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Evaluation of some Bread Wheat Genotypes under Normal and Saline Soil Conditions

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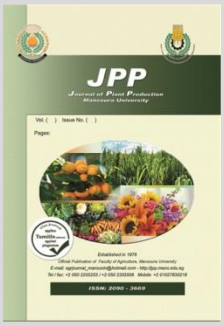

ABSTRACT

A study was accomplished in a field experiment at Sakha Agricultural Research Station Farm, to assess 18 bread wheat genotypes (16 promising lines and 2 checks) during 2014/2015 and 2015/2016 seasons over ordinary and salinity soil circumstances. Analysis of variance showed highly significant effects between genotypes and salinity soil treatments. Interaction effects were highly significant between all components of interaction except few cases. There were significant reductions in all studied characters due to salinity circumstances measure up to through normal circumstance. The obtained results showed that Lines 2, 14 and 15 and cultivar Misr 1 were the best genotypes under study. These genotypes had highest values for grain yield and its components under non-saline and/or saline soil conditions. Stress tolerance indices (STI's) results indicated that GMP and STI indexes gave similar ranks for lines 2 and 14 which can identified as salt tolerant genotypes. Lines 8 and 10 were recognized as sensitive genotypes, for reason that their little means for GMP and STI. In the similar situation, the 2 indexes TOL and SSPI ranked the considered genotypes for salt acceptance and indicated that lines 11, 14 and 2 were further tolerant to salinity stress. The correlation analysis Spearman's rank correlation coefficient between the salinity tolerant indices was used. There were highly significant positive correlation with salinity tolerant indices MP, GMP, STI, TOL and SSPI under normal condition. Whereas, at salinity (Ys) conditions correlation was highly significant and positive with salinity tolerant indices MP, HM, GMP, STI, YI and YSI.

Keywords: Wheat, Salinity tolerance indices, Spearman's rank, correlation coefficient

INTRODUCTION

Wheat is a strategic crop which has a significant role on the national economy of the world countries (Yadav *et al.*, 2018). Whereas, it demand is increasing day by day to meet the food security of increasing population (Jahan *et al.*, 2019). Productivity of wheat across the globe is influenced by several abiotic stresses (heat, drought and salinity). Saline soil is the most important one, particularly in arid and semi-arid regions (Out *et al.*, 2018). Study depicts that nearly 20% of the total cultivated land across the world is under salt stress (Oproi and Madosa, 2014).

Egypt is one of the countries that suffer salinity problems (Al-Naggar *et al.*, 2015). For example, 33% of the land in Egypt under cultivated is already salinized (Yassin et el., 2019). .Expansion of wheat production in Egypt is a necessity to supply the demands of a rapidly growing population and reduce the dependence on importing wheat (Milad *et al.*, 2016). Therefore, wheat cultivation was extended to the newly reclaimed lands to increase the production to overcome the gap between consumption and production. The most efficient way to increase wheat yield in Egypt is to improve the salt tolerance of wheat genotypes, because this way is much less expensive for poor farmers comparing with other management practices (Gadallah *et al.*, 2017). In bread wheat germplasm, salinity is considered a major factor in limiting plant growth and crop productivity (Rus *et al.*, 2000). The effect of high salinity on plant can be observed at the whole plant level in terms of plant death and/or decreasing productivity (Parida *et al.*, 2004). Therefore, grain yield is frequently used in crops, such as wheat, as the main criteria for salt tolerance. Salinity reduced production by about 30% threatens poor livelihoods of agriculture and has a significant negative impact on food production in Egypt as a whole (El-Lakany *et al.*, 1986).

Salt tolerance can be distinct as the capability of plants to stay alive and preserve their augmentation and create a relatively advantageous yield in salty conditions. Stress tolerance indices (STI's) were used as simple mathematical equations to measure and compare grain yields under stressful and under stressful conditions to distinguish between tolerant / sensitive genotypes (Mitra, 2001). There are a variety of stress tolerance indices such as tolerance index (TOL), mean productivity "MP", (Rosielle and Hamblin 1981), stress sensitivity index "SSI" (Fischer and Maurer, 1978), geometric mean productivity (GMP) and stress tolerance index STI's (Fernandez, 1992), and others that have been employed to evaluate the comparative yield performance of promising wheat genotypes under both optimal and saline conditions. Abd El-Mohsen *et al.* (2015), Singh *et al.* (2015) and Ali and El-Sadek (2016) found perfect or highly significant associations between some (STI's), indicating that these indices are identical for ranking genotypes for salt tolerance and they can be used as a substitute for each other.

Considering the important issue, the present study was under taken to fulfil the following objectives: to assess the effect of saline soil on grain yield and its components

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of wheat genotypes, and to identify saline tolerant wheat genotypes based on salinity tolerance indices (STI) to use the tolerance lines in breeding program to salinity, and evaluate the superior lines under national trials.

MATERIALS AND METHODS

This study was conducted at the Experimental Farm of Sakha Agricultural Research Station, Kafr El-Sheikh, during two successive seasons 2014/2015 and 2015/2016. Details of the experiment soil properties are given in Table 1. The tested wheat genotypes contained 16 lines that were selected as promising lines from the local breeding program in addition to two cultivars as cheeks (Misr 1 and Giza 171). The name, pedigree and selection history of the studied genotypes are listed in Table 2.

Sowing date was on 28th November in the two growing seasons. Every season, genotypes were evaluated at two experimental sites representing two different site conditions: natural soil (N) and saline soils (S) using the flood irrigation method. All cultural practices recommended for the timely cultivation of wheat have been applied. Before soil preparation, some physical and chemical analyzes were performed for each experimental site, where two samples of surface and subsoil were collected with a depth of 0-30 cm and a depth of 30-60 cm during the two study seasons in the laboratory. (Table 1).

Table 1. Mechanical and chemical soil analyses of normal and salt-affected soils during two growing seasons.

Location	Sample depth	Soil structure	PH	EC dsm^{-1}	Anion mEq/l			Cation mEq/l			
					$HCO3^{-}$	CL^{-}	$SO4^{--}$	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
2014/015											
Normal soil	0 - 30	Clay	8.61	2.33	2.50	10.00	43.32	10.60	6.10	12.38	0.29
	30 - 60	Clay	8.70	2.10	2.25	12.50	48.69	6.60	4.90	8.00	0.33
Saline soil	0 - 30	Clay	8.90	11.40	3.00	70.00	101.98	87.10	56.90	78.15	1.58
	30 - 60	Clay	8.70	10.10	3.00	120.00	95.59	70.35	59.25	57.50	1.49
2015/016											
Normal soil	0 - 30	Clay	8.06	2.01	3.00	8.11	9.11	5.60	3.91	10.34	0.31
	30 - 60	Clay	7.90	1.50	2.50	4.80	7.16	3.23	2.33	8.42	0.29
Saline soil	0 - 30	Clay	8.80	10.31	4.00	34.56	45.60	24.90	16.90	44.23	0.45
	30 - 60	Clay	8.70	8.65	3.00	25.90	42.60	12.10	10.20	40.59	0.33

Table 2. Name, pedigree and selection history of the studied wheat genotypes*.

Name	Pedigree
Line # 1	PJN / BOW // OPATA*2 /3/ CROC-1 / AE.SQUARROSA (224) // OPATA /4/ SKAUZ *2 / SRMA S. 16331-04S-04S-1S -0S
Line # 2	PJN / BOW // OPATA*2 /3/ CROC-1 / AE.SQUARROSA (224) // OPATA /4/ SKAUZ *2 / SRMA S. 16331-04S-04S-2S -0S
Line # 3	CHIBIA//PRLII/CM65531 /7/ BUC // 7C / ALD /5/ MAYA74 / ON // 1160.147 /3 BB / GLL /4/CHAH"S" /6/ MAYA / VUL // CMH74A.630 /4*SX S. 16342-011S-09S-3S -0S
Line # 4	DVERD 2 / AE - SQUARROSA (214)// 2* BCN /5/ WEAVER /4/ NAC / TH.AC // 3* PVN /3/ MIRLO / BUC S. 16255 -016S-011S-0SY-1S -0S
Line # 5	CHEN/AEGILOPS SQUARROSA (TAUS) // BCN/3/2*KAUZ /4/ PJN / BOW // OPATA*2 /3/ CROC-1 / AE.SQUARROSA (224) // OPATA S. 16279 -026S-07S-0SY-1S -0S
Line # 6	ATTILA*2/PBW65 /4/ CHEN/AEGILOPS SQUARROSA (TAUS)//BCN/3/2*KAUZ S. 16233-01S-2S-1S -0S
Line # 7	SERI*3 // RL6010 / 4*YR /3/ PASTOR /4/ BAV92 /5/ KAUZ // BOW / NKT S. 16305-04S-1S-1S -0S
Line # 8	SERI*3 // RL6010 / 4*YR /3/ PASTOR /4/ BAV92 /5/ KAUZ // BOW / NKT S. 16305-04S-3S-2S -0S
Line # 9	SERI*3 // RL6010 / 4*YR /3/ PASTOR /4/ BAV92 /5/ KAUZ // BOW / NKT S. 16305-04S-4S-1S -0S
Line # 10	VEE/PJN//2*TUI/3/GALVEZ/WEAVER /4/ CHIBIA//PRLII/CM65531 S. 16313-06S-1S-3S -0S
Line # 11	VEE/PJN//2*TUI/3/GALVEZ/WEAVER /7/ BUC // 7C / ALD /5/ MAYA74 / ON // 1160.147 /3/ BB / GLL /4/CHAH"S" /6/ MAYA / VUL // CMH74A.630 /4*SX S. 16314-03S-1S-1S -0S
Line # 12	PJN/BOW//OPATA*2/3/CROC-1/AE.SQUARROSA (224)//OPATA /4/ VEE/PJN // 2*TUI /3/ GALVEZ/WEAVER S. 16332-02S-2S-2S -0S
Line # 13	CHIBIA // PRLII /CM65531/3/ SKAUZ *2 / SRMA S. 16338-03S-1S-1S -0S
Line # 14	CHIBIA // PRLII /CM65531/3/ SKAUZ *2 / SRMA S. 16338-03S-1S-2S -0S
Line # 15	SAKHA 94 // KAUZ / PASTOR S. 15962-1S-03S-1S-2S -0S
Line # 16	GEN*2//BUC/FLK/3/BUCHIN /4/ GIZA 168 S. 16343 -033S-013S-0SY-1S -0S
Cheek (Misr 1)	OASIS/SKAUZ//4*BCN/3/2*PASTOR CMSS00Y01881T -050M-030Y-030M-030WGY-33M-0Y--0EGY
Cheek (Giza 171)	SAKHA 93 / GEMMEIZA 9 S.6-1GZ-4GZ-1GZ-2GZ-0S

***Source: Wheat Res. Dep., FCRI, ARC, Egypt.**

The experiment was carried out in a randomized complete block design (RCBD) with three replications under each soil condition. The plot area was 2.4 m^{-2} consisted of four rows, 2 m long and 30 cm apart. Grains were by hand drilled at 300 seeds m^{-2}. The studied characters were: Days to heading (DH), days to maturity

(DM), plant height (PH, cm), No. of spikes m^{-2} (SM^{-2}), No. of kernels per spike (KS^{-1}), 1000-kernel weight (KW, g), grain yield (GY, ardab/fed) and harvest index (HI).

For every genotype, nine stress tolerance indicators were calculated on typical grain yield over normal (Y_n) and stressed (Y_s) sites crossways the two seasons. The names, equations and references of the stress tolerance indices are shown in Table 3.

The genotypes which have high values of mean productivity (MP), harmonic mean (HM), geometric mean productivity (GMP), stress tolerance index (STI), yield index (YI), yield stability index and (YSI) or low values of tolerance index (TOL), stress susceptibility percentage index (SSPI) and stress susceptibility index (SSI) are considered to be more tolerant to saline soil stress.

Table 3. The name, equation and reference of 10 salinity tolerance indices.

No.	Index name	Formula	Reference
	% Reduction	$(Y_n-Y_s)\times 100/Y_n$	
	The high values of the following indices indicated salinity stress tolerance		
1	Mean Productivity (MP)	$(Y_n+Y_s)/2$	(Rosielle and Hamblin, 1981)
2	Harmonic Mean (HM)	$(2\times Y_n\times Y_s)/(Y_n+Y_s)$	(Jafari *et al.*, 2009)
3	Geometric Mean Productivity (GMP)	$(Y_n\times Y_s)^{0.5}$	(Fernandez, 1992)
4	Stress Tolerance Index (STI)	$(Y_n\times Y_s)/(\bar{Y}_n)^2$	(Fernandez, 1992)
5	Yield Index (YI)	$Y_s/\bar{Y}_s$	(Gavuzzi *et al.*, 1997)
6	Yield Stability Index (YSI)	Y_s/Y_p	(Bouslama and Schapaugh,1984)
	The low values of the following indices indicated salinity stress tolerance		
7	Tolerance Index (TOL)	Y_n-Y_s	(Rosielle and Hamblin, 1981)
8	Stress Susceptibility Percentage Index (SSPI)	$Tol\times 100/(2\bar{Y}_n)$	(Moosavi *et al.*, 2008)
9	Stress Susceptibility Index (SSI)	$[1-(Y_s/Y_n)]/[1-(\bar{Y}_s/\bar{Y}_n)]$	(Fisher and Maurer, 1978)

Statistical analysis

The statistical analyses were performed using the statistical routines available in EXCEL (2016). However, the coefficients of variations in each soil condition in the two seasons was lower than 20 %, all soil conditions under the two seasons were included in the combined analysis (Gomez and Gomez 1984). Seasons were random, while the sites and genotypes were fixed. Means of studied genotypes under both conditions were compared by using LSD method at 5 % level of probability.

RESULTS AND DISCUSSION

Mean squares (MS) of all studied characters under normal and salinity stress conditions over all the two seasons are shown in Table 4.

Effects of years (Y), treatments (T) and genotypes (G) were highly significant on all studied characters, except the effect of years for plant height and No. of kernels $spike^{-1}$. Interaction effects were highly significant for all studied characters overall the two years and conditions, except the interaction between years and treatments for grain yield $plant^{-1}$ and interaction between genotypes and years for harvest index.

Mean performance

Data in Table 5 shows the mean performance of the genotypes for all studied characters crossover normal and saline soil conditions at the two seasons. Values for days to heading ranged from (88 days) for Line 11 to (94 days) for Line 6, whereas, the earliest genotypes in maturity were Lines No. 2 and 10 with (138 days) and the latest genotypes were Lines 12, 15 and 16 with (143 days). For plant height, cultivar Giza 171 recorded the highest value (107cm), on the other hand, the shortest genotypes were Line 6 and Line 4 (93cm). Line 6 had the highest value for No. of spikes per m^2 (385), whereas, Line 4 had the minimum value (276). Concerning for No. of kernels $spike^{-1}$ and 1000-kernel weight, the highest values were recorded for Lines 1 and cultivar Giza 171 (57 and 46.9 g) respectively, whereas, the lowest values were recorded for Lines 6 and 11 (42 and 37.7 g). With regard to grain yield $plant^{-1}$ and harvest index Line 2 had the highest values (19.1 ardb/fed and 40.23%), on the contrary, the lowest values were recorded for Line 10 (14.7 ardb/fed and 32.06%). Data indicated that Misr1 and Line 2 can be used in both normal and saline soil conditions. These results are in agreement with Darwish *et al.*, 2017 and Gadallah *et al.*, 2017.

Table 4. Mean squares of the studied wheat genotypes characters combined over normal and stress conditions and over the two seasons.

		DH	DM	PH (cm)	SM^{-2}	KS^{-1}	1000 KW(g)	GY (ardab/fed)	HI
	d.f					M.S			
Year (Y)	1	3030.01**	3758.34**	7.41	306069.9**	6.59	1460.28**	0.64**	1026.76**
Treatments (T)	1	2380.04**	3577.04**	39474.07**	2316327.8**	1329.99**	63.76**	59.86**	765.84**
Y* T	1	2096.89**	381.34**	740.74**	34538.2**	5407.84**	106.07**	0.12	945.48**
Error a	8	2.55	3.01	20.95	429.8	14.49	5.07	0.01	2.93
Genotype (G)	17	27.17**	37.41**	181.35**	13971.4**	214.29**	69.86**	0.17**	58.99**
G * Y	17	32.92**	29.59**	75.79**	7226.6**	116.99**	47.29**	0.09**	11.12
G * T	17	5.01**	17.55**	57.16**	4066.6**	96.93**	41.36**	0.11**	35.90**
G * Y * T	17	5.61**	29.63**	62.06**	8761.8***	123.13**	24.36**	0.05**	26.29**
Pooled error b	136	1.87	2.06	16.41	501.9	13.96	4.25	0.01	5.54
Total	215	41.78	46.33	228.00	15381.8	84.33	24.92	0.32	26.81
CV%		1.5	1	4.1	7.1	7.3	4.9	8.1	6.5

**** = highly significant at 0.05 and 0.01 levels of probability.**

DH: Days to heading, DM: days to maturity, PH: plant height, SM^{-2}: No. of spikes m^{-2}, , K/S: No. of kernels/ spike, 1000 KW: weight of 1000 kernels, GY: grain yield and HI: harvest index.

Table 5. Mean performance of all genotypes for all studied characters combined over the normal and salinity soil conditions and the two seasons.

Characters	DH	DM	PH (cm)	SM^{-2}	KS^{-1}	1000 KW (g)	GY (ardab/fed)	HI
Line 1	92	142	98	328	57	43.4	16.6	35.77
Line 2	90	138	104	329	55	43.2	19.1	40.23
Line 3	89	140	94	294	56	42.9	17.0	34.06
Line 4	89	141	93	276	48	43.0	15.1	36.39
Line 5	89	140	100	347	49	40.2	18.0	32.90
Line 6	94	142	93	385	42	39.4	15.4	36.58
Line 7	91	139	101	321	46	44.8	16.9	36.98
Line 8	90	139	98	294	45	43.5	15.2	38.90
Line 9	89	139	102	277	55	41.0	17.2	35.71
Line 10	90	138	100	295	47	41.2	14.7	32.06
Line 11	88	141	100	343	54	37.7	16.9	35.94
Line 12	93	143	102	282	50	46.2	17.4	36.35
Line 13	91	141	102	296	54	40.3	18.0	38.04
Line 14	89	142	100	384	51	40.0	18.0	38.19
Line 15	91	143	103	286	48	43.6	18.4	36.90
Line 16	91	143	96	313	55	41.6	15.5	37.55
Misr 1	92	140	101	341	53	44.3	19.1	37.42
Giza 171	93	144	107	288	52	46.9	15.9	32.32
LSD 0.05	1.10	1.16	3.27	18.09	3.02	1.66	1.16	1.90

DH: Days to heading, DM: days to maturity, PH: plant height, SM^{-2}: No. of spikesm^{-2}, KS^{-1}: No. of kernels/ spike, 1000KW: weight of 1000 kernels, GY: grain yield and HI: harvest index.

Interaction effects

A- Effect of years:

Table (6) illustrates the average values of all studied characters combined across the two normal and saline soil conditions in the two seasons. Data showed an increase in days to heading, days to maturity, plant height and No. of spikes m^{-2} from 1st season compared the 2nd season. On the other hand, values of No. of kernels spike^{-1}, 1000-kernel weight, grain yield and harvest index% were decreased from season to another. For days to heading, the earliest Lines were Line 5 and Line 4(83 & 93 days) in the two seasons, respectively. With regard to days to maturity, Lines 9 and 10 were the earliest lines in the 1st season (133days), whereas, in the 2nd season Lines 6&7 (142 days) were the earliest genotypes. With respect to plant height the tallest genotypes were Line 6 and Giza 171(106 &113 cm) under the two seasons respectively. Concerning No. of spikes m^{-2} the highest values crossover the two seasons were recorded for Lines 14 and 6 (345&476), respectively. For No. of kernels spike^{-1}the highest values in the 1st season was recorded for Line 1(61), whereas, at the 2nd season were recorded for Lines 13&16 (58). With respect to 1000-kernel weight, the best value was (50.2 g) for Line 12 in the 1st season, while in the 2nd season the highest value was (46.1 g) for variety Giza 171. With regard for grain yield, the highest values were (20 & 19.8 ardab/fed) for Line 3 in the 1st season and Misr 1 in the 2nd season. Finally, for harvest index % the best estimates were recorded by Lines 8 and 2 (42.09 &41.81%) in the two seasons, respectively.

Table 6. Mean performance of all genotypes for all studied characters combined over the normal and salinity soil conditions and 2014/2015 (1st) and 2015/2016 (2nd) seasons.

Characters	DH		DM		PH (cm)		SM^{-2}		KS^{-1}		1000 KW (g)		GY (ardab/fed)		HI	
Years	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Line 1	89	95	139	145	99	97	272	384	61	54	47.2	39.5	17.9	15.3	39.21	32.32
Line 2	86	94	134	143	103	105	270	389	53	57	44.2	42.3	19.7	18.7	39.66	40.81
Line 3	84	95	138	143	96	92	294	293	54	57	44.7	41.0	20.0	14.1	37.02	31.09
Line 4	86	93	137	146	94	92	231	320	50	46	42.4	43.5	15.1	15.1	38.38	34.40
Line 5	83	96	137	143	100	101	315	379	46	51	46.2	34.3	18.9	17.0	34.04	31.77
Line 6	93	95	141	142	88	97	293	476	47	37	38.9	40.0	15.5	15.4	38.56	34.59
Line 7	87	95	136	142	103	98	284	358	48	45	46.1	43.5	17.9	16.0	39.40	34.56
Line 8	86	95	135	143	98	98	245	343	46	44	46.0	41.0	15.3	14.9	42.09	35.70
Line 9	85	94	133	145	106	98	244	309	53	57	43.5	38.5	18.3	16.1	38.12	33.31
Line 10	84	96	133	142	102	98	232	358	50	44	46.7	35.6	16.2	13.3	33.88	30.25
Line 11	83	94	137	144	100	100	289	397	53	56	43.2	32.2	18.4	15.4	38.44	33.43
Line 12	92	94	141	144	103	101	271	294	56	45	50.2	42.3	18.3	16.6	39.26	33.43
Line 13	87	95	135	147	99	105	251	341	49	58	43.2	37.4	18.3	17.7	41.22	34.86
Line 14	86	93	137	146	98	103	345	423	47	54	44.7	35.3	19.8	16.2	39.81	36.57
Line 15	88	95	137	148	102	104	285	287	46	51	45.0	42.1	17.3	19.6	38.13	35.68
Line 16	87	95	137	149	95	97	266	359	51	58	43.1	40.0	14.8	16.1	40.09	35.01
Misr 1	90	93	135	146	103	99	334	348	53	52	47.0	41.6	18.6	19.8	40.16	34.68
Giza 171	91	95	139	150	101	113	280	297	49	54	47.6	46.1	16.0	15.8	34.06	30.58
LSD 0.05	1.57		1.66		4.66		25.46		4.27		2.37		1.51		2.65	

DH: Days to heading, DM: days to maturity, PH: plant height, SM^{-2}: No. of spikesm^{-2}, KS^{-1}: No. of kernels/ spike, 1000KW: weight of 1000 kernels, GY: grain yield and HI: harvest index.

B- Effect of saline soil conditions:

Data in Table 7 illustrated the mean performance of the studied wheat genotypes under the two soil conditions. Non-saline soil showed the highest values for all characters compared with saline soil condition except for 3 genotypes for No. of kernels spike^{-1}and 8 genotypes for 1000-kernel weight. The earliest genotypes for days to heading and maturity under the two soil conditions were Lines 11 and 10 (92 & 84 and 141 &135 days), respectively. Giza 171 was the best genotype for plant height under the two conditions (12 2& 93cm). Concerning No. of spikes m^{-2} the best value was (507) for Line 14 under non-saline soil, whereas, in saline soil the best value was 280 for Line 5. Regarding to No. of kernels spike^{-1}the highest number of kernels were recorder for Line 1and Line 2 (63 & 55) under the two soil conditions, respectively and lines 2, 3 and 13 under saline conditions. With respect to 1000-kernel weight the highest values were recorded for Giza 171 and Line 12(50.8 & 46.8 g) under the two soil conditions, respectively. For grain yield plant cultivar Misr 1 was the highest genotypes under non-saline soil conditions (27.1 ardab/fed), whereas, under saline soil condition the highest genotype was Line 2(13.7ardab/fed). Harvest index % highest values under the two saline soil conditions were recorded for Line 2 and Line 13(42.68 & 38.92%), respectively. For grain yield reduction % the lowest values were recorded for Line 11, 14 and 2 (38.89, 41.54 and 44.81%), respectively. Similar finding were reported by Darwish *et al.* (2017) and Yassin *et al.* (2019).

Table 7. Mean performance of all genotypes for all studied characters over the normal (N) and saline soil (S) conditions combined over the two seasons.

Characters Genotypes	DH		DM		PH (cm)		SM^{-2}		KS^{-1}		1000 KW (g)		GY (ardab/fed)		HI		GY reduction %
	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	
Line 1	94	90	147	137	113	83	455	201	63	52	45.2	41.5	23.9	9.1	40.40	31.14	61.95
Line 2	94	86	142	135	118	91	399	259	55	55	43.8	42.7	24.7	13.7	42.68	37.79	44.81
Line 3	92	86	144	137	106	82	418	169	58	53	43.9	41.8	25.3	8.8	39.08	29.04	65.44
Line 4	93	85	146	137	103	83	387	164	46	50	43.2	42.8	20.9	9.2	38.42	34.37	55.87
Line 5	92	87	144	136	113	88	414	280	50	47	38.6	41.9	23.3	12.6	33.93	31.88	46.00
Line 6	97	91	148	136	103	82	504	266	39	44	39.0	39.8	20.0	10.9	36.95	36.21	45.61
Line 7	95	87	143	135	116	86	456	186	46	47	47.6	42.0	23.6	10.3	38.68	35.28	56.44
Line 8	94	87	143	136	116	81	403	184	51	39	46.8	40.3	21.4	9.0	39.96	37.83	57.92
Line 9	92	87	141	137	115	89	380	174	57	52	38.4	43.5	24.4	10.0	37.47	33.96	58.85
Line 10	93	87	141	135	113	87	393	198	55	39	42.8	39.6	20.8	8.8	36.31	27.82	57.87
Line 11	92	84	144	138	111	89	442	244	59	50	36.3	39.1	21.0	12.8	34.72	37.16	38.89
Line 12	97	89	146	139	118	86	383	182	52	49	45.6	46.8	23.1	11.7	39.13	33.56	49.49
Line 13	94	88	146	136	113	91	391	202	54	53	39.6	40.9	24.2	11.9	37.16	38.92	50.72
Line 14	93	86	147	137	118	83	507	261	53	48	38.6	41.4	22.8	13.3	38.15	38.23	41.54
Line 15	94	88	148	137	116	90	373	198	50	46	43.3	43.8	24.6	12.3	39.71	34.10	50.24
Line 16	94	89	149	137	111	81	407	218	61	49	42.3	40.8	21.5	9.5	39.11	35.99	55.98
Misr 1	95	88	142	138	113	88	437	245	56	49	47.1	41.5	27.1	11.3	39.11	35.73	58.19
Giza 171	97	89	149	140	122	93	393	184	54	50	50.8	43.0	22.8	9.0	35.24	29.40	60.51
LSD 0.05	1.57		1.66		4.66		25.46		4.27		2.37		1.51		2.65		

DH: Days to heading, DM: days to maturity, PH: plant height, SM^{-2}: No. of spikesm^{-2}, KS^{-1}: No. of kernels/ spike, 1000KW: weight of 1000 kernels, GY: grain yield and HI: harvest index.

C- Effect of interactions among seasons, soil conditions and genotypes

Data in Tables 8 & 9 showed the interaction among saline soil conditions, seasons and genotypes for all studied characters. There were significant reductions in the saline soil condition compared with non-saline soil condition for all studied characters except some cases for No. of kernels spike $^{-1}$, 1000-kernel weight and harvest index. These cases may be due to the reduction in No. of spikes m^{-2} and the length of grain filling period.

Table 8. Mean performance of all genotypes for days to heading, maturity, plant height and No. of spikes m^{-2} under the normal and saline soil conditions during the two seasons.

	DH				DM				PH (cm)				SM^{-2}			
	2014/15		2015/16		2014/15		2015/16		2014/15		2015/16		2014/15		2015/16	
	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S
Line 1	94	84	93	96	146	131	147	142	112	87	113	80	361	182	550	219
Line 2	94	78	95	94	138	130	146	139	117	90	118	92	327	212	472	306
Line 3	89	78	95	94	143	131	144	142	105	87	107	77	366	222	471	116
Line 4	93	78	94	92	144	131	149	143	103	85	103	80	330	132	444	196
Line 5	89	77	95	97	144	129	144	142	113	87	113	88	349	280	479	280
Line 6	98	88	96	93	150	132	145	139	97	80	110	83	441	145	566	387
Line 7	95	78	95	96	142	130	144	140	118	88	113	83	408	160	504	211
Line 8	94	78	95	95	140	129	145	142	112	85	120	77	353	136	453	232
Line 9	90	79	94	94	136	130	146	144	117	95	113	83	334	155	427	192
Line 10	90	77	96	96	136	131	145	139	113	90	112	83	270	195	515	201
Line 11	90	76	94	93	141	133	146	142	105	95	117	83	370	208	514	279
Line 12	99	85	94	93	148	134	144	144	113	92	122	80	357	185	409	178
Line 13	93	82	96	94	138	132	155	139	110	88	117	93	348	155	433	249
Line 14	91	80	94	91	145	130	148	145	117	80	120	85	429	260	584	262
Line 15	94	81	94	95	143	131	153	144	113	90	118	90	360	209	386	188
Line 16	93	81	94	96	142	132	156	142	105	85	117	77	358	175	456	262
Misr 1	96	84	94	92	137	132	147	144	112	93	115	83	480	187	393	303
Giza 171	98	84	95	95	144	133	154	146	118	83	125	102	396	164	390	203
LSD 0.05	2.23				2.35				6.59				36.01			

Table 9. Mean performance of all genotypes for No. of kernels spike^{-1}, 1000-kernel weight, grain yield plant^{-1}and harvest index% overall the normal and saline soil conditions under the two seasons

	K/S				1000 KW (g)				GY (ardab/fed)				HI			
	2014/15		2015/16		2014/15		2015/16		2014/15		2015/16		2014/15		2015/16	
	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S
Line 1	68	55	58	49	47.8	46.6	42.6	36.4	23.3	11.7	24.5	5.8	44.3	34.1	36.5	28.2
Line 2	62	43	47	66	43.1	45.3	44.5	40.1	25.7	14.0	24.5	12.8	42.6	36.8	42.8	38.8
Line 3	69	39	48	67	43.9	45.5	44.0	38.0	28.0	11.7	22.2	5.8	45.1	29.0	33.1	29.1
Line 4	54	45	37	55	42.3	42.6	44.1	43.0	22.2	8.2	19.8	10.5	43.5	33.3	33.4	35.4
Line 5	57	35	44	59	42.9	49.4	34.2	34.3	25.7	11.7	21.0	12.8	36.4	31.7	31.5	32.1
Line 6	47	47	32	41	36.8	41.0	41.2	38.7	21.0	10.5	19.8	11.7	38.6	38.6	35.3	33.9
Line 7	50	46	42	48	51.2	41.1	44.1	42.9	25.7	10.5	22.2	10.5	43.4	35.4	33.9	35.2
Line 8	58	34	44	44	48.8	43.2	44.8	37.3	21.0	9.3	21.0	8.2	43.4	40.8	36.5	34.9
Line 9	62	43	52	61	42.0	45.0	34.8	42.1	26.8	10.5	22.2	9.3	42.6	33.7	32.4	34.2
Line 10	63	37	47	41	45.5	47.9	40.0	31.2	22.2	10.5	19.8	7.0	40.0	27.8	32.6	27.9
Line 11	60	46	58	54	41.2	45.3	31.5	32.9	23.3	12.8	18.7	12.8	40.2	36.7	29.3	37.6
Line 12	62	50	42	47	46.6	53.8	44.7	39.9	23.3	12.8	23.3	10.5	43.5	35.1	34.8	32.1
Line 13	53	46	56	60	41.8	44.5	37.4	37.3	25.7	11.7	23.3	12.8	44.0	38.4	30.3	39.4
Line 14	56	37	49	59	44.7	44.6	32.4	38.2	24.5	15.2	21.0	11.7	42.1	37.5	34.2	38.9
Line 15	50	42	51	51	45.7	44.3	40.9	43.4	23.3	10.5	25.7	14.0	46.9	29.3	32.5	38.9
Line 16	58	45	64	53	42.7	43.4	41.8	38.2	21.0	9.3	22.2	10.5	44.2	35.9	34.0	36.0
Misr 1	60	46	52	52	48.6	45.4	45.6	37.5	26.8	10.5	26.8	12.8	43.2	37.1	35.0	34.3
Giza 171	57	41	51	58	51.5	43.7	50.1	42.2	23.3	9.3	22.2	9.3	39.2	28.9	31.2	29.9
LSD 0.05	6.04				3.35				2.21				3.75			

Table 10. Estimates of reduction percentage in grain yield and salinity tolerance indices (STI's) and their respective ranks of 18 bread wheat genotypes based on grain yield under non-salinity and salinity soil conditions across the two seasons and corresponding ranks.

Genotypes	Y(n)	Rank	Y(s)	Rank	MP	Rank	GMP	Rank	HM	Rank	STI	Rank	YI	Rank	YSI	Rank	TOL	Rank	SSI	Rank	SSPI	Rank
Line 1	23.9	7	9.1	14	1.42	12	1.26	12	1.13	12	0.41	12	0.85	14	0.38	17	1.27	16	1.16	17	32.07	16
Line 2	24.7	3	13.7	1	1.65	1	1.57	1	1.51	1	0.63	1	1.27	1	0.55	3	0.95	5	0.84	3	23.99	5
Line 3	25.3	2	8.8	18	1.46	9	1.28	11	1.11	14	0.42	11	0.82	17	0.35	18	1.42	18	1.22	18	35.86	18
Line 4	20.9	16	9.2	13	1.29	17	1.19	16	1.10	16	0.36	16	0.86	13	0.44	9	1.00	7	1.04	9	25.25	7
Line 5	23.3	9	12.6	4	1.54	6	1.47	5	1.40	3	0.55	5	1.17	4	0.54	5	0.92	4	0.86	5	23.23	4
Line 6	20.0	18	10.9	9	1.32	15	1.26	13	1.20	11	0.41	13	1.01	9	0.54	4	0.78	2	0.85	4	19.70	2
Line 7	23.6	8	10.3	10	1.45	11	1.33	10	1.23	9	0.45	10	0.96	10	0.44	11	1.14	13	1.05	11	28.79	13
Line 8	21.4	14	9.0	15	1.30	16	1.19	17	1.08	17	0.36	17	0.84	15	0.42	13	1.06	12	1.08	13	26.77	12
Line 9	24.4	5	10.0	11	1.48	8	1.34	9	1.22	10	0.46	9	0.93	11	0.41	15	1.23	15	1.10	15	31.06	15
Line 10	20.8	17	8.8	17	1.27	18	1.16	18	1.06	18	0.34	18	0.82	18	0.42	12	1.03	8	1.08	12	26.01	8
Line 11	21.0	15	12.8	3	1.45	10	1.41	8	1.37	7	0.51	7	1.20	3	0.61	1	0.70	1	0.73	1	17.68	1
Line 12	23.1	10	11.7	7	1.49	7	1.41	7	1.33	8	0.51	8	1.09	7	0.51	6	0.98	6	0.92	6	24.75	6
Line 13	24.2	6	11.9	6	1.55	4	1.45	6	1.37	6	0.54	6	1.11	6	0.49	8	1.05	10	0.95	8	26.52	10
Line 14	22.8	12	13.3	2	1.55	5	1.49	3	1.44	2	0.57	3	1.24	2	0.58	2	0.81	3	0.78	2	20.45	3
Line 15	24.6	4	12.3	5	1.58	3	1.49	4	1.40	4	0.57	4	1.14	5	0.50	7	1.06	11	0.94	7	26.77	11
Line 16	21.5	13	9.5	12	1.33	14	1.22	15	1.12	13	0.38	15	0.88	12	0.44	10	1.03	9	1.05	10	26.01	9
Misr 1	27.1	1	11.3	8	1.65	2	1.50	2	1.37	5	0.57	2	1.05	8	0.42	14	1.35	17	1.09	14	34.09	17
Giza 171	22.8	11	9.0	16	1.36	13	1.23	14	1.10	15	0.38	14	0.84	16	0.39	16	1.18	14	1.13	16	29.80	14

Salt tolerance indices

The results in Table10 presented average cereal production of genotypes under non-saline conditions (Yn) and saline soil condition (Ys) as well as estimates of salt tolerance indices and their ranks. The average yield of cereals under salty stress conditions was 46.46% lower than that under normal conditions. There were critical differences between the studied genotypes with respect to grain production under the unsalted sites and soil salinity that showed high genetic diversity among them, which enabled us to examine salinity-resistant genotypes. Cereal crops were formulated from genotypes tested under saline and saline conditions to calculate different sensitivity and tolerance indicators. Genotypes with high values of mean productivity (MP), harmonic mean(HM), engineering mean productivity(GMP), stress tolerance index(STI), yield index(YI), and yield stability index(YSI) can be identified as genotypes of salinity .

It should be noted that the GMP and STI indicators gave similar degrees of salt tolerance as lines 2 and 14 were identified as genotypes of salt tolerance. These genotypes had greater values for GMP and STI. While lines 8 and 10 were identified as sensitive genotypes, due to their low values for GMP and STI. In the same context, the TOL and SSPI indicators ranked the studied genotypes for tolerance of salt in the same order. Using these two indicators, lines 11, 14, and 2 were more tolerant to salinity stress. While lines 1 and 3 were more sensitive compared to other lines. Accordingly, it is preferable to grow lines 2, 11 and 14 under salinity conditions. Lines 1 and 3 were more sensitive to salinity. The similarity between pairs or three indicators in the classification of genotypes of salt tolerance can be attributed to the fact that these indicators are a function of each other as shown in Table 2. However, the three indicators MP, HM and MSTI gave a different arrangement of genotypes to carry them to salinity. A similar trend of results was found by Ali and El-Sadek (2016), Darwish *et al.*, (2017) and Yassin *et al.*, (2019).

Table 11. Spearman's rank correlation coefficients among grain yield (under non-saline and saline soil), and their corresponding salt tolerance indices (STI's).

Parameters	Y(p)	GMP	MP	HM	STI	YI	YSI	TOL	SSI	SSPI
Y(n)	0.22	0.81**	0.60**	0.43	0.59**	0.22	-0.27	0.67**	0.29	0.67**
Y(p)		0.75**	0.91**	0.97**	0.92**	1.00**	0.88**	-0.57*	-0.87**	-0.57*
GMP			0.97**	0.90**	0.97**	0.74**	0.30	-0.02	0.30	-0.02
MP				0.96**	0.99**	0.85**	0.45	0.14	0.45	0.14
HM					0.94**	0.62**	0.34	0.62**	0.34	0.85**
STI						0.85**	0.46*	0.15	0.46*	0.15
YI							0.83**	0.60**	0.83**	0.60**
YSI								0.93**	1.00**	0.93**
TOL									0.93**	1.00**
SSI										0.93**

***, ** = Significant at 0.05 and 0.01 levels of probability, respectively.**

Correlation analysis among salinity tolerance indices.

To clarify the most suitable salinity tolerant criteria, the correlation coefficients between Yp, Ys, and other quantitative indices of salinity tolerance were considered. The correlation analysis Spearman's rank correlation coefficients between the salinity tolerant indices and mean yield over non-salinity and salinity conditions are given in Table 11. Results from analysis of correlation revealed that grain yield at non-salinity condition had positive and non-significant correlation with grain yield under salinity condition (r =0.22).

An appropriate index must have a significant correlation with grain yield under both conditions. Yield in non-salinity (Yn) condition was high significantly and positively correlated with salinity tolerant indices MP, GMP, STI, TOL and SSPI. Whereas, yield at salinity (Ys) condition was highly significant and positive correlated with salinity tolerant indices MP, HM, GMP, STI, YI and YSI. On the other hand, yield in salinity (Ys) condition was high significantly and negative correlated with salt tolerance indices TOL, SSI and SSPI. These results indicating that these criteria were more effective in identifying high yielding cultivars under different conditions. Barutcular *et al.*, (2016) recorded that the findings under both stress environments indicated positive and significant correlations between (Yn) with TOL, MP, GMP, STI, SSI and HM selection indices. As well as, the correlations between YS with GMP, STI, and HM indicated that selection based on these indices may increase yield in stress and non-stress conditions.

Regarding the relationships between stress tolerance indicators, the results showed that there were high significant and positive correlations between all indicators of a pair of MP, HM, GMP, STI and YI. High statistically significant correlation coefficients were observed between YSI and TOL, SSI and SSPI. Also, YI was positive and closely related to TOL, SSI, and SSPI. According to Khokhar et al. (2012) who report that in the event of a significant correlation between MP and GMP, GMP can reflect performance under pressure slightly better than MP. MP, STI, GMP, and YI were closely related to cereal production in both cases, indicating that these indicators are most appropriate for examining drought-tolerant genotypes. The best indices are those which have high correlation with dry matter yield in both non-stress and stress conditions and would be able to identify potential upper yielding and salt tolerant genotypes according to Talebi *et al.*, (2007).

CONCLUSION

Our findings revealed that, among the genotypes, three promising genotypes namely; Lines 2, 14, 11 and cultivar Misr 1 that were characterized by high grain yield inder each of the normal and saline soils. Accordingly, these findings indicated that these agronomical and characters could be useful tools to identify several genotypes in a short time, and provide significant information about salinity stress tolerance, which might be useful to wheat breeders to identify and improving salt-tolerant genotypes. Therefore, these four genotypes may be recommended to cultivate under the saline condition of Egypt and also may be used in the future breeding program to develop salinity tolerant wheat cultivars.

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REFERENCES

Abd El-Mohsen, A.A. ; M.A. Abd El-Shafi ; E.M.S. Gheith. and H.S. Suleiman (2015). Using different statistical procedures for evaluating drought tolerance indices of bread wheat genotypes, Adv. Agric. Biol., 4(1): 19-30.

Ali M.B. and A.N. El-Sadek (2016). Evaluation of drought tolerance indices for wheat (*Triticum aestivum* L.) under irrigated and rainfed conditions. Communications in Biometry and Crop Sci., 11(1): 77–89.

Al-Naggar, A.M.M. ; S.R. S. Sabry ; M.M.M. Atta and O.M.A. El-Aleem (2015). Effects of salinity on performance, heritability, selection gain and correlations in wheat (*Triticum aestivum* L.) doubled haploids. Scientia, 10(2): 70-83.

Barutcular, C. ; A. EL-Sabagh ; O. Konuskan and H. Saneoka (2016). Evaluation of maize hybrids to terminal drought stress tolerance by defining drought indices. J. of Exp. Bio. and Agric. Sci., 4: 610-616.

Bouslama, M. and W. T. Schapaugh (1984). Stress tolerance in soybean. Part. 1: Evaluation of three screening techniques for heat and drought tolerance. Crop Sci., 24: 933-937.

Darwish, M.A.H. ; W.M. Fares and Eman, M.A. Hussein (2017). Evaluation of some bread wheat genotypes under saline soil conditions using tolerance indices and multivariate analysis. Plant Production, Mansoura Univ., 8(12): 1383-1394.

El-Lakany, M.H. ; M.N. Hassan ; A.M. Ahmed and M. Mounir (1986). Salt affected soils and marshes in Egypt; their possible use for forages and fuel production. Reclamation and Revegetation Res., 5: 49-58.

Fernandez, G.C.J. (1992). Effective selection criteria for assessing stress tolerance. In C. G. Kuo (Ed.), Proc. of the Intern. Sym. on Adaptation of Vegetables and Other Food Crops in Temperature and Water Stress. Publication, Tainan, Taiwan.

Fischer, R.A. and R. Maurer (1978). Drought resistance in spring wheat cultivars. I. Grain responses. Aust. J. Agric. Res., 29: 897-912.

Gadallah, Maha A. ; Sanaa, I. Milad ; Y.M. Mabrook ; Amira, Y. Abo Yossef and M.A. Gouda (2017). Evaluation of some Egyptian bread wheat (*Triticum aestivum* L.) cultivars under salinity stress. Alex. Sci. Exch. J., 38(2): 259-270.

Gavuzzi, P. ; F. Rizza ; M. Palumbo ; R.G. Campaline ; G.L. Ricciardi and B. Borghi (1997). Evaluation of field and laboratory predictors of drought and heat tolerance in winter cereals. Canadian J. Plant Sci., 77: 523-531.

Gomez, K. A. and A. A. Gomez (1984). Statistical procedures for the agricultural researches.John Wiley and Son.Inc. New York.

Jahan, M.A.H. ; S.A. Hossain ; A. Jaime ; T. Da-Silva ; A. EL- Sabagh ; M.H. Rashid and C. Barutçular (2019). Effect of naphthaleneacetic acid on root and plant growth and yield of ten irrigated wheat genotypes. Pakistan J. of Bot., 51(2), DOI: 10.30848/PJB2019-2/11.

Jafari, A. ; F. Paknejad and M. AL-Ahmaidi (2009). Evaluation of selection indices for drought tolerance of corn (*Zea mays* L.) hybrids. Int. J. Plant Prod., 3: 33–38.

Khokhar, M.I. and J.A. Teixeira da Silva (2012). Evaluation of barley genotypes for high yield and drought tolerance under normal and water-stressed conditions. Pakisatan J. Agric. Sci., 49(3): 303-313.

Milad, S.I. ; A.I. Nawar ; A.M. Shaalan ; M. Eldakak and J.S. Rohila (2016). Response of different wheat genotypes to drought and heat stresses during grain filling stage. Egypt, J. Agron. 38(3): 369-387.

Mitra, J. (2001). Genetics and genetic improvement of drought resistance in crop plants. Curr. Sci., 80: 758-762.

Moosavi, S.S. ; B.Y. Samadi ; M.R. Naghavi ; A.A. Zali ; H. Dashti and A. Pourshahbazi (2008). Introduction of new indices to identify relative drought tolerance and resistance in wheat genotypes. Desert, 12: 165-178.

Oproi, E. and M. Madosa (2014). Germination of different wheat cultivars under salinity conditions. J. of Hort., Forestry and Biotech., 18: 89-92.

Out, H. ; V. Celiktas ; S. Duzenli ; A. Hossain and A. El-Sabagh (2018). Germination and early seedling growth of five durum wheat cultivars (*Triticum durum* desf.) is affected by different levels of salinity. Fresenius Env. Bul., 7(11): 7746-7757.

Parida, A.K. ; A.B. Das and B. Mittra (2004). Effects of salt on growth, ion accumulation photosynthesis and leaf anatomy of the mangrove, Bruguiera parviflora. Trees 18: 167-174.

Rosielle, A.A. and J. Hamblin (1981). Theoretical aspects of selection for yield in stress and non-stress environments. Crop Sci., 21(6): 943-946.

Rus, A.M. ; S. Rios ; E. Olmos ; A. Santa-Cruz and M.C. Bolarin (2000). Long term culture modifies the salt responses of callus lines of salt-tolerant and salt-sensitive tomato species. J. Plant Physiol., 157: 413-420.

Singh, S. ; R.S. Sengar ; N. Kulshreshta ; D. Datta ; R.S. Tomar ; V.P. Rao ; D. Grag and A. Ojha (2015). Assessment of multiple tolerance indices for salinity stress in bread wheat (*Triticum aestivum* L.). J. of Agric. Sci., 7(3): 49-57.

Talebi, R. ; F. Fayaz and N.B. Jelodar (2007). Correlation and path coefficient analysis of yield and yield components of chickpea (*Cicer arietinum* L.) under dry land condition in the west of Iran. Asian J. of Plant Sci.. 6: 1151-1154.

Yadav, S.S. ; R.J. Redden ; J.L. Hatfield ; A.W. Ebert and D. Hunter (2018). Food Security and Climate Change. – John Wiley & Sons, Dec 14, 2018 - Technology & Engineering, p. 568.

Yassin, M. ; Sahar, A. Farag ; A. Hossain ; H. Saneoka and A. El-Sabagh (2019). Assessment of salinity tolerance bread wheat genotypes using stress tolerance indices. Fresenius Envi. Bul., 28 (5): 4199-4217.

تقييم بعض التراكيب الوراثية من قمح الخبز تحت ظروف الأراضى الطبيعية والمتأثرة بالأملاح

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لقد تم إجراء الدراسة بالمزرعة البحثية بمحطة البحوث الزراعية بسخا- كفر الشيخ بهدف تقييم ١٨ تركيب وراثي من قمح الخبز (١٦ سلالة مبشرة والصنفين التجاريين مصر ١ وجيزة ١٧١) فى ظل الأراضي الطبيعية والأراضي المتأثرة بالأملاح خلال الموسمين الزراعيين ٢٠١٤-٢٠١٥ و ٢٠١٥-٢٠١٦. نفذت التجربة باستخدام تصميم القطاعات كاملة العشوائية في ثلاثة مكررات. تم حساب تسعة مؤشرات لتحمل الإجهاد (STI) بناءً على متوسط محصول الحبوب في ظل ظروف التربة الطبيعية والمتأثرة بالأملاح خلال الموسمين. أظهر تحليل التباين وجود اختلافات عالية المعنوية بين التراكيب الوراثية تحت ظروف الأراضي الطبيعية والمتأثرة بالأملاح. كانت تأثيرات التفاعل بين التراكيب الوراثية و نوعي التربة عالية المعنوية لمعظم الصفات المدروسة. وكنتيجة التأثر بالأملاح كان هناك إنخفاض في الصفات محل الدراسة مقارنة بظروف الأراضي الطبيعية. أوضحت النتائج أن السلالات أرقام ٢ و ١٤ و ١٥ والصنف مصر ١ كانوا أفضل التراكيب الوراثية قيد الدراسة حيث سجلت أعلى القيم لمحصول الحبوب ومكوناته تحت ظروف التربة الطبيعية والمتأثرة بالأملاح. أظهرت نتائج مؤشرات تحمل الإجهاد (STI) أن الأدلة GMP و STI أعطوا رتبًا مماثلة للسلالات ٢ و ١٤ والتي يمكن تحديدها على أنها تراكيب وراثية متحملة للملوحة. في حين تم تحديد السلالات ٨ و ١٠ على أنها أنماط وراثية قابلة للتأثر، نظرًا لقيمها المنخفضة في GMP و STI. في نفس السياق وباستخدام المؤشران TOL و SSPI لتصنيف التراكيب الوراثية المدروسة لتحمل الملوحة ، وأشارت النتائج إلى أن السلالات٢ و ١١ و ١٤ كانوا الأكثر تحملاً للملوحة. تم استخدام معامل ارتباط تحليل الرتب سبيرمان بين مؤشرات تحمل الملوحة. وكان هناك ارتباط إيجابي عالى المعنوية مع مؤشرات تحمل الملوحة MP، GMP، STI، TOL و SSPI في حالة الأراضي الطبيعية. في حين كان الارتباط تحت ظروف الأراضي المتأثرة بالأملاح إيجابيا وعالى المعنوية لمؤشرات تحمل الملوحة MP و HM و GMP و STI و YI و YSI.