EVALUATION OF NINE EGYPTIAN BREAD WHEAT CULTIVARS FOR SALT TOLERANCE AT SEEDLING AND ADULT-PLANT STAGES

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ABSTRACT

The present study was conducted at the Experimental Farm and the Laboratories of Wheat Research Department and Soil Physical and Chemical Research Department of Sakha Agricultural Research Station, Agricultural Research Center, Kafrelsheikh, Egypt, in 2014/2015 season. The objectives of this investigation were to study salinity effect on different nine bread wheat cultivars, to identify salt tolerance in several growth stages, and to identify salt tolerance screening criteria by studying the relationship between wheat yield under salt affected soil and several growth stages characters. Three experiments were conducted in 2014/2015, i.e., seedling test in the lab (open area), adult plant evaluation in pots in open area and field experiment in normal soil and salt affected soil. Salinization in seedling and pots experiments was established using five levels of Mediterranean Sea water to tap water mixture (0, 26, 29, 31, 33 and 35% sea water) which established EC 0.48, 13.5, 15.0, 16.0, 17.0 and 18.0 dS m⁻¹, respectively. The nine cultivars Misr 1, Misr 2, Giza 139, Giza 144, Gemmeiza 9, Gemmeiza 3, Hindi 62, Sids 1, and Sids 12 were used. Results indicated that increasing salt concentrations caused significant decrease in shoot dry weight, shoot length, root dry weight, root length and emergence index at seedling stage; plant height, biological yield, grain yield, straw yield, number of kernels per spike and kernel weight at adult plant stage; however, shoot root dry weight ratio at seedling stage was increased. The variances due to salt treatments had the major portion of total variance, indicated the large effect of salt stress on growth characters compared to genotypes and genotypes × salt concentration interaction's variances. The treatment 33% sea water mix (17 dS m⁻¹) seems to be suitable for screening the studied cultivars for salt tolerance. The large variance among the nine cultivars for shoot length, emergence index and shoot-root dry weight ratio under salt stress indicated the importance of these characters in studying the effect of salt stress at seedling stage. Strong and positive correlations were found between biological yield (under salt affected soil) and each of emergence index and shoot length at seedling stage; number of spike per pots, biological and straw yields per pot at adult-plant stage. Based on stress tolerance index, out of the nine studied cultivars, Misr 2 can be classified as salt tolerant cultivar and Gemmeiza 3 and Sids 12 as salt sensitive cultivars.

Keywords: Bread wheat, Salinity stress, seedling and adult-plant salt tolerance.

INTRODUCTION

Wheat is moderately tolerant to salt with threshold without yield loss at 6 dS m⁻¹ and with yield 50% loss at 13 dS m⁻¹ (Mass and Hoffman, 1977). Approximately 7% of the world’s total land area is affected by salinity (Flowers et al., 1997). The saline area increases by 10% per year all over the world (Ponnamiera, 1984). Salinity is a major constraint to food production because it limits crop yield and restricts use of land previously uncultivated. In Egypt, 33% of cultivated area suffer severe salinity problems (Ghassemi et al., 1995). The Egyptian Government has spent large sums on reclamation, mainly on drainage projects (more than US$ 30 million annually) to solve salinity problems in irrigated area, but the annual average net income from crops grown with drainage system is more limited than for those grown without drainage system (Amer et al., 1989). Therefore, genetic improvement for salt tolerance particularly in major crops has become an urgent task in dealing with salinity problems in the Egyptian agriculture sector, because this approach is less expensive for poor farmers than others. Regardless of the fact that irrigation waters and agricultural soil solutions are comprised of multiple combinations of cations and anions, the shortcomings of salinity experiments use NaCl as the sole salinating salt reported by Lazof and Bernstein (1999). So, many researchers used levels of diluted sea water as salinized treatments (Abdelsalam, 2012, Aldesuquy et al., 2012 and Almaghrabi, 2012). Breeding for salt tolerance is a difficult and slow progress due to a combination of many factors: changes in salt tolerance with different growth stages; the large number of physiological parameters that contribute to salt tolerance; lack of effective evaluation methods for salt tolerance among genotypes; low selection efficiency using multiple parameters; the complex interactions of salinity and environment on salt tolerance of plants. Therefore, wheat breeder could use simple, quick and non-destructive screening methods to develop salt tolerant wheat genotypes (El-Hendawy, 2004). The objectives of this investigate are to 1) Estimate the salinity effect on nine bread wheat cultivars at several growth stages, 2) Identify salt tolerance cultivars at several growth stages, and 3) Identify salt tolerance screening criteria by studying the relationship among yield of salt affected soil and several growth stages characters.

MATERIALS AND METHODS.

The present study was conducted in the Experimental Farm and the Laboratories of Wheat Research Department and Soil Research Department of Sakha Agricultural Research Station, Agricultural Research Center, Kafrelsheikh, Egypt, in 2014/2015 season. This study includes nine Egyptian bread wheat cultivars (Table 1).
Ten plants from each cup were fertilized (0.5 g / pot / week) added to solutions and the distance from crown to the end of longest root was measured as root length. The samples of shoots and roots were dried at 70 ºC for 48 h to determine the dry weight of shoots and roots and its ratio.

Measurements at the seedling stage were conducted at every three days with abundant amount of solutions (100 ml per cup) to avoid salt accumulation. The salt stress was applied from the first day of the experiment. All treatments, nine cultivars and six salt concentrations, were arranged in factorial experiment in completely randomized design with three replicates. Seeds were considered emerged when the tip of coleoptile appears on the sand surface. The emerged seedling was counted daily after four days from sowing.

Three experiments were established, the first one was established in the laboratory (open area) in order to study the effect of salinity on seedling emergence and seedling characters. In the fourth of March 2014, the seeds of the studied cultivars (12 seeds / cup and 1.5 cm sown depth) were grown in the 6.5 x 13 cm plastic cups, with three drain pores, filled with 600 g of tap water washed sand. Salt stress treatments were induced using diluted sea water. After two weeks (completely germination) only three experiments were grown in the 30 x 40 cm black plastic bag, with 600 g of tap water washed sand. Salt stress treatments were induced using diluted sea water. After two weeks (completely germination) only completely randomized design with three replicates. Seeds were considered emerged when the tip of coleoptile appears on the sand surface. The emerged seedling was counted daily after four days from sowing.

### Table 1: Name, pedigree, selection history origin and year of release of the studied Egyptian bread wheat cultivars.

<table>
<thead>
<tr>
<th>Name</th>
<th>Pedigree</th>
<th>Selection history</th>
<th>Origin</th>
<th>Year of release</th>
</tr>
</thead>
<tbody>
<tr>
<td>HINDI 62</td>
<td>Selected local cultivar.</td>
<td>-</td>
<td>Egypt</td>
<td>1921</td>
</tr>
<tr>
<td>GIZA 139</td>
<td>HINDI-90/KENYA-256G.</td>
<td>-</td>
<td>Egypt</td>
<td>1947</td>
</tr>
<tr>
<td>GIZA 144</td>
<td>REGENT/2*GIZA-139.</td>
<td>-</td>
<td>Egypt</td>
<td>1958</td>
</tr>
<tr>
<td>SIDS 1</td>
<td>HD2172/PAVON&quot;S&quot;/1158.57/MAYA7474&quot;S&quot;.</td>
<td>SD46-4SD-2SD-1SD-0SD.</td>
<td>Egypt</td>
<td>1996</td>
</tr>
<tr>
<td>GEMMEIZA 9</td>
<td>ALD&quot;S&quot;/HUAC&quot;S&quot;/CMH74A.630/SX.</td>
<td>GM4583-5GM-1GM-0GM.</td>
<td>Egypt</td>
<td>1999</td>
</tr>
<tr>
<td>SIDS 12</td>
<td>147/3/BG/GLL/4/6/MAYA/VUL/CMH74A.630/4*SX.</td>
<td>SD7096-4SD-1SD-0SD.</td>
<td>Egypt</td>
<td>2007</td>
</tr>
<tr>
<td>MISR 1</td>
<td>OASIS/SKAUZ/4<em>BCN/3</em>2*PASTOR.</td>
<td>CMSSOOYO18811T-005M-030Y-030M-030WGY-330-0Y-0S.</td>
<td>CIMMYT</td>
<td>2011</td>
</tr>
<tr>
<td>MISR 2</td>
<td>SKAUZ/BAV92.</td>
<td>CMSS96M03611S-1M-010S-010M-010S-010S-010S-8M-0Y-0S.</td>
<td>CIMMYT</td>
<td>2011</td>
</tr>
</tbody>
</table>

### Table 2: Salt treatments, tap and sea water mixture rates, electrical conductivity (EC), anions and cations concentrations.

<table>
<thead>
<tr>
<th>Salt treatments</th>
<th>Mix rates</th>
<th>Sea water mix percent</th>
<th>EC (dSm⁻¹)</th>
<th>Anions (mg/L)</th>
<th>Cation (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>tap water</td>
<td>sea water (ml)</td>
<td></td>
<td>CO₃²⁻</td>
<td>HCO₃⁻</td>
</tr>
<tr>
<td>control</td>
<td>1000</td>
<td>0</td>
<td>0</td>
<td>0.48</td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td>740</td>
<td>260</td>
<td>26</td>
<td>13.50</td>
<td>3.40</td>
</tr>
<tr>
<td>2</td>
<td>710</td>
<td>290</td>
<td>29</td>
<td>15.00</td>
<td>3.38</td>
</tr>
<tr>
<td>3</td>
<td>690</td>
<td>310</td>
<td>31</td>
<td>16.00</td>
<td>3.37</td>
</tr>
<tr>
<td>4</td>
<td>670</td>
<td>330</td>
<td>33</td>
<td>17.00</td>
<td>3.36</td>
</tr>
<tr>
<td>5</td>
<td>650</td>
<td>350</td>
<td>35</td>
<td>18.00</td>
<td>3.35</td>
</tr>
<tr>
<td>Sea water</td>
<td></td>
<td>50.70</td>
<td></td>
<td>-</td>
<td>3.00</td>
</tr>
</tbody>
</table>

Speed of seedling emergence was estimated by the formula described in the Association of Official Seed Analysis (AOSA, 2004) with some modification, Emergence index = [No of emerged seed / Days of first account] + … + (No of emerged seed / Days of final account). Measurements at the seedling stage were conducted at 21 days after sowing. Ten plants from each cup were harvested and the distance from crown to the highest leaf tip was measured as shoot length. The roots were carefully extracted from the sand by mild washing with tap water. The roots were placed above blotter paper for 10 minutes and the distance from crown to the end of longest root was measured as root length. The samples of shoots and roots were dried at 70 ºC for 48 h to determine the dry weight of shoots and roots and its ratio.

The second experiment (pots) was carried out in order to study the effect of salinity stress on adult plant stage. In the 18th November 2014, the seeds of the studied cultivars (10 seeds / bag and 1.5 cm sown depth) were grown in the 30 x 40 cm black plastic bag, with drain pores, filled with 16 kg of sand washed with tap water. After two weeks (completely germination) only six seedlings were left in each pot. The experiment was irrigated (one litter per pot) twice a week and fertilized until heading date using the NPK, 20:10:20 multnutrient fertilizer (0.5 g / pot / week) added to irrigation solution. Chelating microelements FULV- E contain 5% N, 4% K₂O, 4% Fe, 1.2 % Mn, and 0.6% Zn, 0.2% Cu, 5% Mg, 0.2% B, 6% citric acid and 8% Fulvic acid (3 cm / L) were sprayed every week. The experiment was protected using the fungicide CABRIO™ TOP 60%WG (1g/ L). Two salt stress...
treatments (control and 17.0 dSm$^{-1}$, Table 2) were applied 35 days after sowing until physiological maturity. All treatments, nine cultivars and two salt concentrations, were arranged in factorial experiment conducted in completely randomized design with two replications. The studied characters in the second experiment (pots) were plant height (cm), biological yield (g), grain yield (g), straw yield (g), number of spikes per pot, number of kernels per spike, one hundred kernel weight(g).

The third experiment was conducted in order to study the effect of salinity stress under field condition and to study the relationship among yield under salt affected soil and seedling and adult plant stage characters (normal soil, seedling and pots). This experiment was applied in two environments at the Experimental Farm of Sakha Agricultural Research Station; normal soil at 2$^{nd}$ Nattaf farm part 8 and salt affected soil at El-Hamrawy farm part 18 (Table 3).

### Table 3: Soil analysis for normal soil (2$^{nd}$ Nattaf farm part 8) and salt affected soil (Elhamrawy farm part 18).

<table>
<thead>
<tr>
<th>Location</th>
<th>Sample depth</th>
<th>Soil structure</th>
<th>EC (dSm$^{-1}$)</th>
<th>Cations (mg/L)</th>
<th>EC (dSm$^{-1}$)</th>
<th>Cations (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2$^{nd}$ Nattaf farm</td>
<td>0 - 30</td>
<td>clayey</td>
<td>2.02</td>
<td>3</td>
<td>0</td>
<td>8.16</td>
</tr>
<tr>
<td>part 8</td>
<td>30 - 60</td>
<td>clayey</td>
<td>1.46</td>
<td>2.5</td>
<td>7.18</td>
<td>10.262</td>
</tr>
<tr>
<td>Elhamrawy</td>
<td>0 - 30</td>
<td>clayey</td>
<td>8.7</td>
<td>36.48</td>
<td>25</td>
<td>17.2</td>
</tr>
<tr>
<td>farm part 18</td>
<td>30 - 60</td>
<td>clayey</td>
<td>6.49</td>
<td>28.8</td>
<td>12.5</td>
<td>41.52</td>
</tr>
</tbody>
</table>

The nine cultivars were arranged in a randomized complete block design experiment with three replications. Plot area was 2.7m$^2$ (6 rows × 3m long × 0.15m apart). All recommended cultural practices (irrigation, fertilization, weed control, fungicides) were applied at the proper time. The studied characters were plant height (cm), biological yield (kg), grain yield (kg), straw yield (kg), number of spikes per square meter, number of kernels per spike and one thousand kernel weight (g). Salinity tolerance were estimates using the formula described by Fernandez (1992): Stress tolerance index (STI) = \[
\frac{YP(Yp)}{Yp(Yp)}\] where: \(YP\) is the potential yield of a given genotype in non-stress environment, \(Ys\) is the potential yield of a given genotype in stress environment and \(YP\) is mean yield in non-stress environment. The high STI value, the high stress tolerance genotype. The statistical analysis procedure was according to the regular analysis of variance of completely randomized design (CRBD) and complete block design (RCBD). The differences between means were measured using least significant differences (LSD) test at 0.05 probability level. Simple correlation was used to calculate the relationship among yield under salt affected soil and seedling and adult plant stage (normal soil, seedling and pots) characters. In this respect, the statistical computer program Gen-Stat 14th edition was used.

### RESULTS AND DISCUSSION

#### Seedling experiment

The analysis of variance of the studied characters at seedling stage showed highly significant differences among the nine bread wheat studied cultivars, the six salinity concentrations and their interaction for all studied characters (Table 4). The variance due to salinity concentrations had the main portion of the total variance compared with cultivars and cultivars × salinity concentrations interaction variance. These results are in agreement with those obtained by El-Hendawy (2011) and Hussain et al., (2015). Coefficient of variation estimates ranged from 12.3% for shoot- root dry weight ratio to 18.2% for shoot dry weight (Table 4).

### Table 4: Mean squares and coefficients of variation (CV %) for the studied characters at seedling stage.

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d.f.</th>
<th>Root dry weight</th>
<th>Shoot dry weight</th>
<th>Shoot root dry weight ratio</th>
<th>Root length</th>
<th>Shoot length</th>
<th>Emergence index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivars</td>
<td>8</td>
<td>0.009 **</td>
<td>0.003 **</td>
<td>10.262 **</td>
<td>11.1 **</td>
<td>9.12 **</td>
<td>22.9 **</td>
</tr>
<tr>
<td>Salinity concentrations</td>
<td>5</td>
<td>0.963 **</td>
<td>0.442 **</td>
<td>6.760 **</td>
<td>164.6 **</td>
<td>10.48 **</td>
<td>2474.4 **</td>
</tr>
<tr>
<td>Cultivars × Salinity</td>
<td>40</td>
<td>0.005 **</td>
<td>0.002 **</td>
<td>2.058 **</td>
<td>2.1 **</td>
<td>1.8 **</td>
<td>5.7 **</td>
</tr>
<tr>
<td>CV%</td>
<td>17.6</td>
<td>18.2</td>
<td>12.3</td>
<td>12.5</td>
<td>15.8 **</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** Significant at 0.01 level of probability.

The effect of salinity concentrations on all studied characters at seedling stage are illustrated in Figure 1a and b. Increasing salt concentration led to significant decrease mean values of shoot length, root length, shoot dry weight, root dry weight and emergence index. In contrary, increasing salt concentration led to increase of shoot-root dry weight ratio. This may be due to antagonism between cations, anions of salts and cations, anions of the nutrients i.e., Cl$^-$ and NO$_3^-$, Na$^+$ and K$^+$, in addition to specific effects of some cations like Na$^+$, Almaghrabi (2012) reported that increasing salt concentration from 0.0 to 8704 ppm caused significant decreases in shoot and root length and increased shoot-root ratio. No significant differences
were found between the two salt treatments 26 and 29% for all studied characters and between the two salt treatments 33 and 35% for all studied characters, except shoot length (LSD = 0.351) and emergence index (LSD, 0.545) (Figure 1b). These results showed that the salinity level of the sea water mix percent 33% (17.0 dSm\(^{-1}\)) is suitable for screening bread wheat genotypes for salinity at adult plant stage. This may be due to EC above 13 dSm\(^{-1}\) affects the tolerant cultivar which helps in for screening wheat genotypes. These results are in agreement with Sharma (2015) who reported that seedling growth response to salinity ranged from stimulation in some cultivars at lower salinity levels (4 to 8 EC) to severe suppression in most cultivars at higher levels (12-16 EC) and the 12 EC considered as critical salt concentration.

![Figure 1a: Sea water mix percent effects on root dry weight and shoot dry weight](image1a)

![Figure 1b: Sea water mix percent effects on shoot root dry weight ratio, root length, shoot length and seedling emergence index](image1b)

**Figure 1a and b:** Sea water mix percent effects on root dry weight and shoot dry weight (a) and shoot root dry weight ratio, root length, shoot length and seedling emergence index (b) at seedling stage.

The effect of cultivars on all studied characters at seedling stage are illustrated in Figure 2a and b. The three bread wheat cultivars Sids 12, Gemmeiza 3 and Gemmeiza 9 recorded high root dry weight mean values, while the bread wheat cultivars Sids 1 and Hindi 62 recorded low mean values (LSD, 0.02). The highest shoot dry weight mean values were recorded for Giza 139 and Misr 2, while, the lowest value recorded for the bread wheat cultivars Misr1 (LSD, 0.015). For shoot-root dry weight ratio, the bread wheat cultivars Hindi 62, Misr 2 and Giza 139 had the highest values, but the bread wheat cultivars Sids 12 and Gemmeiza 3 had the lowest values (LSD, 0.709). The bread wheat cultivars Giza 139, Hindi 62, Giza 144 and Misr 2 recorded high mean values for shoot length, while, Misr1 had lowest value (LSD, 0.430). The bread wheat cultivars Misr 2 and Giza 139 had high values of emergence index, while Sids 12 and Gemmeiza 3 had low values (LSD, 0.668).
Fig. 2 (a and b): Cultivars effects on root dry weight and shoot dry weight (a) and shoot root dry weight ratio, root length, shoot length and seedling emergence index(b) at seedling stage.

The interaction between salt treatments and cultivars for shoot dry weight, root dry weight and shoot-root dry weight ratio are illustrated in Figure 3.

The nine studied cultivars differed in their response to salinity concentrations. For shoot dry weight, Figure 3 a, high mean values recorded for the bread wheat cultivars Gemmeiza 3 and Sids 12 under control; Giza 139 under 26 and 29% treatments; Misr 2 and Giza 139 under the remain treatments, while constant response (low values) over all salt treatments recorded for the cultivar Misr1 (LSD, 0.048). For root dry weight Figure 3b, high mean values obtained for the cultivar Sids 12 under control; Gemmeiza 9 and Gemmeiza 3 under 26% treatment; Gemmeiza 9, Giza 139, Giza 144 and Gemmeiza 3 under 29% treatment; Gemmeiza 9, Gemmeiza 3, Sids 12 and Misr 2 under 33% treatment; Gemmeiza 3 and Misr 2 under 33% treatment; Misr 1, Gemmeiza 9 and Misr 2 under 35% treatment. Meanwhile, low root dry weight mean values recorded for Misr 1 under control, 26, 29 and 31% treatments; Hindi 62 under 33% treatment; Gemmeiza 3 and Sids 1 under 35% (LSD, 0.037). Regarding shoot-root dry weight ratio, low mean values recorded for the cultivars Gemmeiza 3 under 26, 29, 31 and 33% treatments; Sids1 and Sids 12 under 35% treatment. While Giza 139, Hindi 62 and Misr 2 had high mean values for all salt treatments (LSD, 1.735).

The interaction between salt treatments and cultivars for root length, shoot length and emergence index are illustrated in Figure 4(a, b and c). For root length Figure 4a, the bread wheat cultivar Giza 144 had high mean value under control; Gemmeiza 9 and Giza 139 under 26 and 31% treatment; Gemmeiza 9, Giza 139 and Giza 144 under 29% treatment; Giza 139 under 33% treatment; Gemmeiza 9 under 35% treatment. But low root length mean values recorded for the cultivar Misr 1 under all treatments (LSD, 0.006). Regarding shoot length the bread wheat cultivars Gemmeiza 3, Sids 1, Hindi 62 and Misr 2 recorded high values under control; Giza 139, Sids 1 and Hindi 62 under 26% treatment; Giza 139, Giza 144 and Hindi 62 under 29% treatment; Giza 139 and Giza 144 under 31% treatment; Giza 139 under 33% treatment; Misr 2 under 35% treatment. But low shoot length mean values recorded for the cultivar Misr 1 under all treatments (LSD 1.053). For emergence index, no significant differences were recorded among all studied cultivars under control. High mean values recorded for the cultivars Gemmeiza 9, Giza 139, Hindi 62, and Misr 2 under 26% treatment; Giza 139, Giza 144 and Misr 2 under 29% treatment; Gemmeiza 9, Giza 139, Sids 1 and Misr 2 under 31% treatment; Gemmeiza 9, Giza 139, Hindi 62, and Misr 2 under 33% treatment. While low emergence index mean values recorded for the cultivar Misr 1 under all salt treatments (LSD 1.053). Generally, among the studied characters shoot length, shoot root dry weight ratio and emergence index had wide variability under salt stress and it may be used for detection salt tolerant genotype. Sharma (2015) reported that shoot growth often suppressed more than root growth under 12 dSm$^{-1}$ salt concentration.
Fig. 3 a, b, and c: Interaction between the studied bread wheat cultivars and sea water mix percent for shoot dry weight (a), root dry weight (b) and shoot root dry weight ratio (c).

**Pots experiment**

Regarding pots experiment, highly significant differences were found among the nine studied bread wheat cultivars for the studied characters (Table 5). The mean square of salt treatments was highly significant for all studied characters, except number of spikes per pot. While significant and/or highly significant differences were found for cultivars × salt treatments interaction mean square for all studied characters, except grain yield and number of kernels per spike (Table 5). The salt treatments variance had the main portion of the total variance compared with cultivars and cultivars × salt treatments interaction for all studied characters except number of spikes per pot. Coefficients of variation estimates ranged from 4.3% for plant height to 11.0% for number of kernels per spike (Table 5).

The effect of salt treatment on the studied characters of the pot experiments are illustrated in Table 6. Salt treatments led to significant decrease in plant height, grain yield, biological yield, straw yield, number of kernels per spike and one hundred kernels weight. While, number of spikes per pot was not affected by salt treatments. This may be due to salinity effect on the plant by one or more of decreasing water availability, nutrients imbalance and specific ion effect. These results agree with those obtained by Kumar et al. (2012) who reported that increasing salinity levels causes significantly decreases in grain yield, biological yield and one thousand kernels weight. Asli and Zanjan (2014) reported insignificant interaction for number of kernels per spike with salinity levels. Nasab et al. (2014) found insignificant interaction for number of spikes per square meter, one thousand kernels weight and grain yield with salinity.
Fig. 4 a, b, and c: Interaction between the studied bread wheat cultivars and sea water mix percent levels for root length (a), shoot length (b) and seedling emergence index (c) at seedling stage.

Table 5: Mean squares and coefficient of variations (CV %) for the studied characters at adult stage in pots experiment.

<table>
<thead>
<tr>
<th>Character</th>
<th>df</th>
<th>PH</th>
<th>GY/pot</th>
<th>BY/pot</th>
<th>SY/pot</th>
<th>S/pot</th>
<th>K/S</th>
<th>100 KW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivars</td>
<td>8</td>
<td>471.4 **</td>
<td>13.5 **</td>
<td>446.0 **</td>
<td>393.5 **</td>
<td>65.0 **</td>
<td>461.0 **</td>
<td>2.3 **</td>
</tr>
<tr>
<td>Salt treatments</td>
<td>1</td>
<td>2540.2 **</td>
<td>738.4 **</td>
<td>8332.0 **</td>
<td>4109.7 **</td>
<td>0.16</td>
<td>1182.2 **</td>
<td>9.3 **</td>
</tr>
<tr>
<td>Cultivars × Salt treatments</td>
<td>8</td>
<td>86.8 **</td>
<td>13.1</td>
<td>46.4 **</td>
<td>51.0*</td>
<td>9.7 **</td>
<td>14.8</td>
<td>0.45 **</td>
</tr>
</tbody>
</table>

*, ** significant at 0.05 and 0.01 probability respectively. PH= plant height, GY= grain yield, BY= biological yield, SY= straw yield, S= spikes, K W = kernels weight.

Table 6: Mean of salt treatments for plant height (PH), grain yield (GY), biological yield (BY), straw yield (SY), number of spike per pot (S/pot), number of kernels per spike (K/S) and one hundred kernels weight(100KW) for pots experiment.

<table>
<thead>
<tr>
<th>Character</th>
<th>PH(cm)</th>
<th>GY(g)</th>
<th>BY(g)</th>
<th>SY(g)</th>
<th>S/pot</th>
<th>K/S</th>
<th>100KW(g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salt treatments</td>
<td>N</td>
<td>S</td>
<td>N</td>
<td>S</td>
<td>S</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>N = normal, S = salt treatment</td>
<td>86.56</td>
<td>69.89</td>
<td>21.08</td>
<td>12.03</td>
<td>71.44</td>
<td>41.01</td>
<td>50.36</td>
</tr>
</tbody>
</table>
The effects of cultivars on the studied characters of the pot experiment are illustrated in Table 7. In this respect, the highest mean values were recorded for the bread wheat cultivars Hindi 62 for plant height; Giza 144 for yield and number of spikes per pot; Misr 2 for biological yield and straw yield; Sids 12 for number of kernels per spike; Gemmeiza 3 for one hundred kernels weight. While the lowest mean values were recorded for the bread wheat cultivars Misr 1 for plant height; Giza 139 for grain yield; Sids 12 for biological yield, straw yield and number of spikes per pot; Giza 144 for number of kernels per spike; Misr 2 for one hundred kernels weight. Varying bread wheat genotypes for salinity response was reported by many researchers such as El-Hendawy et al. (2011), Hussain et al. (2015) and Sharma (2015).

Table 7: Mean of cultivars for plant height (PH), grain yield (GY), biological yield (BY), straw yield (SY), number of spike per pot (S/pot), number of kernels per spike (K/S) and one hundred kernels weight (100KW) for pots experiment.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>PH</th>
<th>GY</th>
<th>BY</th>
<th>Straw Y</th>
<th>S/pot</th>
<th>K/S</th>
<th>100KW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Misr 1</td>
<td>65.0</td>
<td>15.39</td>
<td>53.19</td>
<td>37.81</td>
<td>10.25</td>
<td>41.66</td>
<td>3.30</td>
</tr>
<tr>
<td>Gemmeiza 9</td>
<td>73.0</td>
<td>15.61</td>
<td>62.99</td>
<td>47.38</td>
<td>12.50</td>
<td>40.55</td>
<td>3.19</td>
</tr>
<tr>
<td>Giza 139</td>
<td>76.0</td>
<td>13.95</td>
<td>50.91</td>
<td>36.97</td>
<td>16.70</td>
<td>30.65</td>
<td>2.62</td>
</tr>
<tr>
<td>Giza 144</td>
<td>81.0</td>
<td>19.685</td>
<td>62.11</td>
<td>42.42</td>
<td>17.50</td>
<td>28.37</td>
<td>3.83</td>
</tr>
<tr>
<td>Gemmeiza 3</td>
<td>74.0</td>
<td>17.83</td>
<td>48.25</td>
<td>30.42</td>
<td>8.75</td>
<td>36.99</td>
<td>5.00</td>
</tr>
<tr>
<td>Sids 1</td>
<td>83.5</td>
<td>16.955</td>
<td>62.62</td>
<td>45.66</td>
<td>13.50</td>
<td>44.08</td>
<td>2.87</td>
</tr>
<tr>
<td>Sids 12</td>
<td>69.0</td>
<td>14.955</td>
<td>34.40</td>
<td>19.45</td>
<td>6.25</td>
<td>65.52</td>
<td>3.28</td>
</tr>
<tr>
<td>Hindi 62</td>
<td>103.0</td>
<td>18.46</td>
<td>63.54</td>
<td>45.07</td>
<td>12.25</td>
<td>46.27</td>
<td>3.26</td>
</tr>
<tr>
<td>Misr 2</td>
<td>79.5</td>
<td>16.165</td>
<td>68.06</td>
<td>51.89</td>
<td>17.90</td>
<td>40.69</td>
<td>2.39</td>
</tr>
</tbody>
</table>

LSD, least significant differences at 0.05 level.

The interaction between cultivars and salt treatments for the studied characters are illustrated in Table 8. Under normal condition, high mean values recorded for the bread wheat cultivars Hindi 62 for plant height; Sids 12 for grain yield and number of kernels per spike; Misr 2 for biological yield and straw yield; Gemmeiza 3 for one hundred kernels weight. While the highest mean values under salt treatments recorded for the bread wheat cultivars Hindi 62 for plant height and straw yield; Giza 144 for grain yield; Sids 12 for biological yield and number of kernels per spike; Gemmeiza 3 for one hundred kernels weight. The lowest mean values under normal condition were recorded for the bread wheat cultivars Misr 1 for plant height and grain yield; Sids 12 for biological yield and straw yield; Giza 144 for number of kernels per spike, Misr 2 for 100 kernels weight. The least differences between normal and salt treatment conditions were found in the bread wheat cultivars Hindi 62 for plant height; Misr 1 and Giza 144 for grain yield; Hindi 62 for biological yield; Sids 1, Sids 12 and Hindi 62 for straw yield; Gemmeiza 3 for number of kernels per spike; Giza 144 for one hundred kernel weight. In contrast, the largest differences between normal and salt treatment conditions were found in the bread wheat cultivars Giza 139 for plant height, biological yield and straw yield; Sids 12 for grain yield and one hundred kernel weight; Hindi 62 for number of kernels per spike.

Table 8: Means of plant height (PH), grain yield (GY), biological yield (BY), straw yield (SY), number of kernels per spike (K/S) and one hundred kernels weight (100KW) for nine bread wheat cultivars under normal and salt stress conditions, pots experiment.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>PH(cm)</th>
<th>GY(g)</th>
<th>BY(g)</th>
<th>SY(g)</th>
<th>K/S</th>
<th>100KW(g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Misr 1</td>
<td>N 72</td>
<td>S 58</td>
<td>N 18.9</td>
<td>S 11.9</td>
<td>N 67.1</td>
<td>S 39.3</td>
</tr>
<tr>
<td>Gemmeiza 9</td>
<td>81</td>
<td>65</td>
<td>20.4</td>
<td>10.8</td>
<td>77.4</td>
<td>48.5</td>
</tr>
<tr>
<td>Giza 139</td>
<td>95</td>
<td>57</td>
<td>19.3</td>
<td>8.6</td>
<td>73.0</td>
<td>28.8</td>
</tr>
<tr>
<td>Giza 144</td>
<td>90</td>
<td>72</td>
<td>22.7</td>
<td>16.7</td>
<td>76.2</td>
<td>48.0</td>
</tr>
<tr>
<td>Gemmeiza 3</td>
<td>82</td>
<td>66</td>
<td>24.0</td>
<td>11.7</td>
<td>65.1</td>
<td>31.4</td>
</tr>
<tr>
<td>Sids 1</td>
<td>84</td>
<td>83</td>
<td>21.8</td>
<td>12.1</td>
<td>75.9</td>
<td>49.4</td>
</tr>
<tr>
<td>Sids 12</td>
<td>76</td>
<td>62</td>
<td>22.9</td>
<td>7.0</td>
<td>48.6</td>
<td>20.3</td>
</tr>
<tr>
<td>Hindi 62</td>
<td>112</td>
<td>94</td>
<td>21.4</td>
<td>15.5</td>
<td>73.6</td>
<td>53.5</td>
</tr>
<tr>
<td>Misr 2</td>
<td>87</td>
<td>72</td>
<td>18.4</td>
<td>13.9</td>
<td>86.1</td>
<td>50.0</td>
</tr>
</tbody>
</table>

LSD, Least significant differences at 0.05 level. N= normal. S= salt treatment

Field experiment

Regarding to field experiment, the analysis of variance of the studied characters are illustrated in Table 9. Significant differences were recorded for all the studied characters among the two environments (normal and salt affected soil), cultivars and their interaction
except for number of spikes per square meter and number of kernels per spike for the environments; spikes per square meter for differences among cultivars; number of kernel per spike and one thousand kernels weight for differences due to cultivars × environments interaction (Table 9). The environments variance had the main portion from the total variance for plant height, grain yield, biological yield and straw yield (Table 9).

The interaction between cultivars and environments (normal and salt affected soil) and decrease percent for the studied characters are illustrated in Table 12. Under normal condition, the highest mean values were recorded for the bread wheat cultivars Hindi 62 and Giza 144 for plant height; Misr 2 for grain yield; Gemmeiza 9 and Misr 2 for biological yield; Misr 2 and Hindi 62 for number of spikes per square meter. While the highest mean values under salt affected soil recorded for the bread wheat cultivars Hindi 62 and Giza 144 for plant height; Misr 1, Misr 2 and Giza 144 for grain yield; Giza 144, Giza 139, Misr 1, Misr 2 and Sids 1 for biological yield; Giza 144 and Misr 2 for number of spikes per square meter. The

### Table 9: Mean squares and coefficient of variations (CV %) for plant height (PH), grain yield (GY), biological yield (BY), straw yield (SY), number of spike per square meter (S/m²), number of kernels per spike (K/S) and one thousand kernels weight (1000KW) in the field experiment.

<table>
<thead>
<tr>
<th>SOV</th>
<th>df</th>
<th>PH (cm)</th>
<th>GY (kg)</th>
<th>BY (kg)</th>
<th>SY (kg)</th>
<th>S/m²</th>
<th>K/S</th>
<th>1000KW (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environments</td>
<td></td>
<td>9335.2 **</td>
<td>4.0 **</td>
<td>47.6 **</td>
<td>24.1 **</td>
<td>231</td>
<td>371.3</td>
<td>341.7 **</td>
</tr>
<tr>
<td>Cultivars</td>
<td></td>
<td>835.9 **</td>
<td>0.8 **</td>
<td>2.6 **</td>
<td>1.2 **</td>
<td>5754</td>
<td>530.7 **</td>
<td>296.3 **</td>
</tr>
<tr>
<td>Cultivars × Cultivars</td>
<td></td>
<td>124.8 **</td>
<td>0.4 **</td>
<td>1.1 **</td>
<td>0.2 **</td>
<td>14332.0 *</td>
<td>49.3</td>
<td>17.5</td>
</tr>
<tr>
<td>CV%</td>
<td>8</td>
<td>3.7</td>
<td>10.5</td>
<td>8</td>
<td>9.6</td>
<td>21</td>
<td>12.9</td>
<td>11.7</td>
</tr>
</tbody>
</table>

*, ** significant at 0.05 and 0.01 probability respectively

The effect of environments on the studied characters of the field experiments is illustrated in Table 10. Salinity stress caused significantly decrease in plant height, grain yield, biological yield, straw yield and one thousand kernels weight. Meanwhile, number of spike per square meter and number of kernels per spike not affected by salinity stress (Table 10).

### Table 10: Means for plant height (PH), grain yield (GY), biological yield (BY), straw yield (SY), number of spike per square meter (S/m²), number of kernels per spike (K/S) and one thousand kernels weight (1000KW) affected by salt treatment in the field experiment.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>PH (cm)</th>
<th>GY (kg)</th>
<th>BY (kg)</th>
<th>SY (kg)</th>
<th>S/m²</th>
<th>K/S</th>
<th>1000KW (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>130.7</td>
<td>104.4</td>
<td>2.29</td>
<td>1.75</td>
<td>6.4</td>
<td>4.5</td>
<td>2</td>
</tr>
<tr>
<td>S</td>
<td>342</td>
<td>345</td>
<td>45.9</td>
<td>51.1</td>
<td>46.6</td>
<td>41.6</td>
<td>1</td>
</tr>
</tbody>
</table>

N= Normal soil. S = Salt affected soil.

The effects of cultivars on the studied characters of the field experiment are illustrated in Table 11. The bread wheat cultivars Hindi 62 and Giza 144 had the highest mean value for plant height; Misr1 and Misr 2 for grain yield; Misr 2 for biological yield; Gemmeiza 9, Giza 144, Sids 1 and Misr 2 for straw yield; Misr 1, Gemmeiza 9, Sids 12 and Misr 2 for number of kernels per spike; Gemmeiza 3 for one thousand kernels weight. On the other hand, the lowest mean values were recorded for the bread wheat cultivar Sids 12 for plant height; Hindi 62 for grain yield; Sids 12, Gemmeiza 3 and Hindi 62 for biological yield; Misr 1, Sids 12 and Gemmeiza 3 for straw yield; Giza 139, Giza 144, Gemmeiza 3 and Hindi 62 for number of kernels per spike; Gemmeiza 9, Sids 1 and Misr 2 for one thousand kernels weight.

### Table 11: Means of cultivar for plant height (PH), grain yield (GY), biological yield (BY), straw yield (SY), number of spike per square meter (S/m²), number of kernels per spike (K/S) and one thousand kernels weight (1000KW) in the field experiment.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>PH (cm)</th>
<th>GY (kg)</th>
<th>BY (kg)</th>
<th>SY (kg)</th>
<th>S/m²</th>
<th>K/S</th>
<th>1000KW (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Misr 1</td>
<td>106.7</td>
<td>2.50</td>
<td>5.7</td>
<td>3.1</td>
<td>294</td>
<td>356</td>
<td>43.4</td>
</tr>
<tr>
<td>Gemmeiza 9</td>
<td>110.0</td>
<td>2.01</td>
<td>5.7</td>
<td>3.7</td>
<td>342</td>
<td>355</td>
<td>42.4</td>
</tr>
<tr>
<td>Giza 139</td>
<td>125.8</td>
<td>1.73</td>
<td>5.3</td>
<td>3.5</td>
<td>328</td>
<td>365</td>
<td>43.3</td>
</tr>
<tr>
<td>Giza 144</td>
<td>130.0</td>
<td>2.09</td>
<td>6.0</td>
<td>3.9</td>
<td>369</td>
<td>38.2</td>
<td>43.9</td>
</tr>
<tr>
<td>Gemmeiza 3</td>
<td>115.8</td>
<td>1.83</td>
<td>4.7</td>
<td>2.9</td>
<td>338</td>
<td>40.5</td>
<td>62.1</td>
</tr>
<tr>
<td>Sids 1</td>
<td>115.0</td>
<td>2.13</td>
<td>5.7</td>
<td>3.6</td>
<td>327</td>
<td>51.3</td>
<td>42.2</td>
</tr>
<tr>
<td>Sids 12</td>
<td>100.0</td>
<td>1.79</td>
<td>4.5</td>
<td>2.7</td>
<td>358</td>
<td>58.3</td>
<td>37.4</td>
</tr>
<tr>
<td>Hindi 62</td>
<td>137.5</td>
<td>1.49</td>
<td>5.0</td>
<td>3.5</td>
<td>363</td>
<td>40.9</td>
<td>40.9</td>
</tr>
<tr>
<td>Misr 2</td>
<td>117.5</td>
<td>2.62</td>
<td>6.6</td>
<td>4.0</td>
<td>402</td>
<td>59.3</td>
<td>41.5</td>
</tr>
<tr>
<td>LSD</td>
<td>5.1</td>
<td>0.20</td>
<td>0.5</td>
<td>0.4</td>
<td>86</td>
<td>7.4</td>
<td>6.1</td>
</tr>
</tbody>
</table>

LSD, Least significant differences at 0.05 level. N= Normal soil. S = Salt affected soil.
lowest mean values under normal condition recorded for the bread wheat cultivar Sids 12 for plant height; Hindi 62 for grain yield; Gemmeiza 3, Sids 12 and Hindi 62 for biological yield; all studied cultivars except Hindi 62 and Misr 2 for number of spikes per square meter; Misr 2 for one thousand kernels weight. While the lowest mean values under salinity affected soil recorded for the bread wheat cultivars Misr 1 Gemmeiza 9, Gemmeiza 3 and Sids 12 for plant height; Sids 12 for grain yield; Gemmeiza 3 and Sids 12 for biological yield; all studied cultivars except Giza 144 for number of spikes per square meter.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>PH (cm)</th>
<th>Gy (kg)</th>
<th>BY (kg)</th>
<th>SY (kg)</th>
<th>S/m²</th>
<th>1000KW</th>
<th>K/Si(g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Misr 1</td>
<td>115</td>
<td>98</td>
<td>15</td>
<td>2.8</td>
<td>2.2</td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td>Gemmeiza 9</td>
<td>122</td>
<td>98</td>
<td>19</td>
<td>2.5</td>
<td>1.5</td>
<td>40</td>
<td>7</td>
</tr>
<tr>
<td>Giza 139</td>
<td>143</td>
<td>108</td>
<td>24</td>
<td>1.6</td>
<td>1.9</td>
<td>-17</td>
<td>6</td>
</tr>
<tr>
<td>Giza 144</td>
<td>148</td>
<td>112</td>
<td>25</td>
<td>2.1</td>
<td>2.1</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Gemmeiza 3</td>
<td>133</td>
<td>98</td>
<td>26</td>
<td>2.3</td>
<td>1.4</td>
<td>39</td>
<td>6</td>
</tr>
<tr>
<td>Sids 1</td>
<td>125</td>
<td>105</td>
<td>16</td>
<td>2.3</td>
<td>2.0</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>Sids 12</td>
<td>107</td>
<td>93</td>
<td>13</td>
<td>2.4</td>
<td>1.2</td>
<td>51</td>
<td>6</td>
</tr>
<tr>
<td>Hindi 62</td>
<td>155</td>
<td>120</td>
<td>23</td>
<td>1.6</td>
<td>1.4</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Misr 2</td>
<td>128</td>
<td>107</td>
<td>17</td>
<td>3.1</td>
<td>2.1</td>
<td>31</td>
<td>8</td>
</tr>
<tr>
<td>LSD</td>
<td>6.9</td>
<td>0.3</td>
<td>1</td>
<td>0.6</td>
<td>1</td>
<td>118</td>
<td>8.2</td>
</tr>
</tbody>
</table>

LSD, Least significant differences at 0.05 level. N= Normal soil, S = Salt affected soil

Table 12: Means of cultivar environment interaction and decrease percent (%) for plant height (PH), grain yield (GY), biological yield (BY) and number of spike per square meter (S/m²) for field experiment.

From the data presented in Table 12, it can be classified the studied cultivars into three groups. The first group was low yield potential (under normal condition) cultivars with low grain yield decrease percent under salt affected soil such as Giza 139, Giza 144 and Hindi 62 (-17, 3 and 8% respectively), it may be due to low effect of salinity stress on number of kernels per spike and one thousand kernels weight and it may be consider as genetic resources for salinity tolerance in breeding program. The second one was high yield potential cultivars with moderate grain yield decrease percent under salt affected soil such as Misr 2, Misr 1 and Sids 1 (31, 21 and 14% respectively), these cultivars may be recommended for wheat production under salt affected soil. The third group was high yield potential cultivars with high grain yield decrease percent under salt affected soil such as Gemmeiza 3, Gemmeiza 9 and Sids 12 (39, 40 and 51% respectively) it may be consider as salinity sensitive cultivars.

Stress tolerance index (STI)

The stress tolerance index estimates based on shoot dry weight at seedling, biological yield of pots and salt affected soil for the nine studied cultivars are illustrated in Table 13. High estimates of stress tolerance index values based on shoot dry weight (seedling stage) were recorded for the bread wheat cultivars Misr 2, Gemmeiza 9, Hindi 62, and Giza 139, while low estimates for the others. High estimates of stress tolerance index (STI) values based on biological yield (the pot experiment) were recorded for cultivars Misr 2, Gemmeiza 9, Hindi 62, and Giza 144. While high estimates of STI values based on biological yield (the salt affected soil) were recorded for Misr 2, and Giza 144. These result indicated that salinity tolerance depending on the cultivars and growth stage. Based on STI estimates at seedling and adult plant stages, the studied cultivars could be divided to four groups. The first group, cultivar (MISR 2) was salt tolerant at both seedling and adult plant stages. The second group, cultivars (Gemmeiza 3 and Sids 12) were salt sensitive at both seedling and adult plant stages. The third group, cultivars (MISR 1, Sids 1 and Giza 144) were salt sensitive at seedling stage but tolerant at adult plant stage. The forth group, cultivars had varying degrees of tolerance and or sensitivity at seedling and adult plant stages.

Correlation

The correlation among each of biological, grain and straw yields under the salt affected soil condition and the studied characters under the normal soil and at 33% sea water mix treatments (seedling and pot experiments) are illustrated in Table 14. Biological yield of the salt affected soil had significant strong positive relationship with each of seedling emergence index and shoot length (for the seedling experiment); number of spikes per pot, straw yield per pot and biological yield per pot (for the pots experiment) and straw yield (for the normal soil experiment). While, significant weak correlation recorded with number of kernels per spike (for the pot experiment). Regarding to grain yield under the salt affected soil condition, significantly strong positive correlation were found with each of number of spikes per pots in pots experiment and biological yield under the normal soil condition, but negative correlation were found for number of kernels per spike for the pot experiment. Straw yield of the salt affected soil had significant strong positive correlation with each of seedling emergence index and shoot length for seedling experiment; number of spikes per pot, straw yield per pot and biological yield per pot for the pot experiment; plant height and straw yield for the normal soils experiment. While, significant negative correlation recorded for number of kernels per spike for the pot experiment. Generally, the bread wheat genotype with the high emergence speed (emergence index) and shoot length at seedling stage and high number of spikes per pot, biological and straw yield per pot at adult stage may be had good performance at the salt affected soil.
El-Hendawy et al. (2011) found highly significant correlation between grain yield per plant and shoot parameters (height and dry weight of shoot) at seedling stage. Hussain et al. (2015) reported that shoot parameters had comparatively stronger correlations than root parameters.

Table 13: Stress tolerance index (STI) estimates based on shoot dry weight, biological yield per pots and salt affected soil biological yield for the nine studied cultivars.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Shoot dry weight</th>
<th>Biological Yield pots</th>
<th>Salt affected soil biological yield</th>
<th>Rank sum</th>
<th>Rank mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STI</td>
<td>STI</td>
<td>STI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Misr 1</td>
<td>0.08</td>
<td>0.52</td>
<td>4.88</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>Gemmeza 9</td>
<td>0.14</td>
<td>0.74</td>
<td>4.73</td>
<td>10</td>
<td>3.3</td>
</tr>
<tr>
<td>Giza 139</td>
<td>0.10</td>
<td>0.41</td>
<td>4.3</td>
<td>17</td>
<td>5.7</td>
</tr>
<tr>
<td>Giza 144</td>
<td>0.07</td>
<td>0.72</td>
<td>5.55</td>
<td>14</td>
<td>4.7</td>
</tr>
<tr>
<td>Gemmeiza 3</td>
<td>0.08</td>
<td>0.4</td>
<td>3.19</td>
<td>22</td>
<td>7.3</td>
</tr>
<tr>
<td>Sids 1</td>
<td>0.04</td>
<td>0.73</td>
<td>4.9</td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>Sids 12</td>
<td>0.07</td>
<td>0.19</td>
<td>2.9</td>
<td>26</td>
<td>8.7</td>
</tr>
<tr>
<td>Hindi 62</td>
<td>0.12</td>
<td>0.77</td>
<td>3.85</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>Misr 2</td>
<td>0.21</td>
<td>0.84</td>
<td>6.54</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 14: The correlation (r) among biological, grain and straw yield under the saline soil condition and the studied characters of bread wheat cultivars under normal soil and 33% sea water mix treatments (seedling and pots experiments).

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Character</th>
<th>Field experiment ( saline affected soil)</th>
<th></th>
<th></th>
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</thead>
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<tr>
<td></td>
<td></td>
<td>Straw yield</td>
<td>r</td>
<td>P. value</td>
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<tr>
<td></td>
<td></td>
<td>Grain yield</td>
<td>0.66</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Biological yield</td>
<td>0.93</td>
<td>&lt;0.001</td>
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<tr>
<td></td>
<td></td>
<td>Emergence index</td>
<td>0.69</td>
<td>0.04</td>
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<tr>
<td></td>
<td></td>
<td>Root Dry weight</td>
<td>0.38</td>
<td>0.31</td>
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<tr>
<td></td>
<td></td>
<td>Shoot root ratio</td>
<td>0.32</td>
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<td></td>
<td></td>
<td>Root height</td>
<td>0.43</td>
<td>0.25</td>
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<td></td>
<td></td>
<td>Shoot dry weight</td>
<td>0.41</td>
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<td>Shoot length</td>
<td>0.74</td>
<td>0.02</td>
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<td></td>
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<td>100 kernels weight</td>
<td>-0.25</td>
<td>0.51</td>
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<td>Grain yield</td>
<td>0.57</td>
<td>0.11</td>
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<td>Plant height</td>
<td>0.35</td>
<td>0.36</td>
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<td></td>
<td></td>
<td>Spike /pot</td>
<td>0.93</td>
<td>&lt;0.001</td>
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<td>Straw yield</td>
<td>0.64</td>
<td>0.06</td>
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<td></td>
<td></td>
<td>Kernels / Spike</td>
<td>-0.67</td>
<td>0.05</td>
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<tr>
<td></td>
<td></td>
<td>Biological yield</td>
<td>0.67</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
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<td>1000 kernels weight</td>
<td>-0.35</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
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<td>Biological yield</td>
<td>0.30</td>
<td>0.43</td>
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<tr>
<td></td>
<td></td>
<td>Grain yield</td>
<td>-0.20</td>
<td>0.61</td>
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<tr>
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<td>Plant height</td>
<td>0.62</td>
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<tr>
<td></td>
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<td>Spikes per square meter</td>
<td>0.28</td>
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<tr>
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<td>Straw yield</td>
<td>0.70</td>
<td>0.03</td>
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<tr>
<td></td>
<td></td>
<td>Kernels / Spike</td>
<td>-0.33</td>
<td>0.38</td>
</tr>
</tbody>
</table>

CONCLUSION

Generally, testing the nine bread wheat cultivars at seedling and adult plant stages against salinity stress resulted in significant decreases in most seedling and adult plant characters. Increasing salt concentrations causes significant decrease in shoot dry weight, shoot length, root dry weight, root length and emergence speed (emergence index), plant height, biological yield, grain yield, straw yield, number of kernels per spike and mean kernel weight and increase shoot-root dry weight ratio. The variances due to salt treatments had the major portion of total variance, indicated the large effect of salt stress on growth characters compared with genotype and genotype × salt concentrations interaction variances. The salt concentration 33% sea water mix is not destructive and caused large variation among the studied cultivars so, it can be used for screening wheat
cultivars for salt tolerance. The large variance among the nine cultivars for shoot length, emergence index and shoot-root dry weight under salt stress indicated the importance of these characters in studying the effect of salt stress on bread wheat genotypes at seedling stage. Strong and positive correlation were found between biological yield under salt affected soil and emergence index and shoot length at seedling stage; number of spike per pot, biological and straw yield per pot at adult stage. Based on stress tolerance index, of the nine studied cultivars, Misr 2 was salt tolerant while Gmmeiza 3 and Sids 12 were salt sensitive cultivars.

REFERENCES


GenStat 14th Edition: Available online www.genstat.co.uk


تقييم تسع أصناف قمح خبز مصرية لتحمل الملوحة في طور البادرة والنبات البالغ

خالد الدمرداش رجب
1
و ناصر ابراهيم طلحة
2

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2 معهد بحوث الإراضي والبيئة، مركز البحوث الزراعية – مصر

أجرت هذه الدراسة في كل من المزرعة البحثية ومعمل القمح ومعمل كيمياء وطبيعة الأراضي بمحطة البحوث الزراعية بسوهاج. été

مصر في الموسم الزراعي 2015/2016. كانت الدراسة تتأثر بالملوحة على سبع أصناف من قمح خبز مصرية في أطراف الريح المختلفة للنباتات وتحديد الأصناف المتاحة للملوحة في أطراف الريح المختلفة ومحاولة الوصول إلى طريقة فعالة لفورفر الاستخدام لتحمل الرياح. وقد أجريت ثلاث تجارب في هذه الدراسة (بادرات، أوم، حلقة). وقد تم إجراء معمولات الملوحة في تجربتي البادرة والأصناف بخلط ماء البحر وماء الصنبور اصلاح ستة أضعاف خطط (صفر 1.3, 2.1, 3.9, 4.7). مرت أجريت الدراسة على تسعة أصناف قمح خبز مصرية وهي مصر 0, مصور 4, كوز 012, كوز 022, سود 0, سود 04, كوز 1, كوز 2, هنود 44. ودرسنا صفات سرعة البذور والوزن الجاف للساق والوزن الجاف للجذر وطول الساق وطول الجذر والوزن الجاف للساق والماء الجاف للساق. وكانت الاختبارات من الكهرباء وتحمل الملوحة. وكان النتائج أن زيادة الملوحة أدت إلى تزايد محتوى في سرعة النبات والمحصول البيولوجي ومحصول القمح والساق وعدد الساقين لكل أرضي ومحصول القمح والساق ومحتوى الماء في الساق. أظهر تحليل الانتشار أن التباين الأكثر فاعلًا في الملوحة يمثل النبات الأكثراً من التباين كأعلى وتباين الانتشار في الارتفاع المبسط بين الأصناف. وقد فحصنا التباين الكبير للملوحة على الاصتكاث inspiratio مقارنة بالاكتساب إثر قمون الاصطدام والحصول البيولوجي. وكانت معاملة الملوحة 3.3% فجراً ماء البحر وماه الصنبور يمكن استخدامها لحرق أصناف القمح وتحمل الملوحة. وكانت الصفات الأثارة تابعة تحت معمولات الملوحة في طور البادرة وسرعة البادرة والنسبة بين الزراعة الجافة للساق والجذر ما يشير إلى أهمية هذه الصفات في فوز الانتشار وتحمل الملوحة في طور البادرة. كما وجدت الانتشار أو موجود بين المحصول البيولوجي تحت طف وتضاهي الأرض المفضلة بالمملكة كل من سرعة الانتشار وطول الساق في طور البادرة، بالإضافة إلى عدد الساقين لكل صنف القمح البيولوجي لكل أصلب ومحمول القمح على مستوى صنف القمح البيولوجي (STI) حيث كان من الأصناف المتاحة التفاوت بين النبات البالغ وآثرت نتائج تحليل تحميل الملوحة معرفة. أظهرت الصنف المصري 0.4 حالة نتائج صنف الأصلب المفصلة 0.4 عرض وتحمل الملوحة 0.2 عرض للملوحة ونسبة 0.3 بين استثناء الصنف المصري.