Impact of N and K-Fertilization on Yield of Wheat (*Triticum aestivum-L.*) Grown under Different Soil Salinity.

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ABSTRACT

Three field experiments were carried out during two successive seasons of 2005/06 and 2006/07 at Kafr El-Sheikh Governorate to study the effect of N, K-fertilization on wheat yield under three levels of soil salinity. Grain and straw yield of wheat *(Triticum aestivum)* cv.Sakha 94 had significantly increased with increasing of N application up to 140 kg fed^{-1}under different soil salinity. The yield was also increased with application of 50kg$fed.^{-1}K_2O$. Results indicated that there were highly significantly effects on grain and straw yield of wheat during the two growing seasons due to the interaction between N-K where the grain yield were recorded the highest mean values (23.95, 24.01, 20.86, 20.95 and 19.05, 19.60) by N application of 140Kg $fed.^{-1}$ plus 50Kg $fed.^{-1}$ K_2O for normal soil, medium saline soil and high saline sodic soil in the two growing seasons, respectively. The straw yield were 4.798, 4.787 ton $fed.^{-1}$, 4.084, 4.143 ton fed^{-1} and 3.363, 3.387 ton $fed.^{-1}$ by nitrogen rate of 140Kg $fed.^{-1}$ plus 50Kg K_2O $fed.^{-1}$ for normal soil, medium saline soil and high saline sodic soil in the two growing seasons, respectively.

The N-uptake and recovery by wheat yield was increased with increasing application of nitrogen, but decreased as soil salinity increased, and increased by potassium application. The response of nitrogen application reached to 80kgN/Fed. in normal soil but by increasing N application up to 120kg N/Fed. in medium and high saline soils The highest relative variations of N recovery were +18.2%, +12.4% and +17.1% were recorded by application of N_{40} in normal soil and N_{120} in medium saline soil and high saline sodic soil, respectively.

Nitrogen use efficiency (NUE) by wheat yield was decreased with increasing both application of nitrogen and soil salinity but improved by application of 50 kg $fed.^{-1}$ K_2O, with relative variations of 20.4% and 11.9 % with N_{80} for normal soil and medium saline soil, respectively.

To achieve the highest yield of wheat (*Triticum aestivum*) cv.Sakha 94, it is recommended to apply nitrogen at the rate of 120kgN/Fed. And 50 kg $fed.^{-1}$ K_2O plus 22 kg P_2O_5/fed. in non saline soil and application of N at the rate of 140kgN/Fed.and 50 kg $fed.^{-1}$ K_2O plus 22 kg P_2O_5/fed.in medium saline and highly saline sodic soil, respectively.

INTRODUCTION

Wheat (*Triticum aestivum-L.*) is one of the main winter cereal crops in Egypt for grain production and straw. It is widely distributed all over the country (2.987 million feddan in 2008), with a mean production of about 2.745 tons/feddan. The national production of wheat in 2009 was 8.2 million tons/ and the national consumption of wheat was about 12.0 million tons in 2009. There is a great gab between the consumption and production. Egypt has an area of about one million square kilometres or 238 million feddans (one feddan = $4200m^2$ = 0.42 ha). The total agricultural land in Egypt amounts to nearly 8.4 million feddans (3.5 million ha) and accounts for around 3.5 percent of the total area. One million ha in the irrigated areas suffer from salinization problems, water logging and sodicity. The majority of salt-affected soils are located at the northern-central part of the Nile Delta and at its eastern and western sides. Increased attention is being given to the improvement of salt-affected soils, since they are potentially productive and require less investment, effort, and time for restoring their productivity, than the reclamation of new land, (FAO, 2005).

Egypt utilizes fertilizers at an accelerating rate, due to various factors such as the increase in the cropped area, raising the rate of fertilizer application for various crops and the depletion of Nile irrigation water of some nutrients after the construction of the High Dam. Consequently, Egypt is considered to be a heavy user of chemical fertilizers, especially nitrogen fertilizers followed by phosphorus fertilizers then potassium fertilizers. Soil fertility continues to decline because of combined effects of increasing pressure for land use for crop production, inadequate compensation of nutrients exported and lack of nutrients management.

It was found that yield of wheat were decreased by increasing soil salinity and recorded positive interaction between nitrogen fertilization and soil salinity (Sarhan and Abdel Salam, 1999).

The need of potassium fertilizers are increasing when agriculture is intensified. Thus the intensive and continued cropping of Egyptian soils have greatly reduced the level of available potassium in the soil; now a days insufficient Soil K level is usually corrected by adding K- fertilizers in order to maintain the fertility level of Egyptian soils. It was recorded that each of nitrogen and potassium fertilization resulted in a significant increase in N uptake by the grain and grain K concentration but reduced the grain Na concentration in

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saline soil (Sobh et al., 2000). Phosphorus and potassium in both grain and straw of wheat plant responded significantly to all K fertilizer treatments (El-Beyali et al., 2001).

Nitrogen use efficiency (NUE) has been defined as the grain yield produced per unit of N supply from soil and fertilizer (Sowers et al. 1994) and can be subdivided into components that identify soil and plant processes that contribute to the overall use of N (Moll et al. 1982). Nitrogen is the nutrient most susceptible to loss and recovery of N is usually less than half of that applied (Boswell et al., 1985). Field experiments in north delta of Egypt indicated that N–use efficiency (NUE) of wheat var. Giza 168 decreased by about 28.32 % and NUE of wheat var. Sids 7 increased about 4.85% by increasing N-level from 75 to 120 Kg N/fed and N-recovery increased by application 50 Kg K_2O/fed. 21.89 % and 26.92% for Giza168 and Sids 7, respectively (Amer 2005). Crop plants are able to use about 50% of the applied fertilizer N, while 25% is lost from the soil–plant system through leaching, volatilization and denitrification, (Saikia and V. Jain 2007).

Very little or no data are available in the literature about the interaction effect of nitrogen, potassium and soil salinity on wheat. Therefore, the main target of this investigation was to study the impact of N, K-fertilization and soil salinity on wheat yield and nitrogen use efficiency.

MATERIALS AND METHODS

Three field experiments were carried out during two successive seasons of, 2005/06 and 2006/07.at farmers field with different salinity as follows: One site containing non saline soil (E.C.= 2.6 dS m-1, at EL-Hamra Village, Kafr El-Sheikh District, Kafr El-Sheikh Governorate (6 m altitude, 31° 07- latitude and 30° 52-longitude), and two sites containing medium saline soil (E.C.= 5.4 dS m-1) and saline sodic soil (E.C. = 10.0 dS m-1) at Gad ALLAH village, Sidi Salem District, Kafr El-Sheikh Governorate (6 m altitude, 31° 07- latitude and 30° 57- longitude). The experiment was conducted in split-split plot design, with four replicates. The main plots were assigned to five levels of the nitrogen application (0, 40, 80, 120 and 140kg feddan^{-1}), the sub-plots were two levels of potassium (0 and 50kg K_2O feddan^{-1}), the sub- sub plots were subjected to three levels of soil salinity, (2.6dsm^{-1}, 5.4dsm^{-1} and 10dsm^{-1}). and broadcasted with 22 Kg P_2O_5 / fed.The area of each plot was 3x3.5 (1/400 feddan) and seeds of wheat (*Triticum aestivum* L.) cv.Sakha 94 were sown at 15th November 2005 and 13th November 2006 and harvested at 8 May 2006 and 10 May 2007, respectively.

Surface soil samples (0-30cm depth) from each plot were taken before planting in the two seasons and prepared for physical and chemical analysis (Piper, 1950).These soil samples were air-dried, ground and passed through 2.0 mm sieve for the following chemical analysis. Soil reaction (pH) was measured in 1: 2.5, soil: water suspension at 25 ^{0}C according to Jackson (1967).Total water soluble salts was measured by the electrical conductivity meter in the extract of water soil paste (Richards, 1954).The cation exchange capacity (CEC) was determined using sodium and ammonium acetate method as described by Gohar (1954).The amount of available N was extracted by 1.0M K_2SO_4 and determined using MgO and devarda alloy by Kjeldahl method (Jackson 1967). The amount of available P was determined using sodium bicarbonate method according to Olsen et al., (1954) The amount of available K was extracted by ammonium acetate (1.0N pH 7) method and measured by flame- photometer. Particle size distribution of soil was carried out using the pipette method as described by Dewis and Fertias (1970).Saturated percentage of the soil was determined using the method as described by Richards (1954).The main chemical and physical properties of the experimental soils are shown in Table 1.

Plant samples were taken randomly from an area of 1 m^2 from each plot, at maturity, to determine the grain and straw yield of wheat. These plant samples were taken at each season, washed by distilled water and dried in an oven at 70 ° C for 48 hrs and ground. These oven dried plant samples were wet digested using sulfuric acid with repeated additions of 30% hydrogen peroxide (H_2O_2) as described by Wolf (1982). The amount of nitrogen was determined by micro-Kjeldahl method (Jackson, 1967),and apparent nitrogen recovery of fertilizer (%) was calculated for each treatment according to the following equation (Crasswell and Godwin , 1984):

$$\text{\% Recovery of N fertilizer} = \frac{\text{N-uptake from treatment} - \text{N-uptake from control}}{\text{N-applied to treatment}} \times 100\%$$

$$\text{N use efficiency} = \frac{\text{Grain yield from treatment} - \text{grain yield from control}}{\text{N-applied to treatment}} \ \text{Kg grains / Kg N}$$

$$\text{Relative variation (\%)} = \frac{\text{treatment-control}}{\text{control}} \times 100$$

Data were analyzed statistically according to procedures outlined by Cochran and Cox (1960).

Table 1. The average values of some chemical and physical properties of the experimental soil (0-30cm) before planting in the two growing seasons (2005/2006 and 2006/2007)

season	site	Soil pH 1:2.5	EC dSm^{-1}	SAR	Available N (ppm)	Available P (ppm)	Available K (ppm)	OM %	Total N%	Total $CaCO_3$ %	CEC meq/100g soil	SP %	Particle size distribution Clay %	Slit %	Sand %	Texture grade
1st	1	8.1	2.51	7.36	17.0	12.0	297.6	1.93	0.15	5.07	42.90	82.76	58.21	32.6	9.19	Clayey
	2	8.3	5.31	12.39	10.3	13.0	419.0	1.82	0.13	4.83	41.98	92.35	57.6	32.29	10.11	Clayey
	3	8.5	9.86	17.13	12.6	15.0	430.0	1.71	0.12	4.73	40.80	96.20	58.3	31.10	10.60	Clayey
2nd	1	8.0	2.63	7.46	18.0	12.3	298.0	1.82	0.16	5.11	43.3	82.90	57.8	32.22	10.0	Clayey
	2	8.2	5.42	12.38	11.3	13.6	383.0	1.76	0.13	4.91	42.10	93.21	57.4	32.71	9.89	Clayey
	3	8.4	9.93	15.06	12.1	15.3	392.0	1.73	0.13	4.82	41.50	98.32	58.1	31.70	10.20	Clayey

RESULTS AND DISCUSSIONS

Grain yield:

The grain yield of wheat crop as affected by nitrogen and potassium application are given in Table (2) and Fig. (1).These data reveal significant increase in grain yield by adding nitrogen fertilizer up to 140kgN/Fed.

Moreover, addition of potassium fertilizer by to 50kg Fed^{-1} increased grain yield under the three soil salinity. Grain yield had significantly increased with application of $50KgK_2Ofed.^{-1}$ under different soil salinity. The obtained dataindicated that grain yield of wheat recorded highest value by application of N_{120} plus K_{50}, Amer (2005) achieved the highest mean values of grain yield by 120kg N plus $50kgK_2O$ Fed^{-1} for non saline soil.

The interaction between N-K revealed high significant effect on wheat grain yield. This is indicated by the highest mean values of grain yield (23.95, 24.01, 20.86, 20.95 and 19.05, 19.60) recorded by N application of 140Kg $fed.^{-1}$ plus 50Kg K_2O $fed.^{-1}$for normal soil, medium saline soil and high saline sodic soil in the two growing seasons, respectively.

Table 2. Grain yield of wheat(ardab $fed.^{-1}$)as affected by nitrogen and potassium application under different level of soil salinity in the two growing seasons

Soil salinity (dSm^{-1})	$KgFed^{-1}$ K_2O	Treatments: Nitrogen ($KgFed^{-1}$) 0	40	80	120	140
		2005/2006				
2.6	0	4.93	10.11	15.53	21.50	22.30
	50	5.06	10.85	17.89	23.11	23.95
5.4	0	2.90	9.10	15.01	17.79	19.94
	50	3.06	9.84	16.38	19.13	20.86
10	0	2.51	7.98	12.25	15.53	17.94
	50	2.55	8.55	13.81	16.99	19.05
		2006/2007				
2.6	0	4.86	10.15	15.73	21.65	22.10
	50	5.00	11.45	17.99	23.38	24.01
5.4	0	2.92	9.25	15.05	17.88	19.98
	50	3.05	9.53	16.77	19.37	20.95
10	0	2.43	7.88	13.04	15.33	17.86
	50	2.50	8.67	13.88	16.92	19.60

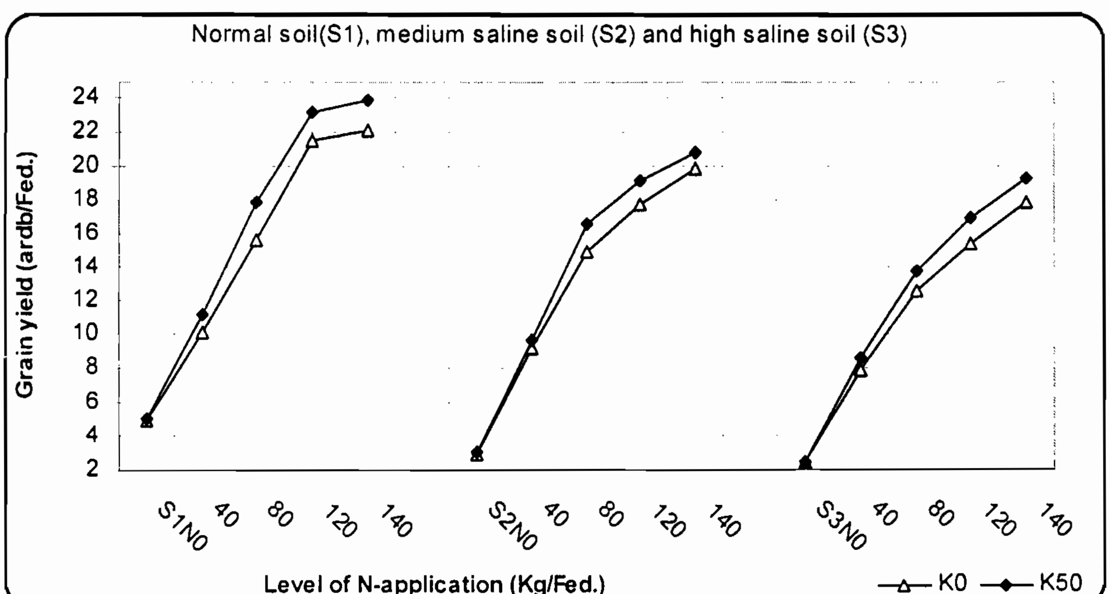

Fig.1. Mean value of wheat grain yield as affected by N and K application under different soil salinity in the two growing seasons

It is clear that, therefore addition of N usually improves plant growth and yield. In addition K plays a vital role in carbohydrate and protein synthesis, and improves water regime of the plant and increases its tolerance to salinity.

Table (3) showed that the grain yield of wheat had significantly increased due to the interactions between nitrogen (N) and potassium (K) fertilization under different soil salinity, during the two growing seasons

Table (4) and Fig. (2) showed that the straw yield had significantly increased with increasing N application up to 140 Kg fed.$^{-1}$ under, different soil salinity during the two growing seasons. Straw yield had significantly increased with application of 50KgK_2Ofed.$^{-1}$ under the three salinity of soils.

Table (4) showed that there were highly significant increases of straw yield of wheat during the two growing seasons due to the interaction between NxKxS where the straw yield recorded the highest mean values (4.798, 4.787 ton fed.$^{-1}$), (4.084, 4.143 ton fed^{-1}) and (3.363, 3.387 ton fed.$^{-1}$) by application rates of nitrogen 140Kg fed.$^{-1}$ plus 50Kg K_2O fed.$^{-1}$ for normal soil, medium saline soil and high saline sodic soil in the two growing seasons, respectively. Close results were obtained by Genaidy and Hegazy (2001).

Table (5) pointed out that the straw yield of wheat had significantly increased due to the interactions between N and K under different soil salinity during the two growing seasons. Similar results were obtained by Abd EL hadi (2004) and Obaid-Ur-Rehman et al. (2006).

Table 3. The main effects of the N, K- fertilization and soil salinity on grain yield of wheat in the two growing seasons

Soil salinity (dSm^{-1})	Nitrogen ($KgFed^{-1}$) 0	40	80	120	140	$F_{test.}$	$LSD_{0.05}$	$KgFed^{-1}K_2O$ 0	50	$F_{test.}$	NxK
					2005/2006						
2.6	5.00	10.48	16.71	22.31	23.13	**	0.062	14.87	16.17	**	**
5.4	2.98	9.47	15.70	18.46	20.4	**	0.14	12.95	13.85	**	**
10	2.53	8.27	13.03	16.26	18.50	**	0.51	11.24	12.19	**	**
					2006/2007						
2.6	4.93	10.80	16.86	22.52	23.06	**	0.124	14.9	16.37	**	**
5.4	2.99	9.39	15.91	18.63	20.47	**	0.134	13.02	13.93	**	**
10	2.47	8.28	13.46	16.13	18.73	**	0.072	11.31	12.31	**	*

Table 4. Straw yield of wheat (ton fed.$^{-1}$) as affected by nitrogen and potassium application under different soil salinity in the two growing seasons

Soil salinity (dSm^{-1})	$KgFed^{-1}K_2O$	Treatments: Nitrogen ($KgFed^{-1}$) 0	40	80	120	140
		2005/006				
2.6	0	1.722	2.388	3.208	4.658	4.681
	50	1.741	2.656	3.281	4.734	4.798
5.4	0	0.779	2.223	2.43	3.183	3.87
	50	0.875	2.308	2.593	3.441	4.084
10	0	0.737	1.991	2. 291	2.942	3.089
	50	0.774	2.126	2.429	3.102	3.363
		2006/007				
2.6	0	1.706	2.418	3.284	4.473	4.693
	50	1.739	2.707	3.336	4.578	4.787
5.4	0	0.746	2.239	2.459	3.221	3.877
	50	0.854	2.360	2.669	3.494	4.143
10	0	0.715	2.038	2.339	2.448	3.161
	50	0.800	2.176	2.449	3.044	3.387

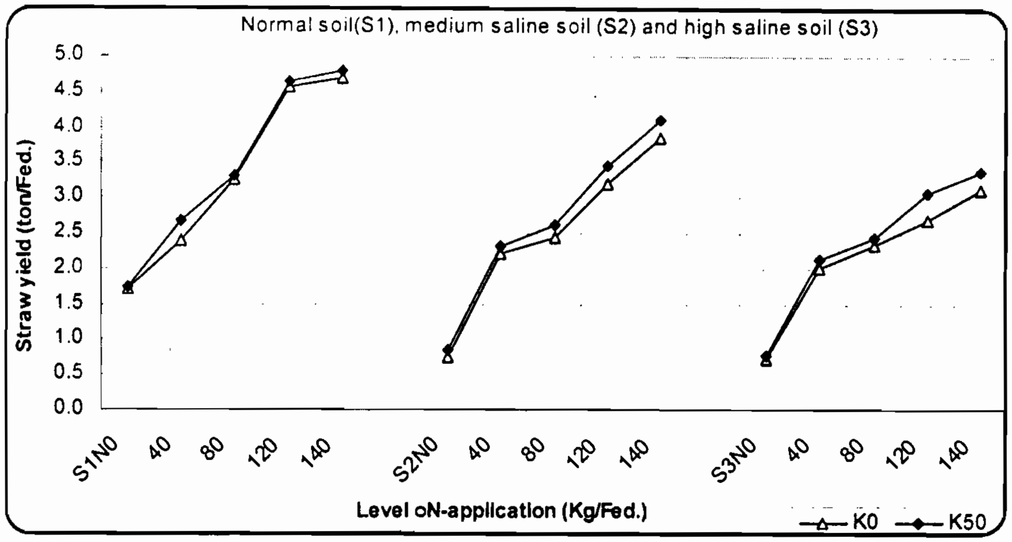

Fig. 2. Straw yield of wheat as affected by N and K application under different soil salinity (over mean value of the two growing seasons)

Table 5. The main effect of N, K- fertilization and soil salinity on straw yield of wheat (ton fed.$^{-1}$) in the two growing seasons

Soil salinity (dSm^{-1})	Nitrogen ($KgFed^{-1}$)					$F_{test.}$	$LSD_{0.05}$	$KgFed^{-1}K_2O$		$F_{test.}$	NxK
	0	40	80	120	140			0	50		
					2005/2006						
2.6	1.703	2.522	3.244	4.696	4.747	**	0.024	3.331	3.442	**	**
5.4	0.733	2.266	2.512	3.312	3.960	**	0.02	2.497	2.660	**	**
10	0.700	,2.059	2.360	3.022	3.226	**	0.03	2.190	2.359	**	**
					2006/2007						
2.6	1.723	2.562	3.310	4.525	4.740	**	0.019	3.315	3.429	**	**
5.4	0.800	2.300	2.564	3.358	4.010	**	0.015	2.508	2.704	**	**
10	0.758	2.107	2.394	2.746	3.274	**	0.021	2.140	2.371	**	*

N-Uptake:

Table 6 showed that N uptake by wheat was increased with increasing application of nitrogen but was decreased with increasing soil salinity. Data indicated that N uptake by wheat yield was increased by potassium application and recorded the highest relative variations (14.6%, 12.0% and 16.0%) by application of N_{80} in normal soil and N_{120} in medium saline soil and high saline sodic soil, respectively.

Nitrogen recovery:

Table 7 showed that nitrogen recovery by wheat yield was decreased with increasing soil salinity. But increased with increasing application of nitrogen. Data revealed that nitrogen recovery by wheat yield was increased by 50 kg (K_2O) fed.$^{-1}$ application and recorded the highest relative variations (18.2%, 12.4% and 17.1%) by application of N_{40} in normal soil and N_{120} in medium saline soil and high saline sodic soil, respectively.

Nitrogen use efficiency (NUE):

Table 8 and Fig. (3) showed that nitrogen use efficiency (NUE) by wheat yield was decreased with increasing soil salinity. That is due to that salt in the soil solution (the "osmotic stress") reduces leaf growth and to a lesser extent root growth, and decreases stomatal conductance and thereby photosynthesis (Munns 1993). The (NUE) decreased with increasing nitrogen level. The decrease in NUE was more pronounced in the presence of potassium in the absence of potassium the decrease in (NUE) was only slight.

This results might indicate that potassium increase the efficiency of uptake and utilization of nitrogen by wheat plants in normal , medium and highly saline soils

Data pointed out that nitrogen use efficiency (NUE) by wheat was increased with application of 50 kg (K_2O) fed.$^{-1}$. The relative variation reached about 20.4% and 11.9 % with N_{80} for normal soil and medium saline soil, respectively, where NUE increased by about 11.0% up to 120kgN Fed^{-1} for high saline sodic soil.

Table 6. N-uptake by dry weight yield of wheat(kg fed^{-1})and relative variation(%) as affected by N and K application under different soil salinity (over mean value of the two growing seasons, grain+straw)

Nitrogen ($KgFed^{-1}$)	Normal soil			Medium saline soil			High saline sodic soil		
	K_0	K_{50}	Relative variation%	K_0	K_{50}	Relative variation%	K_0	K_{50}	Relative variation%
0	10.9	11.3	+3.5	5.8	6.3	+8.5	5.1	5.4	+6.8
40	28.5	32.1	+12.6	26.5	28.3	+6.6	22.8	25.4	+11.6
80	48.2	55.2	+14.6	43.4	48.6	+11.9	36.5	41.3	+13.3
120	68.2	75.5	+10.7	55.4	62.0	+12.0	46.3	53.6	+16.0
140	72.1	78.1	+ 8.4	63.1	66.9	+6.1	54.1	59.5	+9.9

Table 7. Nitrogen recovery and relative variation (%) by wheat as affected by N and K application under different soil salinity (over mean value of the two growing seasons)

Nitrogen (Kg/Fed.)	Normal soil			Medium saline soil			High saline sodic soil		
	K_0	K_{50}	Relative variation%	K_0	K_{50}	Relative variation%	K_0	K_{50}	Relative variation%
40	44.1	52.1	+ 18.2	51.9	55.1	+ 6.1	44.2	49.9	+ 12.9
80	46.6	54.9	+ 17.8	47.1	53.0	+ 12.4	39.3	44.9	+ 14.4
120	47.8	53.5	+ 12.0	41.3	46.5	+ 12.4	34.3	40.1	+ 17.1
140	43.7	47.7	+ 9.2	40.9	43.3	+ 5.8	35.0	38.6	+ 10.3

Table 8. Nitrogen use efficiency and relative variation(%) of wheat as affected by N and K application under different soil salinity (over mean value of the two growing seasons)

Nitrogen (Kg/Fed.)	Normal soil			Medium saline soil			High saline sodic soil		
	K_0	K_{50}	Relative variation%	K_0	K_{50}	Relative variation%	K_0	K_{50}	Relative variation%
40	19.6	23.0	+ 17.3	23.5	24.9	+ 6.0	20.5	22.8	+ 11.2
80	20.1	24.2	+ 20.4	22.7	25.4	+11.9	19.1	21.2	+ 11.0
120	20.9	22.8	+ 9.1	18.7	20.2	+ 8.0	16.2	18.0	+ 11.1
140	18.5	20.3	+ 9.7	18.3	19.1	+ 4.4	16.5	18.0	+ 9.1

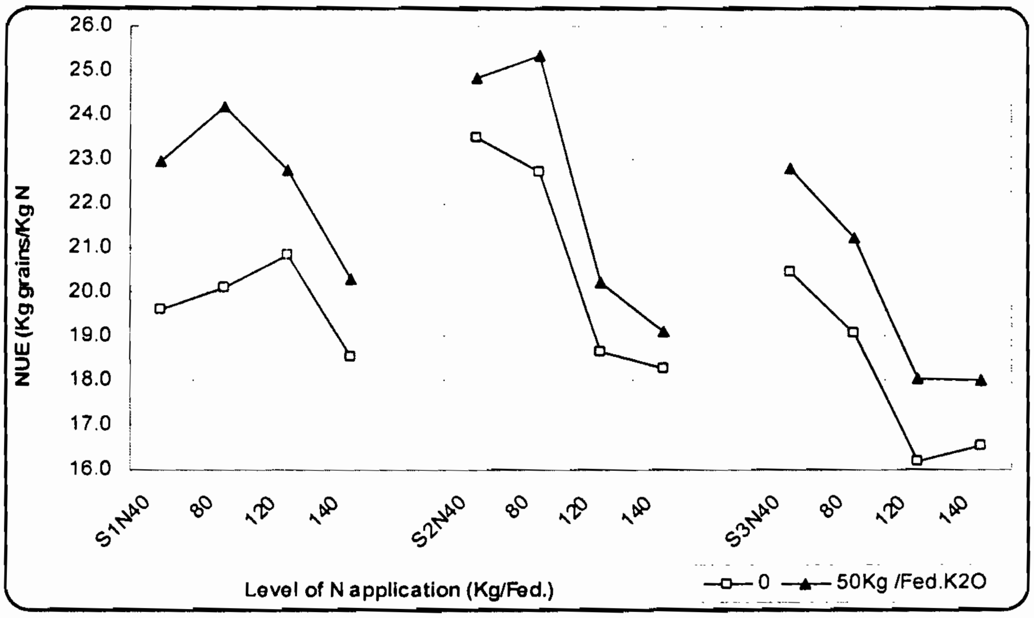

Fig. 3. Nitrogen use efficiency of wheat as affected by N and K application under different soil salinity. (over mean value of the two growing seasons)

CONCLUSION

To achieve the highest yield of wheat (*Triticum aestivum*) cv.Sakha 94, it is recommended to apply nitrogen at the rate of 120kgN/Fed. and 50 kg fed.$^{-1}$ K_2O plus 22 kg /fed^{-1}.P_2O_5 in non saline soil and application of N at the rate of 140kgN/Fed.and 50 kg fed.$^{-1}$ K_2O plus 22 kg /fed^{-1}. P_2O_5 in medium saline and highly saline sodic soil, respectively.

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الملخص العربي

تأثير التسميدالأزوتى والبوتاسى على محصول القمح النامي في أراضى مختلفة الملوحة

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تم إجراء تجربة حقلية في ثلاث أراضى مختلفة الملوحة بمحافظة كفر الشيخ خلال موسمي ٢٠٠٥/٢٠٠٦&٢٠٠٦/٢٠٠٧ لدراسة التأثير المتبادل للتسميد الأزوتى والبوتاسى وملوحة التربة على كفاءة استخدام النيتروجين لمحصول القمح وقد لخصت نتائج الدراسة فيما يلي:

- تبين من النتائج زيادة معنوية لمحصول الحبوب والقش مع إضافة كل من الأزوت حتى مستوى١٤٠كجم/فدان والبوتاسيوم ٥٠كجم/فدان لكل من الأرضي غير الملحية والأراضي متوسطة الملوحة والصودية العالية الملوحة بالترتيب.
- توضح النتائج زيادة معنوية لمحصول الحبوب نتيجة إضافة ١٤٠كجم ن/فدان +٥٠كجم بو٢أ/فدان حيث سجل محصول الحبوب ٢٣,٩٥و ٢٤,٠١؛ ٢٠,٨٦و ٢٠٩٥؛ ١٩,٠٥و١٩,٦ أردب/فدان لكل من الأرضي غير الملحية والأراضي متوسطة الملوحة والصودية العالية الملوحة خلال موسمين الدراسة بالترتيب.
- توضح النتائج زيادة معنوية لمحصول القش نتيجة إضافة ١٤٠كجم ن/فدان + ٥٠كجم بو٢أ/ فدان حيث سجل محصول القش (٤,٧٩٨و ٤,٧٨٧؛ ٤,٠٨٤و٤,١٤٣؛ ٣,٣٦٣و٣,٣٨٧ طن/فدان لكل من الأرضي غير الملحية والأراضي متوسطة الملوحة والصودية العالية الملوحة خلال موسمين الدراسة بالترتيب.
- تشير النتائج إلى زيادة النيتروجين الممتص لمحصول القمح مع زيادة الأزوت المضاف حتى مستوى ١٤٠كجم/فدان لكنه تناقص مع زيادة ملوحة التربة.
- تشير النتائج إلى زيادة النيتروجين المستعاد لمحصول القمح مع زيادة الأزوت المضاف حتى مستوى١٤٠كجم/فدان ومع اضافة البوتاسيوم لكنه تناقص مع زيادة ملوحة التربة.
- أدى التسميد البوتاسى إلى زيادة النيتروجين المستعاد لمحصول القمح بمعدل ١٨,٢%& ١٢,٤%&١٧,١% مع ٤٠كجم ن/فدان تحت ظروف الأراضي غير الملحية، ١٢٠كجم ن/فدان تحت ظروف الأراضي متوسطة الملوحة والصوديةعالية الملوحة.
- تناقصت كفاءة استخدام النيتروجين بزيادة كل من ملوحة التربة والنيتروجين. بينما أدى التسميد البوتاسى إلى زيادة كفاءة استخدام النيتروجين لمحصول القمح بمعدل ٢٠,٤% & ١١,٩% مع ٨٠كجم ن/فدان تحت ظروف الأراضي غير الملحية،ومتوسطة الملوحة، ومن ناحية أخرى لم يتأثر معدل زيادة كفاءة استخدام النيتروجين نتيجة التسميد البوتاسى(١١,٠%) مع زيادة الأزوت من٤٠-١٢٠كجم ن/فدان،وتناقصه إلى ٩,١% مع ١٤٠كجم ن/فدان تحت ظروف الأراضي الصودية عالية الملوحة.
- للحصول على أعلى محصول من القمح لصنف سخا ٩٤ يمكن أن نوصى بإضافة ١٢٠كجم أزوت/فدان مع إضافة ٥٠ كجم بو٢أ/فدان+٢٢كجم فو٢أ٥ /فدان تحت ظروف الأراضي غير الملحية؛ وإضافة ١٤٠كجم أزوت/فدان مع إضافة ٥٠ كجم بو٢أ/فدان+٢٢كجم فو٢أ٥ /فدان تحت ظروف الاراضى ذات الملوحة المتوسطة ،والعالية الملوحة.