Influence of Irrigation with Saline Water on Yield and Nutrients Uptake of Wheat Plant Grown in Sandy and Sandy Loam Soils

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ABSTRACT

This study was carried out using two soil types of West Delta region, Egypt, at El-Bostan (sandy soil) and North El-Tahrir (sandy loam soil). A two-pot experiment at greenhouse had done through two years 2006 and 2007. The saline irrigation water consists of NaCl, $CaCl_2$ and their mixture (1:1), and added them by 4 doses, (0, 0.1, 0.2, 0.3 and 0.4 M/L). The aim of this study attained the effect of irrigation with saline water on nutrients uptake and production of wheat (*Triticum aestivum* L.) Sakha8.

The obtained results indicated when increase levels of salts in irrigation water, soil pH and EC had positively increased, while the nutrients available in soils or uptake were decrease. Therefore, the plant growth and production of wheat had decreased. The NaCl salt had the highest negative effect on nutrients uptake and production of wheat, and $CaCl_2$ salt had the lowest, while the mixture salts had moderate effect. The suitable level range of NaCl salt was 0.1-0.2M/L and 0.1-0.3M/L for $CaCl_2$ salt, which achieved economic yield of wheat. The critical level of salinity was 0.3M/L of NaCl salt and 0.4M/L of $CaCl_2$ salt, which caused high decrease in yield and damage in soil properties. The grain yields of wheat at rate 0.4M/L of NaCl and $CaCl_2$ was 0.33 and 0.51 Ton/Fed respectively, while it was 1.36 Ton/Fed at the control treatment.

INTRODUCTION

The most important factor threatening agricultural land is salinity. Water of EC<0.75 dS/m has no detrimental, 0.75-1.5 dS/m was detrimental effect on sensitive crops, 1.5-3.0 dS/m was require careful management practices, and 3.0-7.5 dS/m was used only for salt tolerant plants (Gary and Delno 2004). Plant growth and dry-matter decreased by increasing application doses of NaCl, $NaNO_3$, Na_2SO_4 and mixture salts. The NaCl had the highest negative effect on dry-matter, but Na_2SO_4 had the lowest, (Aydin et al 2001). Vijay et al. (2006) reported that increasing salinity reduced yield of sugarcane. El-Agrodi et al (2005) showed that raising soil salinity level from (0-0.2%) caused an increase in root dry weight, while soil salinity levels above 0.2% had high significantly decrease on root dry weight.

Concerning to effect of salinity on behavior of nutrients uptake Aydin et al (2001) observed that saline water with high Na content decreased K content in wheat plants. N, P, Mn, Zn and Cu content of plants increased by increasing doses of Na-salts with 0.5% Na salts and generally decreased after that. Mass (1988) stated that wheat is a tolerant crop. Alice et al (2002) stressed that excess salt increases the osmotic pressure of the soil water and produce conditions that keep the roots from absorbing water and nutrients. The objective of this study achieved economic yield of wheat (Sakha8) under irrigated of different saline water in recently reclaiming soils conditions of West Delta.

MATERIALS AND METHODS

Two pot experiments were conducted in greenhouse at the El-Bostan as sandy soils and North El-Tahrir as sandy loam soils during 2006 and 2007 years. Wheat variety (*Triticum aestivum* L.) was Sakha8. The used soils were collected from 0-30 cm depth, air-dried, and passed through 2 mm-sieves. Twenty-kg of each soil were placed in a plastic pot (33cm height and 24cm wide diameter). P as superphosphate (8gP_2O_5/pot) added to each pot thoroughly mixed with the soil during seedbed preparation. The amount applied of N as $(NH4)_2SO_4$ and K as K_2SO_4 were10 and 4g for each pot respectively, and applied their three equal doses after 15, 30 and 75 days from sowing. Seeds of wheat were sown in each pot as randomized application and then soil in each pot was irrigated with enough water to keep wet enough to sustain a satisfactory seed germination.

The uses of salts were NaCl, $CaCl_2$ and their mixtures as ratio (1:1). The levels of each salt were 0.1, 0.2, 0.3, and 0.4 M/L, which applied with irrigation water. The EC values of saline water were 2.35, 4.73, 7.13 and 9.45 dS/m for rates of NaCl salt, 1.86, 2.52, 3.78 and 5.28 dS/m for rates of $CaCl_2$ salt, and 2.18, 3.75, 5.56 and 7.48 dS/m for rates of mixed salt respectively. The EC of control water was 0.55dS/m. The saline water initial used at seedling emergence, after 3 days of planting. The plant samples had collected at three growth stages. The first sample was taken 15 days after emergence as whole plants (stage[1]). The second sample was taken 30 days from sowing (stage[2])., while the third sample was taken at harvest time (stage[3]). At the end of each experiment, the biological yield, grain, straw, 1000-grain weight, and number and weight of

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Table 1. Chemical and physical soil properties and available nutrients in the El Boston and North El-Tahrir soils

Soil Properties	El Boston	North El-Tahrir	Soluble ions**	El Boston	North El-Tahrir	Available nutrients (ppm)	El Boston	North El-Tahrir
pH * **	7.71	7.96	Na	1.08	1.53	N	19.4	35.1
EC dS/m* **	0.56	0.72	K	0.38	0.4	P	1.74	4.5
OM%	0.58	2.13	Ca	1.96	2.39	K	32	69
$CaCO_3$ %	2.26	14.7	Mg	2.18	2.91	Fe	1.12	3.74
C.E.C*	2.23	14.69	CO_3	0	0	Mn	0.84	1.84
Sand%	94.13	68.13	HCO_3	0.75	0.6	Zn	0.23	0.83
Silt%	5.45	14.51	Cl	4.3	5	Cu	0.08	0.31
Clay%	0.42	17.36	SO_4	0.56	1.62			
Texture	S	S.L						

(*)C.E.C (me/100g soil), (**) Soluble cations and anions in soil (me/L), (***) Soluble water 1:.1.

spikes per square meter were recorded in both seasons. The experimental design used was completely randomized factorial design with three salts and control, three replicated and two various soils. The analyses of variance (ANOVA)calculated to verify whether the differences among the treatments were significant or not (Gomez and Gomez 1984).

Soil mechanical analysis was achieved on the original soil samples prior sowing and soil texture was defined according to Piper(1950). Regarding soil chemical analysis, soil pH and EC and soluble cations and anions were achieved according to Jackson(1973),organic matter and CEC were determined according to Page et at(1984),available P was determined according to Watanabe and Olsen (1965) as modified by Bar yosef and Akr (1978), and available N was determined according to keeney and Nelson(1982). Available potassium was determined according to Onyers and Mclean (1969). Available micronutrients determined according to Lindsay and Norvell (1967).

RESULTS AND DISCUSSIONS

Effect of saline water on soil properties and available nutrients in soils:

Figures 1 and 2 showed that available nutrients in the two soils were significantly decreased with increasing rates of salts under conditions of greenhouse pots at two years, while the exchangeable Na increased by increase rates of NaCl salt application.

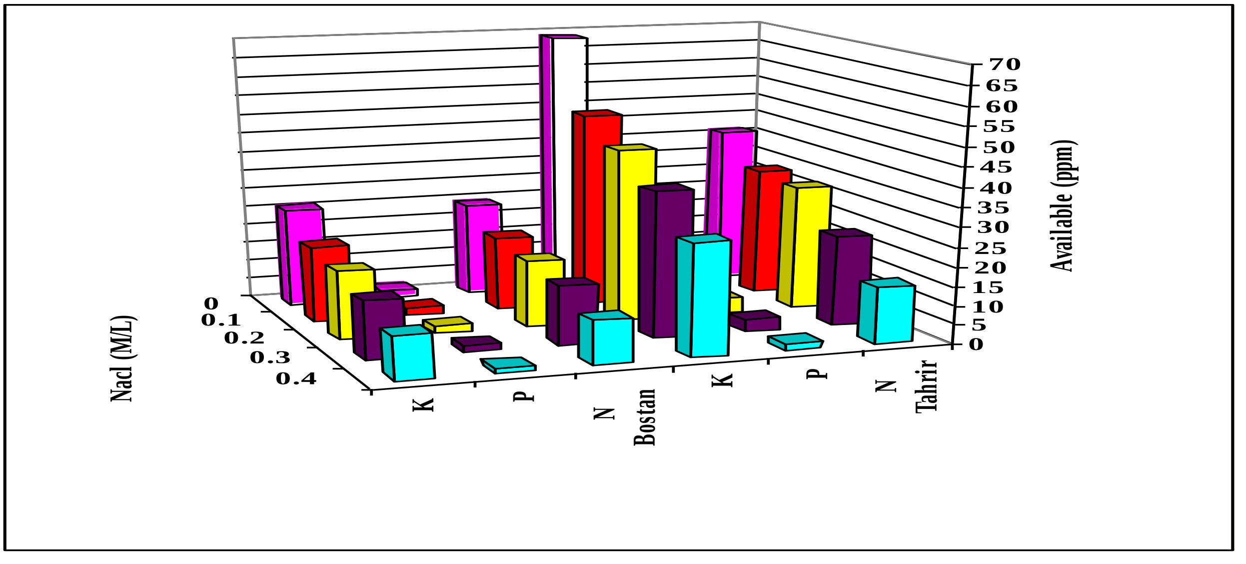

Fig 1. Effect of saline water (NaCl) on available macronutrients of soil studies

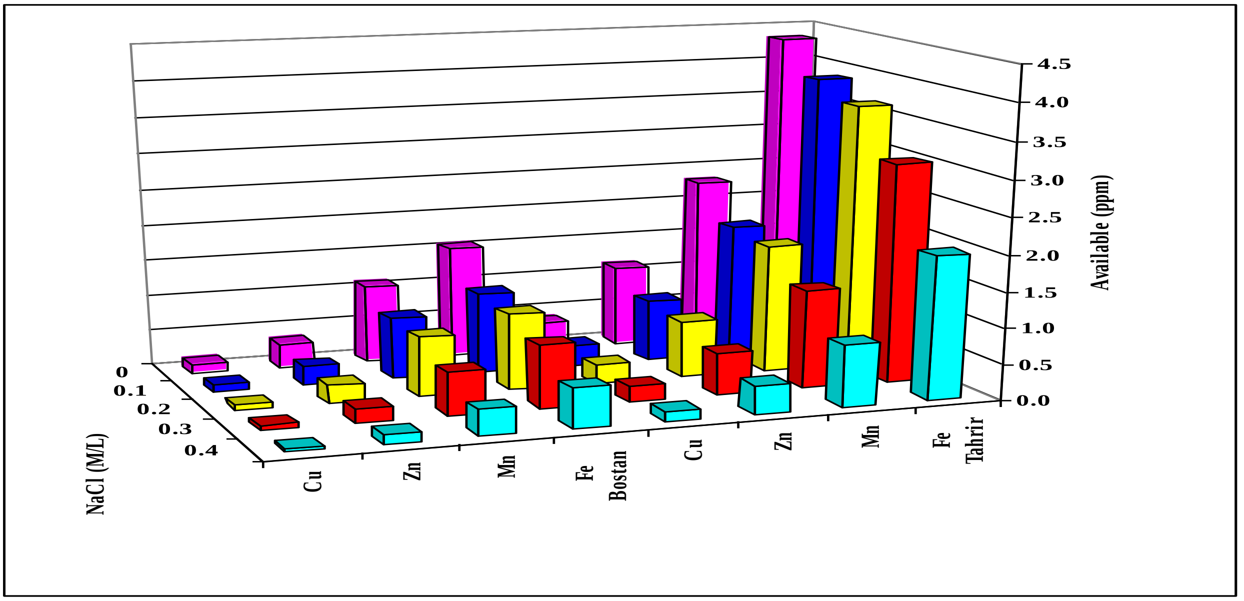

Fig 2. Effect of water saline (NaCl) on available micronutrients of soil studies

The NaCl salt showed highest adverse effect on available nutrients, and $CaCl_2$ salt had the lowest, while the mixture salt had moderately effect between them. The results obtained assure that the critical level of salinity was 0.3M/L of NaCl salt and 0.4M/L of $CaCl_2$ salt, which caused higher decrease in yield parameters of wheat, while decreased of available nutrients and damage in soil properties when comparison with other levels of salts. The results obtained revealed that the sandy loam soil was highly affected by saline water than sandy soils. This could be due to the sandy soil contains lowest in clay content, while it was higher in filtration than sandy loam soil. The obtained results agree with those obtained by Aydin et al (2001).

Table (2) showed that NaCl had the highest effective on EC than other salts at two soils. The EC values generally increased with increasing rates of salts during different stage of wheat growth. Figure (3) revealed that the sand soils had lower EC values than sand loam soil. The results obtained reveal that the greater ability of NaCl prevented available nutrients to the plants than CaCl2 salt. These assure that importance of known type and concentration salt in saline water before using it. Our obtained results agree with those found by Gary and Delno (2004).

Table 2. Effect of water saline on EC during stages of wheat growth

Salts	Dose M/L	Sand loam soil			Sand soil		
		Stages of wheat					
		1	2	3	1	2	3
		E.C dS/m					
Control	0	0.72	0.96	1.17	0.56	0.73	0.95
NaCl	0.1	4.5	5.8	7.2	3.3	4.2	5.3
	0.2	7.2	9.4	12.0	5.0	6.6	8.6
	0.3	9.6	12.1	15.1	6.8	8.6	10.9
	0.4	12.7	14.6	16.4	9.1	10.5	11.9
$CaCl_2$	0.1	2.8	3.5	4.3	2.0	2.5	3.1
	0.2	3.5	4.4	5.5	2.5	3.2	4.0
	0.3	5.7	7.1	8.7	4.2	5.1	6.4
	0.4	6.7	8.5	10.7	4.9	6.2	7.9
Mixture	0.1	3.8	4.8	5.9	2.8	3.5	4.3
	0.2	6.1	7.6	9.5	4.5	5.6	7.1
	0.3	7.8	9.7	12.0	5.6	7.0	8.8
	0.4	10.0	11.9	13.8	7.3	8.6	10.2

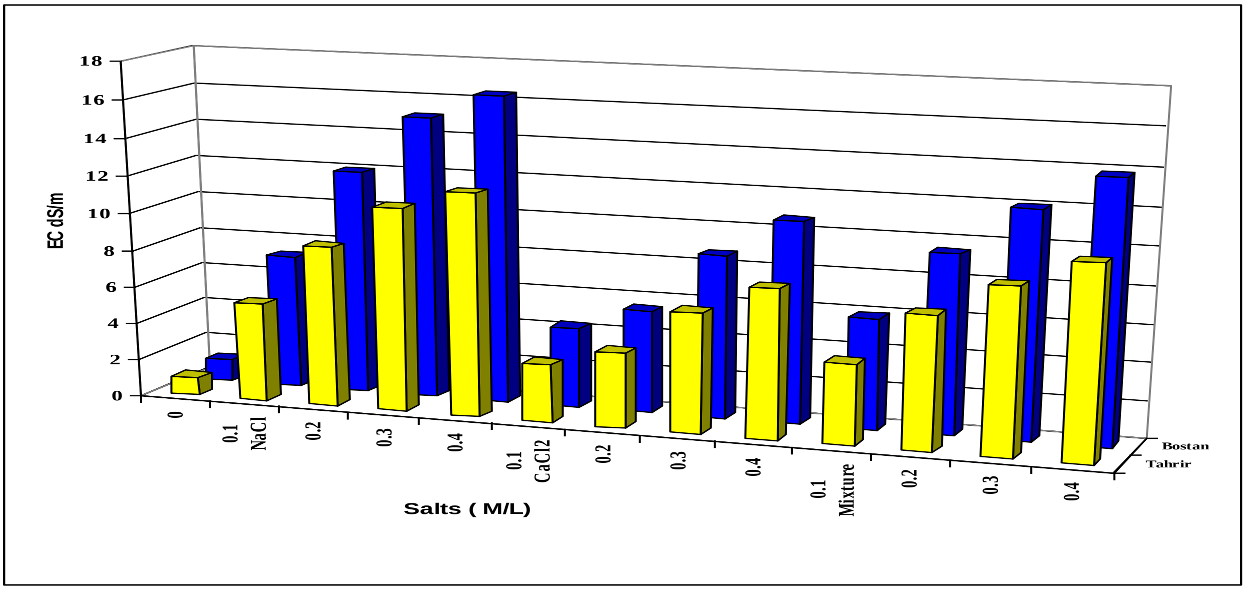

Fig 3. Effect of water saline on EC during harvest stage of wheat in soils

Effect of saline water on yield parameters of wheat:

The levels of salts had significant effect on yield of wheat as the following in Table (3).

Table 3. Effects of saline water on yield components of wheat

Salts	Levels M/L	Yield (g/pot.) bio	Yield (g/pot.) Straw	Yield (g/pot.) grain	Weight 1000 (g)	spikes/m2 W. Kg	spikes/m2 No.
				Sandy soil			
Control	0	69.3	46.9	22.5	33.9	0.38	208
NaCl	0.1	58.8	40.4	18.4	29.2	0.3	195
	0.2	49.8	34.6	15.2	23.4	0.26	171
	0.3	34.3	23.2	11.1	20.3	0.2	153
	0.4	25.8	18.6	6.2	15.4	0.17	141
$CaCl_2$	0.1	63.2	42.7	20.5	30.7	0.33	200
	0.2	51.7	35.3	16.4	26.7	0.29	193
	0.3	44.2	30.4	13.8	21.6	0.23	181
	0.4	32.6	21.6	9.5	17.3	0.2	162
Mixture	0.1	61	41.6	19.5	30	0.32	198
	0.2	50.8	35	15.8	25.1	0.28	182
	0.3	39.3	26.8	12.5	21	0.22	167
	0.4	29.2	20.1	9.1	16.4	0.19	152
LSD.05		0.3	0.2	0.1	0.1	0.01	0.5
Sig.		***	***	***	***	***	***
				Sandy loam soil			
Control	0	105.5	72.6	32.9	45.2	0.72	250
NaCl	0.1	89.1	63.5	25.6	38.6	0.6	240
	0.2	75.1	55.7	19.4	30.3	0.51	220
	0.3	57	43.4	13.6	24.3	0.41	205
	0.4	38.7	32.5	7.2	19.7	0.32	181
$CaCl_2$	0.1	94.1	65.3	28.8	40.3	0.62	242
	0.2	85.8	60.6	25.2	33.1	0.55	228
	0.3	72.2	51.7	20.5	26.9	0.44	210
	0.4	47.8	38.3	11	21.9	0.34	198
Mixture	0.1	91.6	64.4	27.2	39.5	0.61	241
	0.2	80.5	58.2	22.3	31.7	0.53	224
	0.3	64.6	47.6	17.1	25.6	0.43	208
	0.4	43.3	35.4	9.5	20.8	0.33	190
LSD.05		0.5	0.3	0.2	0.2	0.03	0.5
Sig.		***	***	***	***	***	***

Bio (Biological), W. Kg (Weight spikes by Kg), No (Number of spikes)

The yield parameters were reduced by increasing rates of salts applied to soil. The suitable level range was 0.1-0.3M/L of NaCl salt and 0.1-0.2M/L of $CaCl_2$ salt, which produce economic yield of wheat under conditions of irrigation by saline water at two soils. The higher levels over above ranges caused damage in soil properties and yield production. The NaCl salt at level 0.4M/L gave significantly higher decrease in biological, straw and grain yields of wheat when compared with control treatment by 63, 58 and 75% respectively, analogously the $CaCl_2$ salt decreased by 54, 51 and 62% for the same yield parameters of wheat during 2 seasons. The obtained results go with those obtained by El-Agrodi et al (2005).

Figures 4 and 5 showed that, the grain and straw yield were generally decreased with increasing salts levels. The sandy loam soil attained much higher increase yield parameters of wheat when compared with sandy soil by 18, 19, 16, 12, 14 and 5 % for biological, straw, grain, 1000-grain weight, and weight and number of spikes respectively during the two seasons (Table3). This attributed to the relatively higher nutrient supplying power of the sand loam soils. Davis et al. (2002) obtained similar results.

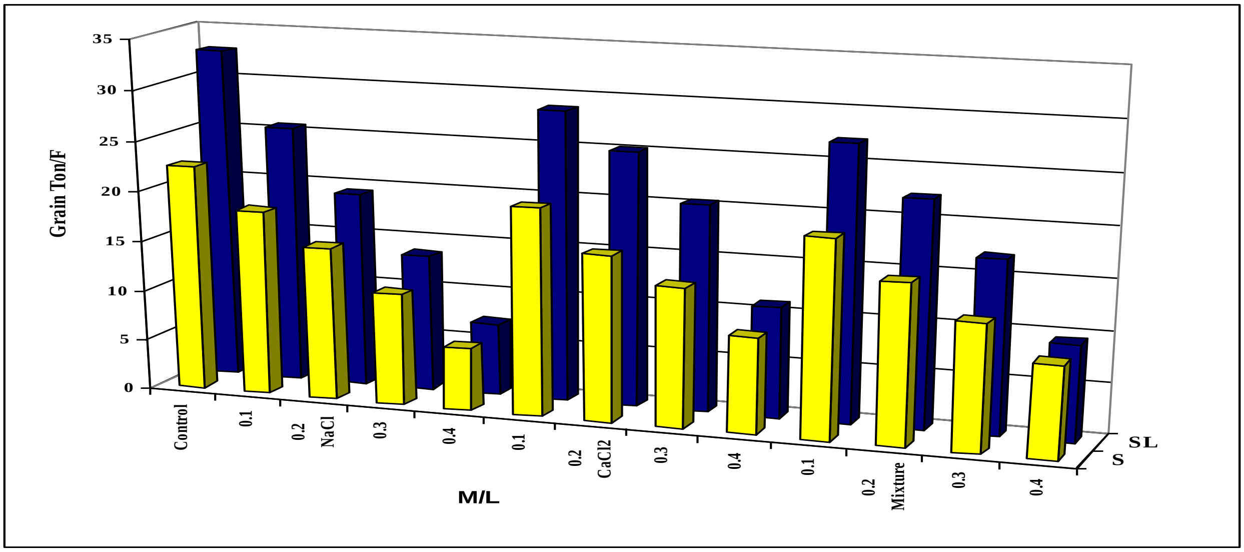

Fig 4. Effects of saline water irrigation on grain yield in soils

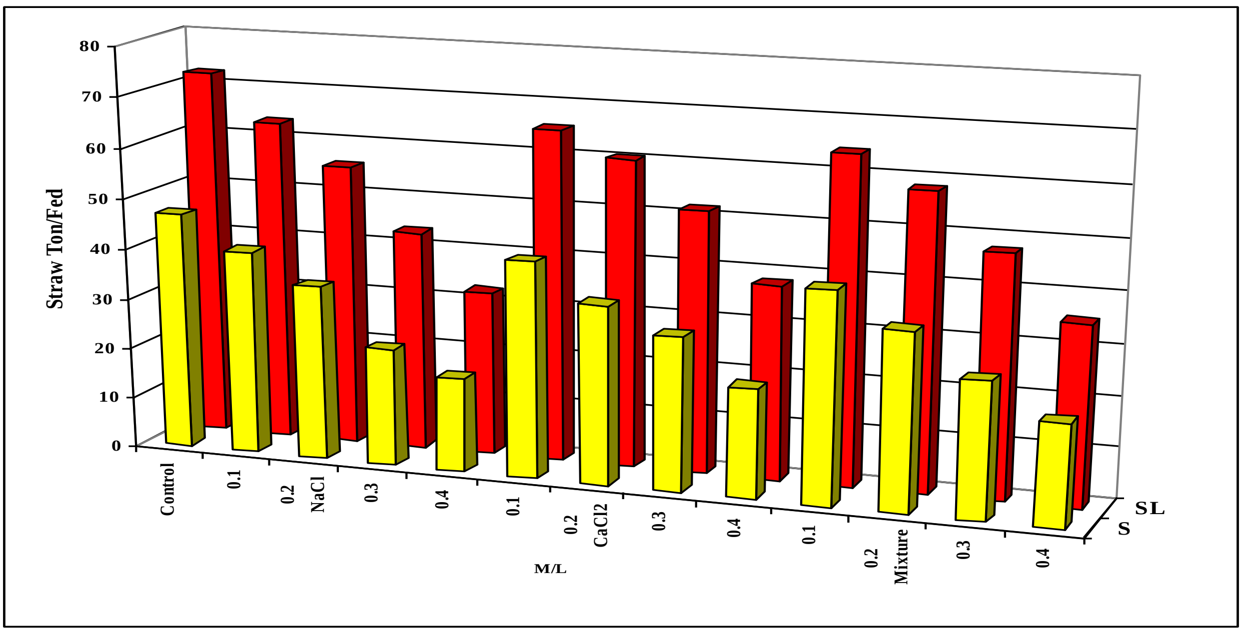

Fig. 5. Effects of saline water irrigation on straw yield in soils

Effect of saline water on nutrients uptake by wheat:

Tables 4 and 5 showed that increasing rates of NaCl salt led to a decrease of K, N, P, Mn, Zn and Cu content in grain and straw at harvest stage of wheat. The plants treated by CaCl2 and mixtures salts had higher nutrients absorption than plants treated with NaCl salt through different rates of salts. The generally trends were decrease in dry matter of wheat by increasing salts levels at two soil and two seasons. The lowest nutrients uptake by plant was at the level 0.4M/L of all salts, while the higher was at control. The results obtained revealed that higher NaCl salt caused low nutrients in plant tissues, when compared with CaCl2 salt, while the mixture salt was moderately effect between their. The critical level of salinity was 0.3M/L of NaCl salt and 0.4M/L of CaCl2 salt, which caused higher decrease of nutrients uptake by wheat than other levels of salts. This results goes with Gary and Delno (2004) found similar results that increasing rates of salts resulted in low nutrients in plant tissues. The obtained results indicated that sand texture soil was more ability to resistance the high salinity in irrigation water when comparison with the sandy loam soil. This results may be due to the sandy soil was higher filtration than sandy loam soil. The results obtained agree with and Davis et al. (2002).

In conclusion, the obtained results showed that the nutrients uptake by plant and yield parameters of wheat had negatively affected by increase rates of whole salts in irrigation water. The NaCl salt had the highest significantly effect on decreasing of available nutrients, nutrients uptake and wheat yield, while the CaCl2 salt was lowest.

The suitable levels ranges were 0.1-0.2M/L of NaCl salt and 0.1-0.3M/L of $CaCl_2$ salt for produce economic yield of wheat at studied soils.

Table 4. Effect of water saline on nutrients uptake (mg/pot) at harvest stage of wheat

Salts	Dose M/L	N Straw	N Grain	P Straw	P Grain	K Straw	K Grain	Na Straw	Na Grain
Sand soil									
Control	0	183	317	70	63	582	113	86	60
NaCl	0.1	134	207	51	40	422	78	184	120
	0.2	92	136	35	25	288	54	167	99
	0.3	42	78	16	13	135	35	127	76
	0.4	19	35	8	5	62	19	77	48
$CaCl_2$	0.1	154	269	60	53	483	98	91	60
	0.2	109	179	44	33	348	71	85	51
	0.3	71	131	28	23	227	55	67	47
	0.4	35	77	14	13	112	34	49	33
Mixture	0.1	146	231	54	44	458	85	142	94
	0.2	97	157	37	30	309	62	129	79
	0.3	57	101	23	17	183	44	106	67
	0.4	29	58	10	9	91	28	76	49
LSD.05		2.1	3.7	0.9	0.8	6.6	1.5	2.4	1.5
Sig.		***	***	***	***	***	***	***	***
Sand loam soil									
Control	0	537	721	167	158	1721	224	174	115
NaCl	0.1	400	448	123	95	1273	148	318	149
	0.2	300	268	95	54	959	97	317	157
	0.3	182	141	58	27	588	57	275	139
	0.4	101	43	31	6	323	22	215	89
$CaCl_2$	0.1	438	559	137	121	1391	179	168	108
	0.2	376	436	115	93	1200	144	162	95
	0.3	274	297	83	62	874	105	144	80
	0.4	149	88	46	15	479	40	112	45
Mixture	0.1	412	485	125	105	1310	157	244	126
	0.2	326	348	99	71	1049	118	242	136
	0.3	219	200	68	40	707	74	217	116
	0.4	120	67	37	10	387	32	169	81
LSD.05		6.6	7.3	2.1	1.5	20.7	2.5	4.5	2.3
Sig.		***	***	***	***	***	***	***	***

Table 5. Effect of water saline on nutrients uptake (mg/pot) at harvest stage of wheat

Salts	Dose M/L	Fe		Mn		Zn		Cu	
		Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain
		Sandy soil							
Control	0	4.16	2.12	1.12	0.68	0.76	0.27	0.25	0.19
NaCl	0.1	3.01	1.34	0.81	0.43	0.55	0.17	0.19	0.12
	0.2	2.07	0.84	0.56	0.27	0.38	0.11	0.13	0.08
	0.3	0.97	0.45	0.26	0.14	0.18	0.06	0.06	0.04
	0.4	0.44	0.17	0.12	0.06	0.08	0.02	0.03	0.02
$CaCl_2$	0.1	3.45	1.76	0.93	0.56	0.63	0.23	0.21	0.16
	0.2	2.49	1.13	0.67	0.36	0.45	0.15	0.15	0.10
	0.3	1.64	0.80	0.44	0.25	0.30	0.10	0.10	0.07
	0.4	0.80	0.44	0.22	0.14	0.15	0.06	0.05	0.04
Mixture	0.1	3.27	1.50	0.88	0.48	0.59	0.19	0.20	0.14
	0.2	2.22	0.98	0.60	0.31	0.40	0.13	0.14	0.09
	0.3	1.31	0.60	0.35	0.19	0.24	0.08	0.08	0.05
	0.4	0.65	0.31	0.17	0.10	0.12	0.04	0.04	0.03
LSD.05		0.05	0.02	0.01	0.01	0.01	0.01	0.01	0.01
Sig.		***	***	***	***	***	***	***	***
		Sandy loam soil							
Control	0	12.85	6.18	2.83	1.59	2.69	0.87	0.76	0.53
NaCl	0.1	9.52	3.74	2.10	0.96	1.99	0.52	0.56	0.32
	0.2	7.16	2.15	1.58	0.55	1.50	0.30	0.42	0.18
	0.3	4.38	1.05	0.96	0.27	0.91	0.15	0.26	0.09
	0.4	2.42	0.25	0.53	0.07	0.51	0.04	0.14	0.02
$CaCl_2$	0.1	10.40	4.73	2.29	1.22	2.17	0.67	0.61	0.40
	0.2	8.95	3.62	1.98	0.93	1.87	0.51	0.53	0.31
	0.3	6.51	2.39	1.44	0.62	1.36	0.34	0.38	0.20
	0.4	3.58	0.60	0.79	0.15	0.75	0.08	0.21	0.05
Mixture	0.1	9.80	4.06	2.16	1.04	2.05	0.57	0.57	0.35
	0.2	7.83	2.83	1.73	0.73	1.63	0.40	0.46	0.24
	0.3	5.29	1.56	1.17	0.40	1.10	0.22	0.31	0.13
	0.4	2.88	0.42	0.63	0.11	0.60	0.06	0.17	0.04
LSD.05		0.15	0.06	0.04	0.02	0.03	0.01	0.01	0.01
Sig.		***	***	***	***	***	***	***	***

So that this studies recommended did not use saline water over above levels ranges of salts in both of studies soils, whereas the critical level of salinity was 0.3M/L of NaCl salt and 0.4M/L of $CaCl_2$ salt, which it caused high decrease in yield and damage in soil properties.The sand loam soil was higher significantly increase of available nutrients, nutrients uptake and wheat yield than sand soils, this attributed to the relatively higher nutrient supplying power of the sand loam. The sand soils were lower of EC values than sand loam soils, this was due to the sand soils was lowest in clay content and highest filtration.

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الملخص العربي

تأثير الرى بالماء المالح على امتصاص المغذيات وانتاجية نبات القمح النامى فى الاراضى الرملية والرملية الطميية

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اقيمت هذة الدراسة مستخدمة نوعيين من الاراضى لقطاع غرب الدلتا بمصر فى البستان وتمثل الاراضى الرملية وشمال التحرير وتمثل الاراضى الرملية الطميية. وتم عمل تجربتين اصص فى الصوبة الزجاجية خلال عامى 2006 و2007 م. لمياة الرى الملحية المستخدمة تتكون من كلوريد الصوديوم و كلوريد الكالسيوم ومخلوط بينهما بنسبة(1:1) والتى تضاف بمستويات (صفر, 0.1, 0.2, 0.3, 0.4 مول/لتر). والهدف من هذة الدراسة معرفة تأثير ماء الرى المالح على امتصاص المغذيات وانتاجية محصول القمح(صنف سخا 8).

ولقد أوضحت النتائج عند زيادة مستوبات الاملاح فى مياة الرى فأن pH وEC يرتفع بينما ينخفض الميسر والممتص من المغذيات، لذلك فأن نمو وإنتاجية القمح تنخفض.

وأن ملح كلوريد الصوديوم أعطى أعلى تأثير معنوى على خفض المغذيات الممتصة وإنتاجية القمح وكان ملح كلوريد الكالسيوم هو الاقل تأثير، بينما المخلوط كان متوسط التأثير. فالمدى المناسب لمستويات ملح كلوريد الصوديوم ينحصر ما بين 0.1-0.2 مول/لتر والملح كلوريد الكالسيوم من 0.1-0.3 مول/لتر ، والذى من خلالة يمكن ااحراز محصول اقتصادى من القمح. الحد الحرج للملوحة كان 0.3 مول/لتر لملح كلوريد الصوديوم و 0.4 مول/لتر لملح كلوريد الكالسيوم والذى عندة يحدث انخفاض كبير فى المحصول وضرر بالغ فى خواص التربة. لذلك نجد أن إنتاجية الحبوب عند 0.4 مول/لتر كانت 0.33 و 0.51 طن/فدان لملح كلوريد الصوديوم وللملح كلوريد الكالسيوم على التوالى بينما كانت 1.36 طن/فدان معاملة الكنترول.