Selection under salt stress conditions in F3 and F4 generations of wheat (Triticum aestivum L.)

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ABSTRACT

This study was carried out during two winter successive seasons 2017/18 and 2018/19 to determine the effect of salinity stress on yield and yield components in F_3 and F_4 segregating populations of the two bread wheat crosses (Sakha 93 x Gemmaiza 9) Cross1 and (Sakha 93 x Giza 168) Cross II. The results showed highly significant differences between means of the two crosses and families for most the traits in F_3, and 100 grain weight in F_4 generations. The differences between salinity levels were highly significant for all traits in both F_3 and F_4 generations. The interaction between crosses × families was highly significant for all traits, except for number of grains/spikes in F_3, while it was highly significant for number of grains per spike and weight of 100 grain in F_4. The interaction between crosses × salinity levels was highly significant for all traits in F_3, while it was highly significant for weight of 100 grain in F_4. As for the interaction between families, salinity levels were highly significant for most traits in F_3, while F_4 were highly significant for weight of 100 grain. The interaction between crosses × families × salinity levels, were highly significant for most traits in F_3, while in F_4 were highly significant for weight of 100 grain. Highest values of H and GA were found for grain yield / plant and weight of 100 grain under salinity conditions in F_4 generation. These traits would be improved by direct selection under saline soil conditions.

Keywords: Genetical variability, Selection, Salinity, Wheat.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important and strategic cereal crops in Egypt and all over the world which belongs Poaceae family which is constituted by out-standing group of food plants. The wheat breeders are concentrating to improve the yield potential of wheat by developing new varieties. In Egypt, 3.00 million feddan of wheat are planted, this area produces 8.10 million tons and the consumption is about 16.768 million tons (CAPMAS2017). This indicates that wheat consumption in Egypt has exceeded domestic production, thus requiring the importation of about 8.66 million tons annually. This constituted a high level of import, and food security becoming a serious problem. Therefore, it is necessary to increase wheat production to realize the food security.

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).** Egypt is one of the countries that suffer from severe salinity problems. For example, 33% of the cultivated lands, 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 annual domestic demand for wheat (Salam, 2002). Therefore, it is necessary to increase wheat production in Egypt by raising the wheat grain yield. Obviously, the most efficient way to increase wheat yield in Egypt is to improve the salt tolerance of wheat genotypes Epstein *et al*. (1980), Shannon. (1997) and Pervaiz *et al*., (2002).

Heritability plays a predictive role in breeding, expressing the reliability of phenotype as a guide to its breeding value. It is understood that only the phenotypical value can be measured directly, while breeding values of individuals are derived from appropriate analysis. It is the breeding value, which determines how much of the phenotype would be passed onto the next generation (Rehman and Alam 1994). High genetic advance coupled with high heritability estimates offers the most effective condition for selection (Larik, *et al.,* 2000). Thus, genetic advance is yet another important selection parameter that aids breeder in a selection program (Shukla, *et al*., 2004). Phenotypic and genotypic variance, heritability and genetic advance have been used to assess the magnitude of variance in wheat breeding material (Bhutta, 2006). Kumar *et al.,* (2003) reported high heritability coupled with high genetic advance for plant height, number of spikelets per spike, 1000 -grain weight and number of tillers per plant in wheat. The high heritability indicates that the characters were less influenced by environment. The similar results were also found by Yadav *et al*., (2003) and Gupta *et al*., (2004).

The main objectives of this study:

Studies the effects of salinity levels for two crosses populations (F_3 and F_4) for all the studied characters.

Estimate genetic parameters (σ^2_g , σ^2_{ph} , σ^2_e , PCV, GCV, H and GA %) for F_3 and F_4 populations.

MATERIALS AND METHODS

This experiment was conducted at the Experimental Farm of Agronomy Department, Faculty of Agriculture, Al-Azhar University Nasr City Cairo, Egypt during two successive seasons of 2017/18 and 2018/19.

The experimental materials comprised of two bread wheat crosses, (Sakha 93 × Gemmiza 9) and (Sakha 93 × Giza 168), which were installed in a previous study of three varieties of wheat. The plant materials (F_1 and F_2) were obtained from Khamees, (2016). Agronomy Dept., Fac.of Agric., Al-Azhar Univ. These materials were tested for salinity tolerance by grown under salinity levels (control, 6000, 9000 and 12000 ppm), which were farming in plastic pots of 30 cm diameter, 25 cm deep and the sand soil weight in each pot was 12 kg. Each plot contained of 8 plants. Salinity concentration setting throw determine (Leaching Requirement) according to the following equation:

L.R= EC (irrigation water) / (EC water drainage) ×100

In 2017/18 growing season, the seeds of tolerant and high yielding plants for the two crosses and their parents which selected under each salinity level in F_2 seeds were planted as families (a family for each plant) to obtain F_3 families.

In 2018/19 growing season, the selected plant seeds which were salinity tolerant for all salinity levels under study from F_3 generation of the two crosses and their parents. They were planted to obtain F_4 plants and evaluated as families under all salinity levels (a family for each plant).

The crosses and their parents were evaluated in a randomized complete block design (RCBD) with three replicates for each salinity level.

Data were recorded on individual guarded plants for number of spikes/plant, number of grains/spike, 100- grain weight (g) and grain yield/plant (g).

Statistical analysis and genetical parameters:

Data were estimated analysis according to Snedecor and Cochran (1980) the means differences were tested against the least significant difference (L.S.D) at 5% level of probability according to Gomez and Gomez (1984).

Analysis variance and expectation of mean squares, for source of variation are shown in Table (1)

The variance components were estimated according to (Millar *et al* 1959) as follows:

Genotypes (σ^2_g) = (M5+M2-M3-M4)/rbc

Genotypes × families (σ^2_{gb}) = (M4-M2)/rc

Genotypes ×concentration (σ^2_{gc}) = (M3-M2)/rb

Genotypes × families × concentration (σ^2_{gbc}) = (M2-M1)/r

Error (σ^2_e) = M1

The importance of genotypic component of variance in relation to phenotypic variance (σ^2_{ph}) is as follows:

$\sigma^2_{ph} = \sigma^2 g + (\sigma^2 gb/b) + (\sigma^2 gc/c) + (\sigma^2 gbc/bc) + (\sigma^2 e/gbr)$

Heritability

The estimates of broad-sense heritability were computed as suggested by **Allard (1960).**

$H^2_b = \sigma^2_g / \sigma^2_{ph} \times 100$

Phenotypic and genotypic coefficient of variation

Phenotypic (PCV) and genotypic (GCV) coefficient of variation were estimated using the formula suggested by Burton (1952) as follows:

$PCV = \sqrt{\sigma^2_{ph}} / \bar{x} \times 100$

$GCV = \sqrt{\sigma^2_g} / \bar{x} \times 100$

Genetic advance

Genetic advance (GA) (10 % selection intensity) as percent means and genetic advance as percentage of mean (GA %) by Lush (1949) and Johnson *et al*. (1955).

$GA = K \times \sqrt{\sigma^2_{ph}} \times h^2_b$ $GA\ \% = GA / \bar{x} \times 100$

RESULTS AND DISCUSSION

Analysis of variance and average performance.

Analysis of variance and average performance. Average performance for four characters treated by salinity levels.

Analysis of variance

Analysis of variance for all the traits in F_3 and F_4 families are shown in Table (2) revealed high significant differences between two crosses for all traits in F_3 and non-significant differences between crosses for all traits, except 100-grain weight (g) in F_4. Moreover, high significant differences are shown between families, except number of grains/spikes in F_3, while in F_4 families were non-significant differences between them except, for 100-grain weight (g). The differences between salinity levels were highly significant for all studied traits in F_3 and F_4 generations. On the other hand there were high significant differences for interaction (crosses× families) for all the studied traits, except number of grains/spike in F_3, and number of spikes/plant and grain yield /plant (g) in F_4 generation. Highly significant differences were shown for interaction AC (crosses× salinity levels) for all the studied traits in F_3, but they were non-significant differences for all the traits, except 100-grain weight (g) in F_4. Highly significant differences were observed for interaction BC (families× salinity levels) for all traits, except number of grains/spikes in F_3, while they were non-significant differences for all the traits, except 100-grain weight (g) in F_4. The interaction between ABC (crosses× families× salinity levels) were highly significant for all the traits, except number of grains/spikes in F_3, and non-significant for all the traits, except for 100-grain weight (g) in F_4. This indicated that these populations are highly diversified for their performance and selection can be performed for various traits.

Average **performance:**

Average performance was variable according to the incidence of crosses, families, salinity levels, and interaction between them.

Number of spikes/plant:

This trait is presented in Table (3). Results indicated highly significant differences between two crosses in F_3. while the differences between crosses in F_4 were non-significant.

As for the families, results indicated high significant differences between families in Table (2). Family No. 8 gave the highest mean value (1.680),while family No. 10 gave the lowest one (1.297) in F_3. The differences between families in F_4, were non-significant differences.

As for salinity levels, results revealed high significant differences between salinity levels, control gave the highest value (1.968) and no significant differences between 6000 and 9000 ppm (1.303) and (1.297) respectively, while the salinity level 12000 ppm recorded the lowest value (1.199) in F_3. In F_4 generation the differences between salinity levels were non-significant Table (2).

Furthermore, the interaction between crosses× families were high significant differences, the family No.8 gave the highest mean value (1.802) for cross I, while, family No. 1 recorded the lowest value (1.245) for cross Π in F_3 generation, the interaction between crosses× families in F_4 was non-significant.

The interaction between crosses × salinity levels were highly significant in F_3, cross I recorded the highest mean value (2.298) under control, while cross I recorded the lowest value (1.184) under 12000 ppm. These results agreed with those reported by EL-Amin *et al*. (2011) and Aziza, M. Hassanein (2016). The interaction in F_4 was non-significant.

The interactions between families × salinity levels in F_3 were high significant. The family No. 8 gave the highest value (2.430) under control, while the family No.1 and No. 9 gave the lowest value (1.000) under salinity level 12000.

The family No. 1 for F_4 gave the highest mean value (1.733) under control, while all families under 12000 ppm recorded the lowest values (1.000).

The interaction between crosses × families × salinity in F_3 generation for number of spikes per plant were highly significant and recorded the highest mean values (3.260) for cross I in family No. 8 under control. The families No. 6, No. 8 and No. 9 in cross I recorded the lowest value (1.000) in F_3 generation, while, the average performance for families No. 1, No. 4, No. 5 and No. 9 under the salinity level 12000 ppm in cross Π recorded the same value (1.000), the interaction between crosses × families × salinity levels were non-significant in F_4 generation.

Number of grains/spike:

This trait is presented in Table (4). Results indicated high significant differences between crosses in F_3. Cross Π gave the highest mean value (39.136), while cross I gave the lowest one (34.014) and the differences between crosses in F_4 were non-significant

Concerning the families, results indicated non-significant differences between families in F_3 and F_4.

In F_3, results revealed high significant differences between salinity levels and the control gave the highest value (52.387). On the other hand, the salinity level 12000 ppm recorded the lowest value (28.527) and there were no significant differences between 6000, 9000 ppm (32.713) and (32.672). These results are in agreement with Ahmad *et al*. (2013). In F_4 generation, the differences between salinity levels were high and significant. The control level gave the highest value (50.328). On the other hand, the salinity level 12000 ppm recorded the lowest value (30.889).

Moreover, the interaction between crosses and families were non-significant in F_3, while, the interaction between crosses and families in F_4 were highly significant. Family No. 2 gave the highest mean value (41.948) for cross Π, while family 1 in cross I recorded the lowest mean value (30.122).

The interaction between crosses and salinity levels was highly significant in F_3. Cross Π recorded the highest mean value (52.713) under control. On the other hand, the cross I recorded the lowest value (25.710) under level 12000 ppm. These results are in agreement with EL-Amin *et al*. (2011) as he found that the interaction in F_4 was non-significant.

The interaction between families and salinity levels in F_3 were high significant. The family No. 3 gave the highest mean value (55.267) under control, while family No. 9 recorded the lowest value (20.795) under level 12000 ppm in F_3, but in F_4 were non-significant.

The interaction between (crosses, families and salinity) were non-significant differences in F_3 and F_4.

100- grain weight:

It is presented in Table (5). Results showed, high significant differences between crosses in F_3. Cross Π gave the highest mean value (2.214), while cross I gave the lowest one (2.026). The differences between crosses in F_4 were high significant. Cross Π gave the highest mean value (2.149), while, cross I gave the lowest mean value (1.954).

As for the families, results indicated high significant differences between families. Families No. 2 and No. 3 gave the highest values (2.399 and 2.373), respectively, while Family No. 10 gave the lowest mean value (1.862) in F_3. In F_4, results indicated high significant differences between families. Family No. 2 gave the highest value (2.135), while Family No. 3 gave the lowest mean value (1.887).

As for the salinity levels, the results revealed high significant differences between salinity levels, the control gave the highest value (3.206), but the salinity level 6000 ppm recorded the lowest value (1.632) in F_3. F_4 generation showed high significant differences between salinity levels. The control gave the highest value (3.263), but the salinity level 12000 ppm recorded the lowest value (1.291).

The interaction between crosses and families was high and significant and the family No. 3 gave the highest mean value (2.642) for cross Π in F_3. The interaction between crosses and families, in F_4 were highly significant. The family No. 1 gave the highest mean value for cross Π.

The interactions between crosses and salinity levels were highly significant in F3, cross Π recorded highest mean under control (3.209). On the other hand the cross I recorded the lowest value under levels 6000 ppm (1.589). These results are in agreement with El-Hendawy *et al*. (2005). In F_4 generation the interaction between crosses and salinity levels was highly significant. Cross Π recorded the highest mean under control (3.402). On the other hand, the cross I recorded the lowest value (1.322) under level 12000 ppm.

The interactions between families and salinity levels were highly significant. Family No. 3 gave the highest mean value (3.518) for control in F_3, while family No. 6 recorded the lowest value (1.195) under level 9000 ppm in F_3. Family No. 4 gave the highest mean value (3.450) under control. Family No.3 recorded the lowest value (1.063) under level 12000 ppm in F_4 generation.

Furthermore, the interaction between (crosses, families and salinity) in F_3 were highly significant with the highest mean value (3.840) for family No. 7 in cross I under the control, while the lowest values were (1.067) for cross I in family No. 10 under level 12000 ppm. The interaction between (crosses, families and salinity) in F_4 were highly significant, with the highest mean value (3.553) for cross Π in family No. 1 under the control, but the lowest value was (0.770) for cross Π in family No. 3 under level 12000 ppm.

Grain yield/plant (gm.)

They are presented in Table (6). Results showed, high significant differences between crosses in F_3. The cross Π gave the highest mean value (1.445), while, cross I gave the lowest mean value (1.221). In F_4 generation, the differences between crosses were non-significant.

As for the families, results indicated high significant differences between families. Family No. 2 gave the highest value (1.460 gm), while family No. 9 gave the lowest mean values (0.990 gm) in F_3. The differences between families in F_4 were non-significant.

Additionally the salinity levels, results revealed high significant differences between salinity levels, the control gave the highest value (2.877 gm.), followed by (0.853gm) under salinity level 9000 ppm in F_3, on the other hand, the salinity level 12000 ppm recorded the lowest value (0.803gm). In F_4 generation, the differences between salinity levels were high significant. The control gave the highest value (2.352 gm.), but the salinity level 12000 ppm recorded the lowest value (0.443 gm.)

The interactions between crosses and families were high significant differences, the family No. 8 gave the highest mean value (1.693gm) for cross Π in F_3, but the interaction between crosses and families in F_4 were non-significant.

The interactions between crosses and salinity levels were highly significant in F_3 generation. Cross Π recorded the highest mean under levels control (2.892gm). On the other hand, the cross I recorded the lowest value (0.591gm) under level 9000 ppm. These results are in agreement with, Mresheh *et al*. (2009), EL-Amin *et al*. (2011). In F_4, the differences were non-significant.

The interactions between families and salinity levels in F_3 were highly significant. Family No. 8 under the control gave the highest mean value (3.632gm), while family No. 9 and No. 10 recorded the lowest values under 12000 ppm. The interaction between families and salinity levels in F_4 was non-significant.

In F_3 generation, the interactions between (crosses, families and salinity) were high significant. The highest mean value was (4.290 gm) for cross I in family No. 8 under the control, while, family No. 9 in cross I recorded the lowest value (0.170gm.) under salinity level 12000 ppm. The interaction between crosses, families and salinity levels was non-significant in F_4 generation.

These results indicated that most of investigated traits were sensitive to salinity stress. These results are in agreement with Aslam *et al*. (1989). The reduction in the values of the number of spikes/plant, number of grains/spike, 100- grains weight (g) and grain yield/plant (g) may be due to low uptake of water by plants as well as toxicity of Na and C1 because of their high concentration in the irrigation water. Also, salinity stress significantly reduced greatly values of the most investigated traits under study. The reduction in the value of these characters might be due to the toxic effect of salt on plant growth (Bhatti, 2004).

Genetical variability under salinity conditions

Genetic parameters i.e. σ^2_g,σ^2_{ph},PCV,GCV, h^2 % and GA% for plant height and yield and its component traits under salinity conditions are indicated in Table (7) for F_3 and F_4 families.

Table (7) showed that PCV values were higher than the GCV values for all the characters. These results are confirmed with those reported by (Ali *et al.* 2008), Ehdaiel and Waines (1987) and Moghaddam *et al.* (1997). The estimates of PCV and GCV gave the highest values for grain yield/ plant 69.76 and 65.26. Other traits showed low estimates ranged between 23.99 and 22.60 %, respectively for number of spikes per plant to 48.20 and 38.30 % for number of grains / spikes, respectively under salinity conditions in F_3 generation. The estimates of PCV and GCV gave the highest values for number of grains / spike11.03 and 9.12 %. Other traits showed low estimates ranged between 1.005 and .083 % for number of spikes per plant to 8.28 and 7.94 % 100 grain weight in F_4 generation. These results are in agreement with that reported by Pathak and Nema (1985).

The broad sense heritability (H %) estimates ranged from 79.46 to 94.21% for number of grains per spike and number of spikes per plant, respectively in F_3 generation. The broad sense heritability (H %) estimates ranged from 71.42 to 95.88 % for grain yield per plant and 100 grain weight in F_4 generation. Sachan and Singh (2003) found that high heritability estimates were also shown for the traits (plant height, grain yield, number of grains per spike, 100 grain weight and number of spike per plant). High heritability estimates indicate that, the selection for these traits will be effective, being less influenced by environmental effects (Maniee *et al.* 2009).

The estimates of the expected genetic advance (GA %), as percentage of the mean is shown in (Table 7). Genetic advance (GA %) ranged between 7.81% for number of grains per spike and 67.60 % for number of spikes per plant in F_3 generation. The estimates of the expected genetic advance (GA %), as percentage of the mean is shown in (Table 12). Genetic advance (GA %) ranged between 13.38 % for number of spikes per plant and 46.31 % for 100 grain weight in F_4 generation. Dwivedi *et al*. (2002) reported that100-grain weight recorded highest values for genetic advance %. High heritability accompanied with high genetic advance indicates predominance of additive gene action and in such cases selection will be effective Panse and Sukhatme (1967).

CONCLUSION

This result indicates the traits 100-grain weight and grain yield per plant had high estimates of heritability and Genetic advance under salinity conditions in F_4 generation. These traits would be improved by direct selection under saline soil conditions.

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Table 1. The outline of analysis of variance and expectation of mean squares.

S.O.V	Df	MS	EMS
Rep (r)	r-1		
Genotype (a)	a-1		
Families(b)	b-1		
concentrations (c)	c-1	M5	
a× b	(a-1) (b-1)		$\sigma^2e + r\sigma^2aec + re\sigma^2ac + rc\sigma^2ae +$
a×c	(a-1)(c-1)	M4	$rec\sigma^2a$
b×c	(b-1) (c-1)	M3	$\sigma^2e + r\sigma^2aec + re\sigma^2ac$
a×b×c	(a-1) (b-1) (c-1)	M2	$\sigma^2e + r\sigma^2aec + re\sigma^2ge$
Error	a (a-1) (b-1) (c-1)	M1	$\sigma^2e + r\sigma^2aec$
			σ^2e

Table 2. Mean squares for studied characters as affected by salinity levels in F_3 and F_4 families of wheat crosses during 2017/18 F_3 and 2018/19 F_4 season.

S.O.V	d. f		No.of spikes/plant		No.of grains/Spike		100-grain weight (g)		Grain yield/plant(g)	
	F_3	F_4	F_3	F_4	F_3	F_4	F_3	F_4	F_3	F_4
Rep	**2**	**2**	0.005	0.009	203.580	16.947	0.017	0.014	0.012	0.013
Crosses (A)	**1**	**1**	0.675**	0.003	1574.042**	139.563	2.139**	0.915**	3.002**	0.082
Families (B)	**9**	**3**	0.271**	0.020	117.439	5.610	0.857**	0.298**	0.794**	0.105
AB	**9**	**3**	0.125**	0.011	66.533	101.917**	0.619**	0.337**	0.333**	0.026
Salinity levels (C)	**3**	**3**	7.522**	2.348**	6898.442**	1770.252**	32.00**	17.710**	63.614**	18.888**
AC	**3**	**3**	2.103**	0.005	237.709**	47.970	0.617**	0.219**	0.775**	0.014
BC	**27**	**9**	0.249**	0.010	73.250	10.254	0.481**	0.103**	0.488**	0.029
ABC	**27**	**9**	0.324**	0.013	63.924	25.929	0.556**	0.130**	0.739**	0.018
Error	**158**	**62**	0.010	0.012	49.012	22.486	0.008	0.015	0.016	0.047

Table 3. Average performance for number of spikes/plants as affected by salinity levels in F_3 and F_4 families of wheat crosses during 2017/2018 and 2018/2019 season.

Crosses (A)	Salinity levels (C) / Families (B)	Control		6000 ppm		9000 ppm		12000 ppm		**Average**	
		F_3	**F_4**	**F_3**	**F_4**	**F_3**	**F_4**	**F_3**	**F_4**	**F_3**	**F_4**
Sakha93× Gemmiza 9 F_3 and F_4	1	2.733	1.733	1.827	1.210	1.083	1.000	1.603	1.000	1.661	1.236
	2	1.700	1.533	1.150	1.127	1.300	1.000	1.040	1.000	1.438	1.165
	3	1.767	1.667	1.370	1.087	1.743	1.000	1.247	1.000	1.480	1.188
	4	2.067	1.667	1.360	1.087	1.227	1.087	1.287	1.000	1.475	1.210
	5	2.290		1.280		1.303		1.120		1.540	
	6	2.393		1.043		1.000		1.000		1.389	
	7	2.790		1.000		1.000		1.380		1.447	
	8	3.260		1.570		1.000		1.000		1.802	
	9	2.400		1.333		1.067		1.000		1.450	
	10	1.583		1.043		1.443		1.168		1.268	
Average		2.298	1.650	1.298	1.127	1.217	1.022	1.184	1.000	1.495	1.200
Sakha93× Giza 168 F_3 and F_4	1	1.567	1.733	1.043	1.170	1.370	1.000	1.000	1.000	1.245	1.226
	2	1.900	1.800	1.043	1.043	1.000	1.000	1.707	1.000	1.412	1.211
	3	1.500	1.533	1.210	1.000	1.327	1.000	1.607	1.000	1.411	1.133
	4	1.700	1.600	1.087	1.087	1.360	1.043	1.000	1.000	1.287	1.183
	5	1.600		2.000		1.440		1.000		1.510	
	6	1.567		1.227		1.000		1.377		1.292	
	7	1.600		1.587		1.680		1.130		1.499	
	8	1.600		1.560		1.617		1.450		1.557	
	9	1.783		1.000		1.617		1.000		1.350	
	10	1.567		1.333		1.363		1.043		1.327	
Average		1.638	1.667	1.309	1.075	1.377	1.011	1.231	1.000	1.389	1.188
Overall mean	1	2.150	1.733	1.435	1.190	1.227	1.000	1.000	1.000	1.453	1.231
	2	1.800	1.667	1.097	1.085	1.150	1.000	1.655	1.000	1.425	1.188
	3	1.633	1.600	1.290	1.043	1.535	1.000	1.323	1.000	1.445	1.161
	4	1.883	1.633	1.223	1.087	1.293	1.065	1.123	1.000	1.381	1.196
	5	1.945		1.640		1.372		1.143		1.525	
	6	1.980		1.135		1.000		1.248		1.341	
	7	2.195		1.293		1.340		1.065		1.473	
	8	2.430		1.565		1.308		1.415		1.680	
	9	2.092		1.167		1.342		1.000		1.400	
	10	1.575		1.188		1.403		1.022		1.297	
Average		1.968	1.658	1.303	1.101	1.297	1.016	1.199	1.000		

L. S. D at 5 %

F_3 A * B 0.057 C 0.11 AB 0.036 AC 0.051 BC 0.081 ABC 0.162

F_4 A NS B NS C NS AB NS AC NS BC 0.063 ABC NS

Table 4. Average performance for number of grains/spikes as affected by salinity levels in F_3 and F_4 families of wheat crosses during 2017/2018 and 2018/2019 season.

Crosses (A)	Salinity levels (C) / Families (B)	Control		6000 ppm		9000 ppm		12000 ppm		**Average**	
		F_3	**F_4**	**F_3**	**F_4**	**F_3**	**F_4**	**F_3**	**F_4**	**F_3**	**F_4**
Sakha93× Gemmiza 9 F_3 and F_4	1	50.733	49.227	25.920	37.760	20.83	30.337	23.750	27.420	30.122	36.186
	2	51.133	52.733	29.170	38.380	36.213	35.420	35.583	34.587	38.025	40.280
	3	59.600	51.133	40.293	31.460	35.170	33.127	23.500	23.963	39.641	34.921
	4	52.867	50.067	26.710	36.170	21.793	33.500	38.960	27.253	35.083	36.747
	5	54.600		28.543		29.750		25.170		34.516	
	6	45.667		35.797		26.420		19.420		31.826	
	7	48.533		21.710		29.463		22.543		30.563	
	8	56.133		37.670		21.543		29.420		36.192	
	9	53.200		34.337		27.753		17.753		33.261	
	10	48.133		27.087		27.420		21.003		30.911	
Average		52.060	50.790	30.724	35.943	27.561	33.096	25.710	28.306	34.014	37.034
Sakha93× Giza 168 F_3 and F_4	1	52.133	52.000	32.293	42.043	40.587	34.667	28.083	32.710	38.274	40.355
	2	57.200	50.867	36.877	35.793	34.587	32.500	39.130	30.087	41.948	37.312
	3	50.933	49.800	36.253	43.880	36.297	33.627	37.670	39.213	40.288	41.630
	4	54.800	46.800	32.627	39.253	35.293	36.003	32.003	31.877	38.681	38.483
	5	50.867		39.003		34.547		25.503		37.480	
	6	54.867		36.043		32.333		34.753		39.499	
	7	52.800		33.793		44.213		30.670		40.369	
	8	52.000		42.293		36.543		31.710		40.637	
	9	47.867		25.170		39.880		23.837		34.188	
	10	53.667		32.670		43.543		30.087		39.992	
Average		52.713	49.867	34.702	40.243	37.782	34.199	31.345	33.472	39.136	39.445
Overall Average	1	51.433	50.613	29.107	39.902	30.335	32.502	25.917	30.065	34.198	38.270
	2	54.167	51.800	33.023	37.087	35.400	33.960	37.357	32.337	39.987	38.796
	3	55.267	50.467	38.273	37.670	35.733	33.377	30.585	31.588	39.965	38.275
	4	53.833	48.433	29.668	37.712	28.543	34.752	35.482	29.565	36.882	37.615
	5	52.733		33.773		32.148		25.337		35.998	
	6	50.267		35.920		29.377		27.087		35.662	
	7	50.667		27.752		36.838		26.607		35.466	
	8	54.067		39.982		29.043		30.565		38.414	
	9	50.533		29.753		33.817		20.795		33.725	
	10	50.900		29.878		35.482		25.545		35.451	
Average		52.387	50.328	32.713	38.093	32.672	33.648	28.527	30.889		

L. S. D at 5 %

F_3 A * B NS C 2.505 AB NS AC 3.542 BC 7.922 ABC NS

F_4 A NS B NS C 2.737 AB 3.871 AC NS BC NS ABC NS

Table 5. Average performance for 100-grain weight(g) as affected by salinity levels in F_3 and F_4 families of wheat crosses during 2017/2018 and 2018/2019 season.

Crosses (A)	Salinity levels)C(Families (B)	Control		6000 ppm		9000 ppm		12000 ppm		**Mean**	
		F_3	**F_4**	**F_3**	**F_4**	**F_3**	**F_4**	**F_3**	**F_4**	**F_3**	**F_4**
Sakha93× Gemmiza 9 F_3 and F_4	1	3.430	3.327	1.310	1.830	1.737	1.180	1.597	1.120	2.018	1.864
	2	3.110	3.047	1.563	1.907	1.940	1.550	2.217	1.410	2.208	1.978
	3	3.210	2.767	1.900	1.867	1.830	1.413	1.477	1.357	2.104	1.851
	4	3.720	3.353	1.383	2.067	1.753	1.663	1.890	1.400	2.187	2.121
	5	2.570		1.490		1.930		1.467		1.864	
	6	3.677		1.523		1.147		1.920		2.067	
	7	3.840		2.277		1.200		1.727		2.261	
	8	3.170		1.920		1.557		1.830		2.119	
	9	2.937		1.170		1.760		1.630		1.874	
	10	2.373		1.353		1.427		1.067		1.555	
Average		3.204	3.123	1.589	1.917	1.628	1.452	1.682	1.322	2.026	1.954
Sakha93× Giza 168 F_3 and F_4	1	2.857	3.553	1.633	2.143	3.067	2.123	1.740	1.480	2.324	2.325
	2	3.837	3.387	2.000	2.380	2.303	2.020	2.220	1.383	2.590	2.293
	3	3.827	3.123	1.787	2.030	2.573	1.770	2.383	0.770	2.642	1.923
	4	3.083	3.547	1.730	1.827	3.010	1.437	1.460	1.407	2.321	2.054
	5	3.193		1.610		1.823		2.087		2.178	
	6	3.030		1.170		1.243		1.690		1.783	
	7	1.617		2.130		1.790		1.977		1.878	
	8	3.743		1.827		1.677		1.847		2.273	
	9	3.363		1.100		1.700		1.780		1.986	
	10	3.537		1.773		1.797		1.567		2.168	
Average		3.209	3.402	1.676	2.095	2.098	1.837	1.875	1.260	2.214	2.149
Overall **Average**	1	3.143	3.440	1.472	1.987	2.402	1.652	1.668	1.300	2.171	2.095
	2	3.473	3.217	1.782	2.143	2.122	1.785	2.218	1.397	2.399	2.135
	3	3.518	2.945	1.843	1.948	2.202	1.592	1.930	1.063	2.373	1.887
	4	3.402	3.450	1.557	1.947	2.382	1.550	1.675	1.403	2.254	2.087
	5	2.882		1.550		1.877		1.777		2.021	
	6	3.353		1.347		1.195		1.805		1.925	
	7	2.728		2.203		1.495		1.852		2.070	
	8	3.457		1.873		1.617		1.838		2.196	
	9	3.150		1.135		1.730		1.705		1.930	
	10	2.955		1.563		1.612		1.317		1.862	
Average		3.206	3.263	1.632	2.006	1.863	1.645	1.779	1.291		

L. S. D at 5 %

F_3 A * B 0.052 C 0.104 AB 0.033 AC 0.046 BC 0.073 ABC 0.147

F_4 A * B 0.071 C 0.071 AB 0.100 AC 0.100 BC 0.142 ABC 0.201

Table 6. Average performance for grain yield/plant (g) as affected by salinity levels in F_3 and F_4 families of wheat crosses during 2017/2018 and 2018/2019 season.

Crosses (A)	Salinity levels)C(Families (B)	Control		6000 ppm		9000 ppm		12000 ppm		**Average**	
		F_3	**F_4**	**F_3**	**F_4**	**F_3**	**F_4**	**F_3**	**F_4**	**F_3**	**F_4**
Sakha93× Gemmiza 9 F_3 and F_4	1	2.353	2.300	0.620	0.960	0.413	0.527	0.880	0.347	1.067	1.033
	2	2.467	2.273	0.613	0.730	1.280	0.680	1.203	0.503	1.391	1.047
	3	2.940	2.203	1.227	0.630	1.023	0.480	0.393	0.400	1.396	0.928
	4	2.573	2.373	0.580	0.677	0.273	0.587	1.010	0.457	1.109	1.023
	5	2.377		0.487		0.580		1.493		1.234	
	6	2.780		0.767		0.337		0.333		1.054	
	7	3.970		0.540		0.400		0.343		1.313	
	8	4.290		1.157		0.357		0.910		1.678	
	9	2.907		0.623		0.377		0.170		1.019	
	10	2.260		0.463		0.873		0.213		0.952	
Average		2.892	2.288	0.708	0.749	0.591	0.568	0.695	0.427	1.221	1.008
Sakha93× Giza 168 $F_3$and F_4	1	2.580	2.617	0.507	0.910	1.673	0.713	0.657	0.453	1.354	1.173
	2	3.397	2.507	0.497	0.837	0.730	0.630	1.493	0.450	1.529	1.106
	3	2.423	2.200	0.850	0.733	1.153	0.537	1.070	0.463	1.374	0.983
	4	3.243	2.347	0.517	0.683	1.430	0.510	1.517	0.470	1.677	1.002
	5	2.697		1.490		1.437		0.510		1.533	
	6	3.033		1.297		0.320		1.250		1.475	
	7	2.380		1.063		1.343		0.620		1.352	
	8	2.973		1.487		1.333		0.977		1.693	
	9	2.420		0.287		0.673		0.463		0.961	
	10	3.483		0.927		1.053		0.550		1.503	
Average		2.863	2.417	0.892	0.791	1.115	0.598	0.911	0.459	1.445	1.066
Overall **Average**	1	2.467	2.458	0.563	0.935	1.043	0.620	0.768	0.400	1.210	1.103
	2	2.932	2.390	0.555	0.783	1.005	0.655	1.348	0.477	1.460	1.076
	3	2.682	2.202	1.038	0.682	1.088	0.508	0.732	0.432	1.385	0.956
	4	2.908	2.360	0.548	0.680	0.852	0.548	1.263	0.463	1.393	1.013
	5	2.537		0.988		1.008		1.002		1.384	
	6	2.907		1.032		0.328		0.792		1.265	
	7	3.175		0.802		0.872		0.482		1.332	
	8	3.632		1.322		0.845		0.943		1.685	
	9	2.663		0.455		0.525		0.317		0.990	
	10	2.872		0.695		0.963		0.382		1.228	
Average		2.877	2.352	0.800	0.770	0.853	0.583	0.803	0.443		

L. S. D at 5 %
F_3 A * B 0.071 C 0.100 AB 0.045 AC 0.063 BC 0.141 ABC 0.200
F_4 A NS B NS C 0.125 AB NS AC NS BC NS ABC NS

Table (7). Genetic parameters for studied characters in F_3 and F_4 families of wheat crosses during 2017/2018 and 2018/2019 season.

Parameters	No. of spikes/plant		No. of grains/spike		100-grain weight		Grain yield/plant	
	F_3	F_4	F_3	F_4	F_3	F_4	F_3	F_4
PCV%	23.99	1.005	48.20	11.03	25.00	8.28	69.76	2.70
GCV %	22.60	0.83	38.30	9.12	22.92	7.94	65.26	1.92
H %	94.21	83.33	79.46	82.70	91.69	95.88	93.54	71.42
GA%	67.60	13.38	7.81	16.05	55.18	46.31	11.91	20.28

PCV, phenotypic coefficient at variation; GCV, Genetic coefficient at variation; H, Heritability in broad sense; GA%, Genetic advance as percentage of mean

الإنتخاب تحت ظروف الإجهاد الملحي في الأجيال الإنعزاليه الثالث والرابع في القمح

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الملخص العربي

أجري هذا البحث خلال موسمي 18/2017 و19/2018، في المزرعة البحثية بقسم المحاصيل-كلية الزراعة- جامعة الأزهر – القاهرة- مدينة نصر-مصر لتقدير تأثير إجهاد الملوحة لصفات المحصول ومكوناته لهجينين من قمح الخبز الهجين (سخا93 × جميزة9) والهجين (سخا93 × جيزة 168) تحت مستويات الملوحة (كنترول , 9000,6000 وppm12000) في الجيلين الانعزالين الثالث والرابع. تمت دراسة صفات عدد السنابل/نبات، عدد الحبوب /سنبلة، وزن 100 حبة ومحصول حبوب / نبات لدراسة إمكانية استخدام هذه الصفات باعتبارها دلائل في برامج التربية بالانتخاب لتحمل الملوحة.

وتتلخص أهم النتائج في الآتي : كانت هناك إختلافات معنوية عالية بين الهجن وأيضا العائلات لمعظم الصفات في الجيل الثالث ولصفة وزن 100حبة في الجيل الرابع., كان هناك إختلافات معنوية عالية بين مستويات الملوحة لكل الصفات في الجيلين الثالث والرابع .,-كان التفاعل بين الهجن والعائلات معنويا لكل الصفات ماعدا عدد الحبوب في السنبلة في الجيل الثالث, وكان معنويا لصفتي عدد الحبوب في السنبلة ووزن 100حبه في الجيل الرابع.,-كان التفاعل بين الهجن ومستويات الملوحة معنويا لكل الصفات في الجيل الثالث، بينما كان معنويا لصفة وزن 100حبه في الجيل الرابع.,-كان التفاعل بين العائلات ومستويات الملوحه معنويا لمعظم الصفات في الجيل الثالث ومعنويا لصفة وزن 100حبه في الجيل الرابع.,-كان اللتفاعل بين الهجن والعائلات ومستويات الملوحه معنويا لمعظم الصفات في الجيل الثالث ومعنويا لوزن 100حبه في الجيل الرابع.,- وأظهرت النتائج وجود قيم عالية لدرجة التوريث والتحسين الوراثي لصفتي محصول الحبوب ووزن 100 حبة في الجيل الرابع . مما يوضح أن هذه الصفات يمكن تحسينها من خلال الانتخاب المباشر تحت ظروف الملوحة.

الكلمات الاسترشادية: التباين الوراثي ،الانتخاب،الملوحة،القمح.