S_2: 4.85	S_3: 6.60	S_4: 8.86	S_1: 0.43	S_2: 4.85	S_3: 6.60	S_4: 8.86
	Sandy soil				Calcareous soil			
D1	82.2	53.3	47.3	27.1	61.0	15.2	21.9	12.1
D2	91.0	64.8	62.3	51.5	72.1	26.7	36.9	19.4
D3	95.7	77.0	73.3	65.0	79.6	46.0	52.5	31.5
D4	97.0	79.6	79.6	70.0	86.0	69.6	69.1	51.0
D5	97.3	82.1	84.2	74.2	88.5	77.1	73.2	59.6
D6	97.3	84.6	86.0	76.0	88.6	79.6	74.9	62.7
D7	97.3	84.6	87.3	77.9	90.2	84.4	77.7	68.3
D8	97.3	86.5	87.3	78.9	90.8	86.7	79.1	72.5
D9	97.3	88.3	87.3	78.9	92.5	86.7	80.3	73.3
D10	97.3	88.8	87.3	80.4	92.9	87.7	80.7	76.3
Germination %	95.0	79.0	78.2	68.0	84.2	66.0	64.6	52. 7
Germination rate	0.98	0.89	0.88	0.81	0.93	0.88	0.81	0.77

LSD 5% germination % and germination rate were 1.3, 2.4 and 0.03, 0.05 for sandy and calcareous, respectively.

On the other hand, in sandy soil there is an early germination at low salinity level (S_1) compare to the higher ones. The number of days required to reach the final germination percentage, were 10, 12, 13 and 15 days for control, S_2, S_3 and S_4 treatments, respectively. These findings confirmed that the gradual increments in salt content of irrigation water not only negatively influenced the wheat germination but also delay it. Result also, indicated that increasing salinity of irrigation water decreases the mean daily germination of wheat in sandy and calcareous soils. This effect is more pronounced in sandy soil. **Othman *et al.* (2006)** stated that seed germination significantly decreased by salinity levels of irrigation water. To avoid postpone germination when saline water used under experimental condition, it could prefer exist another source of fresh water to be used during this stage.

Regarding the effect of water salinity levels on germination rate, Table1 showed that increasing water salinity was associated with decreasing germination rate in both studied soil. The highest and lowest soil EC values were recorded after S_1 and S_2 under sandy and calcareous soils, respectively. This finding was in agreement with those obtained by **Ebtisam (2007)** who found that water salinity is more pronounced effect on germination than soil salinity.

Effect of Irrigation Water Salinity on Some Chemical Properties of Soil

Data in Table (4) showed that irrigation with saline water increases the total soluble salts in the soil. Soil electrical conductivity increased as a result of increasing salinity levels of irrigation water, it is more pronounced in calcareous soils. This may be due to the great surface area of the fine particles, which adsorb more soluble and exchangeable cations of saline solution. This finding is in agreement with those obtained by **Abd El-Nour (1989),** who found that the significant increases in soil EC was proportional to the salts concentration in the irrigation water. The highest value were 1.99 and 5.38 dS m^{-1} for S_4 treatment and the lowest one is found for S_1 control treatment (0.41 and 1.89 dS m^{-1}) in sandy and calcareous soil, respectively. The concentration of soluble calcium plus magnesium in sandy and calcareous soil increased as a result of irrigation with saline solution. The highest value is found for the treatment of S_4 while the lowest one is found for control treatment (S_1). The calcium plus magnesium ions, as compared with control one, increased by 120, 188 and 286 % in sandy soil, respectively. The salinity treatments in calcareous soil increased soluble calcium plus magnesium by 30, 78 and 110 % as compared with control one, respectively. Soluble sodium content in the studied soil is increased by increasing sodium content in irrigation water, (Table 4). In sandy soil treatment, the rate of increase in the soluble sodium content was rather lower than that of the sandy loam one. This could be attributed to the higher adsorption capacity of sodium by the latter soil than by the former one. This is probably due to the fact that the cation exchange capacity of the sandy soil is appreciably lower than that of the calcareous soil.

Soluble sodium content in the studied soil is increased by increasing sodium content in irrigation water. The highest value is found for the 8.86 dS m^{-1} treatments (S_4), while the lowest one is found for control (S_1). The soluble sodium ions, as compared with control one, increased by 121, 285 and 610 % in sandy soil and 94, 267 and 531 % in calcareous, respectively. Increasing salinity levels of irrigation water showed significant effect on potassium and bicarbonate content in the studied soil.

The content of chloride ions in the sand soil increase by increasing the salinity levels of irrigation water. The highest value is found for the S_4 treatment and the lowest one is found for control (S_1). The salinity treatments, as compared with control one, increased by 156, 262 and 466 %, respectively. In calcareous soil, there is significant effect between salinity treatments and Cl^{-1} content in soil over control. The highest value is found for the S_4 treatment (33.21 meq l^{-1}) and the lowest one is found for control treatment (12.54 meq l^{-1}).

Table (4): Effect of water salinity on some chemical properties of sandy and calcareous soils at wheat harvest

Water salinity dS m^{-1}	pH	EC dS m^{-1}	Soluble ions (meq l-1)						SAR
			Ca^{++} + Mg^{++}	Na^{+}	K^{+}	$HCO3^{-}$	Cl^{-}	$SO4^{=}$	
Sandy soil									
S_1: 0.43	7.80	0.41	2.10	1.62	0.39	0.38	2.28	1.45	1.58
S_2: 4.85	7.86	0.88	4.61	3.58	0.45	0.57	5.84	2.23	2.36
S_3: 6.60	7.91	1.26	6.04	6.24	0.34	0.71	8.26	3.65	3.59
S_4: 8.86	7.90	1.99	8.11	11.50	0.26	0.94	12.91	6.02	5.71
LSD 0.05	0.08	0.24	1.36	1.18	0.06	0.07	1.19	0.78	1.34
Calcareous soil									
S_1: 0.43	8.81	1.89	14.06	3.73	0.84	1.74	12.54	4.35	1.41
S_2: 4.85	8.26	2.64	18.25	7.25	0.93	1.61	19.34	5.48	2.40
S_3: 6.60	8.32	3.95	25.04	13.68	0.75	1.64	26.83	11.00	3.87
S_4: 8.86	8.32	5.38	29.57	23.52	0.68	1.74	33.21	18.82	6.12
LSD 0.05	0.13	1.25	2.41	2.54	0.05	0.03	3.45	1.09	0.78

Continuous increases in sulfate contents are attained by increase of the levels of irrigation water salinity in both soils. This could be attributed to the fact that saline solutions increase the solubility of none readily soluble sulfates in soil media. The highest value is found for the S_4 treatment while the lowest one is found for control treatment. The salinity treatments in calcareous soil, as compared with control one, increased by 26, 153 and 333 %, respectively. **Hassanein *et al.* (1993)** found that the distribution and concentration of most cations and anions were increased with increasing salt concentration in irrigation water.

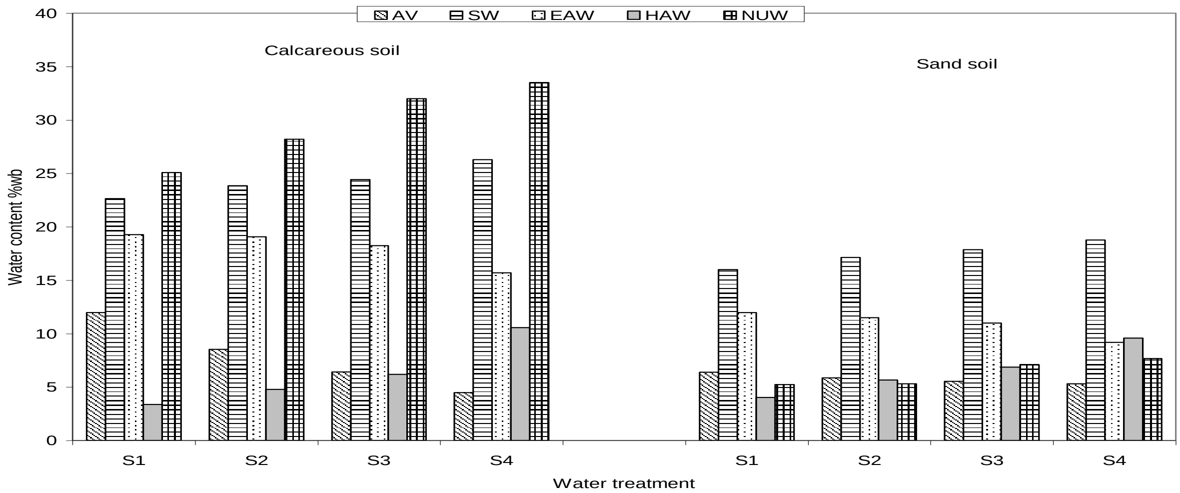
The irrigation with saline water seems to increase SAR in sand soil. The percent of increases were showed the highest values for SAR 5.71 obtained with S_4 treatment comparing with other treatments. The percent of increases were the highest values for SAR 334 % over the control obtained with S_4 treatment comparing with those obtained with S_2 treatment (70 %) in calcareous soil.

Soil Water Constants

The calcareous soil of Maryout however, shows that the moisture content decreases gradually with increasing the applied pressure as expected for heavy textured soils. Figure (1) illustrates moisture content at different suction expressed in type of water in soil under two studied soils after wheat harvested. Results showed that water stored in calcareous soil increased with increasing water salinity by 5, 8 and 16 % after water salinity 4.85, 6.60 and 8.86 dS m^{-1} as compare with control treatment (tap water), respectively. The same trend was obtained in moisture content at non-useful water (NUW) one with increment percentage 9, 24 and 29 % in the same sequence mentioned. One can notice that the increase in storage water (SW) after using salinity water led to increase in NUW due to the salt resulted from irrigation water at the end of the season. According to the easily available water (EAW), which retained between 0.3 and 15.0 bars, there were significant difference between water treatments at 5 % level except between control and 4.85 dS m^{-1} water salinity.

There was a negative relation between EAW and water salinity where increasing water salinity led to decrease in EAW by 1, 5 and 22 % after water salinity S_2, S_3 and S_4 as compare with control treatment (tap water). The opposite trend was true in case of hardly available water (HAW) which increases with water salinity increased with values 40, 48 and 212 % after water salinity 4.85, 6.60 and 8.86 dS m^{-1} relative to control, respectively. This result may be due to increase salt content relative to water treatment especially Na^+ which characterized by its large hydration layer as compared with the other divalent cations (Ca^{++} + Mg^{++}). Regardless the water retained in soil, air volume plays an important role in root respiration and gas diffusion in root zone. Results noticed that increasing water salinity from S_2, S_3 and S_4 decrease air volume by 28.8 and 62.6 as compared with control one, respectively. This finding may be due to salt accumulation in soil and quickly break down soil structure which noticed in calcareous soil (**FAO, 2002**).

According to the sand soil, soil moisture retained in different suction after harvest of wheat was shown in Fig. (1). Data show that water stored in soil associated with increasing water salinity and the increase were 7, 12 an 17 % after water salinity S_2, S_3 and S_4 dS m^{-1} as compare with control one, respectively. Also, water contents in sand soil in case of NUW were 1, 37 and 47 % as compared with untreated one. While, increasing water salinity accompanied with decreasing EAW where the highest and lowest value were observed under control (12 %) and water salinity 8.86 dSm^{-1} (9 %). The decreasing in EAW contents were 4, 8 and 23 % after water salinity S_2, S_3 and S_4 as compare with control one, respectively.



AV: air volume, SW: stored water, EAW: easily available water, HAW: hard available water, NUW: non-useful water

LSD 5% for sand soil AV= 0.12, SW= 0.35, EAW= 0.21, HAW=1.14, NUW= 0.13

LSD 5% for calcareous soil AV= 1.32, SW= 1.25, EAW= 1.15, HAW=1.02, NUW= 2.27

Fig. (1) Effect of water salinity on phases of soil water (%) in the studied soils

NUW increase was in geometric sequence with increasing water salinity by 40, 71 and 138 % relative to control treatment after water salinity 4.85, 6.60 and 8.86 dS m^{-1}, respectively. With respect to air volume, there were significant differences among water salinity treatment at 5% level. There were decreasing in air volume associated with increasing water salinity 4.85, 6.60 and 8.86 dS m^{-1} by 9, 14 and 17 % as compared with control one, respectively. There were highly significant correlation coefficients were attained between water salinity from side and SW, EAW, HAW and NUW with r values -0.382*, -0.493**, 0.767** and 0.257*, respectively.

Effect of Irrigation Water Salinity on Some Macronutrients Uptake

The obtained results in Table (5) showed that N, P and K/Na uptake by wheat grown soil was significantly affected by water salinity and soil types.

The maximum N uptake values by grains (695.7 and 1456.3 mg pot^{-1}) were found in sandy and calcareous soil under S_3 level. This may be due to increasing of plant ability for nitrogen absorption up to 6.60 dS m^{-1} and the minimum was observed at the higher water salinity level (S_4). This is because higher salinity may affect different metabolic processes such as protein synthesis. The concentrations of soluble salts through their high osmotic pressures affect plant growth by restricting the uptake of water by plant roots. High salinity can also cause nutrient imbalances **(Abou El-Nour, 2005)**. **El-Leboudi *et al.* (1997)** found that increasing salinity reduced the content of free amino acids in wheat as a result of decreasing nitrate reeducates activity that plays an important role in conversion of nitrate to ammonium.

Table (5): Effect of water salinity on N, P, K and Na uptake at wheat harvest

Water salinity (dS m^{-1})	Macronutrients (mg pot^{-1}) in grain					Macronutrients (mg pot^{-1}) in straw				
	N	P	K	Na	K/Na	N	P	K	Na	K/Na
Sandy soil										
S_1: 0.43	564.5	148.6	231.7	47.5	4.88	320.6	104.2	849.7	272.6	3.12
S_2: 4.85	675.0	128.6	192.9	50.5	3.82	481.0	91.9	983.3	456.3	2.15
S_3: 6.60	695.7	165.3	252.3	82.7	3.05	450.6	100.1	913.7	572.6	1.60
S_4: 8.86	504.0	130.7	186.7	56.0	3.33	371.8	88.5	829.3	475.1	1.75
LSD (5%)	36.2	15.1	33.7	2.2	6.27	41.6	2.1	30.2	22.8	0.11
Calcareous soil										
S_1: 0.43	1120.8	247.5	458.5	80.1	5.72	1167.8	424.6	1129.2	685.2	1.65
S_2: 4.85	1266.3	267.9	541.8	97.4	5.56	1163.5	398.9	1437.8	681.5	2.11
S_3: 6.60	1456.3	446.3	581.3	158.5	3.67	1130.6	363.2	1164.9	722.9	1.61
S_4: 8.86	993.4	350.4	309.2	115.4	2.68	1063.7	311.8	1051.5	559.4	1.88
LSD (5%)	210.5	23.6	15.6	6.2	0.97	25.3	29.8	37.8	31.7	0.13

Phosphorus uptake in grain increased by 11 and 80 % at S_3 level over control treatment both sand and calcareous soil, respectively. While the lowest P uptake values (88.5 and 311.8 mg pot^{-1}) by straw were obtained in sand and calcareous soil under S_4. Also, the increase in P uptake was observed up to S_3 salinity level and after that decreased under higher salinity level (S_4). Results in Table (5) revealed that K: Na ratio of wheat plants were affected by water salinity levels and soil types. The obtained results showed a substantial decrease in K:Na ratio was observed with increasing water salinity. **Leight *et al.* (1988)** reported that wheat plants containing chromosome 4D were able to maintain high K: Na ratio when grown under saline condition. The highest K:Na ratio values in grains (4.88 and 5.72) were found in sandy and calcareous soil under S_1 level and the lowest were obtained under higher salinity levels. **Ahsan *et al.* (1996)** found that salt-tolerant lines had significantly lower accumulation of Na in the leaves and higher K/Na ratio than salt-sensitive lines. **Tester and Davenport (2003)** reported that metabolic toxicity of Na^+ is largely a result of its ability to compete with K^+ for binding sites essential for cellular function.

Effect of Irrigation Water Salinity on Yield Parameters of Wheat

Results in Table (6) revealed that irrigation water salinity significantly affected weight of 100 grains and finally grain and straw yields. The obtained data showed that increasing the irrigation water salinity decreases the weight of 100 grains. The magnitude of this decrease depends on salinity level. The lower the salinity level, the higher is the weight of 100 grains and vice versa. The statistical analysis shows a significant difference between the treatments of low salinity level (S_1) and that of highest one (S_4) in both studied soils.

Table (6): Effect of water salinity and soil types on yield parameters of wheat plants

Water salinity (dS m^{-1})	Sandy soil			Calcareous soil		
	100 grain wt (g)	Grain/pot	Straw/pot	100 grain wt (g)	Grain/pot	Straw/pot
S_1: 0.43	4.46	59.42	80.16	4.71	72.78	96.51
S_2: 4.85	3.73	45.92	70.74	4.51	60.88	83.11
S_3: 6.60	3.61	43.50	62.58	3.58	58.72	68.52
S_4: 8.86	2.93	37.33	59.02	3.07	41.22	61.13
LSD (5%)	0.21	1.25	3.07	0.18	1.55	3.24

The obtained data show that increasing irrigation water salinity drastically decreases the grain yield per pot. The statistical analysis showed that increasing irrigation water salinity above 0.43 dS m^{-1} (control) significantly decreases the grain yield per pot. Increasing water salinity in sandy soil up to 4.85 dS m^{-1} reduces the grain yield by about 23 %, while to 16 % reduction is found in calcareous soil. The yield reduction increases by increasing irrigation water salinity and reaches its maximum at 8.86 dS m^{-1} salinity level. The excessive salt appears to affect the growth and wheat yield by restricting nutrients uptake to extent that a deficiency take place. This may be due to a possibility that plants grown under saline condition utilize energy for osmotic adjustment process at the expense of growth and the most important factor which is the high soil water potential, hence the water flow from soil to plant is very much limited under saline conditions.

The obtained data showed similar trend as it previously found in the case of grain yield per pot. Generally, the straw yield significantly decreases by increasing irrigation water salinity above S_1 (control). The minimum value of straw yield is found in the treatment of S_4 salinity level and the maximum one is at the lowest salinity level in the two soils and during the two seasons. The responses of wheat grain and straw yields were negatively and highly correlated with soil salinity and in particular with the mean soil salinity in the top 50 cm **(El-Morsy *et al.*, 1993**). They added that the partial regression showed that most of the yield variations under soil salinity are mainly due to the total soluble salts rather than specific ions effect. Also, **Zein *et al.* (2003)** found that wheat grain and straw yields as well as plant height, spike length, and 1000 grain weight were significantly affected by increasing irrigation water salinity.

Table (7) illustrates the simple correlations between wheat yield components and EAV, HAW, Ws treatments and soil salinity under both studied soils. Data revealed that K/Na in grain is highly positive significant with EAW and negatively with HAW one in both soils. Also, one can notice that there were negatively significant correlations between water salinity and soil EC with K/Na ratio in wheat grain in both soils. According to the wheat yield of grain highly significant negative correlations were observed with HAW, water salinity and soil EC, while the relations were highly positive with EAW. Same trend was attained in case of seed index (SI) under investigated soils.

Table (7): Simple correlation among some studied parameters

Parameter	K/Na grain	K/Na straw	Grain	Straw	SI
Sandy soil					
EAW	0.602**	0.584*	0.789**	0.816**	0.982**
HAW	-0.703**	-0.682**	-0.871**	-0.882**	0.948**
Ws	-0.937**	-0.919**	-0.994**	-0.987**	-0.981**
Soil EC	-0.812**	-0.795**	-0.931**	-0.949**	-0.976**
Calcareous soil					
EAW	0.839**	0.976**	0.976**	0.888**	0.926**
HAW	0.735**	-0.989**	-0.989**	-0.956**	-0.957**
Ws	-0.536*	-0.946**	-0.946**	-0.981**	-0.911**
Soil EC	-0.725**	-0.972**	-0.972**	-0.955**	-0.976**

SI: Seed index (weight of 100 grains), EAW: easily available water, HAW: hardly available water, Ws: water salinity

Multi regression equations were estimated from obtained data to asses the close relations between grain, straw and K/Na as independent variable with water salinity and soil EC as dependent ones in both studied soils.

In sandy Soil:

Grain yield = 59.34 – 3.17 Water salinity + 3.21 Soil salinity 0.993 ***

Straw yield = 81.76 – 2.46 Water salinity – 0.76 Soil salinity 0.975 ***

In calcareous soil:

Grain = 83.22 – 1.34 Water salinity – 5.17 Soil salinity 0.936 ***

Straw = 105.53 – 2.55 Water salinity – 4.33 Soil salinity 0.982 ***

In both soils for grain:

K/Na (sand) = 4.63 – 4.21 Water salinity + 1.19 Soil salinity 0.929 ***

K/Na (calcareous) = 8.05 + 0.16 Water salinity – 1.29 Soil salinity 0.976 ***

From the above mentioned, one can notice that grain yield is more affected by both water and soil salinity in sandy soil than in calcareous one. The opposite was true in case of straw. Also calcareous soil has a pronounced effect on increasing K/Na ratio than in sandy one. This may be due to its ability to retain and absorbs more salts than in sandy soil.

CONCLUSION

Using low water quality will take place in new decades, especially in new reclaimed areas. Coarse texture soils such as sandy are preferred. Since reduce time of contact between salty irrigation water and soil particles are needed. Also, grown plants under this condition mustn't expose to water and /or salt stress which have harmful effect on different growing stages and plant growth. To maximize yield production under this condition, avoid bad effect of water salinity during germination stage is necessary through exist another source of fresh to over come decreasing in germination percentage and help seedlings as to be grow strongly and tolerant in next stages.

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