Effect of Irrigation Water Salinity on Some Soil Properties and Wheat Yield in Egypt

Mashali*, S; A. Balba ; E. Alwakil, and R. Atia

Abstract

Wheat plant (*Triticum aestivum*, sakha-8) was grown in pot experiment to study the effect of salinity levels and salt composition of irrigation water with and without N fertilization on soil chemical properties and grain yield of wheat plant.

Therefore surface soil samples of nonsaline silty clay loam soil was used. Tap water was salinized to be as natural irrigation water in the studied region using mixture of $CaCl_2$, $MgCl_2$ and NaCl at different ratios. Three salinity levels were prepared from different mixture to give nine type of irrigation water and tap water was used as control treatment.

Soil salinity after plant harvesting increased with increasing water salinity up to 12.70 dS/m compared with it before planting (2.23 dS/m) or after harvesting using irrigation with good water (2-79dS/m).On the other side, soil reaction (pH) decreased from 8.17 to 7.65 with increasing water salinity. Values of sodium adsorption ratio (SAR) for soil solution also increased from 3.65 up to 11.24 and soil exchangeable sodium percentage (ESP) was correlated with soil SAR, where it increased from 4.24 to 11.91%. Soil content of available N and P almost decreased with increasing water salinity after plant harvesting.

The results indicated that, the grain yield was significantly decreased either with increasing salinity levels or Na concentration in irrigation water used. This effect was decreased with added-N, where grain yield was increased by about 2 to 3 fold compared with it without N fertilization under this conditions. Grain content of Na was increased to give less quality of grain yield. Plant uptake of Na decreased with increasing levels of added –N.

Key words: Irrigation water salinity, wheat yield, soil salinity, soil reaction, SAR and ESP.

Introduction:

Because of agriculture in Egypt depends on irrigation water and irrigation water resources are limited, the policy of the Government is to use drainage water directly for irrigation where its salinity is less than 700 mg/L; to mix 1:1 or 1:2 or 1:3 with the Nile water if its concentration is more than 700 or 1500 or 3000 mg/L (Abu Zeid, 1988). Utilization of this water would significantly increase irrigated areas and hence crop production. The quality of irrigation water and irrigation practices are very important factors contributing to salinity and alkalinity control. Abd El-Salam and Sarhan (1999) found that the increasing N levels increased wheat growth, wheat yield and the uptake of N, P and K when irrigation water had more salinity and alkalinity. Therefore, the aim of this study was to investigate the changes in chemical soil properties and wheat yield as a result to use different type of saline water for irrigation with and without N-fertilization.

Materials and Methods :

Surface soil sample (0 – 20 cm) of nonsaline silty clay loam soil (EC_e = 2.23 dS/m & 11% sand, 47% silt and 42% clay) from Kafr El-sheikh Governorate of Egypt was collected (Figure 1).

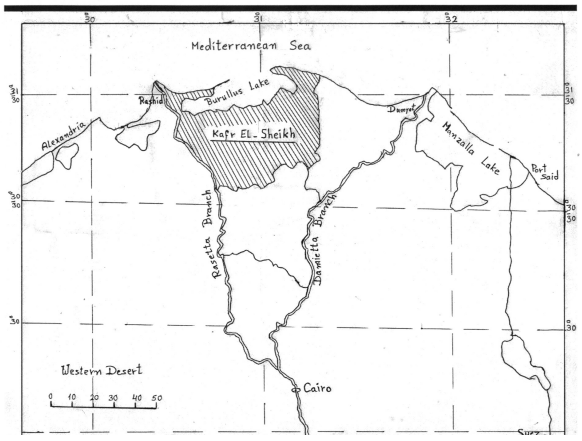

Fig. (1): Location of the studied area.

Soil pH was 8.17 (1:2.5 soil suspension) and had 21 and 99 mg/kg of available P and N, respectively. Irrigation water used was Salinized to be as natural irrigation water in the studied region using a base of tap water (W_0C_0) by mixture of $CaCl_2$, $MgCl_2.6H_2O$ and NaCl at the ratios of 1:1:1 (W_1), 1:1:2 (W_2) and 1:2:6 (W_3), respectively.. Three salinity levels [25 (C_1), 50 (C_2) and (C_3) 75 meq/L] were prepared from different mixture to give 9 nime types of irrigation water and compared with tap water (4.27meq/L)

A factorial greenhouse pot experiment was carried out using 4 kg of air dried soil per pot with 15 grains of wheat per pot. The pots were irrigated with the corresponding water salinity treatment at 90% of saturation capacity until 15 days before harvesting. Four levels of N(0, 72, 144 and 216 kg N/ha) from urea in 2 equal doses were added. All treatments were replicated 3 times and fertilized with KH_2PO_4 in solution form equivalent to 36 Kg P_2O_5 and 24 kg k_2O/ha, where total treatment were 40 to give 120 pots. The plants were harvested after maturity and grain weight was recorded. Samples of grain were digested by mixture of H_2SO_4 and $HCLO_4$ (10:1) according to Chapman and Pratt (1961) and N, P, K and Na were determined according to Page *et al*., 1984.

Soil reaction (pH)., Soil salinity (EC), soluble cations (Na, Ca and Mg) were measured in soil solution and SAR was calculated for treated soil after harvesting. Exchangeable sodium percentage (ESP) was calculated from SAR values according to the following equation:

% ESP= 0.56 + 1.01 SAR (Shams and Abou El-khir, 1996)

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Results and Discussion :

Changes in soil properties :

Table (1) shows that saline water increased soil salinity (EC) after plant harvesting in all treatments from 2.79 up to 12.69 dS/m. Values of EC for irrigated soil clearly increased with increasing salinity water used but the difference between water composition was not clear. That means, the importance effect of total water salinity of irrigation water. On the other side, table (1) disclose that values of soil reaction (pH) decreased with increasing salinity levels (e.g., from 8.16 to 7.65).

Table (1): Effect of salinity levels, salt composition of irrigation water and nitrogen fertilization on EC of soil solution (soil paste) and soil pH after wheat harvest

Treatments		EC (dS/M)					pH (1:2.5 soil suspension)				
Water quality	salinity level	N_0	N_1	n_2	N_3	Mean	N_0	N_1	n_2	N_3	Mean
W_0	C_0	2.79	2.81	2.71	2.84	2.79	8.14	8.17	8.18	8.17	8.16
W_1	C_1	7.53	7.54	7.59	7.61	7.57	7.85	7.84	7.84	7.85	7.85
	C_2	10.33	10.35	10.28	10.36	10.33	7.73	7.73	7.74	7.72	7.73
	C_3	12.66	12.67	12.69	12.72	12.69	7.68	7.66	7.65	7.62	7.65
W_2	C_1	7.30	7.32	7.39	7.33	7.34	7.83	7.83	7.84	7.86	7.84
	C_2	10.27	10.32	10.28	10.30	10.29	7.85	7.85	7.85	7.88	7.86
	C_3	12.60	12.56	12.61	12.68	12.61	7.86	7.83	7.78	7.78	7.81
W_3	C_1	7.04	7.07	7.02	7.00	7.06	7.88	7.82	7.86	7.96	7.88
	C_2	10.04	10.01	9.96	9.92	9.98	7.89	7.91	7.96	7.96	7.93
	C_3	12.51	12.46	12.50	12.36	12.46	7.90	7.97	7.97	8.00	7.96

The mean values of calculated SAR after plant harvesting increased from 3.65 up to 11.24 as shown in Fig. (2) with increasing sodium concentration in irrigation water used.

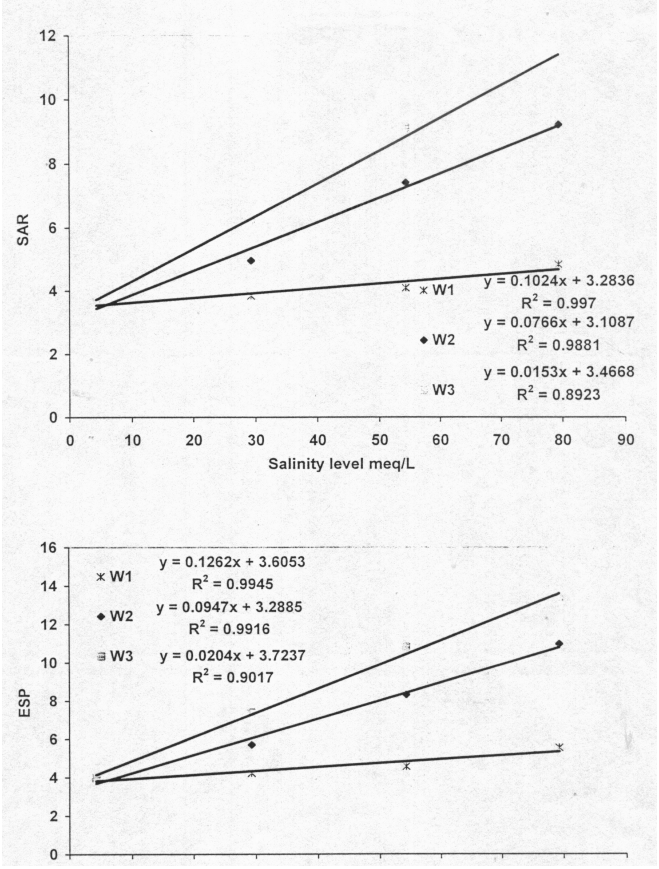

Fig. (2): Effect of salinity levels of different irrigation water on SAR and ESP of soil after harvesting

The difference in SAR values were pronounced with the third type of irrigation water which contains ratio of 1:2:6 from $CaCl_2$, $MgCl_2$. $6H_2O$ and NaCl respectively. The calculated ESP was correlated with SAR values of irrigated soil after harvesting (Fig. 2). These results were in agreement with Amer *et al* (1997), they reported That the poor quality of irrigation water caused more soil salinity and alkalinity.

The results tabulated in Table (2) show that, the available N and P of the soil used after harvesting almost decreased with increasing salinity levels of irrigation water (available N from 99 to 67 mg/kg and available P from 21 to 15 mg/kg). Decreasing in available N may be due to ion exchange and increased N uptake by wheat plant under soil salinity, and the decrease in available P almost attribute to increasing soluble Ca and hence precipitated Ca – phosphate Compound (Mashali *et al*.,1995)

Table (2): Soil content of available N and P after wheat harvesting as affected by salinity levels and salt concentration of irrigation water.

Treatments		Available-N, mg N/kg soil					Available-P, mg P/kg soil				
Water quality	Salinity level	N_0	N_1	N_2	N_3	Mean	N_0	N_1	N_2	N_3	Mean
W_0	C_0	99	92	88	81	90	29	28	26	24	27
W_1	C_1	99	91	84	81	89	28	27	25	24	26
	C_2	84	81	78	77	80	27	26	24	23	25
	C_2	81	77	74	73	76	26	24	24	20	24
Mean		88	83	79	77	82	27	26	24	22	25
W_2	C_1	98	90	80	78	87	25	24	21	20	23
	C_2	81	77	77	70	76	19	18	17	16	18
	C_2	76	72	67	67	71	17	17	16	15	16
Mean		86	80	75	72	78	20	20	18	17	19
W_3	C_1	85	84	84	77	83	26	23	22	20	23
	C_2	83	81	81	74	80	22	22	20	19	21
	C_2	79	77	76	72	76	19	19	18	17	18
Mean		82	74	81	74	80	22	21	20	19	20

Wheat yield :

Figure (3) show that, the grain yield of wheat plant significantly reduced by raising the levels of water salinity where the percentage of this decrease was, 10, 20 and 30% when irrigation water had, 25,50 and 75 mg/L of salts and salts ratio was 1:1:1 compared with control treatment and without added-N. Salinity water generally have a bad effect on plant growth through its influence on several facets of plant metabolism like osmotic adjustment, ions uptake, protein, nucleic acids synthesis, enzyme activities and hormonal balance in plant (Abou El–Soud,1987)

On the other side, the addition of three units of N/ha increased grain yield by 300, 330 and 385% using C_1, C_2 and C_3 of W_1, respectively compared with it without added-N. These results indicate that the addition of N fertilizer under these conditions of water salinity rising plant tolerance to salinity and sodicity, where the grain content of Na decreased with increasing levels of added–N. Salinity level of water type had more effect on grain yield than the different ratio of salt concentration for water type. The mean values of grain yield were 10.2, 10.32 and 10.16 g/pot for W_1, W_2 and W_3, respectively compared with 11.25 g/pot for control treatment (W_0).

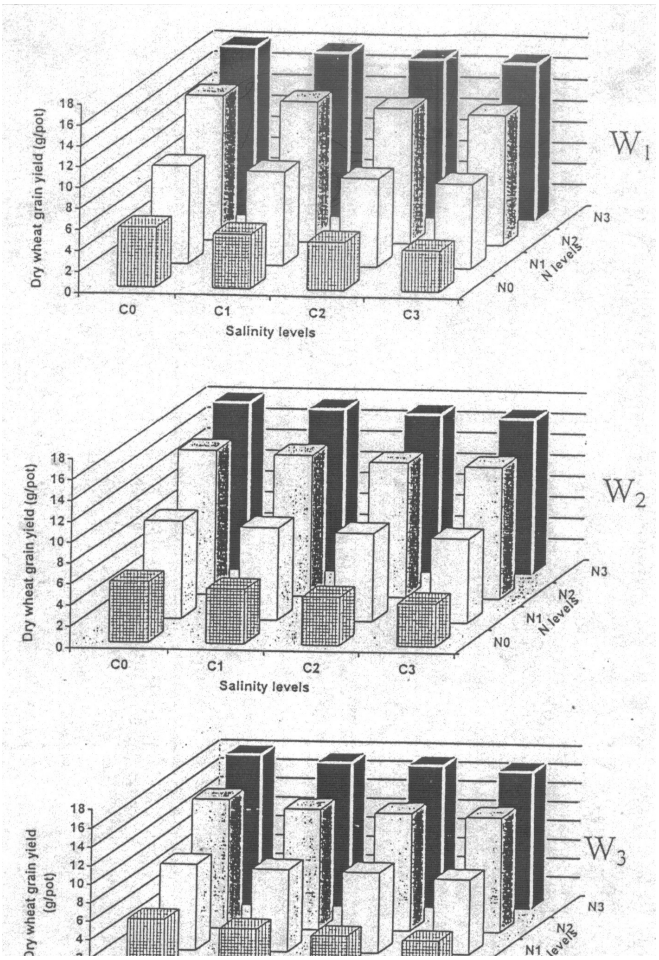

Fig. (3): Grain yield of wheat plant as affected by salinity levels of irrigation water and N levels.

Plant analysis shows that Na concentration of wheat grain increased as a function of salinity and SAR of irrigation water qualities and this lead to decreasing plant content of K,P and N (Fig. 4). Sodium concentration decreased from 0.14% to 0.06% when N added by 3 units using W_1 of irrigation water.

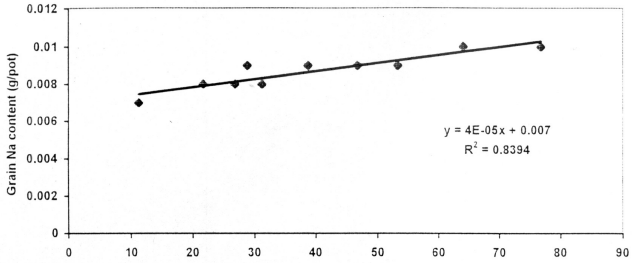

Fig. (4): The correlation between soluble Na^+ in soil solution and wheat grain after plant harvesting

Conclusion

The present study indicated that, in case of, shortage supply by good quality of irrigation water the farmers can use the other sources of water which have less quality but this is under limited circumstances. Soil texture, composition of irrigation water, climatic region and growing plant are important factors to use the irrigation water. Addition of N fertilizer rise plant tolerance to salinity and sodicity effect of irrigation water, where nitrogen fertilizer increases plant growth and hence photosynthetic area,

Under moderately and heavy textures of Egyptian soil, must be not use water salinity for irrigation more than 50 meq/L (5dS/m) where the decrease in grain weight yield was economically increase under any addition of N fertilizer.

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