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EFFECT OF NITROGEN, PHOSPHORUS AND POTASSIUM APPLICATION AS SOIL AND FOLIAR ON WHEAT PRODUCTIVITY AT SOIL SALINITY CONDITIONS

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ABSTRACT

Two field experiments were conducted at the farm of Tag Al-Ezz Research station, Dakahlia Governorate, Egypt during successive growing seasons 2011/2012 and 2012/2013 on wheat (variety Sakha 93). The experiments conducted to evaluate the effect of methods and rates of applying NPK fertilizers as soil and foliar (100% soil application of recommended NPK, 50% soil + 0.5% NPK foliar, 50% soil + 1% NPK foliar, 25% soil + 0.5% NPK foliar and 25% soil + 1% NPK foliar) on wheat yield, plant height, 1000-grain weight, protein %, N,P,K and Na uptake and K/Na ratio under two levels of soil salinity EC1 (saline soil) and EC2 (non saline soil). The results showed that values of Plant height, grain and straw yield, 1000-grain weight, protein%, NPK uptake and K/Na ratio were decreased with soil salinity (EC1) compared with its values under non saline soil (EC2), while Na uptake was increased with salinity soil in both seasons. Grain yield was decreased under saline soil by 37.44 % and 39.31%, while straw yield was decreased by 32.84% and 41.53% respectively, in both seasons. Application of NPK fertilizers as soil or soil with foliar significantly increased plant height, grain and straw yield, 1000-grain weight, protein %, NPK uptake and K/Na ratio in both seasons. Application of NPK fertilizers at 50% of the recommended as soil +1%N + 1%P + 1%K foliar (F3) recorded the highest grains yield 1.91 and 2.00 t/fed respectively, in both seasons. In concerning, the effect of interaction between soil salinity (EC1 and EC2) and fertilization treatments significantly increased plant height, grain and straw yields, N-uptake, P-uptake and K-uptake. The highest grain yield was 2.42 t/fed with interaction EC2xF3 in second season. Yield results showed that the superiority of fertilization treatment was for 50% soil application with 1%N + 1%P + 1%K as foliar under salinity conditions or non saline soil. Interaction between salinity and fertilization treatments was affected insignificantly on K/Na ratio in both seasons. The highest means of K/Na ratio in straw were 2.22 and 2.52 with interaction EC2XF2 and EC2XF3 respectively, while the highest means of K/Na ratio in grains were 3.23 and 3.55 with interaction EC2XF3 in both seasons respectively.

INTRODUCTION

Soil salinity is one of the major problems in Egyptian agriculture. Salinity problems usually occur in arid and semiarid regions of the world, where rainfall and irrigation are not sufficient to transport salts away from the plant root zone. Because of semiarpid climate in Egypt and shortage water irrigation, salt affected soil become in increasing. Where, the salt affected soils are most located in the North of Delta (El-Agrodi *et al*., 1991). Productivity of crops was decreased in these soils.

Wheat (*Triticum aestivum,* L.) is the most strategic cereal crop in the world as well as in Egypt. It is know that there is gap between production and consumption in Egypt. Wheat is conceder of moderately tolerance crop to salinity. Increasing wheat production could be achieved through maximizing the yield per unit area or invading deserts to expand the cultivated area and or raise the productivity of salinity soils. It is established that salinity in soil affects the growth, yield and nutrients uptake to a large extent (El-Agrodi *et al*., 1991).

Eisa, (1997) found that N, P and K content and its accumulation in both stem and leaves were decreased with increasing soil salinity from 4.33 to 12.45 dSm^{-1}. In contrary, the Na^+ and Cl^- ions increased with increasing soil salinity levels and its accumulation in plant tissues. Also, found that Na/K ratio increased with increasing soil salinity levels in leaves. Ghogdi *et al*., (2012) found that salinity stress (1.3 dSm^{-1} as control, 5, 10, 15 dSm^{-1}) decreased K^+ content, K^+/Na^+ ratio and grain yield; however Na^+ content in all the genotypes of wheat were increased. Also, showed that the salinity tolerance in tolerant cultivars as manifested by lower decrease in grain yield is associated with the lower sodium accumulation and higher K^+/Na^+ compared to the sensitive cultivars.

Faizy, *et al*., (2010) showed that grain yield of wheat cv. Sakha 94 decreased significantly with increasing soil salinity levels (EC = 2.6, 5.4 and 10 dSm^{-1}). The data recorded decrease in grain yield by about 13.74% and 24.11% of the mean value for medium and highly saline sodic soil as compared with normal soil .The mean values recorded a decrease of straw yield by about 23.46% and 32.85%due to increasing soil salinity under medium and highly saline sodic soil, respectively as compared to non saline soil

Fertilization plays a vital role on wheat productivity under salinity conditions, especially foliar fertilization, as mentioned by many researchers. Schmidhalter *et al*., (1999) found that foliar fertilization of NPK or NK significantly affected plant height of wheat under drought or salinity. The efficacy of foliar fertilization is higher than that of soil fertilizer application in these situations. The reasons for this are because of the supply of the required nutrient directly to the location of demand in the leaves and its relatively quick absorption (e.g. 0.5– 2 h for N and 10–24 h for K), and the independence of root activity and soil water availability (Romheld and El-Fouly 1999).

Ling and Silberush, (2002) illustrated that foliar nutrient application under drought and salinity conditions may be able to exclude or include a water deficit or nutrient effect under short-term drought or salt stress. Where, foliar fertilization with nitrogen, phosphorus, and potassium (N-P-K) can be supplemented with soil applied fertilizers but cannot replace soil fertilization in the case of maize. Therefore, correcting the plant's deficiency by foliar application seems plausible. Jamal, *et al*., (2006) revealed that foliar application of nutrients (NPK) along with soil application of nutrients gave higher values in almost all the parameters of wheat under discussion. The higher 1000-grain weight was obtained from foliar + soil applied treatments on average. Also, El-Defan *et al*., (1999) found that soil + foliar treatments were superior for increasing 1000-grain weight for wheat.

Sarhan *et al*., (2004) showed that foliar application of 3% N with 15 kg N/fed soil activated dose gave a high increase in wheat grain and straw yield and contents of N and P in comparison with soil application. Mosali *et al*. (2006) demonstrated that foliar applications of P at rates (0, 1, 2, 4, 8, 12, 16, and 20 kg ha^{-1}) with and without pre-plant rates of 30 kg ha^{-1} generally increased wheat grain yields and P uptake versus no foliar P.

Khan, *et al*.,(2009) showed that effe

ct foliar application of urea applied in different concentrations (0, 2, 4, 6, 8 and 10%) and at different stages along with 60 and 120 kg N ha^{-1} were applied as soil application on wheat significantly increased plant height, hundred grain weight, biological yield, grain yield and N uptake by the crop. The foliar spray of 4% urea solution was found to be most effective for enhancing the quantitative and qualitative traits. Gul *et al*., (2011) reported that growth performance of wheat was highly influenced by the foliar application of two times of 0.5 % N, 0.5% K and 0.5% Zn solutions at tillering and booting stages.

So, the main objectives of the present investigation were to study the effect of soil and foliar applied NPK on wheat yield, NPK uptake and K/Na ratio under saline and normal soil conditions.

MATERIALS AND METHODS

Two field experiments were conducted at the farm of Tag Al-Ezz research station, Dakahliea governorate, Egypt during successive growing seasons of 2011/2012 and 2012/2013. The experiments conducted to evaluate the effect of rates and methods of applying NPK fertilizers as soil and foliar on wheat yield, plant height, 1000-grain weight, protein content, N,P,K and Na uptake and K/Na ratio under two levels of soil salinity EC1 (saline soil), EC2 (non saline soil) as shown in table1. As clear in table 1, there are differences in values of EC1 and EC2 in two seasons. This varies in EC values return to nature conditions of soil in station farm. First season was sown at 25 November 2011, and harvested at 10 may 2012, while second season was sown at 20 November 2012 and harvested at 5 may 2013. Wheat variety was Sakha 93.

The two experiments were designed as split plot design with three replicates, and plot area was $10.5m^2$. Experimental treatments were carried out as follow:

The main plot: (soil salinity EC1 and EC2) were as shown in table1

The sub plots: methods of NPK fertilization (F1, F2, F3, F4 and F5).

F1: 100% of recommended doses of NPK as a soil application (control).

F2: 50% of recommended doses of NPK as a soil application and 0.5%N+0.5%P+0.5%K foliar

F3: 50% of recommended doses of NPK as a soil application and 1%N+1%P+1%K foliar

F4: 25% of recommended doses of NPK as a soil application and 0.5%N+0.5%P+0.5%K foliar

F5: 25% of recommended doses of NPK as a soil application and 1%N+1%P+1%K foliar

Data in table (1) show some soil properties of the experimental field before sowing, according to Jackson (1967), Page (1982) and Garcia (1978). The soil of experimental field was silty clay loam in texture. The values of mechanical analysis, SP%, OM%, $CaCO_3$%, PH and available NPK were means.

Table (1) some chemical and physical analyses of the soil before sowing:

Characteristics		Season 2011/2012	Season 2012/2013	Characteristics		Season 2011/2012	Season 2012/2013
Mechanical analysis	Sand %	14.75	15.60	**EC1		9.24	7.56
	Silt %	49.80	48.15	Soluble Cations and anions (meq/L)	Ca^{++}	15.66	12.58
	Clay %	35.45	36.25		Mg^{++}	12.04	9.96
	Texture	S. C. L.	S. C. L.		Na^{+}	70.75	62.54
SP%		60.0	63.0		K^{+}	2.43	1.94
					CO_3^{--}	--	--
OM%		0.43	0.57		HCO_3^{-}	1.96	1.98
					Cl^{-}	78.9	64.00
CaCO3%		1.35	1.77		SO_4^{--}	20.02	21.04
				**EC2		2.42	2.10
*PH		8.43	8.30	Soluble Cations and anions (meq/L)	Ca^{++}	8.3	7.86
					Mg^{++}	6.0	6.05
Available N ppm		18	20		Na^{+}	14.0	9.03
					K^{+}	1.1	2.05
Available P ppm		6.3	8.5		CO_3^{--}	--	--
					HCO_3^{-}	1.85	2.00
Available K ppm		310	340		Cl^{-}	17.30	13.8
					SO_4^{--}	10.25	9.19

***pH in 1:2.5 soil : water suspension, ** EC in soil paste extract.**

The recommended doses of NPK for wheat plant were 75 kg N/fed, 15 kg P_2O_5/fed and 24 kg K_2O/fed according to extension guide for wheat, ministry of agriculture, Egypt, Negm (2009). The soil application of N was as ammonium nitrate fertilizer (33.5 % N), potassium as potassium sulfate fertilizer (50 % K_2O) and phosphorus as calcium single super phosphate fertilizer (15.5 % P_2O_5). Super phosphate fertilizer was added as one dose before sowing. Soil application of NK fertilizers was as two doses for F1, F2 and F2 first dose was 1st irrigation after sowing and second dose with the following irrigation. While soil application for F4 and F5 were as one dose with first irrigation after sowing. Foliar application of NPK was as two times, first time (100 L/fed) was after sowing by 45 days and second time (200 L/fed) was after sowing by 60 days. 0.5%N + 0.5%P + 0.5%K foliar were prepared by mixing solution of 0.5% N (as urea 46.5%N), 0.5% P (super phosphate) and 0.5% K (potassium sulfate) at all times of spraying. Every solution prepared alone before foliar, except phosphor prepared by soaking fertilizer in water for 24 hours and then take the extract for mixing with N and K solutions. 1%N + 1%P + 1%K foliar prepared as same strips in 0.5%N +

0.5%P + 0.5%K but from 1% N, 1%P and 1%K solutions and mixed at spray time.

Plant height, grain and straw yield and 1000-grain weight were recorded. Nitrogen, phosphorus, potassium and sodium concentrations were determined at plant samples that taken at harvest stage according to Jackson, (1967). K/Na ratio was calculated by dividing K concentration (%) on Na concentration (%). Protein was calculated by multiplying N % in grains by 5.25.

The statistical analysis was estimated according to the method of Gomez and Gomez (1984) and means values were compared against least significant differences test (L.S.D.) at 5% level.

RESULTS AND DISCUSSION

Plant height:

Data in table 2 show the effect of salinity and methods of NPK fertilization on plant height at 75 days from planting and at harvest stage. Data reveal that Plant height values were decreased with salinity level EC1, where the effect of salinity on plant height was significant in both seasons.

Table2: Effect of soil salinity and methods of NPK fertilization on plant height of wheat plants.

Treatments		Plant height at 75 days (cm)		Plant height at harvest (cm)	
		1st season	2nd season	1st season	2nd season
Mean of EC					
EC_1		38.03	44.47	64.87	65.67
EC_2		47.00	48.73	80.07	83.20
LSD at 5%		*2.50*	*0.57*	*2.58*	*3.73*
Mean of fertilization					
F1		43.58	46.67	71.83	78.00
F2		41.00	45.83	75.33	73.50
F3		44.33	45.67	75.83	77.00
F4		42.17	46.83	70.00	73.00
F5		41.50	48.00	69.33	70.67
LSD at 5%		*1.293*	*1.208*	*1.278*	*3.13*
Mean of interaction EC * fertilization					
EC_1	F1	37.50	41.33	59.67	69.67
	F2	35.33	43.33	68.67	62.33
	F3	41.33	42.00	68.67	68.00
	F4	38.33	46.00	65.00	65.67
	F5	37.67	49.67	62.33	62.67
EC_2	F1	49.67	52.00	84.00	86.33
	F2	46.67	48.33	82.00	84.67
	F3	47.33	49.33	83.00	86.00
	F4	46.00	47.67	75.00	80.33
	F5	45.33	46.33	76.33	78.67
LSD at 5%		*2.395*	*2.238*	*2.368*	*ns*

Application of fertilization treatments significantly increased the values of plant height in both seasons. The differences between fertilization treatments (soil and soil + foliar application) were no significant in most cases, especially between F1 (control) and F3 (50% soil application +1%N + 1%P + 1%K foliar). Interaction effect between EC levels and fertilization treatments were significant on plant height, except on plant height at harvest stage in 2nd season. It is obvious from results the clear effect of salinity on plant height, where the means of plant height were higher under EC2 (normal soil) than under EC1 (saline soil) in both seasons. These results are in agreement with El-Agrodi *et al*., (1991) and Eisa, (1997). As soon as, the significant effect of fertilizers application as soil and foliar are agree with Schmidhalter *et al*., (1999) and Ling and Silberush (2002).

Grain and straw yield:

Data in table 3 illustrate the significant effect of salinity on grain and straw yield in both seasons. Grain yield was decreased under EC1 (saline soil) by 37.44 % and 39.31%, while straw yield was decreased by 32.84% and 41.53% respectively, in both seasons.

Table3: Effect of soil salinity and methods of NPK fertilization on grain and straw yield of wheat plants.

Treatments		Grain Yield (t/fed)		Straw Yield (t/fed)	
		1st season	2nd season	1st season	2nd season
Mean of EC					
EC_1		1.369	1.424	2.293	2.145
EC_2		2.190	2.241	3.410	3.661
LSD at 5%		0.088	0.049	0.316	0.102
Mean of fertilization					
F1		1.909	1.968	2.931	3.037
F2		1.843	1.880	3.085	2.954
F3		1.907	2.003	3.318	3.332
F4		1.605	1.621	2.380	2.517
F5		1.632	1.691	2.543	2.674
LSD at 5%		0.0471	0.0536	0.2147	0.0968
Mean of interaction EC * fertilization					
EC_1	F1	1.461	1.536	2.248	2.196
	F2	1.419	1.440	2.677	2.301
	F3	1.467	1.589	2.756	2.637
	F4	1.232	1.227	1.781	1.664
	F5	1.264	1.328	2.003	1.924
EC_2	F1	2.357	2.400	3.614	3.877
	F2	2.267	2.320	3.493	3.607
	F3	2.347	2.416	3.880	4.027
	F4	1.979	2.016	2.978	3.371
	F5	2.000	2.053	3.084	3.424
LSD at 5%		0.087	0.099	ns	0.179

This effect may be return to effect of salinity under EC1 on plant growth that appears from plant height and straw yield. These results are in accordance with El-Agrodi, *et al*., (1991) and Ghogdi, *et al*., (2012). Also, data reveal that the effect of fertilization on grain and straw yield was significant in both seasons. The difference between F1 and F3 was not significant for grain yield and significant for straw yield in both seasons.

Fertilization treatment F3 recorded the highest grain yield 1.91 and 2.00 t/fed in both seasons, respectively. In concerning, the effect of interaction between EC and fertilization treatments, grain and straw yield increased significantly, except straw yield in 1st season was insignificant. The differences between interactions ECxF1 and ECxF3 were insignificant under EC1 and EC2 in both seasons for grain and straw yield. The highest grain and straw yield were 2.42 and 4.03 t/fed with interaction EC2xF3. So it is obvious from yield results that the superiority of fertilization treatment F3 (50% soil application +1%N + 1%P + 1%K foliar) under EC1 or EC2 conditions. This effect may be return to effect on plant growth as plant height and straw yield that appear the superiority of treatment application F3. These results are in harmony with Ling and Silberush (2002) and Sarhan, *et al*., (2004).

1000-grain weight:

Data in table 4 show that the effect of soil salinity on 1000-grain weight was significant in 1st season and not significant in 2nd season. The mean value of 1000-grain weight increased significantly with fertilization treatments. While the interaction between soil salinity and fertilization treatments had no significant effect on 1000-grain weight in both seasons. Results show that means of 1000-grains weight were decreased under salinity conditions (EC1) than EC2. The highest 1000-grain weight was recorded with F3 (50% soil application +1%N + 1%P + 1%K foliar).

Table4: Effect of soil salinity and methods of NPK fertilization on 1000-grain weight and protein content of wheat grain.

Treatments		1000-grain weight (g)		Protein %	
		1st season	2nd season	1st season	2nd season
Mean of EC					
EC_1		41.19	41.93	8.36	8.78
EC_2		45.37	44.47	9.56	9.71
LSD at 5%		2.663	ns	0.341	0.155
Mean of fertilization					
F1		40.90	40.84	9.75	9.91
F2		42.50	42.39	9.48	9.66
F3		44.87	44.80	9.03	9.42
F4		43.82	43.71	8.23	8.78
F5		44.32	44.25	8.31	8.47
LSD at 5%		2.444	2.478	0.401	0.297
Mean of interaction EC * fertilization					
EC_1	F1	39.90	40.62	9.31	9.47
	F2	38.97	39.67	9.03	9.24
	F3	43.68	44.47	8.21	8.84
	F4	40.47	41.20	7.51	8.45
	F5	42.92	43.69	7.75	7.91
EC_2	F1	41.90	41.06	10.19	10.34
	F2	46.03	45.11	9.92	10.08
	F3	46.05	45.13	9.85	10.01
	F4	47.17	46.22	8.94	9.10
	F5	45.72	44.80	8.87	9.03
LSD at 5%		ns	ns	ns	ns

Protein content:

Also, results in table 4 illustrate that protein % was affected significantly by soil salinity. Protein content was higher under EC2 than EC1. Fertilization treatments had a significant effect on protein %. While the effect of interaction between EC and fertilization was not significant in both seasons.

N-uptake (kg/fed):

As shown in table5 soil salinity affects significantly on N-uptake by straw and grain of wheat. N-uptake values decreased under EC1 (saline soil) compared with its uptake under EC2. Similar results were obtained by Eisa (1997). Application of fertilization treatments increased N-uptake significantly up to F3. Addition 50% of recommended NPK doses with foliar fertilization by 1%N + 1%P + 1%K recorded the highest total N-uptake 95.85 and 101.36 kg/fed in both seasons, respectively. Where, soil application at 25% with foliar (F4 and F5) recorded the lowest N-uptake. Interaction between salinity levels and fertilization treatments had a significant effect on N-uptake by wheat plants, except on N-uptake by straw yield in 1st season. The highest total N-uptake was 123.14 and 130.27 kg/fed in both seasons, respectively with interaction EC2XF3. These results are in accordance with Khan, *et al*., (2009).

Table5: Effect of soil salinity and methods of NPK fertilization on N-uptake by wheat plants.

Treatments		N-Uptake(kg/fed) 1st season		N-Uptake (kg/fed) 2nd season	
		straw	grain	straw	grain
Mean of EC					
EC_1		34.06	21.93	33.11	23.93
EC_2		66.51	40.03	71.76	41.63
LSD at 5%		5.268	2.152	2.179	1.204
Mean of fertilization					
F1		54.42	35.83	58.71	37.49
F2		56.40	32.35	54.63	34.24
F3		61.04	34.81	64.19	37.17
F4		39.85	25.65	41.72	27.34
F5		39.70	26.24	42.92	27.67
LSD at 5%		4.177	1.569	2.215	1.439
Mean of interaction EC * fertilization					
EC_1	F1	35.46	25.92	36.08	27.70
	F2	41.41	22.17	36.75	24.24
	F3	43.29	25.27	44.49	27.96
	F4	24.50	17.61	22.64	19.75
	F5	25.62	18.67	25.57	20.01
EC_2	F1	73.38	45.74	81.33	47.29
	F2	71.39	42.52	72.51	44.24
	F3	78.79	44.35	83.89	46.38
	F4	55.20	33.70	60.79	34.94
	F5	53.77	33.81	60.26	35.33
LSD at 5%		ns	2.906	4.102	2.666

P-uptake (kg/fed):

The results in table 6 show the significant effect of soil salinity on P-uptake by straw and grain of wheat in both seasons. The total P-uptake (straw + grain) was lowest (11.53kg/fed) under salinity conditions (EC1) compared with total P-uptake (19.24kg/fed) under non saline soil (EC2). These may be return to effect of salinity on P availability and consequently its uptake by plants, which agree with Eisa (1997). Application of fertilization treatments soil or soil + foliar application significantly affect on P-uptake. Fertilization treatments F3 (50% soil application + 1%N + 1%P + 1%K foliar) recorded the highest total P-uptake 17.61 and 18.56 kg/fed in both seasons, respectively. While the difference between F1 and F3 was insignificant. Interaction between soil salinity and fertilization treatments had a significant effect on P-uptake by straw yield and insignificant effect on P-uptake by grain yield. The highest values of P-uptake under EC1 were 13.54 and 14.18kg/fed with interaction F3, and under EC2 were 22.00 and 23.46kg/fed with interaction F1 in both seasons, respectively. But the differences between interaction EC2xF1 and EC2xF3 were no significant; these refer to superiority of foliar application with soil applied under salinity soil. This results in accordance with that obtained by Mosali *et al*., (2006).

Table6: Effect of soil salinity and methods of NPK fertilization on P-Uptake by wheat plants.

Treatments		P-Uptake-(kg/fed) 1^{st} season		P-Uptake-(kg/fed) 2^{nd} season	
		straw	grain	straw	grain
Mean of EC					
EC_1		6.32	5.21	5.99	5.56
EC_2		10.17	9.07	11.06	9.54
LSD at 5%		0.569	0.919	0.134	1.059
Mean of fertilization					
F1		7.96	9.18	8.41	9.72
F2		7.33	8.83	7.63	8.83
F3		7.86	9.75	8.48	10.08
F4		6.25	6.46	6.49	6.89
F5		6.31	6.99	6.72	7.11
LSD at 5%		0.646	0.976	0.441	1.016
Mean of interaction EC * fertilization					
EC_1	F1	6.58	5.71	6.65	6.16
	F2	6.97	5.51	6.24	5.64
	F3	7.88	5.66	7.86	6.32
	F4	4.59	4.63	4.23	4.74
	F5	5.56	4.57	4.98	4.93
EC_2	F1	11.78	10.22	12.80	10.66
	F2	10.69	9.16	11.42	9.63
	F3	11.63	10.07	12.31	10.64
	F4	8.32	7.87	9.55	8.24
	F5	8.42	8.06	9.25	8.50
LSD at 5%		1.197	ns	0.817	ns

K-uptake (kg/fed):

As shown in table 7, soil salinity affects significantly on K-uptake by straw and grain of wheat in both seasons. The uptake of K decreased under salinity conditions (EC1) compared with the K-uptake under EC2. These results are in agreement with those obtained by Eisa (1997) and Ghogdi *et al*., (2012). Application of NPK fertilizers affects significantly on K-uptake in both seasons. Application of fertilizers at 50% as soil with foliar of 1%N + 1%P + 1%K (F3) recorded the highest total K-uptake (straw + grain) 72.62 and 77.48 kg/fed respectively, in both seasons. Interaction between soil salinity and fertilization had a significant effect on K-uptake by straw yield in 1st season and grain yield in 2nd season, while it was insignificant on K-uptake by straw in 2nd season and K-uptake by grain yield in 1st season. The highest total K-uptake was 90.82 kg/fed in 1st season and 98.86 kg/fed in 2nd season at interaction EC2XF3. These results are agreed with Ling and Silberush (2002).

Table7: Effect of soil salinity and methods of NPK fertilization on K-Uptake by wheat plants.

Treatments		K-Uptake (kg/fed) 1st season		K-Uptake (kg/fed) 2nd season	
		straw	grain	straw	grain
Mean of EC					
EC_1		36.23	9.05	35.28	9.99
EC_2		60.78	15.74	69.71	16.78
LSD at 5%		5.617	1.208	2.219	0.939
Mean of fertilization					
F1		52.79	13.96	56.48	15.04
F2		54.55	12.39	55.48	13.28
F3		59.22	13.40	62.75	14.73
F4		37.40	10.94	42.85	11.60
F5		38.57	11.31	44.92	12.28
LSD at 5%		4.793	0.585	3.235	0.41
Mean of interaction EC * fertilization					
EC_1	F1	36.64	10.23	37.12	11.36
	F2	44.10	8.98	39.06	9.70
	F3	44.58	9.82	44.85	11.26
	F4	27.54	7.89	26.61	8.34
	F5	28.30	8.35	28.77	9.30
EC_2	F1	68.95	17.68	75.84	18.71
	F2	65.00	15.80	71.90	16.85
	F3	73.85	16.97	80.66	18.20
	F4	47.26	13.98	59.10	14.85
	F5	48.85	14.26	61.06	15.26
LSD at 5%		8.877	ns	ns	0.760

Na-uptake (kg/fed):

Data in table 8 show that Na-uptake insignificantly affected by soil EC in both seasons, whereas total Na-uptake by wheat plants (straw+ grain) increased with soil salinity. Application of NPK fertilizers as soil and foliar affected significantly on Na-uptake up to F3 by straw yield, but insignificantly on Na-uptake by grain yield in both seasons. Also, data reveal that the effect of interaction was insignificant on Na-uptake by straw but significant on grain in 1st season, and in 2nd season the effect of interaction was significant on Na-uptake by straw and insignificant on grain. The results are in agreement with those obtained by Eisa (1997) and Ghogdi *et al*., (2012).

Table 8: Effect of soil salinity and methods of NPK fertilization on Na-uptake by wheat plants.

Treatments		Na-Uptake-(kg/fed) 1st season		Na-Uptake-(kg/fed) 2nd season	
		straw	grain	straw	grain
Mean of EC					
EC_1		26.18	6.14	22.04	5.89
EC_2		24.63	5.69	21.14	4.99
LSD at 5%		ns	ns	ns	ns
Mean of fertilization					
F1		26.18	6.13	22.51	5.65
F2		29.27	5.55	24.20	5.11
F3		26.86	5.73	22.32	5.54
F4		21.83	5.48	18.99	4.81
F5		22.89	6.67	19.94	6.08
LSD at 5%		3.187	ns	1.450	ns
Mean of interaction EC * fertilization					
EC_1	F1	24.52	6.53	22.10	6.09
	F2	29.56	5.06	23.86	5.19
	F3	30.23	6.14	25.59	5.94
	F4	22.51	5.42	18.42	4.99
	F5	24.08	7.53	20.25	7.23
EC_2	F1	27.843	5.73	22.924	5.20
	F2	28.310	6.05	22.817	5.03
	F3	24.148	5.31	20.776	5.14
	F4	21.153	5.54	19.563	4.63
	F5	21.693	5.81	19.630	4.93
LSD at 5%		ns	2.879	2.686	ns

K/Na ratio:

The results in table 9 illustrate that soil salinity affected significantly on K/Na ratio in straw and grain. The values of K/Na ratio decreased under EC1 (saline soil) compare**d** with under EC2 (non saline soil). Generally, the values of K/Na ratio were lowest under EC1 and increased under EC2, this return to high concentration of Na under EC1. These results agree with Ghogdi *et al*., (2012). Also, results show that application of fertilization treatments significantly increased K/Na ratio up to F3. Interaction between salinity and fertilization treatments affected insignificantly on K/Na ratio in both seasons. The highest means of K/Na ratio in straw were 2.70 with interaction EC2XF3 in 1st seasons and 3.54 with interaction EC2XF3 in 2nd season, while the highest means of K/Na ratio in grains were 3.23 and 3.55 with interaction EC2XF3 in both seasons respectively.

Table 9: Effect of soil salinity and methods of NPK fertilization on K/Na ratio in wheat plants.

Treatments		K/Na ratio 1st season		K/Na ratio 2nd season	
		in straw	in grain	in straw	in grain
Mean of EC					
EC_1		1.37	1.52	1.59	1.74
EC_2		2.46	2.80	3.31	3.40
LSD at 5%		0.283	0.552	0.801	0.649
Mean of fertilization					
F1		1.99	2.34	2.51	2.76
F2		2.05	2.20	2.65	2.63
F3		2.10	2.44	2.57	2.73
F4		1.74	2.02	2.25	2.48
F5		1.71	1.82	2.27	2.25
LSD at 5%		0.144	0.372	0.196	ns
Mean of interaction EC * fertilization					
EC_1	F1	1.50	1.59	1.68	1.90
	F2	1.49	1.78	1.64	1.88
	F3	1.47	1.64	1.75	1.92
	F4	1.24	1.46	1.45	1.67
	F5	1.18	1.14	1.42	1.32
EC_2	F1	2.48	3.09	3.34	3.42
	F2	2.62	2.62	3.50	3.37
	F3	2.70	3.23	3.54	3.55
	F4	2.24	2.57	3.04	3.29
	F5	2.25	2.50	3.11	3.18
LSD at 5%		ns	ns	ns	ns

DISCUSSION

It is obvious from previous results that high soil salinity had a negative effect on plant height, straw and grain yield, protein %, N, P and K uptake and K/Na ratio in both seasons. In contrary, Na-uptake was increased under salinity. This effect are in accordance with that obtained by El-Agrodi *et al*. (1991), Eisa (1997), Faizy *et al*., (2010) and Ghogdi *et al*. (2012). Whereas the method of application NPK fertilizers and rates (fertilization treatments) had a positive effect on most of wheat parameters, while the superiority was to 50% soil application of recommended NPK doses with foliar application of 1%N+ 1%P+ 1%K mixed at two times(F3). Under interaction between soil salinity and methods of NPK fertilization and rates treatments, it can be noticed that treatment F3 was the best treatment under EC1 (saline soil) and EC2 (non saline soil). Whereas the differences between F3 treatment and F1 (control) were no significant under EC2. Also, fertilization treatment F3 can be save in NPK fertilizers for wheat yield by 20-25% for N, 10-15% for P and 20-25% for K per feddan.

So, this study can be recommended by wheat fertilization as soil application of NPK fertilizers at rate 50 % of recommended doses with foliar application of 1%N + 1%P + 1%K at two times to obtain the high yield of wheat under the same study conditions.

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تأثير إضافة النتروجين والفوسفور والبوتاسيوم أرضيا وورقيا على إنتاجية القمح تحت ظروف التربة الملحية

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أقيمت تجربتان حقليتان فى مزرعة محطة بحوث تاج العز- مركز البحوث الزراعية- محافظة الدقهلية- مصر خلال موسمي ٢٠١٢/٢٠١١ و ٢٠١٣/٢٠١٢ على القمح صنف سخا ٩٣ وذلك لتقييم طرق إضافة النتروجين والفوسفور والبوتاسيوم أرضى وورقي (١٠٠% أرضى من الموصي به ؛ ٥٠%أرضى +رش ٠.٥% ن- فو- بو ؛ ٥٠% أرضى + رش ١% ن- فو- بو ؛ ٢٥%أرضى +رش ٠.٥% ن- فو- بو ؛ ٢٥% أرضى + رش ١% ن- فو- بو) على محصول القمح وارتفاع النبات ووزن الألف حبة ومحتوى بروتين الحبوب والممتص من عناصر النتروجين والفوسفور والبوتاسيوم والصوديوم ونسبة بو/ص تحت تأثير ملوحة التربة (تربه ملحية وأخرى غير ملحية).

وكانت أهم النتائج المتحصل عليها كما يلي:

تشير النتائج إلى انخفاض قيم ارتفاع النبات و محصولي الحبوب والقش ومحتوى البروتين والممتص من عناصر النتروجين والفوسفور والبوتاسيوم ونسبة البوتاسيوم/الصوديوم تحت التربة الملحية مقارنة بقيمها تحت ظروف التربة غير الملحية. في حين زادت قيم الصوديوم الممتص تحت الظروف الملحية فى كلا الموسمين. انخفض محصول الحبوب تحت ظروف التربة الملحية بنسبة ٣٧.٤٤ و ٣٩.٣١%، فى حين انخفض محصول القش بنسبة ٣٢.٨٤ و ٤١.٥٣% على التوالي فى كلا الموسمين. زادت قيم كلا من ارتفاع النبات و محصولي الحبوب والقش ووزن الألف حبة ومحتوى بروتين الحبوب والممتص من عناصر النتروجين والفوسفور والبوتاسيوم ونسبة البوتاسيوم/الصوديوم مع إضافة معاملات التسميد أرضى أو أرضى مع رش فى كلا الموسمين. أدت معاملة التسميد ٥٠% ارضي من الموصى به مع رش ١% من كل من النتروجين والفوسفور والبوتاسيوم إلى تحقيق أعلى محصول حبوب ١.٩١و ٢.٠٠ طن للفدان فى كلا الموسمين على التوالي. تأثر معنويا كل من ارتفاع النبات و محصولي الحبوب والقش والممتص من النتروجين والفوسفور والبوتاسيوم عند التفاعل بين ظروف ملوحة التربة ومعاملات التسميد . سجل اعلي محصول حبوب ٢.٤٢ طن/فدان عند التفاعل بين معاملة التسميد ٥٠% أرضى + رش ١% ن- فو- بو تحت ظروف التربة غير الملحية. تشير نتائج المحصول إلى تفوق معاملة التسميد ٥٠% أرضى من النتروجين والفوسفور والبوتاسيوم الموصى به + رش ١% ن- فو- بو تحت ظروف التربة الملحية وغير الملحية. التفاعل بين ظروف ملوحة التربة ومعاملات التسميد أثر غير معنويا على نسبة البوتاسيوم/الصوديوم فى كلا الموسمين. كانت اعلي نسبة البوتاسيوم/الصوديوم فى القش ٢.٥٢ وفى الحبوب ٣.٥٥ عند إضافة ٥٠ % أرضى + رش ١% ن- فو- بو تحت ظروف التربة الغير الملحية.

قام بتحكيم البحث

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