Wheat response to nitrogen and zinc fertilization under saline condition in calcareous soil

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ABSTRACT

A pot experiment was carried out to study the effect of nitrogen and zinc fertilization on the growth, nutrient uptake and yield of two wheat cultivars (Sakha 8 and Sakha 69) grown under saline water irrigation in calcareous soil. Nitrogen, as ammonium sulphate and ammonium nitrate, was applied at rate of 100 kg N/fed. Zinc was applied as zinc sulphate at rates of 0.0 and 5 kg/fed. Three salinity levels (EC 0.62; Nile water as control, wells water have 7.8 and 15.6 dSm^{-1}) were applied.

Nitrogen and zinc fertilization enhanced the dry matter and grain yield of plants. However, ammonium sulphate was more effective than ammonium nitrate. N, P, K and Zn uptake in shoots and grains were increased by N and Zn fertilizers addition. Increasing salinity from EC 7.6 to 15.8 reduced the dry matter yield, grain yield and N uptake. Meanwhile, the Na concentration in shoots was increased. Sakha 8 was more effective than Sakha 69 for grain yield, minerals uptake. The cultivar Sakha 8 is salt tolerance more than Sakha 69.

1. Introduction

Wheat is one of the most important field crops for human food. Thus intensive efforts have been performed to increase its production by several agricultural means. One of these means is the use of N-fertilization (EL-KOUMEY and EL-SHAFIE, 1997).

Competition among all sectors of society for good-quality water has focused a great attention on the use of the poor-quality waters in agriculture (DEVITT et al., 1987). However, if saline or waste water is used, attention must be given to assess the impact of such water on productivity. Low quality of irrigation water, such as well water, has been used in some Egyptian areas for irrigation, whenever, the Nile water was not available. These areas may be subjected to salt accumulation. The potential of crop productivity under such conditions is depending on the plant response to osmotic stress and on the relative toxicity of some ions such as Na^+ and Cl^- (MARSCHNER, 1995). In most cases, a reduction in the yield was normally associated with an accumulation of soluble salts in plant tissues (MENGEL and KIRKBY, 1987).

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Nitrate and ammonium ions constitute the most important nitrogen forms taken up by plants. Moreover, in many arable soils where nitrification normally takes place rapidly, nitrate and ammonium are the prominent sources (EL-SHINNAWI et al., 1988).

Since zinc is very closely involved in the N metabolism within plant tissues, foliar spray of wheat plants with Zn under certain soil conditions such as high pH, in arid and semi-arid regions, had been found to have a positive effect on its growth and yield. This enhancing effect may be due to the high degree of nutrient utilization in plant tissues (DORING and GERIKE, 1985).

This work is an attempt to spot a light on the effect of two N forms (nitrate & ammonium) and Zn fertilization on the growth, nutrient uptake and yield of two wheat cultivars grown under saline conditions in calcareous soil.

2. Materials and Methods

Surface (0 – 30 cm) calcareous soil samples were collected from the Experimental Farm of the soil salinity laboratory, Agric. Res. Center, Alexandria, Egypt. Soil samples were air dried and ground to pass through a 2 mm sieve. Physical and chemical properties of the used soil were determined according to BLACK (1982) as shown in Table (1 a).

Table 1 – a: Some physical and chemical characteristics of the experimental soil.

Property	Value	Property	Value
Physical characteristics:		Soluble ions (meq 100 g $^{-1}$):	
Sand, %	81	Ca^{2+}	1.66
Silt, %	10	Mg^{2+}	2.87
Clay, %	9	Na^{+}	7.29
Texture class	Loamy sand	K^{+}	3.30
Chemical characteristics:		HCO_3^-	1.06
OM, %	0.40	Cl^-	11.66
pH (1 : 2.5 soil / water sus.)	7.30	$SO_4^=$	2.40
EC, dS m^{-1}	1.08	Total N, %	0.09
$CaCO_3$ %	33.14	Available P µg g^{-1}	16.0
SAR	4.95	Zn µg g^{-1}	1.80
ESP	4.52	Fe µg g^{-1}	3.20
		Mn µg g^{-1}	4.10

Glazed pots, (30 cm diameter and 25 cm depth) were filled with 12 kg air dried soil. Twenty grains of wheat (*Triticum aesativum* L., Sakha 8 and Sakha 69 cvs.) were sown and 20 days later, the seedlings were thinned to 10 per pot. The pots were arranged in a complete randomized block design with four replicates. The other agriculture practices were applied as recommended for wheat production in Egypt.

Three salinity levels were used Nile water with EC 0.62 dSm^{-1} as a control, ground water wells with 7.8, and 15.6 dSm^{-1} in the Soil Salinity Laboratory at Abis, Alexandria Governorate. Water characteristics are tabulated in Table (1 b).

Two nitrogen forms, ammonium nitrate and ammonium sulphate were added to the soil at the rate of 100 kg N/feddan, corresponding to 3.6 and 5.7 g N/pot, respectively. N fertilizer was added in two equal portions, before the first and the second irrigation. Zinc sulphate was applied as foliar application at two rates 0 and 5 kg / fed. Foliage spray of Zn was applied at 35 days from sowing.

Plant samples were taken during the growth period (at 45, 90 and 120 days from sowing), washed, air dried. The plant materials were divided into two parts, one dried at 70°C (24 hrs) for chemical analysis and the another at 105°C for dry weight determination. Samples were thoroughly ground and ashed by wet digestion according to JACKSON (1967). Total N was determined using micro-kjeldahl method after JACKSON (1967). P, K and Na were determined by flame fotometer as described by CHAPMAN and PRATT (1961). Available Fe, Zn and Mn in wheat shoots were determined using the atomic absorption spectrometer (Model Phillips Pu 9100).

At harvest time, the number and weight of spikes / pot, weight of 100 grains, grains weight (g/pot) were determined. N, P, K and Zn in grains were determined according to CHAPMANN and PRATT (1961). Grain crude protein content was calculated by multiplying N values by the conversion factor 6.25.

All data were statistically analyzed according to GOMEZ and GOMEZ (1983).

Table 1 – b: Chemical characteristics of irrigation water samples.

Property	Irrigation water dSm^{-1}		
	EC 0.62	EC 7.8	EC 15.6
pH	7.9	7.7	7.6
SAR	1.96	21.10	28.40
Soluble ions mg L^{-1}:			
Ca^{++}	2.20	6.45	20.19
Mg^{++}	1.73	10.92	23.90
Na^{+}	2.75	62.21	133.50
K^{+}	0.18	3.90	6.31
HCO_3^{-}	3.55	2.90	4.35
Cl^{-}	2.11	59.47	125.37
$SO_4^{=}$	1.20	21.11	54.8

3. Results and Discussion

3.1. Dry matter yield

Data in Table (2) revealed that the dry matter yield of wheat shoots increased gradually to reach a maximum value at 90 days from sowing, then tended to decrease. This decrease may be due to stopping the development of new leaves and / or leaf shedding in the late stages of growth. Moreover, the migration of minerals from leaves to grains may share the decrease in dry matter yield at late stage.

Data in Table (2) indicated also that ammonium sulphate was more effective in increasing dry matter yield than ammonium nitrate. This enhancing effect of ammonium sulphate is probably due to its content from sulpher which is an essential nutrient element. Sulpher also may improve the soil pH since its solution has an acidic effect. Similar results were obtained by EL-SHINNAWI et al. (1988) EL-MOATASEM et al. (1993).

Zinc fertilizer showed an enhancing effect on the dry matter yield of wheat at both nitrogen forms. This results may be due to the role of Zn as a co-factor in the enzymatic reactions of the anabolic pathways in plant growth. These results are parallel to those obtained by EL-HABBAL et al. (1995) and EL-KOUMEY and EL-SHAFIE (1997).

Sakha 8 variety showed a superiority on Sakha 69 in its tolerance to salinization. The dry matter yield was not affected by the (EC 7.8) and slightly affected by the irrigation with the high level of salinity (EC 15.6). The higher level of saline water showed a depressing effect on dry matter yield of wheat plants. This effect may be attributed to the high osmotic pressure of the soil solution which induces a detrimental effect on the nutrient absorption by plants, consequently impairing the growth of wheat crops (MARSCHNER, 1995). This results are in accordance with those obtained by FRANCOIS et al. (1986), NOUR et al. (1990) and EL-HADDAD et al. (1993).

3.2. Macronutrients

3.2.1. Nitrogen

Data in Table (3) revealed that ammonium sulphate surpassed ammonium nitrate in increasing the concentration and uptake of nitrogen by both cultivars of wheat. This may be ascribed either to genetical properties of wheat plants which have a preference for taking up ammonium nitrogen, or to the enhancing effect of ammonium sulphate on the availability of nutrients in the soils consequently stimulating the plant growth and their capability to take up more nitrogen from the soil (MENGEL and KIRKBY, 1987).

Zinc application with the both nitrogen forms showed a beneficial effect on enhancing the N-uptake of wheat plants. This may be due to the important role of Zn in plant growth. These results go along with those of EL-BASIONI et al. (1993).

Table 2: Dry weight of wheat shoots (g/pot) as affected by saline water, N and Zn fertilization at different growth stages.

Treatments	Salinity levels dSm^{-1}								
	EC 0.62 (control)			EC 7.8			EC 15.6		
	45 DAS	90 DAS	120 DAS	45 DAS	90 DAS	120 DAS	45 DAS	90 DAS	120 DAS
	Sakha 8								
$Zn_0 + N_4H\ NO_3$	59.0	91.0	51.0	62.0	96.0	47.0	49.0	86.0	34.0
$Zn_1 + N_4H\ NO_3$	68.0	97.0	57.0	67.0	99.0	55.0	57.0	95.0	37.0
$Zn_0 + (N_4H)_2\ SO_4$	67.0	104.0	56.0	66.0	105.0	57.0	53.0	91.0	40.0
$Zn_1 + (N_4H)_2\ SO_4$	75.0	113.0	69.0	75.0	115.0	66.0	61.0	102.0	48.0
Mean	68.0	101.0	58.0	68.0	104.0	56.0	55.0	94.0	40.0
	Sakha 69								
$Zn_0 + N_4H\ NO_3$	54.0	84.0	43.0	42.0	73.0	39.0	32.0	46.0	28.0
$Zn_1 + N_4H\ NO_3$	59.0	90.0	59.0	45.0	79.0	56.0	39.0	51.0	28.0
$Zn_0 + (N_4H)_2\ SO_4$	59.0	93.0	53.0	50.0	79.0	49.0	34.0	57.0	31.0
$Zn_1 + (N_4H)_2\ SO_4$	68.0	96.0	69.0	53.0	85.0	59.0	44.0	64.0	30.0
Mean	60.0	91.0	56.0	48.0	79.0	51.0	37.0	55.0	29.0

			45 DAS	90 DAS	120 DAS
LSD	(A)	5%	4.4	4.0	6.0
	(B)		3.7	3.0	5.0
	(C)		3.0	3.0	4.0

DAS	Days after sowing
(A)	Fertilizers
(B)	Salinity
(C)	Variety

Table (3): N, P, K and Na concentration (%) and uptake (mg / plant) in wheat shoots as affected by salinity, N and Zn fertilization at 90 days after sowing.

Treatments	Salinity levels dSm^{-1}											
	EC 0.62 (control)		EC 7.8		EC 15.6		EC 0.62 (control)		EC 7.8		EC 15.6	
	%	Uptake mg/pot	%	Uptake mg/pot	%	Uptake mg/pot	%	Uptake mg/pot	%	Uptake mg/pot	%	Uptake mg/pot
	Sakha 8						Sakha 69					
	N											
$Zn_0 + N_4H\ NO_3$	2.95	2685.0	3.00	2880.0	2.73	2348.0	3.00	2520.0	2.88	2102.0	2.71	1247.0
$Zn_1 + N_4H\ NO_3$	3.18	3085.0	3.08	3049.0	2.85	2708.0	3.15	2835.0	3.00	2370.0	2.73	1392.0
$Zn_0 + (N_4H)_2\ SO_4$	3.38	3.515.0	3.40	3570.0	2.95	2685.0	3.25	3023.0	3.03	2394.0	2.68	1528.0
$Zn_1 + (N_4H)_2\ SO_4$	3.67	4147.0	3.52	4048.0	3.18	3244.0	3.25	3120.0	3.10	2635.0	2.88	1843.0
Mean		3358.0		3387.0		2746.0		2875.0		2375.0		1503.0
	P											
$Zn_0 + N_4H\ NO_3$	0.25	228.0	0.26	250.0	0.29	249.0	0.34	286.0	0.25	183.0	0.27	124.0
$Zn_1 + N_4H\ NO_3$	0.29	281.0	0.33	327.0	0.33	314.0	0.30	270.0	0.37	292.0	0.35	179.0
$Zn_0 + (N_4H)_2\ SO_4$	0.31	322.0	0.34	357.0	0.30	273.0	0.32	298.0	0.30	237.0	0.35	200.0
$Zn_1 + (N_4H)_2\ SO_4$	0.40	452.0	0.47	541.0	0.47	479.0	0.35	336.0	0.41	349.0	0.37	237.0
Mean		321.0		369.0		329.0		297.5		266.3		185.0
	K											
$Zn_0 + N_4H\ NO_3$	4.21	3831.0	4.03	3869.0	3.90	3354.0	4.00	3360.0	3.43	2504.0	3.90	1794.0
$Zn_1 + N_4H\ NO_3$	5.04	4889.0	4.53	4485.0	4.05	3848.0	4.73	4257.0	4.24	3349.0	4.11	2096.0
$Zn_0 + (N_4H)_2\ SO_4$	4.37	4545.0	4.29	4505.0	3.90	3549.0	4.16	3869.0	3.74	2955.0	4.11	2343.0
$Zn_1 + (N_4H)_2\ SO_4$	5.20	5876.0	4.94	5681.0	4.83	4927.0	5.12	4915.0	4.94	4199.0	4.21	2694.0
Mean		4785.3		4635.0		3919.5		4100.3		3292.0		2232.0
	Na											
$Zn_0 + N_4H\ NO_3$	0.070	63.7	0.255	244.8	0.405	348.3	0.073	61.3	0.272	198.6	0.463	213.0
$Zn_1 + N_4H\ NO_3$	0.079	76.6	0.377	373.2	0.610	579.5	0.116	104.4	0.394	311.3	0.659	336.1
$Zn_0 + (N_4H)_2\ SO_4$	0.072	74.9	0.303	318.2	0.579	526.9	0.096	89.3	0.374	295.5	0.650	370.5
$Zn_1 + (N_4H)_2\ SO_4$	0.097	109.6	0.487	560.1	0.828	844.6	0.141	135.4	0.576	489.6	0.908	581.1
Mean		81.2		374.1		574.8		97.6		323.5		375.2

Salinity at high level decreased N uptake by wheat plants. The average reductions of N uptake were 23 and 92% for Sakha 8 and Sakha 69, respectively. This decrease in the nitrogen uptake may reflect the inhibiting effect of the high salinity on the dry matter yield of plant shoots.

3.2.2. Phosphorus

Data presented in Table (3) showed that ammonium sulphate increased phosphorus concentration and uptake by wheat plant more than ammonium nitrate. This increase may be attributed to the acidic effect of ammonium sulphate added to the calcareous soil on elevating the availability of phosphorus in soil and consequently increasing its uptake by plants. Similar results in confidence with these findings are reported by MOSTAFA and HASSAN (1995). In this connection, SOON and MILLER (1977) found that the ammonium–fed plants usually have higher phosphorus contents in the shoots than nitrate–fed plants.

Phosphorus uptake by wheat plants greatly increased by zinc application with both nitrogen forms, however, the increase with $(NH_4)_2\ SO_4$ tremendously excelled that one occurred by $NH_4\ NO_3$ addition. These results obviously revealed the beneficial effect of zinc application to calcareous soil on stimulating the capability of wheat varieties to uptake more phosphorus, particularly under ammonium sulphate fertilization.

The same data elucidated also that the phosphorus concentration in wheat plants was slightly affected by salinity levels, however the P uptake was affected by the highest salt concentration of the applied water in Sakha 69. These results are in agreement with those obtained by MASHHADY et al. (1982), SOLIMAN et al. (1994), MOSTAFA and HASSAN (1995) and MASHEN (1996).

3.2.3. Potassium

Results in Table (3) show in most cases that application of N in different sources caused significant effects on K uptake. Furthermore, data reveal that addition of $(N_4H)_2SO_4$ recorded higher amounts of K contents than those obtained by using N_4HNO_3. Application of zinc fertilizer showed a marked increase in potassium concentration and uptake. This may be due to the beneficial effect of applied zinc.

The high salinity level showed a significant decrease in dry matter yield of plant shoots, which has been reflected on the potassium uptake (Table 3). Similar results are reported by CHIPA and LAL (1986) and SHARMA (1996).

3.2.4. Sodium

The data in Table (3) showed that irrigation of the wheat plants by saline water vigorously raised Na^+ concentration and uptake in comparison with the plants irrigated with the Nile water. This is referred to the remarkable diffusion and mass flow from the higher concentration gradient (Na^+) of the saline soil solution to plant roots, consequently, plant tops. Similar results were obtained by REGGIANI et al. (1995), SHARMA (1996).

Zn application increased Na^+ concentration and uptake by wheat plants. The enhancing effect of zinc was more obvious under salinization if compared with non-saline condition. This may be due to the role of zinc in raising the ability of plant to uptake more nutrients under salinization.

3.3. Micronutrients

With respect to the concentrations of Fe, Zn and Mn in wheat shoots, Table (4) showed that increasing the salinization alleviated the antagonistic effect between Zn and Fe.

At the highest salinity level of the irrigation water, Zn application, particularly with Sakha 69, tended to enhanced rather than inhibited the Fe concentration and uptake by wheat plants. It is evident that ammonium sulphate influenced the concentration and consequently the uptake of Fe in treated plant tissues than ammonium nitrate as shown in the same table. Similar results were obtained by MENGEL and KIRKBY (1987) and IBRAHIM and SHALABY (1994).

The data in Table (4) showed no significant differences between ammonium sulphate and ammonium nitrate in their effect on Zn concentration and uptake by wheat plants. The same data explicated that the application of Zn enormously increased Zn concentration and uptake by wheat plants. Zn uptake by Sakha 69 was found to be more significantly decreased by salinity than Sakha 8, this reflects the depressive effect of salinity on dry matter yield of wheat plants and consequently, its nutrients uptake. These results are in a harmony with those reported by SALLAM (1992) and MOHAMED (1994).

Regarding the Mn contents in Zn-untreated wheat plants, data showed an increase in Mn concentration than those treated with Zn. The depressive effect of Zn on Mn concentration and uptake may be attributed to the antagonistic effect of high Zn application on Mn concentration and uptake. This antagonism may be attributed to the competition for binding sites in the roots during the uptake process (MARSCHNER, 1995).

The same antagonistic effect of Zn on Mn was appeared also under salinity condition, although the highest level of saline water apparently reduced this effect. In contrast with the above mentioned results, ammonium nitrate surpassed ammonium sulphate in its enhancing effect on Mn concentration in wheat shoots. This results were confirmative to those of MENGEL and KIRKBY (1987).

Table 4: Fe, Zn and Mn concentration (mg g^{-1}) and uptake (mg / pot) by wheat plants as affected by salinity, N and Zn fertilization at 90 days from sowing.

Treatments	Salinity levels dSm^{-1}											
	EC 0.62 (control)		EC 7.8		EC 15.6		EC 0.62 (control)		EC 7.8		EC 15.6	
	mg g^{-1}	Uptake mg/pot	mg g^{-1}	Uptake mg/pot	mg g^{-1}	Uptake mg/pot	mg g^{-1}	Uptake mg/pot	mg g^{-1}	Uptake mg/pot	mg g^{-1}	Uptake mg/pot
	Sakha 8						Sakha 69					
	Fe											
$Zn_0 + N_4H\ NO_3$	166.7	15.170	216.7	20.803	216.7	18.636	216.7	18.203	200.0	14.600	183.3	8.438
$Zn_1 + N_4H\ NO_3$	183.3	17.780	200.0	19.800	166.7	15.837	233.3	20.997	200.0	15.800	216.7	11.052
$Zn_0 + (N_4H)_2\ SO_4$	200.0	20.800	133.3	13.997	216.7	19.720	233.3	21.697	166.7	13.169	200.0	11.400
$Zn_1 + (N_4H)_2\ SO_4$	183.3	20.713	166.7	19.171	183.3	18.697	216.7	20.803	266.7	22.670	200.0	12.800
Mean		18.616		18.443		18.223		20.425		16.559		10.921
	Zn											
$Zn_0 + N_4H\ NO_3$	193.3	17.590	93.3	8.957	131.7	11.326	108.3	9.097	156.7	11.439	111.7	5.138
$Zn_1 + N_4H\ NO_3$	438.3	42.515	450.0	44.550	385.0	36.575	565.0	50.850	408.3	32.256	390.0	19.890
$Zn_0 + (N_4H)_2\ SO_4$	116.7	12.137	121.7	12.779	126.7	11.529	121.7	11.318	58.3	46.057	106.7	6.082
$Zn_1 + (N_4H)_2\ SO_4$	431.7	78.782	543.3	62.479	329.3	33.589	545.0	52.320	385.0	32.725	383.3	24.831
Mean		37.756		32.191		23.255		30.896		20.256		13.910
	Mn											
$Zn_0 + N_4H\ NO_3$	23.3	2.120	26.7	2.563	25.0	2.150	21.7	1.823	25.0	1.825	23.3	1.072
$Zn_1 + N_4H\ NO_3$	21.7	2.105	23.3	2.307	23.3	2.214	15.0	1.350	16.7	1.319	21.7	1.107
$Zn_0 + (N_4H)_2\ SO_4$	26.7	2.777	23.3	2.447	21.7	1.975	20.0	1.860	20.0	1.580	11.7	0.667
$Zn_1 + (N_4H)_2\ SO_4$	11.7	1.322	10.0	1.150	18.3	1.867	18.3	1.757	21.7	1.845	10.0	0.640
Mean		2.081		2.117		2.052		1.698		1.642		0.872

3.4. Yield and its components

Data in Table (5) showed that N and Zn fertilization significantly increased grain yield per pot, weight of 100 grains, number of spikes/pot and spikes weight (g/pot) of both cultivars of wheat plants.

The salt tolerant cultivar (Sakha 8) had a higher grain-yield of wheat plants than the susceptible one (Sakha 69). Data recorded in Table (5) indicated that the reduction in grain yield per pot at higher salinity level was lower in Sakha 8 than in Sakha 69. With regard to nitrogen forms, the ammonium sulphate was more effective in increasing grain yield per pot than ammonium nitrate. This positive effect of ammonium sulphate is probably due to its content of sulpher which is an essential nutrient element. Similar results were obtained by MOSTAFA and HASSAN (1995) and BOTELLA et al. (1997).

Data presented in Table (5) showed that Zn application significantly increased the grain yield per pot and yield components of wheat plants. This may be due to the important role of Zn for the activation of various types of enzymes, such as those required for the CO_2 assimilation pathway (MARSCHNER, 1995).

The negative effects of salinity on the yield and its components in Sakha 69 was more sensitive to salinity than Sakha 8. The inhibition in growth of wheat plants is due to high salt concentration in the soil solution (i.e. high osmotic pressure and consequently low soil water potential) and high concentration of potentially toxic ions such as Cl^- and Na^+ which might lead to ion toxicity and nutritional imbalance, consequently growth inhibition (MARSCHNER, 1995). Similar results were obtained by IELAND et al. (1994) and SOLIMAN et al. (1994).

3.5. Yield quality

The data in Table (6) indicated that ammonium sulphate excelled ammonium nitrate in their effect on increasing N, protein, P, K and Zn percentages in the wheat grains. This may be attributed to the acidic effect of ammonium sulphate added to the calcareous soil on elevating the availability of P in soil and consequently increasing its uptake by wheat plants. Foliar application of Zn significantly stimulated N, protein, P, K and Zn concentrations in grains. This may be due to the important role of Zn for protein synthesis (MENGEL and KIRKBY, 1987).

Table (6) showed decrease in nitrogen content and increase in P, K and Zn percentages due to increasing salinity levels. The cultivar Sakha 8 showed more accumulation of N, P, K, Zn and protein contents of grains than Sakha 69. These results are in a harmony with those obtained by DEVITT et al. (1987).

Finally, it can be concluded from our results that the application of ammonium sulphate and zinc sulphate showed a beneficial effect on increasing growth, nutrient uptake and grain yield of wheat plants. On the other hand, Sakha 8 was found to be more tolerant to salinization than Sakha 69.

Table (5): Wheat yield and yield components as affected by salinity of the irrigation water, N and Zn fertilization.

Treatments	Salinity levels dSm^{-1}											
	EC 0.62 (control)				EC 7.8				EC 15.6			
	Grain weight g / pot	Weight of 100 grains g	No. of spikes / pot	Spike weight g / pot	Grain weight g / pot	Weight of yield ardeb / fed.	No. of spikes / pot	Spike weight g / pot	Grain weight g / pot	Weight of 100 grains g	No. of spikes / pot	Spike weight g / pot
Sakha 8												
$Zn_0 + N_4H\ NO_3$	15.40	3.90	15.3	21.20	11.80	3.10	12.00	18.90	10.80	2.80	8.30	14.20
$Zn_1 + N_4H\ NO_3$	18.30	4.60	19.0	26.90	17.60	3.90	14.30	23.60	15.30	3.50	12.70	21.00
$Zn_0 + (N_4H)_2\ SO_4$	17.50	4.20	19.0	23.20	15.40	3.20	14.30	21.20	12.40	2.80	11.70	17.00
$Zn_1 + (N_4H)_2\ SO_4$	24.10	4.80	23.3	29.00	21.80	4.20	16.30	26.80	17.50	3.70	13.70	22.80
Mean	18.80	4.38	19.15	25.10	16.70	3.60	14.20	22.62	14.00	3.20	11.60	18.80
Sakha 69												
$Zn_0 + N_4H\ NO_3$	13.50	3.70	11.70	20.62	12.50	2.20	8.00	13.90	5.60	1.90	5.30	12.90
$Zn_1 + N_4H\ NO_3$	16.50	3.90	16.00	20.85	14.80	2.50	10.00	18.80	5.30	2.10	6.00	10.22
$Zn_0 + (N_4H)_2\ SO_4$	16.90	3.70	16.70	23.55	15.10	2.20	10.30	18.30	6.20	1.90	6.70	11.40
$Zn_1 + (N_4H)_2\ SO_4$	20.10	4.30	18.30	26.13	17.30	2.90	12.00	20.60	8.50	2.10	7.00	12.63
Mean	16.80	3.90	15.68	22.80	14.90	2.45	10.10	17.90	6.40	2.00	6.30	11.80

LSD 5%		A	B	C
	Grain weight	1.31	1.14	0.93
	100 grain weight	0.04	0.52	0.42
	No of spikes / pot	1.15	0.99	0.82
	Spikes weight g / pot	1.89	1.64	1.34

Table 6: N, protein P, K, and Zn concentration (%) in wheat grains as affected by salinity of the irrigation water, N and Zn fertilization.

Treatments	Salinity levels dSm^{-1}														
	EC 0.62 (control)					EC 7.8					EC 15.6				
	N %	Protein %	P %	K %	Zn $\mu g\ g^{-1}$	N %	Protein %	P %	K %	Zn $\mu g\ g^{-1}$	N %	Protein %	P %	K %	Zn $\mu g\ g^{-1}$
	Sakha 8														
$Zn_0 + N_4H\ NO_3$	1.30	8.13	0.28	0.39	39.2	1.03	6.44	0.30	0.32	38.7	1.00	6.25	0.40	0.39	39.5
$Zn_1 + N_4H\ NO_3$	1.40	8.75	0.36	0.38	42.5	1.40	8.75	0.42	0.33	50.8	1.36	8.50	0.42	0.43	53.5
$Zn_0 + (N_4H)_2\ SO_4$	1.43	8.94	0.33	0.36	40.5	1.12	7.00	0.42	0.34	40.4	1.20	7.50	0.43	0.41	38.2
$Zn_1 + (N_4H)_2\ SO_4$	1.66	10.38	0.41	0.40	53.9	1.48	9.25	0.48	0.35	59.5	1.39	8.69	0.58	0.44	60.4
Mean	1.45	9.05	0.36	0.38	44.03	1.26	7.86	0.41	0.34	47.4	1.24	7.74	0.46	0.42	47.9
	Sakha 69														
$Zn_0 + N_4H\ NO_3$	0.86	5.38	0.25	0.30	32.2	1.04	6.50	0.25	0.29	35.0	1.00	6.25	0.36	0.35	38.0
$Zn_1 + N_4H\ NO_3$	1.22	7.63	0.33	0.31	38.9	1.14	7.13	0.40	0.31	39.2	1.12	7.00	0.39	0.36	42.3
$Zn_0 + (N_4H)_2\ SO_4$	1.13	7.06	0.35	0.29	35.4	1.09	6.81	0.42	0.28	37.3	1.05	6.56	0.46	0.33	40.1
$Zn_1 + (N_4H)_2\ SO_4$	1.38	8.63	0.42	0.36	44.9	1.19	7.44	0.46	0.32	53.5	1.16	7.25	0.49	0.38	55.9
Mean	1.15	7.18	0.34	0.32	38.9	1.12	6.97	0.38	0.30	41.3	1.08	6.77	0.42	0.36	44.08

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إستجابة القمح إلى التسمين بالنيتروجين والزنك تحت ظروف الملوحة فى الأرض الجيرية

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أجريت تجارب أصص لدراسة تأثير التسميد بالنيتروجين والزنك على النمو وإمتصاص العناصر والمحصول لصنفين من القمح (سخا 8 و سخا 69) النامى تحت ظروف الرى الملحى فى أرض جيرية وكانت صور النيتروجين كبريتات الأمونيوم ونترات الأمونيوم بمعدل 100 كيلوجرام نيتروجين لكل فدان ، بينما تم تسميد الزنك على صورة كبريتات الزنك بمعدل صفر و 5 كيلوجرام للفدان ، وكانت تركيزات الملوحة المستخدمة هى ماء النيل كمقارنة ومياه آبار جوفية بتركيز 7.8 و 15.6 ديسستميتر لكل متر وأظهر التسميد بالنيتروجين والزنك إستجابة واضحة فى المادة الجافة وزيادة فى المحصول كما كانت كبريتات الأمونيوم أكثر كفاءة من نترات الأمونيوم . وجد زيادة فى إمتصاص النيتروجين والفوسفور والبوتاسيوم والزنك وكذلك المحصول بزيادة التسميد بالنيتروجين والزنك . أدت زيادة الملوحة إلى قلة فى المادة الجافة ومحصول الحبوب وإمتصاص النيتروجين بينما زاد تركيز الصوديوم فى المجموع الخضرى للقمح . أظهرت الصنف سخا 8 زيادةً فى المحصول وإمتصاص العناصر وقدرة على تحمل الملوحة أكثر من سخا 69 .