Alex. J. Agric. Res. 50 (3) 131-139, 2005

COMPARATIVE PERFORMANCE OF SOME WHEAT (*TRITICUM AESTIVUM L.*) GENOTYPES IN TRACE ELEMENTS COMPOSITION UNDER SALINITY STRESS.

F. K. Sherif

Received on: 18/7/2005 ***Accepted on: 18/10/2005***

ABSTRACT

Salinity is one of the major factors reducing plant growth and productivity. The cultivation of salt tolerant cultivars is an alternative approach for effective utilization of salt affected soils. The objective of this study was to examine the performance of five different wheat genotypes (Sakha93, Sids1, Giza168, Gimiza7, and Gimiza9) under salinity stress with special reference to micronutrients concentration in plants as a criterion for phytosiderophores production. Genotypes were exposed to five different salinity levels (0, 100, 200, 300, and 400 mM NaCl) in irrigation water. At vegetative growth, increasing salinity decreased chlorophyll content and fresh weight leaf^{1}, except for 100 mM NaCl. The results also showed a highly significant variation among genotypes. Under saline conditions maximum accumulation of Na content was observed in Sakha 93 and Sids 1. On contrary, Salinity decreased K concentration in flag leaves. Also, the concentration of Fe and Zn in flag leaves decreased significantly. Sids 1 and Giza 168 recorded the highest concentration of Fe at 100 mM NaCl. While, under higher salinity levels, Gimiza 9 showed an increasing in Zn concentration. According to the cluster analysis, Gimiza 9 was ranked as the most tolerant genotypes. While, Sakha 93 and Sids 1, as sensitive and Giza 168 and Gimiza 7 as moderate genotypes.

INTRODUCTION

Salinity is one of the major factors reducing plant growth and productivity worldwide, and affects about 7% of the world's total land area (Flowers et al., 1997). The percentage of cultivated land affected by salt is even greater, with 23% of the cultivated land being saline and 20% of the irrigated land suffering from secondary salinization. Egypt is one of the countries that suffer from severe salinity problems. For example, 33% of the cultivated land, which comprises only 3% of total land area in Egypt, is already salinized due to low precipitation (25mm annual rainfall) and irrigation with saline water (Ghassemi et al., 1995). Wheat is the most important and widely adapted food cereal in Egypt. However, Egypt supplies only 40% of its domestic demand for wheat (Salam, 2002). Therefore, it is necessary to increase wheat production in Egypt by raising the wheat grain yield. Obviously, one of the most efficient way to increase wheat yield is to improve the salt tolerance of wheat genotypes (Pervaiz et al., 2002). Saline agriculture technology is an alternative approach for effective utilization of salt affected soils, which involves the cultivation of salt-tolerant cultivars.

Zinc and Fe deficiencies are common micronutrient deficiencies in calcareous soils in which the solubility is extremely low, owing to the high pH, and adversely affect crop production (White and Zasoski, 1999). Zn and Fe deficiency is a particular micronutrient deficiency problem in cereal-growing areas causing large decreases in grain yield and quality, in Australia (Graham et al., 1992), Turkey (Cakmak et al., 1996a, 1999) and India (Takkar et al., 1989).

There is substantial variation in tolerance to Zn or Fe deficiency within and among cereal species. Possibly, the release of phytosiderophores (PS) (non-protein amino acids) from roots in response to Fe or Zn deficiencies is an important factor affecting genotypic variation in the tolerance to Zn and Fe deficiencies. Phytosiderophores are highly effective in solubilization and mobilization of Zn and Fe in calcareous soils (Treeby et al., 1989) and are involved in the uptake of these nutrients by roots (Römheld and Marschner, 1990; Von Wiren et al., 1996). The existence of large differences in tolerance to Fe deficiency between various cereal species correlated well with the release rate of PS from roots (Marschner et al., 1986; Kawai et al., 1988; Römheld and Marschner, 1990). Similarly, differences in tolerance to Zn deficiency between sorghum, wheat and corn correlate well with the amounts of PS released from roots (Hopkins et al., 1998). Wild grasses, adapted to severely Zn-deficient calcareous soils, released high amounts of PS when grown under Zn deficiency (Cakmak et al., 1996b). Bread wheat cultivars show greater tolerance to Zn deficiency than durum wheat cultivars, and this difference in tolerance correlated with differences in the release rate of phytosiderophores (Cakmak et al., 1994; Walter et al., 1994; Rengel et al., 1998).

In saline environment, when salts are present in higher concentrations plant growth is affected negatively in various ways i.e. osmotic effects, specific ion effect and nutritional imbalance (Flowers et al., 1991). A secondary effect of high concentration of Na and Cl in the root medium is the suppression of nutrient uptake of essential nutrients. On the other hand, salt tolerant cultivars can compartmentalize the toxic concentrations of the salts in their tissues and cells (Gorham and Wyn Jones, 1993).

Little information is available about the effect of salinity on PS produced by different wheat genotypes. Therefore, the present study aims to compare the performance of wheat genotypes under salinity stress with special reference to micronutrients concentration in plants as a criterion for phytosiderophores production.

Soil and Water Department, Faculty of Agriculture, Alexandria University.

MATERIALS AND METHODS

1-Plant materials

Five varieties of winter wheat (*Triticum aestivum L.*) were used in this study; Sakha93, Sids1, Giza168, Gemmeza7, and Gemmeza 9. Seeds were obtained from the Agricultural Research Center in Giza, Egypt.

2- Growth conditions

This study was carried out in a greenhouse from the middle of November 2004 to the middle of March 2005. The air temperature ranged from 23 to 26°C during the day. A calcareous surface soil sample (0-15 cm) was collected from Burg El-Arab region. The soil was air dried, ground, passed through a 5 mm mesh screen, and thoroughly mixed. The main chemical characteristics of the studied soils were determined according to the standard methods outlined by Page (1982) and are listed in Table (1).

Table (1). Main chemical characteristics of the studied soil.

Parameters		Parameters	
E.C dSm^{-1}	1.01	Cl meqL^{-1}	5.1
pH (soil paste)	8.04	$CaCO_3$ g kg^{-1}	205
Na meqL^{-1}	4.2	DTPA-Fe mg kg^{-1}	2.22
K meqL^{-1}	5.6	DTPA-Zn mg kg^{-1}	0.16
Ca meqL^{-1}	1.8	DTPA-Cu mg kg^{-1}	0.18
Mg meqL^{-1}	4.6	DTPA-Mn mg kg^{-1}	1.08

A bulk soil sample (about 3.0 kg) was placed in a plastic pot (20 cm^2 diameter, 30 cm height). Before planting, uniform rates of NPK fertilizers were added at the rate of 150 kg fed^{-1} as super phosphate and 50 kg fed^{-1} potassium sulfate. Nitrogen was added at the rate of 300 kg fed^{-1} in three doses (initially, 25, and 50days) of cultivation date. Wheat seeds were sown, and thinned to two seedlings per pot after ten days.

Five salt levels (0, 100, 200, 300, and 400 mM NaCl) were used in irrigated water. The salinity levels were equivalent to an electrical conductivity of 0.55, 8.2, 17.5, 22.5, and 34 dSm^{-1}, respectively. To avoid an osmotic shock for seedling emergence, the salinized water was used after 45 days of sowing (Gorham and Wyn Jones, 1993).

During the experiment, plants were watered to achieve the field capacity. All treatments were replicated three times.

3-Chlorophyll and trace elements determination

At the third leaf stage, after 30 days of salinity treatments, the second leaf were sampled, collected, washed with tap water, then with distilled water. Total, a, and b chlorophyll content were determined according to (Mackinney, 1941).

At the same stage, flag leaves were collected, washed with distilled water, oven dried at 65°C, then homogenized and wet digested using concentrated sulfuric acid and hydrogen peroxide (FAO, 1980) and analyzed for extractable Fe, Zn, Cu and Mn.

3-Yield characteristics

After plant maturity, the above ground plant parts were harvested and the fresh and dry weights of straw and grains were recorded. Plant height, Number of spikes and grains were also recorded.

4-Ranking of genotypes for salt tolerance

Following Zeng et al., (2002) all the data were converted to salt tolerance indices before cluster analysis to allow comparisons among genotypes for salt tolerance. A salt tolerance index was defined as the observation at salinity divided by the average of the control. Cluster group rankings were obtained based on Single-link cluster analysis of the means of the salt tolerance indices for fresh and dry weight per plant, chlorophyll content, and micronutrient content, (SAS Institute, 2000).

5-Statistical analysis of data

Statistical analysis for the effect of salinity levels and genotypes on different growth parameters and elemental composition were carried out using CoStat computer program (1986). Completely randomized block design (CRBD) was used for analysis. L.S.D$_{(0.05)}$ was used to compare salinity levels and genotypes means.

RESULTS AND DISCUSION

1-Vegetative growth characteristics

Vegetative growth of wheat plants is characterized by chlorophyll determination and fresh weight leaf^{-1}. Generally, the values of chlorophyll (total, a, and b) decreased with increasing salinity (Fig.1). The low salinity level (100 mM NaCl) reduced the three forms of chlorophyll to a lesser degree than the other treatments. The results also show a wide variation among genotypes, for instance, at 100 mM NaCl the total chlorophyll was reduced by 28, 26, 8, 0.6, and 5% for Sakha 93, Sids 1, Giza168, Gimiza 7 and Gimiza9, respectively (Fig1).Yamane et al., (2003) reported that, prominent swelling of thylakoids, is induced at the early stage of the damage when plants are affected by salt stress. Also, data presented in (Fig.1) illustrated that fresh weight leaf^{-1} decreased significantly with increasing salinity. However, four genotypes showed an increasing in fresh weight leaf^{-1}at (100 mM NaCl) about 49, 9, 31, and 26% for Sids1, Giza 168, Gimiza 7, and Gimiza 9, respectively relative to control. This increasing in fresh weight may be due to increasing in root absorbing area due to osmotic stresses under saline conditions (Rozeman and Visser, 1981). Whereas, at higher salinity levels fresh weight leaf^{-1} was decreased significantly. This indicate that the reduction in fresh weight was closely related to salinity effect, this reduction was probably due to the extra energy utilization for osmotic accumulation, which is much more ATP consuming for osmotic adjustment (Wyn Jones and Gorham,1993). Indeed, this reduction may be due to the effect of Na which causes a range of osmotic and metabolic problems for plants (Tester and Davenport, 2003).

2-Na and K concentration

Data in Table (2) showed that root zone salinity increased Na concentration in flag leaf. Genotypes differed significantly for sodium accumulation both under control and saline conditions. Under saline conditions maximum accumulation was observed in Sakha 93 and Sids 1(the most sensitive genotypes), this may be due to high Na concentration in the root zone and passive sodium diffusion through damaged membrane (Nawaz et al., 1998) and lack of osmotic adjustment, which resulting in inhibition of water uptake and physiological drought (Harivandi et al., 1992), In agreement with this trend Makus, (2003) found that increasing soil salinity increased Na and Cl leaf blade of vegetable amaranth. On contrary, sodium could not be detected in Gimiza 9 up to 100 mM NaCl. This indicates that this genotype could exclude or restrict the accumulation of Na in their leaves. Greenway and Munns 1980, and Torres and Bingham 1973 found a positive correlation between Na exclusion and relative salt-tolerant in many crops including wheat.

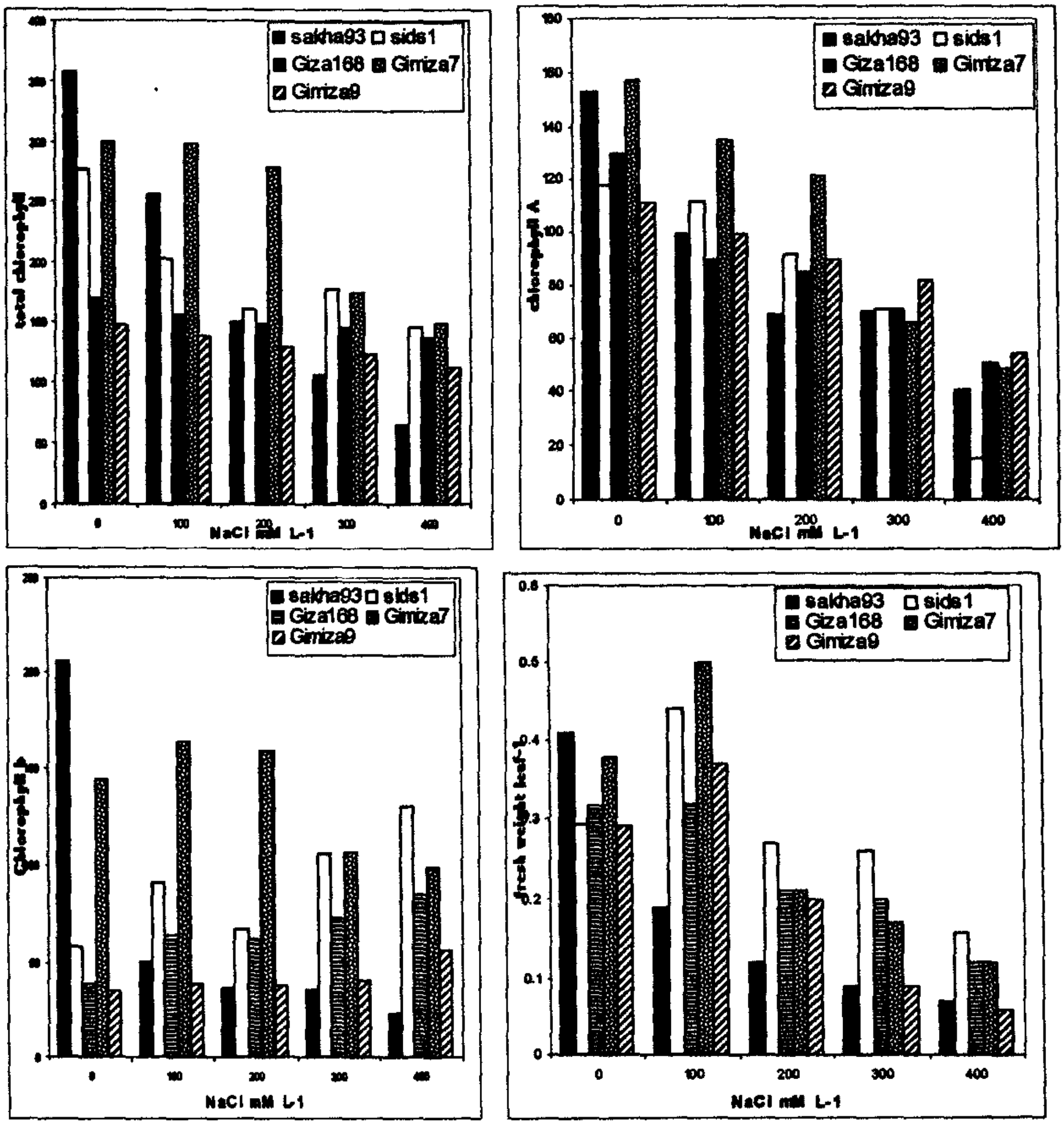

Figure1. Effect of different salinity levels on plant growth parameters at vegetative stage for different wheat genotypes

As shown in Table (2), K concentration in plant decreased with salinity increasing. The observed data showed that the decrease in K concentration was about 18, 10, 7, 12 and 6% for Sakha93, Sids1, Giza168, Gimiza7 and Gimiza9 respectively, relative to control. This decreasing may be due to metabolic toxicity of Na$^+$, which has the ability to compete with K for binding sites essential for cellular function. Also, high Na concentration in plants displaces Ca^{+2} from the plasmalemma resulting in loss of membrane integrity and efflux of cytosolic K$^+$ (Cramer et al., 1985). Bhandal and Malik, (1988) reported that more than 50 enzymes are activated by K and Na cannot substitute in this role.

As regards to varietals accumulation, significant differences in K concentration were observed among genotypes. Data in Table (2) showed that salinity increased K concentration in flag leaves in Gimiza9 under higher salinity (300 and 400 mM NaCl) treatment than lower one (200 mM NaCl). Meanwhile, Gimiza9 accumulate low Na concentration, hence the K concentration was high relative to other genotypes. This was unusually correlated with low Na$^+$ concentration in the leaves. This was explained by efficient K absorption and selective inclusion of Na by cortical cells (Schachtman and Munns, 1992). The high concentration of K in Gimiza9 under salinity stress declare the importance of K in shoot to activate the enzymes for stomatal functioning which is shown to be related to salinity tolerance. Empirically, for a wide range of species, it is found that plants that are more able to tolerate moderately saline environment, have a greater ability to exclude Na from the shoot or at least blades, and concurrently maintain high levels of K$^+$ (Munns et al., 2000, Zhu et al., 2001).

3- Trace elements concentration

The data given in Table (1) showed that the soils are deficient in available (Fe, Zn, Cu, Mn), and the concentration of DTPA-extractable elements were under the normal range, (Alloway, 1995). Therefore, the significant differences in Fe concentration in flag leaves among genotypes showed in Table (3) referred to the performance of each genotype to chelate Fe. However, this ability was affected by salinity levels. The data in Table (3) illustrated that Fe concentration decreased significantly with increasing NaCl concentration. Also, it is obvious that Sids1 and Giza168 recorded higher concentration of Fe at 100 mM NaCl relative to control but this value decreased with increasing NaCl concentration. This may be due to the effect of NaCl which has some effects on soil chemistry, that is, the added Na$^+$ competes with other cations for sorption sites. Moreover, the added Cl$^-$ may complex certain cations.

The same trend was observed with Zn concentration in flag leaves. In agreement with these data, Khoshgoftar et al., (2004) found that high salinity decreased Zn concentration in the wheat shoot. Data in table (3) illustrated that Zn concentration in Gimiza 9 and Giza 168 increased by 31 and 50% respectively, relative to control at 100 mM NaCl. However, the four genotypes (Sakha93, Sids1, Giza 168, and Gimiza7) showed a significant decreasing in Zn concentration at higher salinity levels, Zn concentration in Gimiza 9 increased by 43% at 400 mM NaCl relative to control; this may be due to the ability of these genotypes to release more phytosiderophore under Fe and Zn deficiency (Cakmak et al., 2001). This could be considered another strategy of adaptation mechanism for this genotype in salinity tolerance.

Table (2) Effect of different salinity levels on K and Na concentration (mgkg^{-1}) in flag leaves at vegetative stage for different wheat genotypes.

Parameters	NaCl mML^{-1}	Sakha 93	Sids1	Giza168	Gimiza 7	Gimiza9	Mean
Na	0	108.4	67	6.9	6.4	0.0	50.14 e
	100	208	81.1	26.6	46.8	0.0	72.66 d
	200	380	97.1	57.9	52.7	58.9	129.00 c
	300	430	220	64	77.1	63	171.00 b
	400	450	397.3	90	81	77.1	219.00 a
Mean		315.65 a	172.7 b	61.43 c	52.79 d	39.89 c	
K	0	268.5	187.7	137.2	167.5	147.3	181.48 a
	100	218	167.5	127.1	147.3	137.2	159.34 b
	200	76.6	117	113.1	117	16	81.18 c
	300	16	96.8	96.8	96.5	36.2	68.13 d
	400	66.5	47.3	52.4	66.5	36.2	53.77 e
Mean		129.1 a	123.08 a	118.67 a	98.51 b	74.53 c	

L.S.D$_{(0.05)}$ for Na = 1.81 L.S.D$_{(0.05)}$ for K = 8.78

Concerning Cu concentration in flag leaves. Data in Table (3) showed significant differences among different genotypes. Under non-saline condition Sakha 93 recorded the highest content of Cu.

Increasing salinity levels decreased Cu content in all wheat genotypes except for Gimiza 9 which increased Cu content by 105 and 94% at 100 and 400 mM NaCl respectively, relative to control. This trend confirmed the previously data observed for Zn which indicate that the phytosiderophores released by Gimiza 9 had the ability to chelate Cu also, and this ability was enhanced by increasing salinity levels. It is clear from Table (3) that Cu concentration, at the highest salinity levels (400 mM NaCl), increased relative to the lower salinity levels (200, and 300 mM NaCl), and this increasing differed among genotypes. These variations may be referred to differences in antioxidant activity in response to salinity stress in tolerant and sensitive wheat genotypes (Sarian et al., 2005).

Table (3) Effect of different salinity levels on micronutrients concentration (mgkg^{-1}) in flag leaves at vegetative stage for different wheat genotypes.

Elements	NaCl mML^{-1}	Sakha 93	Sids1	Giza168	Gimiza 7	Gimiza9	Mean
Fe	0	259.2	170.2	93.6	292	187.8	200.3 a
	100	82.4	180.6	184.4	105	147	139.68 b
	200	78	92.4	63.6	66	42.4	68.22 e
	300	140	80.2	105	171.4	78.8	114.8 d
	400	104	113.6	157.6	118.2	92.2	116.8 c
Mean		132.4 b	127 c	120.73 d	150.4 a	109.28 e	
Zn	0	84.56	39.88	42.42	50.96	33.16	50.18 a
	100	40.2	35.46	63.98	26.3	43.48	41.73 b
	200	20.52	46.46	37.82	31.4	22.7	31.67 d
	300	30.12	46.68	43.28	32.88	39.28	35.03 c
	400	33.64	29.74	25.96	20.5	47.48	34.84 c
Mean		41.76 b	39.62 c	42.68 a	32.44 e	36.94 d	
Cu	0	6.4	4.2	3.2	4.4	3.4	4.34 a
	100	2.6	3	1.8	2.4	7.0	3.35 b
	200	1.8	1.4	0.4	0.1	1.0	0.98 e
	300	1.2	3.8	0.2	0.9	0.2	1.26 d
	400	2	1.8	1.6	0.4	6.6	2.46 c
Mean		2.84 b	2.81 b	1.43 d	1.68 c	3.64 a	
Mn	0	36.2	47.6	30.4	62.6	16.8	38.59 a
	100	22.6	34.8	22.6	25.4	16.4	20.88 c
	200	17.2	28.2	24.6	21.6	14.6	16.66 e
	300	11.8	22.8	19.4	19.4	12.8	25.92 b
	400	10.4	21.0	15.8	18.6	9.0	18.42 d
Mean		20.2 d	36.78 a	22.57 c	29.06 b	11.85 e	

L.S.D$_{(0.05)}$ for Fe = 1.20
L.S.D$_{(0.05)}$ for Zn = 0.32
L.S.D$_{(0.05)}$ for Cu = 0.09
L.S.D$_{(0.05)}$ for Mn = 0.55

On contrary, Mn concentration in flag leaves decreased significantly with increasing salinity levels in all genotypes. However, Giza 168 recorded the lowest concentration at control; Sakha recorded the lowest concentration at 400 mM NaCl. These variations in Mn Concentration in flag leaves among different genotypes may be due to the performance of each genotype to release phytosyderophoes and chelate Mn, but this performance was affected by salinity levels.

Yield characteristics

The evaluation of final yields was determined by plant height, fresh and dry weight of straw, fresh and dry weight of grain, number of spikes, and number of grain. Salinity decreased the plant height significantly when compared to control in almost all genotypes (Table 4). This reduction could be attributed to toxic effects of Na$^+$ and Cl$^-$ in the physiologically active parts of tissues, and to inefficient compartmentation for these ions in vacuoles (Yeo and flowers, 1986). Among wheat genotypes, plant height was also differed highly significant. Under non-saline condition, the genotypes (Giza168 and Gimiza7) produced the maximum, while Sids1 produced the minimum. At 100 mM NaCl, plant height in Gimiza7 and Gimiza9 was increased relative to control.

At final harvest, fresh and dry weight of straw decreased significantly with salinity increasing. However, it is obvious from Table (4) that the genotypes gimiza7 and gimiza9 recorded higher fresh weight at 100 mM NaCl, relative to control, but this trend was not observed for dry weight, this may be due to osmotic adjustment by these two genotypes, which resulting in enhancing of water uptake (Gale and Zeroni, 1984). Among genotypes there were highly significant differences in fresh and dry weight, for example at (300 mM NaCl), the fresh weight decreased by 76, 63, 51, 22, and 38% relative to control for Sakha93, Sids1, Giza168, Gimiza7 and Gimiza9, respectively.

Also, fresh and dry grain yield per plant was decreased with salinity increasing. Gale and Zeroni (1984) referred the reduction of yield to disturbed carbohydrate and protein metabolism. However, at 100 mM NaCl the dry grain weight of gimiza9 increased by 42% relative to control. Meanwhile, the plants treated with 300, 400 mM NaCl has no grain for the same genotype (Table 4). The same trend was observed on spikes number. Mass and Poss, (1989) referred the reduction on plant height and spikes number which initiate during early growth stages to salinity effect that has greater influence on final grain yield. Among wheat genotypes, the salt tolerance also changed at different stages (Zeng et al., 2002). The same trend was observed for grain number except for gimiza7 and gimiza9, the grain number increased at 100 mM NaCl by 7 and 34% respectively, relative to control.

Table (4). Effect of different salinity levels on plant growth parameters at harvest stage for different wheat genotypes

Parameters	NaCl mML^{-1}	Sakha 93	Sids1	Giza168	Gimiza 7	Gimiza9	Mean
Plant height	0	65	59	96	69	64	62.66 a
L.S.D$_{(0.05)}$ = 4.28	100	52	55	61.5	76	66	56.03 b
	200	47	46	57	55.5	51	53.6 b
	300	36	30	50	45	30	39.66 c
	400	25	37	39.5	24	21	33.26 d
Mean		41.8 c	47.4 b	55.5 a	51.86 ab	48.66 b	
F.w (straw)	0	9.7	9.85	11.03	7.22	6.5	8.04 b
L.S.D$_{(0.05)}$ = 1.17	100	8.48	7.62	9.95	11.2	6.9	9.45 a
	200	6.14	5.55	8.5	6.12	5.92	6.49 c
	300	2.3	3.55	5.34	5.6	4.02	4.89 d
	400	1.43	2.2	3.4	2.58	1.87	2.62 e
Mean		5.15 c	7.35 a	6.40 adc	6.81 ab	5.78 bc	
D.w (straw)	0	4.9	5.32	4.5	5.36	4.83	4.8 a
L.S.D$_{(0.05)}$ = 0.74	100	2.4	3.78	3.93	4.91	4.3	4.7 a
	200	1.2	3.14	2.5	3.61	3.58	4.24 a
	300	0.19	2.4	2.13	3.4	3.4	3.28 b
	400	0.14	1.7	1.96	0.73	1.7	1.99 c
Mean		3.20 b	4.03 ab	3.92 ab	4.34 a	3.60 ab	
F.W (grains)	0	3.55	3.48	3.55	3.77	1.4	2.8 a
L.S.D$_{(0.05)}$ = 0.38	100	2.67	1.64	3.15	3.47	1.6	2.65 a
	200	1.28	1.56	2.11	1.64	0.29	0.97 b
	300	0.25	1.29	1.25	0.83	0	0.59 bc
	400	0.16	0.35	0.42	0.1	0	0.44 c
Mean		1.35 b	1.68 ab	1.94 a	1.89 a	0.58 c	
D.W (grain)	0	3.07	2.33	3.4	3.16	0.84	2.32 a
L.S.D$_{(0.05)}$ = 0.32	100	2.4	1.51	2.53	3.06	1.2	2.30 a
	200	1.2	1.35	1.45	1.5	0.28	0.88 b
	300	0.2	0.27	1.18	0.68	0	0.51 c
	400	0.14	0.07	0.4	0.08	0	0.31 c
Mean		1.17 b	1.36 ab	1.68 a	1.64 a	0.47 c	
Grain number	0	115	86	120	98	49	87.7 a
L.S.D$_{(0.05)}$ = 11.84	100	75	60	105	105	66	96.53 a
	200	40	34	92	80	39	56.26 b
	300	30	26	79	59	0	34.26 c
	400	24	2	35	1	0	19.73 d
Mean		60.06 bc	52.46 c	84.93 a	67.46 b	29.66 d	
Spikes Number	0	25	19	19	20	21	19.73 a
L.S.D$_{(0.05)}$ = 2.08	100	20	15	17	19	19	18.8 ab
	200	15	13	14	17	20	17.13 b
	300	11	6	14	15	13	14.86 c
	400	9	5	9	9	10	9.26 d
Mean		14.8 a	14.53 a	17.00 a	16.33 a	17.13 a	

Ranking of genotypes for salt tolerance

According to the cluster analysis, the genotypes were divided into four cluster groups (Table5). The results show that genotype Gimiza 9 was ranked as the most tolerant genotype, the salt tolerance indices of grain yield for genotype Gimiza 9 was about two times greater than for (Sakha 93 and Sids 1) Genotypes (Sakha93, and Sids 1) were ranked as the least tolerant genotypes (sensitive), While, Giza 168 and Gimiza 7 were ranked as moderate genotypes.

Table (5) Ranking of genotypes for their relative salt tolerance in a cluster analysis (Single-Link cluster analysis)

Parameters	Genotypes				
	Sakha 93	Sids1	Giza168	Gimiza 7	Gimiza9
Fe conc. in flag leaves	1	2	3	1	4
Zn conc. in flag leaves	1	2	3	1	4
Cu conc. in flag leaves	1	2	1	3	4
Mn conc. in flag leaves	1	2	3	1	4
Total chlorophyll	1	2	3	4	3
Chlorophyll a	1	2	3	4	3
Chlorophyll b	1	2	3	4	3
K conc. in flag leaves	1	2	3	4	1
F.w (straw)	1	1	2	3	4
D.w (straw)	1	2	2	3	4
Fresh grain weight	1	2	3	3	4
Dry grain weight	1	1	2	3	4
Grain & spikes W.	1	2	3	4	4
Grain number	1	1	2	3	4
Height	1	2	3	4	4
Spikes number	1	2	3	3	4
Sum	16	29	43	48	58
Genotypes ranking	1	2	3	3	4
Final total degree	Sensitive	Sensitive	Moderate	Moderate	Tolerant

In conclusion, because Gimiza 9 was identified as the most tolerant genotype in the cluster analysis, and retained low Na concentration, that reflects better K, Fe, Zn, Cu, and Mn uptake. It can be utilized through appropriate selection and breeding programs for further improvement in salt tolerance of Egyptian wheat genotypes.

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الملخص العربى

مقارنة الكفاءة الامتصاصية للعناصر الصغرى
لبعض أصناف القمح فى الظروف الملحية

فاطمة كمال شريف

قسم الاراضي والمياه ـ كلية الزراعة ـ جامعة الإسكندرية

تعتبر الملوحة من اهم العوامل المؤثرة على نمو النبات وإنخفاض المحصول. حيث أن زراعة أصناف متحمله للملوحه هي احد البدائل الهامه عند زراعة الاراضى الملحية أو إستخدام المياه الملحية. وعلى ذلك فإن هدف هذه الدراسة هو إختبار خمس أصناف من القمح فى مدى استجابتها لإنتاج الاحماض الامينية وقدرتها على إذابة وحركة العناصر الصغرى تحت مستويات مختلفة من الملوحة.

وقد زرعت أصناف القمح المختلفة فى أرض جيرية ورويت بمياه يتراوح فيها تركيز كلوريد الصوديوم (صفر، ١٠٠، ٢٠٠، ٣٠٠، ٤٠٠ مللى مول). فى المراحل الخضرية، وجد أن زيادة الملوحة أدت الى انخفاض المحتوى اللكوروفيللى والوزن لكل ورقة. ماعدا المعاملة (١٠٠ ملل مول). كذلك أظهرت النتائج فروق معنوية بين الاصناف المختلفة. كذلك وجد أنه عند التركيزات المرتفعة من كلوريد الصوديوم كان الصنف سخا ٩٣، سدس ١ هما أكثر الاصناف امتصاصاً للصوديوم وعلى العكس فإن زيادة تركيزات الملوحة أدت الى انخفاض تركيز البوتاسيوم فى الاوراق. كذلك فإن تركيز الحديد والزنك إنخفض معنويا بزيادة الملوحة ولقد وجد أن تركيز الحديد فى الصنف سدس ١، جيزة ١٦٨ كان الأعلى قيمه عند تركيز (١٠٠ ملل مول كلوريد صوديوم) بينما عند المستويات الاعلى من الملوحة فإن جيزة ٩ أظهرت زيادة معنوية فى التركيز.

وتبعا لتحليل النتائج فإنه يمكن تصنيف الصنف جيزه ٩ كأكثر الاصناف تحملاً للملوحة بينما يعتبر الصنف سخا ٩٣، سدس ١ أكثرهم حساسية أما الاصناف جيزة ١٦٨، جيزة ٧ فهى متوسطة التحمل للملوحة.