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Assessment of Genetic Variations and Growth/Yield Performance of Some Egyptian and Yemeni Wheat Cultivars Under Saline Condition

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ABSTRACT

Three different experiments were carried out at the Faculty of Agriculture Saba Basha, Alexandria University during two seasons 2013-2014 and 2014-2015 to appraisal the genetic variations, growth, yield and yield components between ten wheat (*Triticuma estivum* L.) cultivars from Egypt and Yemen [five Egyptian cultivars namely;Sakha93 (E1), Giza 168 (E2), Gemmeiza 9 (E3), Shakha94 (E4), Egypt1 (E5),and fiveYemeni cultivars namely; Behoth14 (Y1), Sonalica (Y2), Acsadgahran (Y3), Kaaalhakl (Y4) and Local wheat (Y5)]. Egyptian wheats grain was provided by Agronomy Department, Agriculture Research Center, Giza, Egypt while Yemeni wheats grain from Agricultural Researches Extinction authority (The Regional Agricultural Researches for Central Highland, Yemen).All the tested cultivars were evaluated experimentally under different salt conditions i.e. 50, 100 and 150 mMol NaCl in addition to control treatment the following aspects were detected i.e. seedling length (cm), root length (cm), leaves number/seedling, number of roots/seedling and chlorophyll content (mg/m^2). At the same time, November 15th, the wheat cultivars were planted in field in randomized complete block design (RCBD) with four replications in both seasons to measure plant height (cm), tillers number/plant, spike lets number/spike, grains number/spike, 1000- grain weight (g), grain yield kg/fed., straw yield kg/fed., biological yield kg/fed., harvest index (HI %) and grain protein %. After 50% of tasseling flowers Yemeni wheat cultivars were used as donor for pollen grains and hybridization was done in one way to calculate the heterosis (H%) for twenty-five hybrids. The obtained results showed high significant variations were observed between the tested cultivars and the highest mean values of heterosis were recorded and it can be suggested that the current wheat cultivars could be used in breeding program in the future.

INTRODUCTION

Wheat is an important member of the family *Poaceae*, in2012 world production of wheat was 671.5 million tons, making it the third most produced cereal after maize was 872.8millar tons and rice was 738.2 million tons(FAO, 2014). Wheat is one of the most abundant sources of energy and protein for the world population.

Wheat genetics is more complicated than that of most other domesticated species: it is an allopolyploid, containing three different ancestral genomes (designated A, B and D), each of which contains seven pairs of homologous chromosome (Hussain *et al.,* 2010; Kumar and Singh, 2010). The national wheat production in Egypt is insufficient to meet local consumption. The domestic wheat production in 2014 season was estimated by 8.8 million produced from 3.1 million feddan=0.42 ha. (FAO, 2014).

Planting high yielding wheat cultivars which are tolerant to salinity as results from breeding program; achieved an increase in wheat production especially in newly soil. Miralles and Slafer (2007) reported that variations in yield are mostly explained by changes in grains per unit of soil area. Field salinization is an increasing problem worldwide (Shannon, 1997) who estimated that 10% of the world's cropland and as much as 27% of the irrigated land may already be affected by salinity, and one-third of the world's arable land resources is affected by salinity (Qadir *et al*., 2000).Wheat is the most important food crop in the word. Increasing wheat yield potential has indisputable importance for solving world hunger issues. Heterosis, or hybrid vigor, describes the phenomenon by which an F_1, generated by crossing of two genetically different individuals, is superior to either parent (Shull, 1908; Stuber, 1994). Heterosis has contributed greatly to the production of high-yielding varieties in some crops.

It has been exploited extensively in many field crops and animals to increase agricultural yields throughout the world. Extensive research on the genetic basis of heterosis has been conducted for more than a century, but the molecular underpinnings of the phenomenon remain conjectural (Falconer, 1981; Stuber, 1994; Duvick, 1999). Researchers worldwide have tried to explore the use of heterosis in wheat since the advent of hybrid rice and hybrid corn. Similarly, wheat heterosis has played a huge role in grain production improvements. Several main hypotheses have been proposed to explain heterosis, including dominance (Bruce, 1910; Jones, 1917), over dominance (Shull, 1908) and epistasis (Powers, 1944; Stuber, 1994), but the genetic mechanism of heterosis remains poorly understood. The grain yield of wheat is determined by spikes number per hectare, grains number per spike, and 1000-grain weight (Brancourt-Hulmel *et al*. 2003). This investigation carried out to estimate genetic, growth and yield variations of some Egyptian and Yemeni wheat cultivars under saline conditions.

MATERIALS AND METHODS

Experiment 1: divided into 3 portions

Ten grains from each wheat cultivar (Egyptian and Yemeni) in four replicates were planted in Petri dish on November 15th 2013, using Silica jellsas sowing media which washed with adequate amount of distilled water and irrigated by distilled water for a week. After full germination, salt (NaCl) treatment was applied in three levels 50, 100 and 150 mM with control for three weeks after full germination. Morphological and biochemical characters were assessed for the seedling such as seedling length (cm), root length (cm), leaves number/seedling, number of roots/seedling, chlorophyll (mg/m^2), total chlorophyll content (mg/m^2) was determined by Minolta Chlorophyll Meter 502. Chlorophyll A was calculated by transforming the SPAD units to mg/m^2 using the following equation: Chlorophyll = 1.034 + 0.308 x [SPAD] +0.110 * [SPAD] 2 according to Coste *et al*. (2005) and Monje and Bugbee (1992).

Proline content (μ moles/g/fresh weight) was determined according to the method of (Bates, *et al.*, 1973), and expressed on a fresh weight basis from the standard curve, using standard L-Proline according to the previous method developed (Hasan, *et al.,* 2007). However, the Proline content was determined from a standard curve and calculated on a fresh weight basis as follows : µmoles Proline/g of fresh plant material = [(µg Proline/ml × ml toluene)/115.5 µg/µmoles / (g sample/5)] as reported by Ahmed and Hasan (2011).

For peroxidase activity determination, whereas 10 seedlings were grounded, using a cooled mortar with a pestle, and adding 0.23 M Tris-acetate, pH 5.0. Homogenate was extracted by the solution containing Tris (27.7 g) and citric acid (11.0 g) in 1L volume adjusted with distilled water. Electrophoresis was carried out by the prescriptions recommending 1% agar-starch-olyvinyl-pyrrolidone gel and Tris-orate or Tris-acetate separation buffers. Electrophoresis was conducted at 270 v, 4ºC for 100 min. 100 ml of 0.01 M acetate buffer; pH 5.0, containing 0.1% benzidine and 0.5% hydrogen peroxide (H2O2) were layered over the gel immediately before staining (Sabrah, 1980).

Experiment 2

Planting date was on 15thNovember 2013, the experimental area was 10.5 m^2 (3 x 3.5 m) and seeding rate was 60 kg grains/fed., the first irrigation was applied at 25 days after sowing and plants were irrigated every 25 days till the dough stage. The randomized complete block design (RCBD) with four replications was followed. The experiment was conducted in the Experimental farm, the Faculty of Agriculture, Saba Basha, Alexandria University, Egypt. However, the analysis of physical and chemical properties of the experimental soil site to (0-30cm depth) as shown in Table (1) were carried out according to the methods reported by Page *et al.* (1982).

Table (1): Physical and chemical properties of the experimental soil sites during the two cropping seasons

Soil properties	Season	
	2014/2015	2015/2016
A) Mechanical analysis :		
Clay %	38	37
Sand %	32	33
Silt %	30	30
Soil texture	Clay loam soil	
B) Chemical properties		
PH (1 : 1)	8.20	8.31
E.C. (dS/m)	4.00	4.10
1) Soluble cations (1:2) (cmol/kg soil)		
K^+	1.4٠	1.50
Ca^{++}	8.3٠	8.60
Mg^{++}	14.3٠	14.60
Na^{++}	13.5٠	12.80
2) Soluble anions (1 : 2) (cmol/kg soil)		
CO_3^{--}+ HCO_3^-	3.10	3.20
Cl^-	21.40	21.70
SO_4^{--}	13.00	12.60
Calcium carbonate (%)	6.50	7.00
Total nitrogen %	1.00	0.91
Available phosphate (mg/kg)	3.70	3.55
Organic matter (%)	1.41	1.40

At harvest plants of one square meter was taken randomly from each plot to determine yield and its components i.e. Plant height (cm), tillers number/plant, spikes number/plant, grains number/spike and 1000- grains weight, grain yield (kg/fed.), straw yield (kg/fed.), biological yield (kg/fed.), harvest index (%) and grain protein (%). Protein percentage was determined by estimating the total nitrogen in the grains multiplied by 5.75 to obtain the protein percentage according to (A.O.A.C., 1990).

After 50% of tasting flowers of Yemeni wheat were used as donor of pollen grains (malegamets) and Egyptian wheat were emasculated (ten spike-female) and hybridization were done in one way to calculate the heterosis for twenty-five hybrids.

Experiment 3

15^{th} November, season 2014, Parents and twenty-five wheat hybrids were sown together and the same previous morphological characters were recorded**.** Mid-parent heterosis of each cross was calculated as $H = F_1 - (P_1 + P_2)/2$ (where H is the amount of heterosis, F_1 is the trait measurement of the hybrid, P_1 and P_2 are the measurements of the parents), and used as the input data for analyzing the genetic basis of heterosis.

Data analysis

Data obtained was exposed to the proper method of statistical analysis of variance difference among mean of different treatments as described by Gomez and Gomez (1984). The treatments means were compared using the Least Significant Differences (L.S.D.) test at 5 % level of probability using the RCBD model as obtained by CoStat computer software package (CoStat, Ver. 6.4, 2005).

RESULTS AND DISCUSSION

Morphological performance of wheat cultivars under salinity condition

Concerning the seedling and plant height (cm) of tested wheat cultivars are shown in Tables (2 and 3). However, Sakha 93 exhibited the highest average of plant height under high salt level (12.72 cm, Table 2) but unfortunately, showed the lowest plant height in field experiment (88.67 cm, Table 3). As for Yemeni wheat cultivars, Kaaalhakl cv. showed the lowest seedling under high NaCl concentration (11.0 cm, Table 2) but it showed the highest plant height (117 cm, Table 3), followed by"Behoth14 and Gemmeiza 9" (113 and 103.4 cm), in respect, (Table 3). Behoth14 cv. showed the highest seedling tall under 150 m M., NaCl. All the tested cultivars showed significant variations in seedling height with $L.S.D._{0.05}$=0.494 and between the control treatment and different salt applied concentrations ($L.S.D._{0.05}$=0.31, Table, 2). In Egyptian wheat cultivars the seedling height ranged from 12.30 (Gemmeiza 9) to 14.65 cm (Sakha 93) by range 2.35 cm (Table, 2), while in Yemeni wheat cultivars were 13.79 cm (Sonalica cv.) to 15.62 cm by range 1.83 cm (Behoth14, Table, 2). At the field experiment, plant height ranged from 88.67 cm (Sakha 93) to 103.4 cm (Gemmeiza 9) by range 14.73 cm and in Yemeni wheat ranged from 96 cm (local wheat) to kaaalhaki (117 cm) by range 21 cm (Table, 3). In general Yemeni wheat cultivars showed the highest mean values of seedling and plant height (cm) than Egyptian wheat cultivars (Table2and 3). The interaction between NaCl concentrations and cultivars showed significant difference with $L.S.D._{0.05}$=0.98 and the highest mean value was 18.37 cm for "Kaaalhakl cv." under control cultivars while "Gemmeiza 9 cv." gave the lowest one (10.0 cm). The reduction of plant height under salt stress conditions was also reported by Khan *et al.* (2007).

The obtained data for the seedling root length (cm) under higher salt level of NaCl (150 mM.) as shown in Table (2), indicated the highest significant variations between the Yemeni and Egyptian wheat cultivars under the study. However, "Sakha

93 cv." recorded the highest one (3.33 cm), meanwhile the cultivar “Egypt 1”achieved the lowest mean value (2.33 cm). The general means for all Egyptian wheat cultivars ranged from 3.47 to 4.54 cm and in Yemeni wheat cultivars ranged from 2.69 to 4.21 cm in "Gemmeiza 9, Sakha 93", "Acsadgahra and Behoth14 cv." in respect with L.S.D.$_{0.05}$=0.161 (Table 2). Data showed, significantly, variations between control cultivars and different salt treatments, the highest values was 4.18 cm for control, on the other hand,the lowest one (3.21 cm) was recorded under the higher level of salts by range 0.97 cm, with L.S.D.$_{0.05}$=0.10 (Table 2). This present result is in line with Datta *et al*. (2009) who concluded that different level of salinity significantly affected the growth attributes in wheat throuth reducing root and shoot length for salinity below 125 mM. They found that the reduction in root and shoot development may be due to toxic effects of the higher level of NaCl concentration. High level of salinity may have also inhibit the root and shoot elongation due to slowing down the water uptake for overall osmotic adjustments of the plant body under high salt stress condition.

Data for respecting, number per seedling under different NaCl levels are presented in Table (2). The highest number (3.0 leaves) recorded with the cultivar “kaaalhaki” in comparison with other cultivars which achieved nearly the same average (2.0) (Table, 2). This cultivar “kaaalhaki” showed an increase in leaves number under high NaCl level (150 mM). The general mean between cultivars ranged from 2.12 (Gemmeiza 9 cv.) to 2.44 (kaaalhaki cv.) with L.S.D.$_{0.05}$=0.218. Also, significant variation was observed among control and different NaCl levels with L.S.D.$_{0.05}$=0.14 and in the same time, there was no significant variation between NaCl levels. The average ranged from 3.09 to 3.21 (Table 2). Data, also, showed their interaction between NaCl and cultivars detected that kaaalhaki cv. had the highest value (3.0) under 150 mMNaCl and "Gemmeiza 9 cv." was (1.80) under 50 mMNaCl (Table 2).

However, both "Geiza168 and Behoth14" cultivars recorded the highest root number per seedling (6.50/seedling) under high salt level as shown in Table (2). The lowest number was achieved by local wheat cultivar by average 5.33 root/seedling. The general means for all cultivars ranged from 5.43 to 7.01 in Gemmeiza 9 and kaaalhaki cv., in respect, with L.S.D.$_{0.05}$=0.199 and between control and different salt levels from 5.95 (150 mM) to 6.65 (control) with L.S.D.$_{0.05}$=0.13 (Table, 2). Also, the increase of salt from 50 to 150 mM, onwards, significantly, reduced the root length and number, but the seedling performance was a satisfactory and these results agreed with those, reported by Amor *et al.* (2005) and Rubio-Casal *et al.* (2003) reported that shoot and root length decrease in salt conditions.

Good indicator was used to test the wheat cultivars against salt levels is chlorophyll content (mg/m^2) as shown in Table (2). Approximately 50% decrease in chlorophyll content from control one to the highest NaCl levels (Table 2). Chlorophyll content in control ranged from 91.71 (Sakha 94 cv.) to 178.68 (Behoth 14 cv.), while under 150 mM NaCl ranged from 43.43 (Egypt 1 cv.) to 77.93 (Local wheat cv.). Our results are in the line with those obtained by Seeman *et al*. (1985) and Cha-um *et al.* (2009). Meanwhile, Singh *et al*. (1985)revealed that the reduced in total chlorophyll concentration under NaCl concentrations may be taken place due to membrane deterioration of the cell membrane of the chloroplast leading towards lesser accumulation of chlorophyll and lesser photosynthetic efficiency. Salinity affects both water absorption and metabolic processes and a decline in the rate of Photosynthesis by negatively affecting CO_2 assimilation and leads to decrease nutrient uptake and finally carbohydrate concentration reduced. The protein reduction in the physiologically active leaves is due to reduce capacity to incorporate amino acids into proteins and an increase in proteolytic enzymes or due to contribution of polysomes to monosomes under stress condition or due to the synthesis of abscisic acid which increases the activity of RNase, thus indirectly inhibiting the protein synthesis.

Table 2: Average of plant attributes for five Yemeni and five Egyptian wheat cultivars as affected by different salinity levels and their interaction during the season 2013/2014.

	(B) NaCl (mM)	Season 2013													
		(A) Cultivars											LSD. at 0.05		
		Yemeni cultivars					Egyptian cultivars					Mean (B)	A	B	AxB
		Beh. 14	Son.	Acsad.	Kaa.	L. wheat	Sh. 93	Ge. 168	Ge. 9	Sh. 94	Eg. 1				
Seedling length (cm)	0	17.67	18.19	16.13	18.37	17.97	18.27	15.50	14.80	14.53	14.53	16.60^{a}	0.494	0.31	0.98
	50	16.88	13.23	15.97	15.10	16.23	14.82	13.74	12.73	13.00	12.78	14.45^{b}			
	100	15.10	12.50	15.37	12.67	13.43	12.80	12.83	11.67	11.83	12.03	13.02^{c}			
	150	12.83	11.23	12.40	11.00	11.67	12.72	11.40	10.00	10.33	10.33	11.39^{d}			
Mean (A)		15.62^{a}	13.79^{d}	14.97^{b}	14.29^{c}	14.83^{b}	14.65^{bc}	13.37^{d}	12.30^{e}	12.42^{e}	12.42^{e}				
Root length (cm)	0	5.40	6.18	2.63	3.17	4.47	4.53	4.57	3.87	3.13	3.86	4.18^{a}	0.163	0.10	0.33
	50	4.07	3.93	2.63	2.85	4.37	4.50	3.93	3.87	3.61	3.78	3.09^{c}			
	100	3.55	3.23	2.87	2.85	3.90	4.80	3.07	3.33	3.50	3.54	2.93^{d}			
	150	3.83	3.23	2.62	2.67	3.40	4.33	3.43	2.80	3.20	2.33	3.21^{b}			
Mean (A)		4.21^{b}	4.14^{c}	2.69^{f}	2.89^{f}	4.04^{c}	4.54^{a}	3.75^{d}	3.47^{e}	3.36^{f}	3.38^{e}				
Leaves number /seedling	0	2.67	2.56	2.47	2.60	2.67	2.65	2.76	2.50	2.84	2.64	2.64^{a}	0.218	0.14	0.44
	50	2.00	2.00	2.60	2.10	2.00	2.00	2.00	1.80	2.00	2.00	2.05^{b}			
	100	2.07	2.07	2.10	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.02^{b}			
	150	2.00	2.00	2.10	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.11^{b}			
Mean (A)		2.19^{b}	2.15^{b}	2.32^{ab}	2.44^{a}	2.17^{b}	2.17^{b}	2.17^{b}	2.12^{b}	2.17^{b}	2.17^{b}				
Number of roots/ seedling	0	6.13	6.10	6.70	7.47	6.80	7.60	6.67	5.87	6.60	6.60	6.65^{a}	0.199	0.13	0.39
	50	6.93	6.13	6.27	7.13	7.50	7.00	6.33	5.10	5.40	6.10	6.39^{b}			
	100	6.47	4.40	6.53	6.96	6.00	6.87	6.87	5.27	6.33	6.13	6.18^{c}			
	150	6.50	5.80	6.13	6.47	5.33	5.90	6.50	5.47	6.00	5.40	5.95^{d}			
Mean (A)		6.51^{b}	5.61^{d}	6.41^{b}	7.01^{a}	6.41^{b}	6.84^{a}	6.59^{b}	5.43^{d}	6.08^{c}	6.06^{c}				
Chlorophyll (mg/m^{2})	0	178.68	154.76	116.37	129.16	146.08	124.88	102.12	111.61	91.71	111.76	126.7^{a}	7.60	12.02	24.04
	50	123.60	121.26	96.27	100.71	98.38	85.19	73.18	81.91	69.83	91.69	94.2^{b}			
	100	131.50	113.95	99.01	94.94	83.48	77.41	59.93	64.79	58.52	56.20	83.9^{c}			
	150	63.24	75.88	61.05	68.23	77.93	57.84	52.02	66.16	49.59	43.43	61.54^{d}			
Mean (A)		124.26^{a}	116.5^{a}	93.2^{bc}	98.3^{bc}	101.5^{b}	86.3^{cd}	71.8^{ef}	81.2^{de}	67.4^{f}	75.7^{def}				
- Mean values in the same column/row marked with the same letters are not significantly different at 0.05 level of probability.															

There are some reports where declared an increase in chlorophyll contents was observed in genotypes of wheat but the reduction in chlorophyll contents is to be expected under stress; being membranous bound, its stability is dependent on membrane stability, which under saline condition seldom remains intact. The decrease in chlorophyll content under saline conditions is reported by Iqbal *et al.* (2006). Our results are in agreement with those workers, who reported that in all cultivars, chlorophyll contents were decreased. The decrease is significant in sensitive genotypes in comparison to tolerant. Plants may be more salt tolerant at germination stage, but salt sensitive in following growth stages. Therefore, it has been proposed in some cases in which germination is more tolerant to salt, that the use of this criterion is not logical, since the problem of survival in later sensitive growth stages may still exist. On the other hand, it has been suggested that selection at germination is important and effective in species that are relatively sensitive in this stage. Based on the previous results, it could be possible to mention that number of researchers had suggested that screening for salt tolerance could be more effective if the assessments would be undertaken under controlled environmental conditions and using physiological markers/traits rather than breeding for yield and yield components under saline soil conditions (Flowers and Yeo, 1995). The results of the current study are cope with Norlyn and Epstein (1984) who pointed out that germination percentage % and seedling growth could be the first indicators of salt tolerance. The obtained results are also, in line with those of William *et al.* (1993) who indicated that high salt concentration reduced, seed germination percent, number of roots, root length and shoot length, significantly. Our results agreed, too with those of Flowers *et al.* (2001)

who observed that root length was decreased, drastically, with addition of NaCl to the soil but index of root/shoot increased.

The chlorophyll and total carotenoid contents of leaves decrease, in general, under salt stress. The oldest leaves start to develop chlorosis and fall with prolonged period of salt stress (Hernandez *et al*., 1995, and 1999; Gadallah, 1999; Agastian *et al*., 2000). However, Wang and Nil (2000) revealed that chlorophyll content increased under conditions of salinity in Amaranthus. The current researchis harmony, too with those obtained by Turki *et al.* (2014) who investigated variation in response to salt stress among 119 worldwide landraces and improved varieties of durum wheat at seedling and maturity stages. They pointed out that at seedling stage 100 m M NaCl decreased chlorophyll content, leaf length, number of tillers per plant, number of leaves per plant, shoot length and shoot fresh and dry weights, while at maturity stage plant height, the number of fertile spikes per plant and the number of seeds per spike were affected by at 100 mM NaCl. Ayers and Wescot (1976) detected that wheat yield decreased by 50 percent at soil saturation extracts of 13 dS/m as salinity conditions. The threshold at which grain yield starts to decrease was taken placewith an increase in soil salt was 5.9 dS/m for durum wheat and 8.6 dS/m for bread wheat. Furthermore, wheat yield was decreased at a higher rate with increase in salt content in soil (Maas and Grieve, 1986; Acevedo *et al*., 2003).

In the present study number of tillers/plant as shown in Table (3) ranged from 1.67 to 4.33 with 3 on average (Table, 3) with $L.S.D._{0.05}$=0.829. The highest value (4.33 tillers) was recorded (Acsadgahra cv.) and the lowest one (1.67 tillers) was obtained by planting (Sakha 93) cultivar. These results are in harmony with those results obtained by El-Hendawy (2005); Goudarzi *et al*. (2008) who indicated that the reduction of the number of tillers per plant in wheat recorded under salt stress.

However, the evaluation of final grain yield of growth parameters determining grain yield is critical to breeding programs. The final yield of wheat was determined by the number of spikes per plant and various yield components, such as the fertile spikelet number, grain number, and grain weight. For instance, in this study spikelets and grains number per spike data in Table 3 indicated that cultivars Kaaalhakl cv. and Gemmeiza 9 cv. recorded the highest values were 22.25, 21.50, 68.50 and 68.0, respectively. While, Sonalica, Acsadgahra and local wheat cv. showed the lowest values of spikelets and grains number per spike i.e.(14.75, 15.50) and (44.25, 45.50 and 45.55). High significant variation was observed with $L.S.D._{0.05}$=1.72 and 3.16 (Table 3). The findings results are in agreement with those obtained by Maas and Grieve (1990), Grieve *et al*. (1993); Francois *et al.* (1994) concluded that salt, significantly, reduced the number of spikelet primordia on the main spike of wheat.

Salinity and water stress decreased germination percentage, plant height, total weight, and shoot weight, and increased Na and Cl concentration significantly in shoots. The cultivar Sakha 93 and Gemmieza 7 surpassed other cultivar (Giza 168) under salinity and water stress in the most of characteristics (Kandil *et al*., 2013).

The most important value for any breeder and farmer is yield or grain weight, 1000 grain weight (g) and grain yield per acre (kg) which are an indicator for the end product of any agricultural and scientific applications. Data in Table 3 showed that cultivars Gemmeiza 9 and Kaaalhakl have the highest significant values between them (60.75 and 52.63 g) and (2972.75 and 2226.50 kg), in respect, with $L.S.D._{0.05}$=2.97 and 111.88, respectively. The lowest average value was recorded for Behoth 14 (45.58 g) and 1964.75 kg per acre. In ascending order, the cultivar "Behoth 14" was the fourth one after Sakha 93, & 94 and Local wheat. The range between Egyptian and Yemeni wheat cultivars for 1000 grain weight was 12.50 g from the highest to lowest average (Table 3). During the onset and development of salt stress within a plant, all the major processes such as photosynthesis, protein synthesis, and energy and lipid metabolism are affected adversely, (Flowers *et al.,* 1977; Greenway and Munns, 1980; Ehret and Plant, 1999; Hasegawa *et al*., 2000; Zhu, 2002).

Table 3: Average of plant attributes for five Yemeni and five Egyptian wheat cultivars under field condition, 2013/2014.

Cultivars	Plant height (cm)	Tillers No./ plant	Spikelets No./ spike	Grains No./ spike	1000-Grain Weight (g)	Grain yield kg/fed.	Straw Yield kg/fed.	Biol. Yield kg/fed.	Harvest Index H.I. %	Grain Protein %
Shakha93	88.67	1.67	16.75	45.75	48.05	1863.75	3338.75	5202.50	35.82	8.56
Geiza168	90.0	3.67	18.00	50.00	47.25	2054.50	3615.00	5669.50	36.24	9.29
Gemmeiza 9	103.4	4.67	22.25	68.50	60.75	2972.75	3900.00	6872.75	43.25	9.51
Shakha 94	97.33	3.00	16.50	46.50	48.70	1948.75	3292.50	5241.25	37.18	7.90
Egypt1	94.33	3.66	19.50	63.50	52.65	2142.75	3237.50	5380.25	39.83	8.01
Behoth 14	113.0	3.00	17.00	47.50	45.58	1964.75	3375.00	5339.75	36.79	8.10
Sonalica	100.6	3.67	14.75	44.25	48.50	2033.75	3527.50	5561.25	36.57	8.15
Acsadgahra	94.67	4.33	15.50	45.50	47.48	1981.50	3356.75	5338.25	37.12	8.05
Kaaalhakl	117.0	4.00	21.50	68.00	52.63	2226.50	2887.75	5114.25	43.54	8.57
Local wheat	96.00	3.67	15.50	45.55	48.25	1865.00	2855.25	4720.25	39.51	8.15
L.S. $D_{0.05}$	12.03	0.829	1.72	3.16	2.97	111.88	384.50	398.60	2.91	0.494

As for straw and biological yield per feddan=0.42hectare (kg) as shown in Table (3), the obtained results showed that Gemmeiza 9 cv. expressed the highest yielder cultivar (3900 and 6872.75 kg) compare with other cultivars, although Sonalica cv. have lower number of spikelets per spike (14.75),but showed high straw and biological yield per feddan (3227.50 and 5561.25 kg). Harvest index was calculated for all the cultivars under study and these values were linked to the other morphological data which presented before, so “Gemmeiza 9 and Kaaalhakl” cvs. recorded the high H.I %with values 43.25 and 43.54% (Table 3). The lowest HI % was recorded for“ Sakha 93” cv. by 35.28%. Finally, assessment the grains protein content in both Egyptian and Yemeni wheat cultivars showed that “Gemmeiza 9” cv. had the high value (9.51 %) comparing with the cultivar Sakha 94 (7.90 %). Significant variations were observed between all cultivars in grains protein content with L.S.D.$_{0.05}$=0.494.

Effects of salinity on antioxidative enzymes and antioxidants

In the current research ten Egyptian and Yemeni wheat cultivars were subjected to different NaCl levels in the laboratory (50, 100 and 150 mM) and field (4.75 EC_e (dS/m= 47.5 mM)in addition to control treatment. The data in Figure 1 showed that Kaaalhaki, Sakha 93 and Behoth 14 cultivars showed high enzyme activity (7, 7 and 6.00 loci), respectively under the high NaCl condition (150 mM) as comparing with control plants which ranged from 2 to 4 loci. Compassion with field condition (4.75 EC) the data in Figure (1) ranged from 3 to 5 loci. These data suggested that the previous cultivars maybe salt tolerant in comparison with the other cultivars. In fact, when plants are subjected to environmental stress conditions such as salinity, high light intensity, temperature extremes, drought, high, herbicide treatment, or mineral deficiencies, the balance between the production of reactive oxygen species and the quenching activity of the antioxidants is upset, often resulting in oxidative damage. Plants with high levels of antioxidants, either constitutive or induced, have been reported to have greater resistance to this oxidative damage (Spychalla and Desborough, 1990). The activities of the antioxidative enzymes such as catalase (CAT), ascorbate peroxidase (APX), guaicol peroxidase (POD), glutathione reductase (GR), and superoxide dismutase increase under salt stress in plants and a correlation of these enzyme levels and salt tolerance exists (Benavides *et al.*, 2000; Hernandez *et al.*, 2000; Sreenivasulu *et al.*, 2000; Lee *et al.*, 2001; Mittova *et al.*,2003).

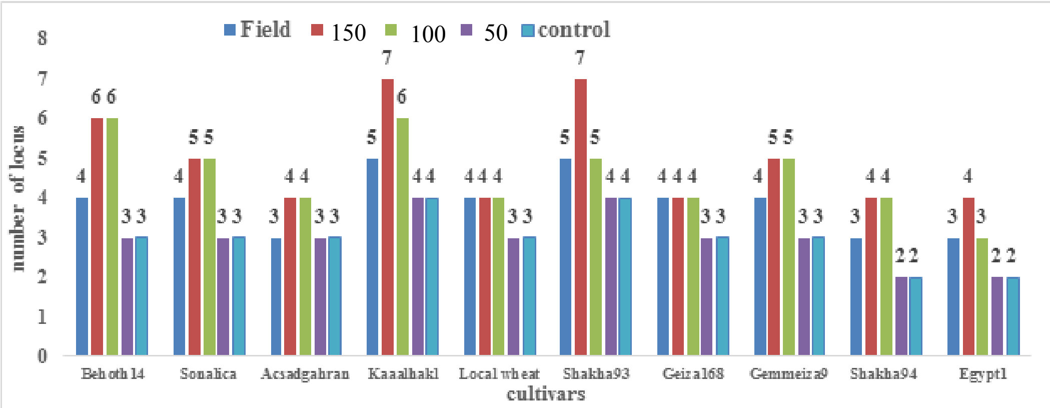

Fig. 1: Peroxidase enzyme activity for the Egyptian and Yemeni wheat cultivars under different salt conditions.

Salt stress causes water deficit as a result of osmotic effects on a wide variety of metabolic activities of plants and this water deficit results in oxidative stress because of the formation of reactive oxygen species such as superoxides and hydroxy and peroxy radicals. The reactive oxygen species that are by-products of hyperosmotic and ionic stresses cause membrane disfunction and cell death (Bohnert and Jensen, 1996). The plants provide defense against these reactive oxygen species by induction of activities of certain antioxidative enzymes which scavenge reactive oxygen species. There are several reports of increasing activity of antioxidative enzymes. Activities of ant oxidative enzymes increase under salt stress in wheat, while Cu/ Zn-SOD remains constant and total ascorbate and glutathione content decrease (Hernandez *et al.*, 2000). The obtained results are in core, more or less, with Fariba *et al.* (1999) who revealed that peroxidase (POD) activity increased significantly especially during tillering stage, when it was grown on the high NaCl media. The data indicated a strong correlation between antioxidant activity and salt tolerance.

Proline content (µ moles/g/fresh weight)

Accumulation of solutes especially proline, glycine-betaine and sugars is a common observation under stress condition (Qasim *et al.*, 2003). Ashraf *et al.* (1990) revealed that proline is an important osmolyte to adjust the plant under drought/saline conditions. Proline is an amino acid and compatible solute commonly accumulates in many plants exposed to various stress conditions such as salinity.

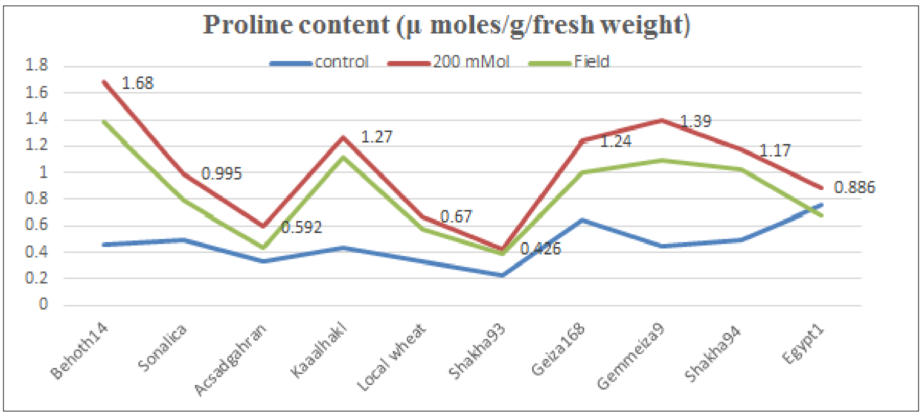

Fig. 2: Proline content of Egyptian and Yemeni wheat varieties affected by different salinity conditions during season 2014 and 2015.

Under stress condition, Proline is synthesized from glutamate due to loss of feedback regulation in the Proline biosynthetic pathway (Treichel, 1975; Boggess and Stewart, 1980).In the present study, the accumulation of proline was commonly observed in almost all cultivars under different salt conditions comparing with control ones. Data in Figure 2 expressed that under 150 mMol of NaCl Behoth 14, Gemmeiza 9 cv. were the highest cultivars in proline accumulation (1.68 and 1.39µ M/g/fresh weight, in each in trun) and Kaaalhakl, Sakha 94 were moderated for proline content (1.27 and 1.17 µ moles/g/fresh weight), while Sakha 93 was the lowest cultivars by 0.426 µ moles/g/fresh weight. On the other hand, in field experiment the value of proline accumulation was decreased due to soil salinity comparing with 150 mM. Also, Behoth 14 was the highest cultivar by mean 1.38 µ M/g/fresh weight followed by Kaaalhakl (1.12) and at end Sakha 93 by 0.39 µ M/g/fresh weight (Fig. 2). From these results we can suggest that Behoth 14, Gemmeiza 9 and Kaaalhakle cv. are salt tolerant cultivars depending on the previous data. This result is in line with that of Munns and James (2003). The obtained results supported the conclusion that proline was more accumulated in the salt, dry soil genotype, and may be useful as a possible salt injury sensor in plants.

This variation of proline could be useful in selection for salt tolerance and used marker of salt tolerant plants. Genotypic variations in proline accumulation have been observed in many studies and attempts were made to correlate its accumulation with tolerance of plants to stress. This apparent correlation between proline accumulation and environmental stress suggests that proline could have a protective function (Ahmed and Hasan, 2011). Measurement of proline accumulation is, also an important criterion for determination of plant tolerance to salt stress (Palfi and Juhasz, 1971). In salt stressed plants osmotic potential of vacuole decreased by proline accumulation (Yoshiba, *et al.,* 1997). It was thought that accumulated proline under environmental stress do not inhibit biochemical reactions and plays a role as some protectant during osmotic stress (Yoshiba, *et al*., 1997). In addition, several possible roles have been attributed to super optimal levels of proline, osmoregulation under drought and salinity conditions, stabilization of proteins, prevention of heat denaturation of enzymes and conservation of nitrogen and energy for a post stress period (Aloni and Rosenshtein, 1984).The relationship between proline accumulation and environmental stress suggests that proline could have some protective function. The present results are in agreement with Manisha Jain, *et al.* (2013) who reported that when subjected seedlings of *T. aestivum* (wheat) to drought conditions of salinity with different concentrations of NaCl showed high accumulation of proline with 65 times of more than that of the control, whereas at low saline conditions of 0.5MNaCl its showed only 31.42% of proline. The increased levels of proline, under salt stress, has been reported in two wheat cultivars (Khatkar and Kuhad, 2000). It was suggested that proline accumulation may be caused by increased proteolysis or by decreased protein synthesis.A positive correlation between magnitude of free proline accumulation and salt tolerance has been suggested as an index for determining salt tolerance potentials between cultivars (Misra and Gupta 2005). The magnitude of increase in free proline accumulation was higher in the tolerant cultivars than in the sensitive ones (Misra and Gupta 2005; Kholová *et al.,* 2010). However, some researchers reported that proline accumulation cannot be used as a sole criterion for salt tolerance (Moradi and Ismail, 2007).

Estimation of heterosis for Egyptian and Yemeni wheat hybrids

Plant height (cm) of tested cultivars were ranges of heterosis for plant height (cm) were 4.31 to 33.94% (Table 4). The highest heterosis percentage was recorded to

Y_3xE_1, Y_1xE_1, Y_4xE_1 (Acsadgahran, Behoth 14 and Kaaalhakl x Sakha 93) with values 33.94, 25.22 and 24.12, in respect. While the lowest heterosis percentage was observed in Y_2xE_2, Y_4xE_2 and Y_4xE_3 (Sonalica and Kaaalhakl x Geiza 168 and Gemmeiza 9) with values 4.31, 5.09 and 5.33, respectively. Significant heterosis in plant height was observed (Table, 3).In this experiment, the hybrid crosses for plant height ranging 99.50–120.61 cm. Previously, Mahajan *et al.* (1999), Singh *et al.* (2004) and Hussain *et al.* (2007) reported positive heterosis for plant height, whereas negative heterosis has been recorded by Bhutta*etal.* (2005), Ilker *et al.* (2010) andBilgin *et al.* (2011). Inamullah *et al*. (2006) reported that taller plants are likely to logde quite often. Tall plantsrequire more energy to translocate solutes to the grain weight and Jan *et al.* (2005), also reported that negative heterosis is desirable when breeding for lodging resistance.

Tillers number per plant showedhigh positive heterosis to all cross hybrids ranges from 3.60 (Y_3xE_4) to 36.90 (Y_1xE_3) as shown in Table 4. Normally, the same trend for hybrids height which was the highest value 5.75 (Y_1xE_3) to 4.08 (Y_3xE_4). Tillers number correlated to spike number per plant and spikelet number per spike. Significantly and positive heterosis values for spikelet number/spike were found in all crosses (Table 4). The maximum heterosis percentage were 27.35 and 28.08 % in Y_4xE_1 andY_3xE_4, respectively, and the lowest percentage was 4.97% Y_2xE_2 (Table 4).These results reflect positive significant heterosis values on spikelet number/spike are agreement with Ilker *et al.* (2010). Yağdı and Karan (2000) reported 2.2 % mean heterosis for spikelet number/spike in the crosses obtained from 13 wheat lines. Their results are highly different in terms of spikelet number/ spike determined in the study. These findings are supported bythese of Chowdhry *et al*. (2005), Çifci and Yağdı (2007) and Bilgin *et al*. (2011).

Positive heterosis for grain number per spike were significant in 25 crosses for heterosis (Table 4). The results indicated that heterosis percentage reached up to 39.90% (Y_5xE_1) and the lowest one was Y_2xE_2 (2.66%). These results could be verified from Tiwari and Chakraborty (1992).

As for 1000 grain weight results (Table 4) were in the same line with the previous data for plant height, tillers number and grain number per spike. The high heterosis was recorded to Y_1xE_1 with percentage 31.82 and the lowest one was 1.16% recorded to Y_4xE_5 . This result indicated that in crosses when spikelet number, kernel number and grain yield per spike increased 1000-kernel weight increased significantly. These results are in agreement with these of Ilker *et al*. (2010). Also, these findings are in agreement with those reported by Yağdı and Karan (2000) and Çifciand Yağdı (2007). Ilker *et al*. (2010) determined negative or lack of significant positive heterosis values. From the previous data we can conclude that using the Yemeni wheat cultivars as donor for pollen grains to the Egyptian wheat cultivars, increased the percentage of heterosis in all morphological characters.

Table 4: Morphological characters and heterosis of Egyptian and Yemeni wheat parents and their hybrids

Characters	Growth characters		Yield characters		
Parents & hybrids	Plant height (cm)	Tillers number /plant	Spikelets number/ spike	Grains number/spike	1000- grain weight (g)
Y_1 (♂)	105.78	2.94	20.91	63.70	52.27
E_1 (♀)	86.85	3.95	18.02	55.30	44.98
(F_1) Y_1E_1	120.61	4.42	22.90	68.7	64.1
H %	25.22	28.30	17.64	15.46	31.82
E_2 (♀)	86.28	4.71	16.85	49.30	52.23
(F_1) Y_1E_2	104.63	4.53	20.19	58.3	58.3
H %	8.95	18.32	9.93	3.18	11.57
E_3 (♀)	107.46	5.36	19.69	59.0	63.18
(F_1) Y_1E_3	121.96	5.75	23.00	66.1	64.5
H %	14.38	36.90	13.30	7.74	11.73
E_4 (♀)	92.67	2.68	15.34	46.7	48.48
(F_1) Y_1E_4	105.88	3.11	20.40	61.4	56.1
H %	6.70	10.55	12.55	11.23	11.36
E_5 (♀)	95.05	3.35	17.84	54.0	59.46
(F_1) Y_1E_5	109.84	3.54	22.35	66.5	62.6
H %	11.03	12.50	15.35	12.99	12.05
Y_2 (♂)	101.60	3.35	18.77	58.5	45.28
E_1 (♀)	86.85	3.95	18.02	55.30	44.98
(F_1) Y_2E_1	112.72	4.81	21.45	64.4	56.87
H %	19.61	24.49	16.58	13.18	26.01
E_2 (♀)	86.28	4.71	16.85	49.30	52.23
(F_1) Y_2E_2	99.50	4.37	18.7	55.5	52.7
H %	4.31	4.39	4.97	2.66	8.09
E_3 (♀)	107.46	5.36	19.69	59.0	63.18
(F_1) Y_2E_3	119.1	5.0	21.8	61.5	58.2
H %	13.93	9.70	13.34	4.68	7.32
E_4 (♀)	92.67	2.68	15.34	46.7	48.48
(F_1) Y_2E_4	105.18	3.36	19.9	60.5	56.1
H %	8.27	5.97	16.65	15.01	19.66
E_5 (♀)	95.05	3.35	17.84	54.0	59.46
(F_1) Y_2E_5	113.05	4.13	20.51	61.2	57.8
H %	15.45	17.86	12.20	8.80	10.36
Y_3 (♂)	93.24	4.52	15.37	46.20	43.39
E_1 (♀)	86.85	3.95	18.02	55.30	44.98
(F_1) Y_3E_1	120.61	5.09	18.02	59.8	53.8
H %	33.94	20.14	18.75	17.83	21.76
E_2 (♀)	86.28	4.71	16.85	49.30	52.23
(F_1) Y_3E_2	105.16	4.88	16.85	57.9	54.9
H %	12.29	5.62	19.77	21.25	14.82

Cont.

Characters / Parents & hybrids	Growth characters		Yield characters		
	Plant height (cm)	Tillers number /plant	Spikelets number/ spike	Grains number/spike	1000- grain weight (g)
E_3 (♀)	107.46	5.36	19.69	59.0	63.18
(F_1) Y_3E_3	115.07	5.65	20.51	61.3	56.6
H %	10.39	13.19	16.97	16.53	6.22
E_4 (♀)	92.67	2.68	15.34	46.7	48.48
(F_1)Y_3E_4	103.72	3.84	19.56	56.1	53.4
H %	7.10	6.53	27.35	20.77	16.25
E_5 (♀)	95.05	3.35	17.84	54.0	59.46
(F_1) Y_3E_5	105.06	4.08	16.38	61.7	58.2
H %	9.36	3.60	9.22	23.15	13.17
Y_4 (♂)	104.38	4.٣١	15.91	47.6	60.94
E_1 (♀)	86.85	3.95	18.02	55.30	44.98
(F_1) Y_4E_1	118.69	5.01	21.73	64.6	60.2
H %	24.12	21.26	28.08	25.55	13.67
E_2 (♀)	86.28	4.71	16.85	49.30	52.23
(F_1) Y_4E_2	100.19	5.15	19.6	58.6	58.8
H %	5.09	14.06	19.65	20.94	3.91
E_3 (♀)	107.46	5.36	19.69	59.0	63.18
(F_1) Y_4E_3	111.57	5.6	21.35	60.3	63.5
H %	5.33	14.60	19.94	13.13	2.32
E_4 (♀)	92.67	2.68	15.34	46.7	48.48
(F_1) Y_4E_4	105.49	3.72	19.16	56.7	56.7
H %	7.06	6.30	22.63	20.25	3.63
E_5 (♀)	95.05	3.35	17.84	54.0	59.46
(F_1) Y_4E_5	105.32	4.21	19.7	58.7	60.9
H %	5.62	9.83	16.74	15.55	1.16
Y_5 (♂)	99.30	3.29	12.92	38.20	47.27
E_1 (♀)	86.85	3.95	18.02	55.30	44.98
(F_1) Y_5E_1	108.65	3.42	19.55	61.2	55.6
H %	16.72	35.57	26.37	30.90	20.54
E_2 (♀)	86.28	4.71	16.85	49.30	52.23
(F_1) Y_5E_2	99.21	3,90	17.8	51.5	51.8
H %	6.91	13.35	19.58	17.71	4.12
E_3 (♀)	107.46	5.36	19.69	59.0	63.18
(F_1) Y_5E_3	110.24	4.91	20.3	61.6	59.4
H %	6.63	34.81	24.50	26.74	7.55
E_4 (♀)	92.67	2.68	15.34	46.7	48.48
(F_1) Y_5E_4	102.91	3.42	15.34	45.8	49.6
H %	7.21	14.40	8.56	7.89	3.60
E_5 (♀)	95.05	3.35	17.84	54.0	59.46
(F_1) Y_5E_5	103.0	3.90	19.49	58.2	58.2
H %	8.17	17.36	26.72	26.24	9.06
$LSD_{=0.05}$ (P)	4.60	0.4263	0.8607	3.18	3.32
$LSD_{=0.05}$ (F_1)	6.03	0.6507	2.128	6.94	6.756
$LSD_{=0.05}$ (PF_1)	5.74	0.5943	1.86	6.18	6.04

* Y1: Behoth14, Y2: Sonalica, Y3: Acsadgahran, Y4: Kaaalhakl, Y5: Local wheat, E1: Shakha93, E2: Geiza168, E3: Gemmeiza9, E4: Shakha94 and E5: Egypt1

*Mean values in the same column marked with the same letters are not significantly different at 0.05 level of probability

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