Salinity Stress Affects Field Performance of Wheat Genotypes Differing in Genetic Background

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ABSTRACT

A field experiment was carried out in three locations affected by salinity with averages (low=0.39, moderate=8.01and high=15.96 dSm^{-1}) at Nubaria Agricultural Research Station, El-Beheira Governorate, Egypt during the two winter seasons of 2016/2017, 2017/2018. The study included 12 bread wheat doubled haploid (DH) lines derived from Sakha8 X Line25 across, along with their parents and four check cultivars Sakha93, Sids1, Giza168 and Gemmiza7. The studied genotypes were classified into tolerant, moderately and sensitive to salinity stress based on salt tolerant index (STI) over both seasons at medium and high salinity levels. All studied characters were significantly reduced with increasing salinity level except days to heading, days to maturity and grain filling period which increased with increasing soil salinity level with varying degrees according to genotype. Grain yield was reduced by 14.05 % and 70.5 %, averaged over genotypes and seasons, at moderate and high salinity levels compared to low salinity level, respectively. The reduction in grain yield was caused by reduction in all yield components especially number of grains/spike and 1000 grain weight.

The results indicated that grain filling rate, grain weight/spike, 1000 grain weight and grain yield were considered as distinguishing characteristics in determining the ability of the DHL's to tolerate salinity. DHL's had a wide range for grain yield/ha where lines 7, 8 and 9 exceeded parents and checks in grain yield. Moreover, these lines had higher grain yield than the other DHL's and were scored, according to STI, as tolerant to salinity at high and medium salinity levels.

Key words: -Wheat, Salinity levels, Doubled Haploid Lines (DHL's), Salinity Tolerant Index (STI), Grain yield.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most extensively grown cereal crop in the world, it is grown all over the world for its highly nutritious and useful grains, as one of the top three most produced cereal crops, along with corn and rice. It is used in the production of bread, biscuits, pasta, confectionery, feeds and much other utilization. It was grown in about ٢١٥ million hectares in 2021 worldwide, accounting for a total of 772.64 million metric tons (FAOSTAT, 2021 and Statista, 2021). Egypt grew 1.43 million hectares, with a total production of 9.3 million tons in 2021 (Economic Affairs Sector, 2021) with an average of 6.5 tons/ha. This total production does not meet the local consumption. The national target is to increase wheat production either horizontally or vertically.

Salt stress is a major limiting factor and has become a major subject of concern for plant breeders around the world (Wani *et al*., 2020). Importantly, due to current and future expected population increase and climate change, the gap between production and consumption is widening. That necessitates increasing producing regions to include marginal areas with high salinity levels. Increased soil salinity had a significant impact on agricultural output around the world (Munns, 2002 and Barnawal *et al*., 2017), where salinity caused a decrease in the area of arable land by 9.8% in Africa in 2019 (Statista, 2021). In Egypt, 35% of agricultural land is affected by salinity ranging between low, moderate and high salinity located in North, East and Delta and some other areas in Wadi Al Natron, Al-Wahat and Al-Fayoum regions (UNDP, 2008). Negative effects of salinity on agriculture are a concern because it affects growth, development and yield of crop plants. Typically, decrease in growth of plant occurs linearly after attending threshold concentration of salinity. Salinity decreases root growth as well as shoot growth, but this reduction is lower in roots than to tops growth (Fageria, 1992).

Munns and Tester (2008) proposed three salinity tolerance mechanisms: ion exclusion, which is the net exclusion of toxic ions from the shoot; tissue tolerance, which is the compartmentalization of toxic ions into specific tissues, cells, and subcellular organelles and shoot ion independent tolerance, which is the maintenance of growth and water uptake regardless of the extent of Na^+ accumulation in the shoot.

Wheat is moderately salt tolerant, with a low yield loss threshold at 7.14 dSm^{-1} and a yield loss of 50% at 13.4 dSm^{-1}, respectively (Maas and Hoffmann, 1977).

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Wheat grain yield was found to be more influenced by tolerance to salinity in the early growth stages, establishment and parentheses, since these stages determine the proper growth of wheat plant and their ability to utilize growth resources to synthesize enough metabolites that will be employed by later reproductive stages to form the grain yield and its components (Kirby, 1988; Guo et al., 2015 and Zou et al., 2016).

Classical breeding in Egypt resulted in the production of some bread wheat cultivars, such as Sakha 8 and Sakha 93, that are more salinity tolerant than other commercial cultivars. Wheat genetic diversity has been decreased as a result of the wheat germplasm's narrow genetic foundation (Wei *et al*., 2000). Wheat breeders are constantly looking for new methodology to improve breeding materials that are more resistant to salinity.

Plant breeding using modern biotechnological methods could be a significant help to produce novel genetic variation that are not present in the gene pool, such as somaclonal and/or gametoclonal variation (Khan *et al*., 2001). Using of doubled haploid (DH) technology in cereal crops allows for the production of genetically homozygous pure lines from heterozygous breeding material in one generation (Yan *et al*., 2017).

The main objectives of this study are (i) Field evaluation for salinity tolerance in different genetic backgrounds of wheat doubled haploid lines and local cultivars. (ii) Ranking genotypes for salt tolerance based on vegetative, physiological, yield and yield component parameters. (iii) Selecting the most salinity tolerant genotypes to be used in the breeding programs or in field directly.

MATERIALS AND METHODS

1. **Experimental site:** The present investigation was carried out in the Experimental Farm of Nubaria Station (El-Beheira Governorate) ARC in 2016/17 and 2017/18 winter growing seasons. The station is located at Latitude: 31º 12`, Longitude: 29º 57̀ and Altitude = 3.4 m osl. In each season, three locations in the same station with three different salinity levels (low salinity 250 ppm = 0.39 dSm^{-1}, moderate salinity level 5125 ppm = 8.01dSm^{-1} and high salinity level 10215ppm = 15.96 dSm^{-1}) were employed. Meteorological data of the Nubaria site, in the two respective growing seasons, are presented in (table 2). Physical and chemical properties of soil at each experimental location are presented in (table 3).
2. **Plant materials:** Seeds of 18 bread wheat genotypes, including 12 doubled haploid lines resulting from Sakha 8 (tolerant) X Line 25 (susceptible) cross, via anther culture technique, and their parents (Abdel Aleem, 2015) Four check cultivars i.e. Sids 1, Sakha 93, Giza 168 and Gemmiza 7, obtained from Wheat Research Department, Field Crops Research Institute (FCRI), Agriculture Center Research (ARC), Egypt, were included in the present study. Pedigree, salinity tolerance and yielding ability of genotypes under field conditions, are presented in table (1). The DH line that were superior in salinity tolerance and yielding ability, according to laboratory evaluation, were selected and employed in the present study to determine their potentiality as new sources for salinity tolerance under field conditions.
3. **Sowing method and agricultural practices:** seeds of genotypes were sown, at the rate of 119 kg/ha in rows. Each row was 3 meters in length and keeping row to row distance of 30 cm and hill to hill spacing of 10 cm. The irrigation and fertilizing were applied as recommended by ARC, for the commercial production of wheat. Flood irrigation was done four times starting 21 days after sowing up to physiological maturity of wheat plants with 20 to 25 days' intervals according to the weather conditions. The fertilization was applied using 35.7 kg P_2O_5/ha as (calcium mono phosphate 15.5%) at soil preparation and 178.57 kg N/ha as (ammonium nitrate 33.5%) splitted to three doses, the first (20%) with sowing, the second (40%) with the first irrigation and (40%) with the second irrigation. No K was added because K may increase the tolerance of genotypes to salinity according to Fageria *et al*. (2011). The meteorological data of Nubaria site of the two growing seasons are presented in table 2. The Initial chemical and physical characteristics data of the soil at the experimental site are presented in table 3.
4. **Recorded characters**: **Days to maturity (DM):** Recorded as the number of days from sowing to the date at which 50% of main peduncles/plot have turned to yellow color (physiological maturity), **Grain filling period (GFP):** Number of days from 50% heading to 50% physiological maturity (on plot basis), **Grain filling rate (GFR):** It was calculated as the accumulated dry matter in grain per plant per day. It was calculated as follows: GFR (g/day) = GY / GFP (Where GY = grain yield, and GFP = grain filling period),

Table 1. Pedigree, salinity tolerance and yielding ability of the bread wheat genotypes used in the present investigation

Genotype	Pedigree and Selection History	Salinity tolerance	Yielding ability
Doubled haploid lines from L1 to L12	Doubled haploids resulted from the cross Sakha-8 X Line-25	Unknown	Unknown
Parents:			
Sakha- 8	INDUS / NORT ENo"s"	Tolerant	Low yielding
Line-25	ISR//16*TC 750451 – ZCOR 1M8BA-*2F2/ 1N1A66** BB12F213/CN079*2/PRL"S"	Susceptible	High yielding
Check cultivars:			
Sids-1	SAKHA 92/TR8 10328 HD2172/PAVON"S"//1158.57/MAYA 74 "S"	Tolerant	High yielding
Sakha-93	Sakha 92/TR 10328 S8871-1S-2S-1S-0S	Tolerant	High yielding
Giza-168	Mrl/Buc//Seri CM 93046-8M-0Y-0M-2Y-0B-0GZ	Susceptible	High yielding
Gemmiza-7	CMH 74 A. 6305/x//Seri 823//Agent CGM 46112-GM-3 GM-3GM-1GM-0GM	Susceptible	High yielding

Source: Wheat Res. Dept., FCRI, ARC, Giza, Egypt.

Table 2. Meteorological data during wheat growing seasons at Nubaria location

Month	Max temp. (°C)	Min temp. (°C)	Relative humidity (%)	Rain fall (mm)
		2016/2017		
October	27.1	20.8	60.0	0.1
November	25.1	16.0	59.0	2.1
December	17.8	10.6	63.0	95.5
January	17.5	6.7	67.0	17.0
February	19.0	8.9	67.0	0.2
March	21.3	13.5	60.7	0.0
April	22.9	13.5	65.7	3.0
May	28.2	18.2	41.3	0.0
		2017/2018		
October	27.7	19.3	57.7	5.8
November	23.5	14.1	59.5	12.0
December	21.2	13.5	68.5	2.3
January	18.7	10.8	68.7	61.6
February	21.2	11.9	71.3	20.0
March	24.4	12.9	66.7	2.0
April	26.2	15.8	44.4	13.1
May	29.2	20.2	64.7	0.0

Source: Meteorological Stations of Agric. Res. Centre at Burg El-Arab.

Table 3. Initial values of main chemical and physical characteristics of the soil at the experimental site

Soil depth (cm)	Total $CaCo_3$	pH 1:2.5	EC dSm^{-1}	Soluble cations (meq L^{-1})				Soluble anions (meq L^{-1})					OM (%)		Particle size (%)	
First location																
				Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	CO_3^{-2}	HCO_3^{-}	Cl^{-}	SO_4^{-2}		Sand	Silt	Clay	Texture class
0-20	25.99	7.87	4.55	14.00	4.95	23.79	2.34	-	1.81	22.15	21.09	0.41	40.00	17.40	42.60	Clay loam
20-40	27.08	7.76	3.91	15.50	6.40	16.01	1.23	-	1.29	16.05	22.52	0.30	30.44	23.52	46.04	Clay loam
Second location																
Soil depth (cm)	Total $CaCo_3$	pH 1:2.5	EC dSm^{-1}	Soluble cations (meq L^{-1})				Soluble anions (meq L^{-1})					OM (%)		Particle size (%)	
				Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	CO_3^{-2}	HCO_3^{-}	Cl^{-}	SO_4^{-2}		Sand	Silt	Clay	Texture class
0-20	23.55	8.01	9.45	21.50	10.55	60.86	2.00	-	2.51	50.35	35.50	0.42	44.10	16.27	39.63	Clay loam
20-40	24.25	7.88	8.37	22.26	9.75	53.23	1.85	-	2.66	45.70	31.66	0.31	32.22	24.12	43.66	Clay loam
Third location																
Soil depth (cm)	Total $CaCo_3$	pH 1:2.5	EC dSm^{-1}	Soluble cations (meq L^{-1})				Soluble anions (meq L^{-1})					OM (%)		Particle size (%)	
				Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	CO_3^{-2}	HCO_3^{-}	Cl^{-}	SO_4^{-2}		Sand	Silt	Clay	Texture class
0-20	23.64	7.86	13.73	52.60	11.74	77.84	6.04	-	2.70	75.05	59.87	0.40	38.34	18.77	32.89	Clay loam
20-40	25.00	8.08	12.77	31.45	11.85	65.65	5.24	-	2.22	70.70	55.27	0.28	29.11	26.14	44.75	Clay loam

Grain weight/spike (GWS): Measured as the total weight of grains per main spike as an average of five random spikes/plot, **Thousand Grains weight (TGW):** Recorded as the weight of 1000 grains from each plot as an average of samples using an electronic balance, **Grain yield/ha (GY):** It was measured as the weight of grains per plot then recorded as ton/ha and **Biological yield/ha (BY):** Recorded as the total (biomass) above ground per plot then recorded as ton/ha.

The previously mentioned traits were used to calculate the following parameters:

1. Salinity tolerance trait index (STTI):

   Salinity tolerance trait index (STTI) modified from dry matter or grain yield efficiency index suggested by Fageria (1992) to classify genotypes for tolerance to salinity, as follows: STTI = (Y1/AY1) X (Y2/AY2)

   Where, (Y1 = trait mean at low salinity level, AY1 = average trait of genotypes at low salinity level, Y2 = trait mean at high salinity level, AY2 = average trait of genotypes at high salinity level).

2. Salinity tolerance index (STI) was calculated as follows: STI = (STT1I + STT2I + ………….. + STTnI)/n (Kim *et al.* 2018).

   Where, STTI1, STTI2 …… STTIn = Trait No.1, Trait No.2 ……. Trait No.n, and n = number of measured traits, when STI is > 1, it indicates that genotype is tolerant (T) to salinity, if STI is > 0.5 to 1, it indicates that genotype is moderately tolerant (MT). If STI is > 0 to < 0.5, it indicates that genotype is sensitive (S).

3. **Statistical Analysis:** The field experiments, in the two seasons, were laid out in a randomized complete block design, with three replications, in each salinity levels. Test for homogeneity of error, according to Hartley (1950), was performed, and accordingly a combined analysis over the three salinity locations and two seasons were carried out according to Gomez and Gomez (1984).

Comparison between treatment means was made using least significant difference (LSD) at 0.05 level of probability. Regression analysis for values of studied characters as a function for salinity levels was performed using (Hyams, 2005), while analysis of variance was done using SAS (Statistical Analysis System) program version 9.1 SAS (2002) according to Steel and Torrie (1980). Wherever the analysis indicated significance of the three-factor interaction (year x salinity level x genotype), the results for that interaction is presented and discussed.

RESULTS AND DISCUSSION

An important goal of salinity tolerance research is to determine genotype tolerance to soil salinity and their ability to maintain yield under adverse conditions. Given that research conducted using pots under greenhouse conditions does not provide a reliable estimation of yield responses, fieldwork needs to be undertaken to quantify yield and yield-related parameters (yield components). Field trials require control (low salinity) and saline plots, with a level of stress depending on the species and the available irrigation. The use of check plots with a known genotype adapted to the region is a prerequisite, as is some degree of replication and accounting for spatial variation.

Analysis of variance: Combined analysis of variance over the two seasons revealed that genotypes differed significantly ($P \leq 0.01$) for all studied traits (tables 4). Mean squares indicated highly significant variation, in all traits, due to years, salinity levels, years x salinity levels (except biological yield), genotypes, years x genotypes (except grain yield), salinity level x genotypes and the second order interaction year x salinity level x genotypes.

Variation in genotypes response with the different seasonal variations and varying salinity levels may complicate the process of tolerant genotypes and necessitate the repeating of trials over several years. As indicated in (table 2), variations in rainfall quantity and distribution between the two seasons caused a differential response of genotypes to salinity levels. Similar findings were reported by Dhayal & Sastry (2003); El-Hendawy *et al*. (2005); Darwish *et al*. (2017) and Gadallah *et al*. (2017).

Salinity levels effect: Means presented in (table 5) revealed that days to maturity and grain filling period increased significantly at moderate salinity compared to the control. That may be explained by the less availability of water to wheat plants due to salt-stress, which may alter the bio-physiological processes in the plant causing a delay in maturity and translocation of metabolites to the grains according to Mohamoud *et al.* (2022).

At higher salinity level, wheat plants tend to terminate their growth cycle to escape the stress conditions, hence maturity period is relatively shorter than that under moderate salinity levels.

Table 4. Combined analysis of variance of vegetative and physiological traits of two seasons 2016-17 and 2017-18

SOV	DF	Sum of Squares %		
		Days to maturity	Grain filling period	Grain filling rate
Rep.	2	23.93	5.59	0.08
Y.	1	2898.03 **	2892.05 **	22.83 **
E (a)	2	5.25	18.95	0.11
S	2	912.19 **	682.73 **	38.83 **
Y X S	2	32751.68 **	7081.29 **	0.93 **
E (b)	8	8.86	26.26	0.15
G	17	49.38 **	66.76 **	0.79 **
Y X G	17	27.14 **	54.72 **	0.21 **
E (c)	68	1.01	1.93	0.03
S X G	34	123.67 **	91.81 **	0.58 **
Y X S X G	34	60.63 **	55.51 **	0.15 **
C. E	136	0.72	1.97	0.04

SOV	DF	Sum of Squares %			
		Grains weight /spike	1000 grains weight	Grain yield	Biological yield
Rep.	2	0.05	7.29	0.91	43.25
Y.	1	2.26 **	1382.19 **	231.43 **	3738.92**
E (a)	2	0.07	13.45	1.48	180.34
S	2	18.17 **	3474.34 **	745.71 **	2519.41 **
Y X S	2	1.56 **	883.58 **	131.32 **	782.34 n.s
E (b)	8	0.09	45.11	3.65	244.85
G	17	0.36 **	238.93 **	8.89 **	150.94 **
Y X G	17	0.35 **	112.46 **	1.36 n.s.	18.66 **
E (c)	68	0.04	28.82	0.51	10.81
S X G	34	0.39 **	239.16 **	7.53 **	112.28 **
Y X S X G	34	0.17 **	159.15 **	1.13 **	21.45*
C. E	136	0.06	20.73	0.57	8.78

Y= years, G= genotypes, S= salinity levels, E= error.

A similar trend was found for grain filling rate, grains weight pre spike and 1000-grain weight where a significant reduction in all three traits was observed with increase in salinity level. Similar findings were reported by Lauchli and Grattan (2007) and Mahmoud *et al*. (2022). The change% in yield components led to a significant change% in grain yield reaching around 70% at the highest salinity level (Mass & Hoffmann, 1977; El-Hendawy *et al*., 2005; Gadallah, 2017 and Abd El-Hamid *et al*., 2020).

Genotypes effect:

Table of means of genotypes (table 6) showed variation among genotypes in their growth with increasing the salinity level over two seasons, where DHL 8 showed the highest values in GFP, GFR, 1000 KW, GY and BY 41.44 (d), 1.54 (kg/ha/d), 39.15 (g) and 27.25 (t/ha) respectively, and DHL 5 showed highest result in KWS by 1.16 (g), and about the checks genotypes and parents Line 25 and Gemmiza 7 showed highest result in GY(6.31 and 6.21 t/ha) and Sakha 93 showed the least GY (3.89 t/ha) with change of 62.2 %).

In general, under soil salinity, the mean of all genotypes decreased significantly for all characters in both seasons. This could be because salinity affects the plant by one or more of the following mechanisms: decreased water availability, nutritional imbalance, and particular ion impact. These findings are consistent with those of Kumar *et al*. (2012), who found that rising salinity levels reduced grain yield, biological yield, and 1000-kernel weight.

Table 5. Salinity levels means and the Change % over the two seasons and wheat genotypes

Salinity	Days to Maturity (days)		Grain filling period (days)		Grain Filling Rate (g/d)		Grains weight /Spike (g)		1000 Grains weight (g)		Grain yield (t/ha)		Biological yield t/ha	
	Means	Change% (1)	Means	Change% (1)	Means	Change% (1)	Means	Change% (1)	Means	Change% (1)	Means	Change% (1)	Means	Change% (1)
Low salinity level (2)	131.37 c	——	42.54 b	——	1.71 a	——	1.27 a	——	38.65 a	——	6.95 a	——	25.75 a	——
Moderate salinity level (3)	137.52 a	4.68	47.34 a	11.28	1.30 b	-23.97	1.00 b	-21.26	36.19 b	-6.36	6.٢٤ b	-10.21	18.64 b	- 27.61
High salinity level (4)	134.52 b	2.4	42.54 b	0	0.53 c	-69.9	0.47 c	-62.99	27.83 c	-27.99	2.08 c	-70.07	16.54 b	- 35.77
LSD 0.05%	0.93		1.61		0.12		0.09		2.11		0.59		4.91	

(1) In comparison to control, (2) 250 ppm = 0.39 dSm^{-1} , (3) 5125 ppm = 8.01 dSm^{-1}, (4) 10215 ppm = 15.96 dSm^{-1}

Table 6. Genotypes means over two seasons

Geno.	Days to Maturity (days)		Grain filling period (days)		Grain Filling Rate (kg/ha/day)		Grains weight /Spike (g)		1000 Grains weight (g)		Grain yield (t/ha)		Biological yield (t/ha)	
DHL 1	136.50	bc	46.06	bc	1.36	b	0.99	bc	34.60	bcd	5.61	bc	21.87	cde
DHL 2	135.17	ef	45.67	bcd	1.14	cde	0.90	cd	33.88	cd	5.22	cd	18.96	ghi
DHL 3	135.00	f	45.39	cde	1.11	cdef	1.03	abc	36.15	abc	4.96	de	23.60	bc
DHL 4	134.33	g	46.56	ab	0.95	hij	0.84	de	35.93	abc	4.43	fg	18.09	ij
DHL 5	131.72	m	42.33	hi	1.36	b	1.16	a	38.99	a	5.51	c	20.50	efgh
DHL 6	135.67	de	44.72	ef	1.08	defg	0.83	de	32.08	de	4.68	ef	18.76	ghi
DHL 7	133.22	ij	44.44	fg	1.18	cd	0.92	cd	36.25	abc	5.19	cd	19.48	fghi
DHL 8	132.44	kl	41.44	hi	1.54	a	1.01	bc	39.15	a	6.02	ab	27.25	a
DHL 9	131.89	lm	42.06	hi	1.33	b	0.93	cd	37.99	ab	5.44	c	18.92	ghi
DHL 10	136.56	b	45.83	bc	1.20	c	0.59	f	25.99	g	5.27	cd	19.41	fghi
DHL 11	135.89	cd	47.39	a	1.03	fghi	0.76	e	29.82	ef	4.81	def	20.84	defg
DHL 12	133.44	hi	42.50	a	0.93	ij	0.72	ef	26.95	fg	4.04	gh	18.59	hij
Sakha 8	137.50	b	47.44	a	1.52	a	1.09	ab	35.19	bcd	6.31	a	24.68	b
Line 25	132.67	ik	43.67	g	1.13	cdef	0.99	bc	32.18	cde	5.17	cd	22.92	bcd
Sakha 93	134.33	g	44.78	def	0.88	j	0.96	bcd	35.80	abc	3.89	h	15.85	K
Sids 1	133.72	ghi	41.61	hi	1.06	efgh	0.77	e	36.10	abc	4.44	fg	18.15	Ij
Giza 168	134.33	g	45.72	bc	0.99	ghij	0.96	bcd	34.34	cd	4.39	fg	16.54	Jk
Gemmiza 7	134.00	gh	43.61	g	1.52	a	0.98	bc	34.01	cd	6.21	a	21.19	def
LSD	0.67		0.92		0.12		0.13		3.75		0.47		2.19	

Year X Genotype X Salinity Interaction:

Table 7 shows that days to maturity over all genotypes (in the first season) had the same direction when exposed to salinity stress, a delay in maturation occurred by exposure to moderate salinity level then maturity was accelerated at high salinity level, in all genotypes to escape from salinity, for example Sakha 93, DHL8, DHL5 and DHL4 had the highest change of 24.69%, 23.71%, 22.73% and 22.50%, respectively, at moderate salinity level, however, DHL 5, Line 25, DHL 12 and Sids 1 had the lowest change of 10.61%, 13.31%, 14.58% and 14.76%, respectively at high salinity level, while DHL 7 had not changed between moderate and high salinity level.

In the second season, results in (table 7) showed that all genotypes varied in their response to increasing salinity levels, where 10 genotypes of 18 genotypes had a negative change% at moderate salinity level with a mean of 1.13%, and in high salinity level had low change% with a mean of 10.66% while Gemmiza 7, Giza 168, DHL 10 and Sakha 8 changed by 28.92%, 25.51%, 18.23% and 15.36%, respectively.

These findings are in agreement with those of Darwish *et al*. (2017) and Al-Naggar *et al*. (2015 a, b), who observed substantial differences in all studied traits among the tested wheat genotypes.

Data in (table 8) shows over all genotypes increasing in grain filling period at moderate and high salinity tolerant levels in two seasons, while the performance in the genotypes Gemmiza 7, DHL 1, Giza 168 and DHL 12 showed the lowest change at 5125ppm (medium salinity level) by 25.74%, 29.41%, 41.18% and DHL 12 48.60%, respectively, and DHL 5, DHL 8, Sids 1 and Line 25 by -28.43%, -17.35%, -14.29% and -10.58% in the first season, but in the second season there were showed tiny differences at all genotypes by means of -18.10% and 2.56 % at 5125 ppm and 10215 ppm, respectively.

At grain filling period, genotypes in the first season had high change, but there were small changes in the second season, that because the rainfall at that season was more regularly distributed throughout the season, which contributed to reducing the effect of salinity. These results were in accordance with those reported by (Al-Naggar *et al*. 2015 a, b).

Table 7. Means of interaction and change % Days to Maturity (days)

Geno.	Season 1					Season 2				
	Control	5125 ppm		10215 ppm		Control	5125 ppm		10125 ppm	
	Mean	Mean	Change%	Mean	Change%	Mean	Mean	Change%	Mean	Change%
DHL 1	110.67	124.00	12.05	141.00	27.41	124.00	126.33	1.88	143.00	15.32
DHL 2	110.67	128.67	16.27	132.67	19.88	122.00	132.33	8.47	134.67	10.38
DHL 3	111.00	134.67	21.32	132.00	18.92	126.00	122.33	-2.91	134.00	6.35
DHL 4	106.67	130.67	22.50	131.33	23.12	123.67	130.33	5.39	133.33	7.82
DHL 5	110.00	135.00	22.73	121.67	10.61	123.67	126.33	2.16	123.67	0.00
DHL 6	111.00	128.00	15.32	140.33	26.43	126.00	116.33	-7.67	142.33	12.96
DHL 7	110.67	132.67	19.88	132.33	19.58	124.00	115.33	-6.99	134.33	8.33
DHL 8	109.67	135.67	23.71	128.00	16.72	126.00	115.33	-8.47	130.00	3.17
DHL 9	107.00	129.67	21.18	132.33	23.68	122.67	115.33	-5.98	134.33	9.51
DHL 10	112.00	134.00	19.64	140.67	25.60	120.67	119.33	-1.10	142.67	18.23
DHL 11	112.67	131.00	16.27	132.33	17.46	125.67	129.33	2.92	134.33	6.90
DHL 12	112.00	132.67	18.45	128.33	14.58	126.00	121.33	-3.70	130.33	3.44
Sakha 8	110.67	135.00	21.99	140.67	27.11	123.67	122.33	-1.08	142.67	15.36
Line 25	112.67	131.00	16.27	127.67	13.31	122.67	122.33	-0.27	129.67	5.71
Sakha 93	106.67	133.00	24.69	133.67	25.31	124.67	122.33	-1.87	135.67	8.82
Sids 1	110.67	132.67	19.88	127.00	14.76	122.67	130.33	6.25	129.00	5.16
Giza 168	107.67	121.00	12.38	140.67	30.65	113.67	130.33	14.66	142.67	25.51
Gemmiza 7	108.67	120.00	10.43	140.67	29.45	110.67	131.33	18.67	142.67	28.92
Means	110.06	130.52	18.61	133.52	21.36	122.69	123.83	1.13	135.52	10.66
L.S.D.						0.90				

Table 8. Means of interaction and change% Grain filling period (days)

Geno.	Season 1					Season 2				
	Control	5125 ppm		10215 ppm		Control	5125 ppm		10215 ppm	
	Mean	Mean	Change%	Mean	Change%	Mean	Mean	Change%	Mean	Change%
DHL 1	34.00	44.00	29.41	50.33	48.04	48.00	41.00	-14.58	59.00	22.92
DHL 2	35.67	55.00	54.21	34.00	-4.67	51.00	44.33	-13.07	54.00	5.88
DHL 3	34.67	55.00	58.65	34.67	0.00	54.00	42.33	-21.60	51.67	-4.32
DHL 4	35.00	55.00	57.14	34.00	-2.86	52.00	54.33	4.49	49.00	-5.77
DHL 5	34.00	51.33	50.98	24.33	-28.43	53.00	45.33	-14.47	45.67	-13.84
DHL 6	33.67	58.00	72.28	39.33	16.83	47.00	39.33	-16.31	51.00	8.51
DHL 7	35.67	52.67	47.66	32.00	-10.28	56.33	38.33	-31.95	51.33	-8.88
DHL 8	32.67	56.67	73.47	27.00	-17.35	48.00	36.33	-24.31	48.00	0.00
DHL 9	35.67	55.67	56.07	33.33	-6.54	45.67	31.33	-31.39	50.67	10.95
DHL 10	35.00	56.00	60.00	42.33	20.95	54.00	35.33	-34.57	52.33	-3.09
DHL 11	35.67	55.00	54.21	37.33	4.67	57.67	49.33	-14.45	49.33	-14.45
DHL 12	35.67	53.00	48.60	35.00	-1.87	54.33	30.33	-44.17	46.33	-14.72
Sakha 8	35.00	63.00	80.00	46.33	32.38	52.00	41.33	-20.52	50.33	0.00
Line 25	34.67	58.33	68.27	31.00	-10.58	46.00	36.33	-21.02	52.00	9.42
Sakha 93	35.67	54.00	51.40	34.00	-4.67	48.00	41.33	-13.89	55.67	15.97
Sids 1	35.00	52.67	50.48	30.00	-14.29	47.67	41.33	-13.29	43.00	-9.79
Giza 168	34.00	48.00	41.18	43.33	27.45	47.00	45.33	-3.55	56.67	20.57
Gemmiza 7	33.67	42.33	25.74	42.00	24.75	43.67	44.33	1.53	55.33	26.72
Means	34.74	53.65	54.43	36.13	4.09	50.30	40.98	-18.10	51.19	2.56
L.S.D.					1.54					

The means of interaction and change% in grain filling rate (table 9) the studied genotypes showed good performance in the first season one where Giza 168, DHL 4, DHL 7 and DHL 12 showed the lowest change percentages under 5125 ppm by 54.45%, 1.08%, -0.95% and -9.60%, respectively, How're DHL 5, Sakha 8, DHL 7 and DHL 8 showed the lowest change% in GFR with high salinity expose -16.82%, -12.60%, -47.91% and -47.12%, respectively. On the other hand, in the second season the genotypes showed change ranged between -94.73% at DHL 1 and -52.87% at DHL 7 at high salinity level with mean -73.50%.

The mean of grain filling period increased under salinity conditions; Thus, we deduce that delayed heading and maturity processes gives the opportunity of late differentiation and ripening, allowing the plant to maintain higher yield component and consequently high grain yield. Allel *et al*. (2019) reported similar results.

The performance of kernel weight/spike (g) presented in (table 10) in first season indicate that six genotypes showed better result than control, i.e., DHL 2, DHL 10, DHL 3, DHL 1 and DHL 11 with change% 85.11%, 61.97%, 40.36%, 35.85%, 25.96% and 21.79%, respectively, at salinity level (5125 ppm) with mean of -2.04%, over all genotypes and wide range between 5125 ppm (medium salinity level) and 10215 ppm (high salinity level) by change mean -2.04% and -54.92%. On the other hand, in the second season there was intermediate change between salinity levels medium and high reached -40.35% and -69.82%.

Means of interaction of 1000-grain weight (table 11) indicated that there was a gradually decreasing trend with increasing salinity level, in the first and second seasons, In the first season, genotypes DHL 12, Sids 1, DHL 10 and DHL 2 showed activation with exposing moderate salinity tolerance by 34.94%, 17.89%, 11.95% and 7.93% while at genotypes DHL 5, DHL 4, DHL 11, DHL 10 and DHL 12 showed result in high salinity level higher than it’s in moderate salinity level with change values -19.79%, -0.08%, 35.97%, 43.16% and 56.06% respectively.

Table 9. Means of interaction and change% Grain Filling Rate (g/d)

Geno.	Season 1					Season 2				
	Control	5125 ppm		10215 ppm		Control	5125 ppm		10215 ppm	
	Mean	Mean	Change%	Mean	Change%	Mean	Mean	Change%	Mean	Change%
DHL 1	2.72	2.11	-22.64	0.12	-95.72	1.83	1.26	-31.27	0.10	-94.73
DHL 2	2.17	1.77	-18.56	0.11	-94.79	1.44	1.26	-12.06	0.10	-92.81
DHL 3	2.11	1.50	-29.02	0.47	-77.76	1.28	1.01	-21.30	0.28	-78.44
DHL 4	1.54	1.56	1.08	0.48	-68.90	0.99	0.71	-28.62	0.40	-59.93
DHL 5	2.14	1.96	-8.57	1.78	-16.82	0.71	0.30	-57.32	0.26	-62.91
DHL 6	2.24	1.33	-40.71	0.15	-93.46	1.51	1.02	-32.60	0.22	-85.46
DHL 7	1.75	1.74	-0.95	0.91	-47.91	1.05	1.15	9.87	0.49	-52.87
DHL 8	2.78	1.12	-59.59	1.47	-47.12	1.78	1.30	-26.92	0.77	-56.64
DHL 9	2.01	1.62	-19.57	0.64	-68.33	1.49	1.85	23.94	0.37	-75.39
DHL 10	2.34	1.56	-33.33	0.26	-88.75	1.43	1.39	-2.79	0.19	-86.51
DHL 11	2.01	1.46	-27.20	0.42	-78.94	1.18	0.92	-21.53	0.17	-85.84
DHL 12	1.60	1.44	-9.60	0.66	-58.66	0.99	0.59	-40.20	0.31	-68.58
Sakha 8	2.04	1.20	-40.92	1.78	-12.60	1.30	1.00	-23.53	0.50	-61.38
Line 25	2.61	1.29	-50.57	0.71	-72.80	1.86	0.89	-52.06	0.71	-61.58
Sakha 93	1.46	1.32	-9.82	0.42	-71.46	1.02	0.78	-23.20	0.27	-73.86
Sids 1	1.91	1.37	-28.15	0.68	-64.34	1.35	0.80	-40.49	0.26	-80.99
Giza 168	1.24	1.91	54.45	0.59	-52.02	0.84	1.11	31.62	0.25	-70.36
Gemmiza 7	2.49	2.19	-12.17	0.94	-62.30	1.83	1.18	-35.82	0.46	-74.73
Means	2.06	1.58	-19.77	0.70	-65.80	1.33	1.03	-21.35	0.34	-73.50
L.S.D.						0.13				

Table 10. Means of interaction and change% Grain weight /Spike (g)

Geno.	Season 1					Season 2				
	Control	5125 ppm		10215 ppm		Control	5125 ppm		10215 ppm	
	Mean	Mean	Change%	Mean	Change%	Mean	Mean	Change%	Mean	Change%
DHL 1	1.06	1.44	35.85	0.61	-42.14	1.78	0.95	-46.34	0.10	-94.56
DHL 2	1.10	2.03	85.11	0.17	-84.19	1.10	0.92	-15.81	0.08	-92.71
DHL 3	1.49	2.09	40.36	0.46	-69.06	1.00	0.86	-13.67	0.26	-73.67
DHL 4	1.04	1.31	25.96	0.51	-51.28	0.95	0.78	-18.25	0.45	-52.28
DHL 5	1.48	1.40	-5.63	0.76	-48.42	1.73	0.94	-45.47	0.64	-63.20
DHL 6	0.99	0.94	-5.37	0.18	-81.88	1.68	1.06	-37.23	0.15	-90.89
DHL 7	1.76	0.90	-48.86	0.42	-76.14	1.13	0.72	-36.09	0.57	-49.11
DHL 8	1.66	0.75	-54.82	0.93	-43.98	1.38	0.59	-57.11	0.76	-45.30
DHL 9	1.39	0.86	-38.37	0.59	-57.31	1.40	0.83	-40.48	0.52	-63.10
DHL 10	0.71	1.15	61.97	0.36	-48.83	0.50	0.39	-22.00	0.41	-18.67
DHL 11	0.78	0.95	21.79	0.45	-42.31	1.47	0.68	-54.07	0.24	-83.71
DHL 12	1.11	0.55	-50.45	0.41	-63.06	1.24	0.56	-54.96	0.43	-65.15
Sakha 8	1.16	1.03	-11.24	0.73	-36.89	1.47	1.16	-21.09	0.41	-72.34
Line 25	1.39	1.27	-8.17	0.63	-54.57	2.14	0.71	-67.03	0.40	-81.34
Sakha 93	1.34	0.83	-38.31	0.33	-75.12	1.92	0.92	-52.26	0.45	-76.74
Sids 1	1.09	0.91	-16.56	0.73	-32.52	1.03	0.68	-33.44	0.16	-84.09
Giza 168	1.62	1.17	-27.72	0.75	-53.59	1.32	0.67	-49.37	0.23	-82.87
Gemmiza 7	1.49	1.45	-2.24	1.08	-27.35	1.08	0.41	-61.73	0.36	-66.98
Means	1.26	1.17	-2.04	0.56	-54.92	1.35	0.77	-40.35	0.37	-69.82
L.S.D.						0.11				

In the second season, eight genotypes showed activation with exposing moderate salinity tolerance where's the changing% by 7.81% over genotype mean. At high salinity level (10215 ppm) genotypes DHL 4, DHL 9 and DHL 11 had lowest change% by -11.35,-13.23% and -14.00% respectively, DHL 10 genotype showed different result in the two seasons over two salinity levels, where it 10 had better result in high salinity level than lower salinity level by change% 43.16% and 26.60% at high salinity level (10215 ppm) in the two successive season.

It is worth to mention that DHL 10 had a positive change at high salinity level in the first and second seasons by 43.16% and 26.60% respectively.

Grain yield (t/ha) data showed in (table 12), In first season over the moderate salinity level, five genotypes were activated when exposed low salinity level with change mean over all genotypes 10.16%, at high salinity level had drop in GY by 68.49%, the Line 25, DHL 5, Gemmiza 7 and DHL 7 had lowest means of change% -63.56%, -40.91%, -52.56% and -53.27%, respectively.

In the second season, under 5125 ppm, genotypes had change reached -38.25%, on the other hand in high salinity level (10215 ppm) genotypes had change reached -72.63%, and Sakha 8, DHL 5, DHL 7 and Line 25 had lowest means of changes% by -46.68%, -52.15%, -55.92% and -69.24%, respectively.

Table 11. Means of interaction and change% 1000 Grain weight (g)

Geno.	Season 1					Season 2				
	Control	5125 ppm		10215 ppm		Control	5125 ppm		10215 ppm	
	Mean	Mean	Change	Mean	Change	Mean	Mean	Change	Mean	Change
DHL1	38.31	34.70	-9.41	33.64	-12.19	34.47	46.04	33.57	20.45	-40.68
DHL2	37.64	40.63	7.93	29.56	-21.47	35.38	42.43	19.92	17.61	-50.22
DHL3	46.17	42.90	-7.09	32.56	-29.48	40.07	35.76	-10.76	19.42	-51.54
DHL4	37.42	36.65	-2.05	37.39	-0.08	35.18	37.72	7.23	31.19	-11.35
DHL5	48.97	34.68	-29.17	39.28	-19.79	42.70	41.92	-1.83	26.36	-38.26
DHL6	34.42	31.86	-7.45	31.00	-9.94	31.95	49.89	56.13	13.37	-58.16
DHL7	51.20	38.81	-24.20	30.64	-40.16	41.46	27.80	-32.95	27.60	-33.43
DHL8	52.02	38.30	-26.38	33.40	-35.80	51.83	25.46	-50.88	33.86	-34.66
DHL9	48.76	36.93	-24.27	30.37	-37.72	38.57	39.83	3.25	33.47	-13.23
DHL10	24.43	27.35	11.95	34.97	43.16	22.96	17.18	-25.19	29.07	26.60
DHL11	27.20	28.66	5.37	36.98	35.97	29.32	31.54	7.55	25.22	-14.00
DHL12	17.41	23.49	34.94	27.17	56.06	16.36	53.90	229.39	23.38	42.90
Sakha8	37.84	38.62	2.06	34.23	-9.54	31.38	52.15	66.16	18.08	-42.39
Line25	45.80	31.62	-30.96	30.28	-33.89	43.05	31.39	-27.09	14.03	-67.41
Sakha93	46.63	35.10	-24.72	23.92	-48.70	43.84	43.02	-1.87	22.31	-49.10
Sids1	37.56	44.28	17.89	39.50	5.17	49.03	31.45	-35.87	14.76	-69.89
Giza168	39.78	41.86	5.23	34.64	-12.93	49.73	24.67	-50.40	15.37	-69.09
Gemmiza7	42.50	43.15	1.53	36.82	-13.36	39.95	21.67	-45.77	19.96	-50.04
Means	39.67	36.07	-5.72	33.13	-10.36	37.63	36.32	7.81	22.53	-34.86
L.S.D.						2.54				

Table 12. Means of interaction and change% Grain yield (t/ha)

Geno.	Season 1					Season 2				
	Control	5125 ppm		10215 ppm		Control	5125 ppm		10215 ppm	
	Mean	Mean	Change	Mean	Change	Mean	Mean	Change	Mean	Change
DHL 1	9.26	9.25	-0.14	0.60	-93.51	8.80	5.16	-41.36	0.59	-93.33
DHL 2	9.73	7.73	-20.59	0.38	-95.08	7.34	5.58	-23.98	0.56	-92.33
DHL 3	8.26	7.28	13.47	1.62	-77.74	6.91	4.26	-38.40	1.42	-79.40
DHL 4	8.57	5.44	57.54	1.62	-70.22	5.17	3.83	-25.87	1.96	-62.00
DHL 5	10.09	7.28	38.62	4.30	-40.91	6.91	3.31	-52.15	1.20	-52.15
DHL 6	7.50	7.73	3.11	0.58	-92.27	7.13	3.99	-43.97	1.13	-84.19
DHL 7	9.11	6.23	46.31	2.91	-53.27	5.91	4.40	-25.59	2.61	-55.92
DHL 8	9.00	6.35	-29.41	3.96	-56.00	8.55	4.71	-44.91	3.57	-58.21
DHL 9	8.97	7.13	25.87	2.12	-70.25	6.77	5.76	-14.92	1.89	-72.08
DHL 10	8.14	8.74	7.33	1.11	-86.36	7.73	4.90	-36.61	1.02	-86.80
DHL 11	8.04	7.13	12.77	1.57	-77.97	6.77	4.52	-33.19	0.81	-88.04
DHL 12	7.65	5.66	35.08	2.31	-59.21	5.38	1.78	-66.85	1.48	-72.49
Sakha 8	7.13	7.59	6.50	5.47	-23.25	6.77	3.66	-45.94	3.61	-46.68
Line 25	9.00	7.54	-16.19	3.28	-63.56	8.55	3.62	-57.63	2.63	-69.24
Sakha 93	7.11	5.18	37.35	1.41	-72.76	4.92	3.23	-34.28	1.49	-69.72
Sids 1	7.19	6.68	7.69	2.03	-69.60	6.34	3.31	-47.84	1.12	-82.33
Giza 168	9.15	4.20	-54.10	2.57	-71.91	5.02	3.99	-20.52	1.41	-71.98
Gemmiza 7	9.30	8.33	11.69	3.95	-52.56	7.91	5.19	-34.34	2.59	-67.30
Means	8.51	6.97	10.16	2.32	-68.49	6.83	4.18	-38.25	1.73	-72.63
L.S.D.						0.55				

Result presented in (table 13) showed that biological yield in the first season, eight genotypes had positive change at medium salinity level (5125 ppm) compared with control, with change% mean 0.70%, however at high salinity level (10215 ppm) two genotypes Giza 168 and Sakha 8 had positive change% by 16.42% and 17.67%, respectively. On the other side, in the second season there was no change between medium and high salinity level with change mean -46.09% and -46.64%.

Obtained results in interaction tables (7, 8, 9, 10, 11 and 12) are supported with those reported by Md *et al*. (2017), who indicated that there was no significant interaction between the traits studied. Meanwhile, for days to maturity, grain filling rate, grain filling period, grains weight/ spikes, 1000-grain weight, grain yield and biological yield. Al-Naggar *et al*. (2015 a, b); Darwish *et al*. (2017) and Hagras *et al*. (2018) reported similar results for the interaction genotypes X salinity levels.

STTI (salinity tolerate trait index) and STI (salinity trait index):

The DH line used had proven that all of those were highly moderate and tolerant to high salinity level (Abdel Aleem, 2015) and those rank at STI rang between (0.83 – 1.22).

In table 14 result of STTI over two seasons showed that all genotypes had tolerant and high moderately tolerant generally in DM and in GFP had the same performance all genotypes ranged between (0.80 – 1.23 STTI).

In GFR trait the genotypes recorded clearly reduction with exposed high salinity level in eight genotypes out of 18 genotypes at medium salinity level and the seven genotypes out of 18 genotypes at high salinity level, showed highly salinity tolerant DHL 8, Sakha 8, Gemmiza 7, DHL 5, DHL 7 and line 25, with STTI 2.78, 2.47, 1.55, 1.43, 1.32 and 1.18 at high salinity level compared with moderately salinity level.

At grains weight/spike (GWS) the DHL 2, 6 and 10 showed sharp drop of STTI results at 10215 ppm by 0.22, 0.39 and 0.39 as a sensitive lines. Conversely, there were six genotypes showed moderate tolerant result and nine genotypes at had salt tolerance result between 2.14, 1.17.

Table 13. Means of interaction and change% Biological yield (t/ha)

Geno.	Season 1					Season 2				
	Control	5125 ppm		10215 ppm		Control	5125 ppm		10215 ppm	
	Mean	Mean	Change	Mean	Change	Mean	Mean	Change	Mean	Change
DHL 1	31.50	22.41	-28.86	19.67	-37.56	29.93	14.42	-51.82	13.27	-55.65
DHL 2	22.13	21.75	-1.69	21.24	-4.01	21.02	15.31	-27.16	12.30	-41.47
DHL 3	32.25	20.47	-36.53	27.77	-13.89	30.64	12.51	-59.16	17.95	-41.43
DHL 4	20.25	26.72	31.95	16.93	-16.40	19.24	11.62	-39.62	13.78	-28.40
DHL 5	26.70	27.04	1.27	23.56	-11.76	25.37	6.03	-76.24	14.28	-43.69
DHL 6	24.30	27.63	13.69	14.24	-41.40	23.09	11.95	-48.25	11.38	-50.72
DHL 7	23.25	21.29	-8.43	20.99	-9.72	22.09	12.81	-42.01	16.47	-25.46
DHL 8	43.20	20.41	-52.76	28.27	-34.56	41.04	13.47	-67.18	17.09	-58.37
DHL 9	24.45	24.04	-1.69	14.28	-41.60	23.23	15.70	-32.43	11.82	-49.12
DHL 10	27.00	21.88	-18.95	17.99	-33.37	25.65	13.87	-45.93	10.05	-60.83
DHL 11	26.70	26.88	0.67	20.92	-21.65	25.37	13.08	-48.46	12.09	-52.36
DHL 12	25.95	24.28	-6.44	16.91	-34.84	24.65	7.28	-70.48	12.49	-49.35
Sakha 8	24.90	32.97	32.42	29.30	17.67	23.66	11.16	-52.83	15.53	-34.35
Line 25	34.80	21.14	-39.26	30.99	-10.95	33.06	11.25	-65.96	16.81	-49.16
Sakha 93	19.05	29.41	54.38	8.81	-53.75	18.10	10.34	-42.85	9.41	-47.99
Sids 1	28.35	20.61	-27.31	13.21	-53.40	26.93	10.50	-61.01	9.28	-65.53
Giza 168	14.25	28.00	96.49	16.59	16.42	13.54	17.64	30.28	9.24	-31.78
Gemmiza 7	26.40	27.35	3.60	18.83	-28.67	25.08	17.91	-28.58	11.56	-53.91
Means	26.41	24.68	0.70	20.03	-22.97	25.09	12.60	-46.09	13.04	-46.64
L.S.D.						0.55				

Concerning 1000 grain weight (TGW), seven genotypes showed salinity tolerant at moderate and high salinity levels, i.e. DHL 3, DHL 5, DHL 7, DHL 8, DHL 9, Line 25 and Sakha 93 by (1.22-1.03), (1.25-1.40), (1.12-1.27), (1.18-1.70), (1.19-1.32), (1.11-0.70) and (1.26-1.00) respectively.

In grain yield (GY) trait ten genotypes DHL 1, DHL 2, DHL 3, DHL 5, DHL 8, DHL 9, DHL 10, DHL 11, Line 25 and Gemmiza 7 showed salinity tolerant at moderate salinity level by 1.52, 1.35, 1.02, 1.02, 1.19, 1.22, 1.26, 1.02, 1.12 and 1.37, respectively. Where's at high salinity level seven genotypes showed salinity tolerant DHL 5, DHL 7, DHL 8, DHL 9, Sakha 8, Line 25 and Gemmiza 7 by 1.45, 1.32, 2.20, 1.02, 2.55, 1.34 and 1.80 respectively.

At biological yield eleven genotypes showed tolerant and highly moderate to salinity stress at moderate and high salinity levels. They were DHL 1, DHL 3, DHL 5, DHL 7, DHL 8, DHL 9, DHL 10, DHL 11, Sakha 8, Line 25 and Gemmiza 7 by (1.22-1.19), (1.11-1.69), (0.80-1.15), (0.83-1.02), (1.55-2.23), (1.03-0.75), (1.02-0.85), (1.08-1.00), (1.05-1.87), (1.15-1.25) and (1.26-0.91).

Results in (table 15) showed STI at moderate and high salinity levels the genotypes DHL 1, DHL 2, DHL 3, DHL 5, DHL 6, DHL 8, DHL 9, Sakha 8, Line 25 and Gemmiza 7 had ≥ 1 in STI at moderate salinity level with average 1.01. The genotypes DHL 5, DHL 7, DHL 8, DHL 9, Sakha 8, Line 25 and Gemmiza 7 showed result ≥ 1 STI at high salinity level (10215 ppm) with average 0.97 over all genotypes.

Also STI showed result over two seasons the genotypes DHL 8, Sakha 8, Gemmiza 7, DHL 5, DHL 9, Line 25, DHL 3, DHL 7 and DHL 1 showed ≥ 1 STI with rank 1, 2, 3, 4, 5, 6, 6, 6 and 9 respectively.

Table 14. Means of STTI (salt tolerant trait index)

Geno.	Days to maturity		Grain filling period		Grain filling rate		Grains weight/spike		1000 Grains weight		Grain yield		Biological yield	
	5125	10215	5125	10215	5125	10215	5125	10215	5125	10215	5125	10215	5125	10215
DHL 1	0.89	1.06	0.88	1.23	1.74	0.27	1.33	0.63	1.05	0.91	1.52	0.36	1.22	1.19
DHL 2	0.92	0.99	1.07	1.02	1.27	0.26	1.24	0.22	1.08	0.79	1.35	0.27	0.88	0.84
DHL 3	0.93	1.00	1.07	1.02	0.97	0.72	1.47	0.75	1.22	1.03	1.02	0.75	1.11	1.69
DHL 4	0.91	0.97	1.20	0.97	0.63	0.63	0.82	0.80	0.96	1.18	0.74	0.78	0.77	0.73
DHL 5	0.93	0.91	1.05	0.80	0.72	1.43	1.49	1.90	1.25	1.40	1.02	1.45	0.80	1.15
DHL 6	0.88	1.06	0.97	0.99	1.03	0.42	1.17	0.39	0.97	0.66	0.99	0.45	0.95	0.73
DHL 7	0.89	0.99	1.03	1.02	0.92	1.32	0.93	1.17	1.12	1.27	0.93	1.32	0.83	1.02
DHL 8	0.90	0.97	0.92	0.80	1.35	2.78	0.82	2.14	1.18	1.70	1.19	2.20	1.55	2.23
DHL 9	0.86	0.97	0.88	0.92	1.53	1.36	0.97	1.31	1.19	1.32	1.22	1.02	1.03	0.75
DHL 10	0.90	1.05	0.99	1.14	1.31	0.58	0.37	0.39	0.38	0.72	1.26	0.56	1.02	0.85
DHL 11	0.94	1.01	1.22	1.08	0.86	0.50	0.73	0.60	0.61	0.82	1.02	0.55	1.08	1.00
DHL 12	0.92	0.98	0.91	0.99	0.57	0.61	0.54	0.86	0.47	0.41	0.53	0.78	0.77	0.89
Sakha 8	0.92	1.06	1.05	1.17	1.13	2.47	1.22	1.48	1.01	1.06	1.12	2.55	1.05	1.87
Line 25	0.91	0.96	1.01	0.88	0.86	1.18	1.33	1.20	1.11	0.70	0.89	1.34	1.15	1.25
Sakha 93	0.90	0.99	1.00	1.00	0.59	0.49	1.22	1.17	1.26	1.00	0.59	0.56	0.73	0.42
Sids 1	0.93	0.95	0.97	0.82	0.81	0.73	0.67	0.73	1.15	0.99	0.77	0.67	0.90	0.74
Giza 168	0.85	1.00	0.95	1.10	0.71	0.63	1.07	1.17	1.03	0.98	0.67	0.89	0.68	0.41
Gemmiza 7	0.84	0.99	0.85	1.03	1.64	1.55	0.95	1.52	0.96	1.07	1.37	1.80	1.26	0.91

Table 15. Means of STI (salt tolerant index)

Geno.	STI for two seasons		STI for the Exe.		
	5125 ppm	10215 ppm	Means	Rank	Type
DHL 1	1.23	0.81	1.02	9	T
DHL 2	1.12	0.63	0.87	10	M
DHL 3	1.11	0.99	1.05	6	T
DHL 4	0.86	0.87	0.86	12	M
DHL 5	1.04	1.29	1.16	4	T
DHL 6	1.00	0.67	0.83	16	M
DHL 7	0.95	1.16	1.05	6	T
DHL 8	1.13	1.83	1.48	1	T
DHL 9	1.10	1.09	1.09	5	T
DHL 10	0.89	0.75	0.82	17	M
DHL 11	0.92	0.79	0.86	12	M
DHL 12	0.67	0.79	0.73	18	M
Sakha 8	1.07	1.67	1.37	2	T
Line 25	1.14	1.07	1.05	6	T
Sakha 93	0.90	0.81	0.85	14	M
Sids 1	0.89	0.80	0.84	15	M
Giza 168	0.85	0.88	0.87	10	M
Gemmiza 7	1.13	1.27	1.20	3	T

CONCLUSION

According to the results of the present study, the following conclusions could be:

1-The traits grain filling rate, grain weight/spike, 1000 grains weight and grain yield were considered as distinguishing characteristics in determining the ability of the DH lines to tolerate salinity.

2-DHL's 3, 4, and 7 exhibited salinity tolerance in moderated and high salinity conditions with on average STTI ≈ 1.

3-DHL's 1, 2, 6, 9, 10, 11 and 12 were found to be moderately tolerant to intermediate and high salinity levels with an average STTI values of 0.9 and 1.01, respectively.

Both DHL 5 and DHL 8 showed high tolerance to salinity with an average STTI value of 1.18, as an average of moderate and high salinity condition. This value was superior to the average value of checks and parents (1.02) indicating the possibility of growing these two lines under high salinity conditions (over 1000 ppm = 15 dSm^{-1}).

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الملخص العربي

تأثير الإجهاد الملحى على السلوك الحقلى لتراكيب وراثية مختلفة من القمح

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أجريت تجربة حقلية في ثلاثة مواقع متأثرة بالملوحة بمستويات (٠,٣٩ تركيز منخفض،٨,٠١ تركيز متوسط و١٥,٩٦ ديسي سيمنز*متر$^{-1}$ كتركيز عالى) وذلك بالمزرعة البحثية لمحطة البحوث الزراعية بالنوبارية، محافظة البحيرة – مصر، خلال موسمي الزراعة الشتويين ٢٠١٦/٢٠١٧، ٢٠١٧/٢٠١٨. اشتملت الدراسة على ١٢ سلالة أحادية التضاعف (DH) من قمح الخبز مشتقة من تهجين الصنف سخا ٨ × السلالة ٢٥، بالإضافة إلى أربعة أصناف متأقلمة لظروف ملوحة المنطقة وهم سخا ٩٣، سدس ١، جيزة ١٦٨ وجميزة ٧. صنفت التراكيب الوراثية إلى متحملة، متوسطة التحمل وحساسة لإجهاد الملوحة بناءًا على مؤشر تحمل الملح (STI) في كلا الموسمين عند مستويات ملوحة متوسطة وعالية. أشارت النتائج إلى إنخفاض قيم جميع الصفات المدروسة معنوياً مع زيادة مستوى الملوحة ماعدا صفات عدد الأيام من الزراعة حتى طرد السنابل وعدد الأيام حتى النضج وفترة إمتلاء الحبوب والتي زادت بدرجات متفاوتة مع زيادة مستوى ملوحة التربة حسب التركيب الوراثي.كما أظهرت النتائج انخفاض محصول الحبوب بنسبة ١٤,٠٥٪ و٧٠,٥٪ على مستوى التراكيب الوراثية ومواسم الزراعة عند مستويات الملوحة المتوسطة والعالية على التوالي مقارنة بتركيز الملوحة المنخفض. أوضحت نتائج الدراسة أن سبب الانخفاض في محصول الحبوب راجع إلى انخفاض جميع مكونات المحصول خاصة عدد الحبوب بالسنبلة ووزن ١٠٠٠ حبة.

إعتبرت نتائج الدراسة أن معدل إمتلاء الحبوب، وزن الحبوب بالسنبلة، وزن ١٠٠٠ حبة ووزن محصول الحبوب من الصفات المميزة والمهمة في تحديد قدرة السلالات أحادية التضاعف (DH) على تحمل الملوحة. هذا وقد أكدت نتائج هذه الدراسة على أن السلالات أحادية التضاعف (DH) لها نطاق واسع لصفة محصول الحبوب للهكتار حيث إجتازت السلالات ٧ و٨ و٩ جميع الآباء بالإضافة إلى الأصناف الموصى بها لظروف المنطقة تحت الدراسة وذلك على مستوى صفة وزن محصول الحبوب. علاوة على ذلك، تم تسجيل هذه السلالات وفقًا لـ STI، على أنها سلالات مبشرة متحملة للملوحة عند مستويات الملوحة المتوسطة والعالية ولما لها من محصول حبوب أعلى من السلالات أحادية التضاعف الأخرى.

الكلمات المفتاحية: القمح، مستويات الملوحة، السلالات الآحادية المتضاعفة، مؤشر تحمل الملوحة، محصول الحبوب.