Germination and Seedling Characters of Different Wheat Cultivars under Salinity Stress

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Abstract: The impact of salt stress under different salinity level (2, 4, 6, 8, 10, 12 and 14 dS/m^{-1} NaCl) on eleven varieties of bread wheat (*Triticum aestivum* L.) viz., Sakha 93, Gemmeza 7, Egaseed 7, Sakha 94, Gemmeza 10, Egaseed 3, Masr 2, Masr 1, Gemmeza 9, Sids 1 and Giza 168 was conducted. A laboratory experiment was conducted at Giza Central Seed Testing laboratory of Central Administration for Seed Testing and Certification, Ministry of Agriculture, Egypt. Wheat cultivars significantly varied in means of final germination percentage, germination rate, germination index, vigor index, shoot length, root length, shoot fresh weight, root fresh weight, shoot dry weight, root dry weight, seedling height reduction and relative dry weight. Sakha 93 and Sakha 94 had positive effects in most of studied characters while, Masr 1 cultivar had negative effects in most of germination parameters under study. Salinity concentrations significantly varied in all germination parameters under study except shoot dry weight character. Increasing salinity concentrations from 0 to 14 dS/m^{-1} gradually decreased average of germination and seedling characters. All studied characters were significantly affected by the interaction between cultivars and salinity stress, vice versa, root length didn't affect by the interaction. It could be concluded that for maximizing wheat germination percentage and seedling parameters under salinity stress are recognized by using Sakha 93, Sakha 94 and Gemmeza 10 cultivars with increasing salinity concentrations levels up to 14 dS/m^{-1}. Among the cultivars under investigation Sakha 93 and Sakha 94 cultivars appeared to be more tolerant to salinity at germination stage compared with other cultivars. These cultivars were more tolerant to salinity and recommended to use in breeding program for enhancing Wheat production in Egypt.

Keywords: Bread wheat cultivars, salinity concentrations, germination characters, seedling parameters.

INTRODUCTION

Wheat production in the Mediterranean region is restricted mainly by the accessibility of water resources and soil salinity. Wheat is a considered main staple food crop for more than one third of the world population [1] and is the main food for Egyptian. There is a huge shortage in production of wheat in Egypt, it imported more than 50% of our consumption [2]. The extreme increase in population in Egypt needs to increase wheat production in order to overcome this lack in production through its cultivation in the new reclaimed soils especially under saline conditions of such soil. Wheat is one of the most effectual and commercial means of reclaiming hundreds of thousands of hectares of saline lands in Egypt. Soil salinity is one of the most imperative abiotic stress and limiting factor [3] for worldwide plant production. Up to 20% of the irrigated soil in arid and semi-arid regions is already salt artificial and is still increasing [4].

Germination of seed is an important point in seedling establishment and subsequent plant health and vigour. Seeds may be more susceptible to stresses than mature plants, because of exposure the dynamic environment close to the soil surface [5]. Seedling establishment at early growth stages of plants is determined of high yield is sternly affected by soil salinity [6].

Wheat varieties showed a great variation in germination due to salinity effects. Many investigators such as [7-9] concluded that differences among wheat cultivars in germination characters and seedling parameters. Therefore, we conclude that the measurements of shoot growth may be effective criteria for screening wheat genotypes for salt tolerance at early growth stages [10]. Salts present in water reduce plant growth due to its decrease water up take by plant which results in slow plant growth and due to salt may break in the leaf xylem and ultimately harm leaves which turn down plant growth.

Salinity is one of the major obstacles in enhancing wheat production in growing areas in Egypt. Salinity affects wheat seed germination [11] and seedling characters plants [12] by slow or less recruitment of reserve foods [13] suspending the cell division, amplification [14] and injuring hypocotyls [15]. Salinity can affect germination and seedling growth either by creating an osmotic pressure that prevents water uptake or by toxic effects of sodium and chloride ions

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on seed germination [16, 17]. However, screening for seeds with a greater tolerance to salt stress aids in the development of salt tolerant cultivars. Increasing levels of salinity (NaCl) significantly reduced the seedling growth parameters in all studied wheat genotypes [6, 16, 18-21]. Therefore the aim of the present study were i) to assess the impact of salt stress on different cultivars of wheat ii) to screen wheat cultivars for salt stress by assessing germination and seedling properties.

MATERIALS AND METHODS

The laboratory experiment was conducted at Giza Central Seed Testing laboratory of Central Administration for Seed Testing and Certification (CASC), Ministry of Agriculture, Egypt during the period of February 2012 to April 2012 to study the response of fifteen cultivars of wheat to germination under salinity stress and to confirm the seedling growth performance to examine a range of genetic variability for salinity tolerance among wheat cultivars.

Plant Material

Eleven breadwheat cultivars were selected i.e. Masr 1, Masr 2, Egaseed 3 Egaseed 7, Sids 1, Sakha 93, Sakha 94, Gemmeza 7, Gemmeza 9, Gemmeza 10 and Giza 168 to study germination of some wheat seed cultivars under different levels of salinity. Wheat seeds of this study were obtained from Agriculture Research except Egaseed cultivars was obtained from private company. Seeds were stored at laboratory conditions in cloth bags inside plastic bags under laboratory conditions. Factorial experiment in Randomized Complete Block Design in four replications was used. The experiment includes two factors. The first factor 7 levels of NaCl beside the control treatment. The salinity NaCl levels 2, 4, 6, 8, 10, 12 and 14 dS/m^{-1} NaCl was used. The second factor include eleven bread wheat cultivars were Sakha 93, Gemmeza 7, Egaseed 7, Sakha 94, Gemmeza 10, Egaseed 3, Masr 2, Masr 1, Gemmeza 9, Sids 1 and Giza 168.

Studied characters

A. Germination Characteristics

1 Final Germination Percentage (FGP): germination count was taken after 14 days from sowing date and expressed as percentage according to the following equation described by [22,23]:

(FGP) = Number of germinated seed / Total Number of seed tested ×100.

2 Germination Rate (GR): it was calculated according to the following equation described by [24]:

(GR) = Number of germinated seeds/Number of germination days

3 Germination Index (%): it was calculated according to [25] as the following equation (GI):

(GI) = % Germination each treatment / % Germination in the control X 100

4 Seedling vigor index (VI): it was calculated according to [26] as the following equation:

(VI) =(Average shoot length + Average root length) X Germination percentage.

B. Seedling Characteristics

After 14 days ten seedlings were selected from each replicates and then seedlings were evaluated as follows:

1 Shoot length: the length of the ten seedlings from the seed to the tip of the leaf blade were recorded and expressed in centimeters as the shoot length.

2 Root length: The root length of ten seedlings from the seed to the tip of the root and recorded and expressed in centimeters (cm) as the root length

3 Shoot fresh weight: The weight of ten seedling shoots was measure and expressed in milligram as the shoot fresh weight.

4 Root fresh weight: The weight of ten seedling roots were measured and expressed in milligram (mg) as the root fresh weight.

5 Shoot dry weight: The weight of ten seedling roots were recorded and expressed in milligram after oven drying at 70 ºc for 72 h.

6 Root dry weight : The weight of ten seedling roots were recorded and expressed in milligram after oven drying at 70 º C for 72 h.

7 Seedling height reduction(%): The seedling height reduction (SHR) according to [23] was calculated using the following equation:

SHR (%) = (Plant height at control – Plant height at saline condition) / Plant height at saline condition X 100.

8 Relative dry weight(%) the relative dry weight (RDW) according to [27] was calculated using the following equation: RDW (%) = Total dry weight under saline condition / Total dry weight under control condition × 100.

Statistical Analysis

All data of this study were statistically analyzed according to the technique of variance (ANOVA) for the factorial Randomized Complete Block Design as published by [28]. Least Significant Difference (LSD) method was used to test the differences between treatment means at 5% level of probability as described by [29].

RESULTS AND DISCUSSION

1. Performance of Cultivars

Results in Table **1** clearly showed that the tested cultivars of Wheat significantly varied for averages of final germination percentage, germination rate, germination index, seedling vigor index, shoot length, root length, shoot fresh weight, root fresh weight, shoot dry weight, root dry weight, seedling height reduction and relative dry weight. Sakha 93 cultivar significantly exceeded the other studied cultivars in final germination percentage (93.66 %). Sown Sakha 94 cultivar came in the second rank (91.25 %). While, the lowest final germination percentage was recorded by Masr 2 cultivar (73.79%). Sakha 93 cultivar significantly exceeded the other studied cultivars in germination rate (11.11%) and Sakha 94 came in the second rank and recorded 11.00%. While, Masr 2 cultivar produced the lowest germination rate (8.65%). Sakha 93 and Sakha 94 cultivars significantly exceeded the other studied cultivars in germination index without significant differences between them (94.41 and 92.04%, respectively). While, Masr 1, Masr 2, Egaseed 3 and Egaseed 7 cultivars produced the lowest germination index without significant differences between them. Sakha 93 significantly exceeded the other studied cultivars in vigor index(32.56%). Sakha 94 came in the second rank and recorded 30.96%.The lowest vigor index values was recorded from sown Masr 2 cultivar. The differences between wheat cultivars in final germination percentage might be due to the genetical factors and heredity variation among the eleven wheat cultivars under study which caused differed in final germination percentage. Sakha 94 cultivar significantly produced tallest shoot (12.96 cm). Gemmiza 7 and Sakha 93 came in the second and third rank (11.97 and 11.27 cm, respectively). Masr 2 cultivar produced the shortest shoots (5.33 cm). Sakha 93 and Sakha 94 cultivars significantly exceeded the other studied cultivars in root length (21.05 and 20.58 cm, respectively) without significant differences between them. Gemmeza 7 cultivar came in the second rank (18.75 cm). While, Masr 2 cultivar produced the shortest root (10.5 cm). Sakha 93 cultivar significantly exceeded other studied cultivars in shoot fresh weight (1.599 g). Sakha 94 cultivar came in the second rank (1.504 g). The lowest fresh shoot weight was obtained from Egaseed 7 cultivar (1.195 g). Sakha 93 cultivar significantly recorded highest weight of fresh root than other studied cultivars (1.892 g). The lowest weight of fresh root was obtained from Masr 2 (0.702 g). Sakha 93 cultivar significantly exceeded other studied cultivars in shoot dry weight (0.164 g). Sakha 94 cultivar came in the second rank (0.155 g). Whilst, Masr 1 cultivar recorded the lowest dry weight of shoot (0.050 g). Sakha 93, Sakha 94, Gemmeza 7, Gemmeza 9, Gemmeza 10 and Sids 1 cultivars significantly enhanced the other studied cultivars in root dry weight (0.167, 0.156, 0.147, 0.137, 0,126 and 0.116 g, respectively). Egaseed 3, Giza 168, Egaseed 7 and Masr 1 came in the second rank (0.101, 0.107, 0.091 and 0.064 g). However, Masr 2 cultivar produced the lowest root dry weight (0.057 g). Highest seedling height reduction percentages were obtained from sown Masr 1 and Masr 2 without significant differences between them (41.67 and 40.33, respectively). Gemmeza 9, Sids 1, Sakha 93, Gemmeza 7 and Sakha 94 came in the second rank without significantly differences between them (28.93, 27.15, 27.07, 26.01 and 24.39%, respectively). However, Gemmeza 10 cultivar produced the lowest seedling height reduction (22.47%). Highest relative dry weight was obtained from sown Egaseed 3, Sakha 93, Egaseed 7, Gemmeza 7, Gemmeza 9, Gemmeza 10, Giza 168, Sakha 94 and Sids 1 came in the first rank without significantly differences between them (96.64, 96.29, 96.26, 95.80, 95.27, 94.77, 94.75, 94.60 and 94.38%, respectively. However, lowest relative dry weight was obtained from sown Masr 1 and Masr 2 without significant differences between them (91.55 and 92.54%, respectively. Salinity reduced all germination properties of wheat cultivars, especially seed vigour. These results might due to genetic variation exist among wheat cultivars in terms of early seedling growth rate under salt stress condition [30]. Salinity affects germination in two ways the first may be enough salt in the medium decrease the osmotic potential to such a point which retard or prevent the

Table 1: Averages of Final Germination Percentage (%), Germination Rate, Germination Index, Vigor Index, Shoot Length, Root Length, Shoot Fresh Weight, Root Fresh Weight, Shoot Dry Weight, Root Dry Weight, Seedling Height Reduction and Relative Dry Weight as Affected by Wheat Studied Cultivars

Characters Treatments	Final germination percentage (%)	Germination rate (days)	Germination index	Vigor index	Shoot length (cm)	Root length (cm)	Shoot fresh weight (g)	Root fresh weight (g)	Shoot dry weight (g)	Root dry weight (g)	Seedling height reduction (%)	Relative dry weight (%)
Cultivars performance:												
Msar 1	75.04	9.09	82.45	13.82	6.02	11.70	1.253	0.787	0.050	0.064	41.67	91.55
Msar 2	73.79	8.65	81.70	12.19	5.33	10.50	1.255	0.702	0.071	0.057	40.33	92.546
Egaseed 3	77.66	9.40	82.08	16.59	7.25	13.45	1.257	1.091	0.101	0.101	35.47	96.646
Egaseed 7	75.45	9.71	82.45	14.89	6.64	12.50	1.195	1.089	0.091	0.091	35.92	96.267
Sids 1	81.75	10.32	87.62	20.43	8.87	15.66	1.314	1.298	0.116	0.116	27.15	94.388
Sakha 93	93.66	11.11	94.41	32.56	11.27	21.05	1.599	1.892	0.164	0.167	27.07	96.292
Sakha 94	91.25	11.00	92.04	30.96	12.96	20.58	1.504	1.766	0.155	0.156	24.39	94.613
Gemmeza 7	87.58	10.70	88.58	27.39	11.97	18.75	1.404	1.830	0.146	0.147	26.01	95.808
Gemmeza 9	85.91	10.92	87.75	24.93	10.60	17.83	1.310	1.559	0.118	0.137	28.93	95.279
Gemmeza 10	84.91	10.34	89.45	22.83	6.60	16.83	1.255	1.383	0.126	0.126	22.47	94.779
Giza 168	79.70	9.99	84.87	18.84	8.10	14.95	1.311	0.921	0.105	0.107	33.61	94.788
F. test	**	**	**	**	**	**	**	**	**	**	**	**
LSD at 5%	1.21	0.06	2.29	0.87	0.41	0.81	0.008	0..027	0.001	0.0006	3.10	1.20
LSD at 1%	1.87	0.08	1.95	1.14	0.54	1.06	0.011	0.031	0.002	0.0007	4.07	1.58

uptake of water necessary for mobilization of nutrient required for germination, the second due to salt constituents or ions may be toxic to the embryo [31]. These results in good accordance with results reported by [6, 7, 9, 16, 18, 21, 30, 32-34].

2. Salinity Stress Effects

The results in Table **2** indicated that salinity stress treatments had significant effects on averages of final germination percentage, germination rate, germination index, vigor index, shoot length, root length, shoot fresh weight, root fresh weight, shoot dry weight, root dry weight, seedling height reduction and relative dry weight. The highest averages of these characters were recorded with control treatment. Highest salinity concentration up to 14 dS/m^{-1} NaCl recorded the lowest averages of these characters. Increasing salinity concentrations from 0 to 14 dS/m^{-1} NaCl gradually decreased averages of root length, shoot length, root fresh weight, shoot fresh weight and root dry weight. Highest final germination percentage (94.39 %) was recorded with the control treatment compared with other salinity levels, Treated seed with 2 and 4 dS/m^{-1} NaCl came in the second and third ranks (92.15 and 90.42%, respectively). Highest salinity levels i.e. 14 dS/m^{-1} NaCl recorded the lowest final germination percentage (68.21%). Highest values of seed germination rate were recorded with the control followed by those treated with 2, 4 and 6 dS/m^{-1} NaCl without significant differences between them (11.07, 10.88, 10,64 and 10.28, respectively). The lowest seed germination rate was produced from increasing salinity levels from 8, 10, 12 and 14 dS/m^{-1} NaCl without significant differences between them (9.83, 9.70, 9.43 and 9.18, respectively). Highest germination index was obtained from the control treatment (100.0%). Salinity level of 4 and 6 dS/m^{-1} NaCl compared in the second and third ranks (97.93 and 93.93%, respectively). Highest of salinity level of 14 dS/m^{-1} NaCl recorded the lowest germination index (71.63%). Highest vigor index percentages were recorded with the control treatment compared with other salinity stress levels (30.75%) followed by salinity levels of 2, 4 and 6 dS/m^{-1} NaCl as an intermediate salinity levels. Highest salinity level of 14 dS/m^{-1} NaCl recorded the lowest vigor index (12.40%). Increasing salinity levels from 0 to 14 dS/m^{-1} NaCl gradually decreased shoot length. Longest shoots length (13.20 cm) produced from the control treatment compared with other salinity levels. Highest salinity level i.e. 14 dS/m^{-1} NaCl produced the shortest shoot (5.37 cm). The desirable effect on shoot length as a result of using salinity treatments might be attributed to sodium concentration in the shoots during early growth. It could be noticed that increasing salinity levels from 2, 4, 6, 8, 10, 12, 14 dS/m^{-1} NaCl significantly decreased with the control treatment. The tallest root length (19.16 cm) was recorded with the control treatment compared with other salinity stress concentrations. Highest salinity level i.e. 14 dS/m^{-1} NaCl effect root length and recorded the lowest root length (12.30 cm). The desirable effect of highest salinity level on root length may be due to damage of membrane as an important role in the cellular toxicity of NaCl. It could be concluded that increasing salinity levels from 2, 4, 6, 8, 10, 12 and 14 dS/m^{-1} NaCl significantly decreased root length by 5.2, 11.6, 14.9, 16,5, 25.2, 30.8 and 35.8%, respectively compared with the control treatment. Increasing salinity levels from 0 to 14 dS/m^{-1} NaCl gradually decreased shoot fresh weight. Highest shoot fresh weight (1.535g) was obtained from the control treatment compared with other salinity stress levels. Highest salinity level of 14 dS/m^{-1} NaCl recorded the lowest shoot fresh weight (1.136g). It could be concluded that increasing salinity levels from 2, 4, 6, 8, 10, 12, 14 dS/m^{-1} NaCl significantly reduced weight fresh shoot by 3.7, 7.9, 11.4, 14.4, 18.8, 23.3 and 26.0%, respectively compared with the control treatment. Increasing salinity level from 0 to 14 dS/m^{-1} NaCl gradually significantly decreased root fresh weight. Highest weight of root fresh (1.592g) was recorded with the control treatment compared with other salinity levels. Highest salinity level of i.e. 14 dS/m^{-1} NaCl recorded the lowest root fresh weight (0.974g), which might be attributed to the toxic effects of salinity. Increasing salinity levels from 0 to 14 dS/m^{-1} NaCl gradually decreased shoot dry weight. Highest weight of dry shoot (0.124g) was obtained from the control treatment compared with other salinity levels. Highest salinity level of 14 dS/m^{-1} NaCl recorded the lowest shoot dry weight (0.102g). Highest root dry weight (0.122g) was obtained from the control treatment compared with other salinity levels, followed by 0.120 and 0.118 mg with 2 and 4 dS/m^{-1} NaCl as intermediate values. Highest salinity level of 14 dS/m^{-1} NaCl recorded the lowest root dry weight (0.110g). Increasing salinity levels from 0 to 14 dS/m^{-1} NaCl gradually increased seedling height reduction. Lowest seedling height reduction (11.61%) was obtained from treated with 2 dS/m^{-1} NaCl compared with other salinity levels. Highest salinity level of 14 dS/m NaCl recorded highest seedling height reduction (59.77%). Increasing salinity levels from 0 to 14 dS/m^{-1} NaCl gradually decreased relative dry weight. Lowest relative dry weight (89.51%) was obtained from treated with highest salinity level (14 dS/m^{-1} NaCl) compared with other salinity levels. Without salinity application (0 dS/m^{-1} NaCl) recorded highest relative dry weight (100%). Our results are in line with the findings of [35, 36] that germination was directly related to the amount of water absorbed and delay in germination to the salt concentration of the medium. The reduced level of seed germination may be due to (i) loss of viability at higher salinity level (ii) delaying germination of seeds at salinities that cause some stress to but not percent germination as reported by some workers [37]. The reduction in root and shoot development may be due to toxic effects of the higher level of NaCl concentration as well as unbalanced nutrient uptake by the seedlings. 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. Decrease and delay in germination in saline medium has also been reported by [17, 38-49].

Table 2: Averages of Final Germination Percentage (%), Germination Rate, Germination Index, Vigor Index, Shoot Length, Root Length, Shoot Fresh Weight, Root Fresh Weight, Shoot Dry Weight, Root Dry Weight, Seedling Height Reduction and Relative Dry Weight as Affected by Salinity Concentrations (NaCl)

Characters Treatments	Final germination percentage (%)	Germination rate	Germination index	Vigor index	Shoot length (cm)	Root length (cm)	Shoot fresh weight (g)	Root fresh weight (g)	Shoot dry weight (g)	Root dry weight (g)	Seedling height reduction (%)	Relative dry weight (%)
Salinity stress (NaCl dS/m-1):												
O (control)	94.39	11.07	100.00	30.75	13.20	19.16	1.535	1.592	0.124	0.122	0.00	100.00
2 dS/m	92.15	10.88	97.93	27.88	11.73	18.16	1.478	1.506	0.121	0.120	11.61	98.482
4 dS/m	90.42	10.64	93.93	25.54	10.92	16.93	1.413	1.451	0.118	0.118	17.62	96.888
6 dS/m	87.36	10.28	91.87	23.05	9.60	16.30	1.360	1.375	0.114	0.116	27.54	95.452
8 dS/m	80.57	9.83	84.33	20.47	8.75	15.98	1.314	1.289	0.111	0.114	35.10	94.455
10 dS/m	75.69	9.70	79.84	17.03	7.50	14.33	1.247	1.208	0.107	0.112	43.90	92.509
12 dS/m	70.63	9.43	73.84	14.10	6.11	13.24	1.178	1.018	0.105	0.111	53.94	91.215
14 dS/m	68.21	9.18	71.63	12.40	5.37	12.30	1.136	0.974	0.102	0.110	59.77	89.512
F. test	**	**	**	**	**	**	**	**	**	**	**	**
LSD at 5%	1.21	0.05	1.95	0.74	0.35	0.69	0.007	0.023	0.001	0.0003	2.64	1.02
LSD at 1%	1.59	0.07	2.57	0.97	0.46	0.91	0.010	0.031	0.002	0.0004	3.47	1.35

3. Interaction Effects

The interaction between wheat cvs and salinity levels significantly affected final germination percentage as illustrated in Figure **1**. Highest final germination % was recorded with sown Sakha 93 cultivar with increasing salinity level from 0 up to 8 dS/m^{-1} NaCl (99.66, 99.66, 90.33,98.66 and 98.0% without significant differences between them, respectively). Highest germination rate was recorded with Sakha 93 cultivar at control treatment and or increasing salinity level up to 2 dS/m^{-1} without significant differences between them followed by Sakha 94 at control treatment as illustrated in Figure **2**. Highest germination index was recorded with all studied cultivars at the control treatment and salinity level of 2 or 4 dS/m^{-1} NaCl without significant differences between them as shown in Figure **3**. Highest vigor index values were resulted from sowing Sakha 93 cultivar with control treatment and or treated with 2 dS/m^{-1} NaCl, which were 42.36 and 41.06, respectively as illustrated in Figure **4**. Tallest shoots was obtained from Sakha 93 and Sakha 94 cultivars at control treatment (18.0 and 17.26, respectively) as presented in Figure **5**. Highest weight of fresh shoot was obtained from sown Sakha 93 cultivar at control

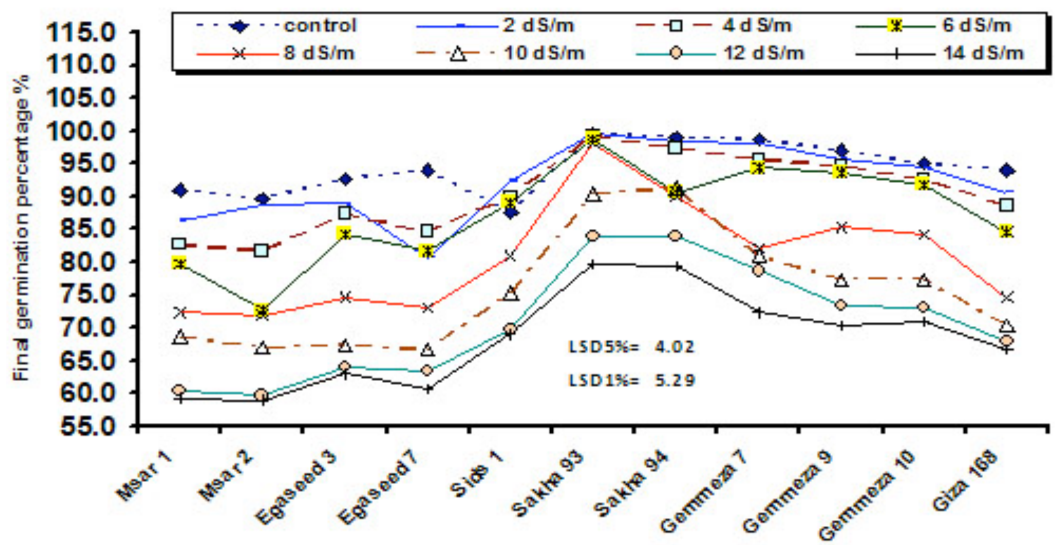

Figure 1: Averages final germination percentage (%) as affected by the interaction between cultivars and salinity stress (NaCl ds/m^{-1}).

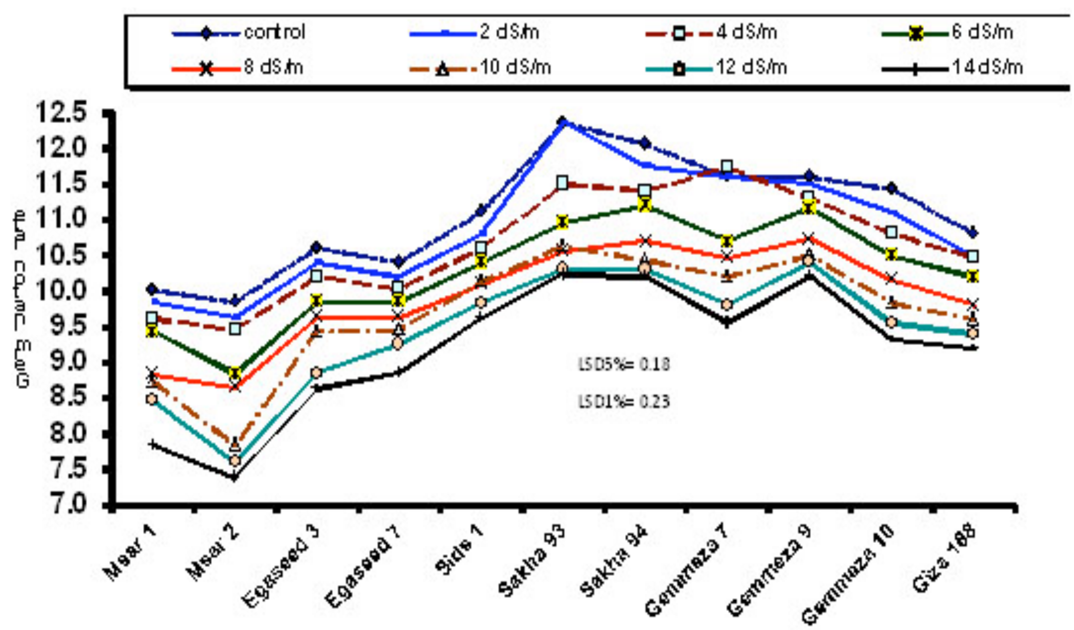

Figure 2: Averages germination rate as affected by the interaction between cultivars and salinity stress (NaCl ds/m^{-1}).

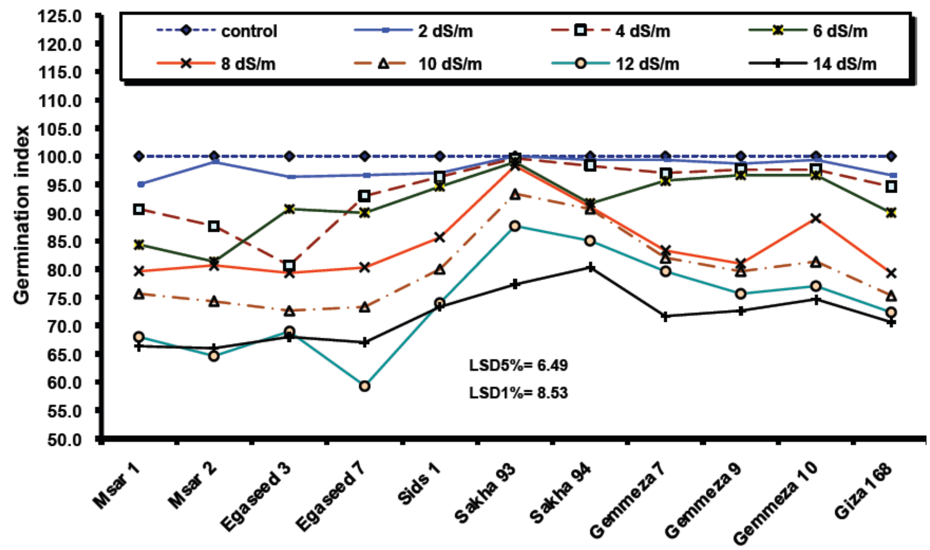

Figure 3: Averages germination index % as affected by the interaction between cultivars and salinity stress (NaCl dS/m^{-1}).

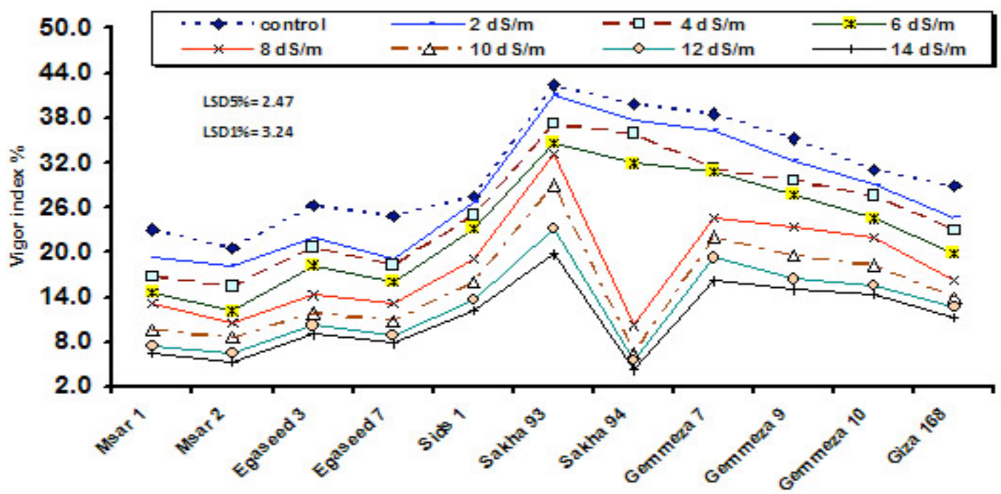

Figure 4: Averages vigor index % as affected by the interaction between cultivars and salinity stress (NaCl ds/m^{-1}).

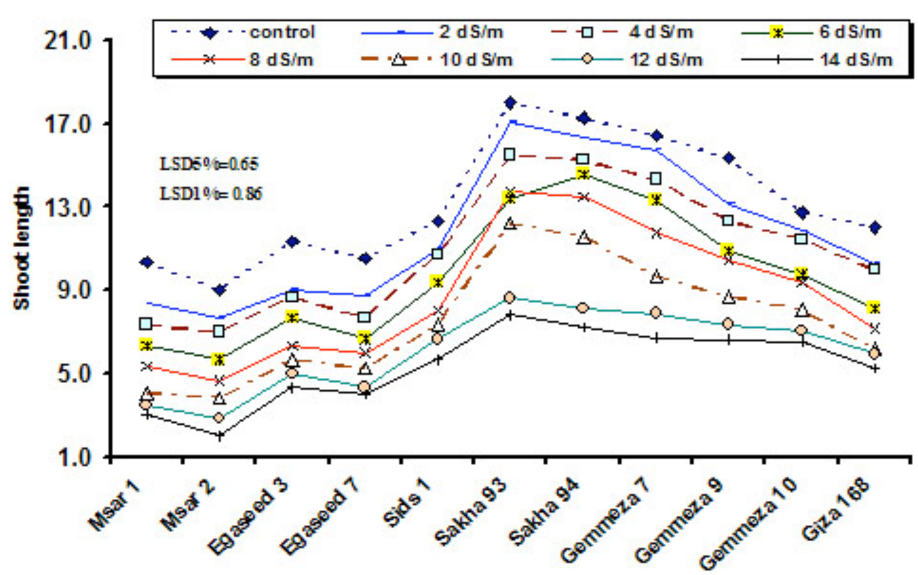

Figure 5: Averages shoot length cm as affected by the interaction between cultivars and salinity stress (NaCl ds/m^{-1}).

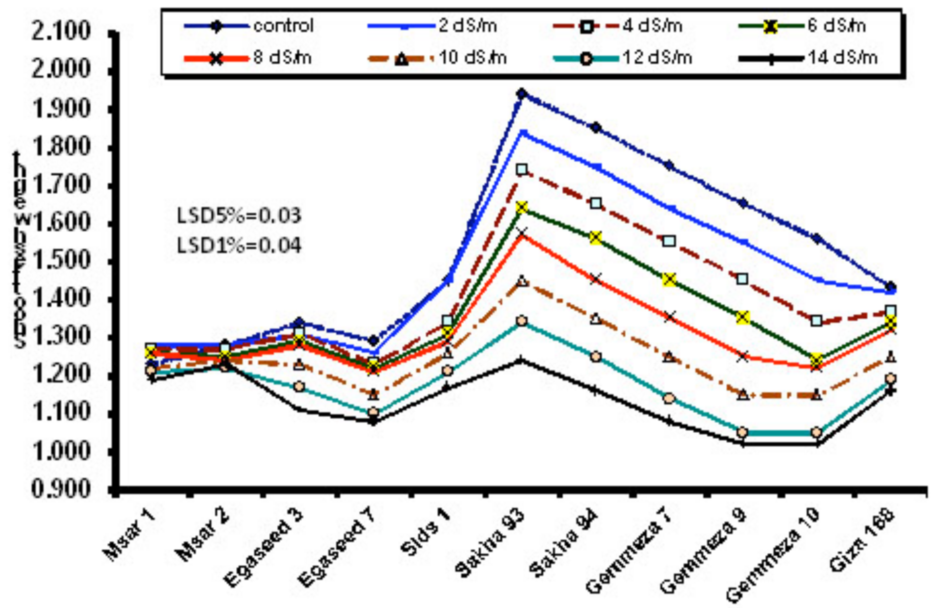

Figure 6: Averages shoot weight mg as affected by the interaction between cultivars and salinity stress (NaCl ds/m^{-1}).

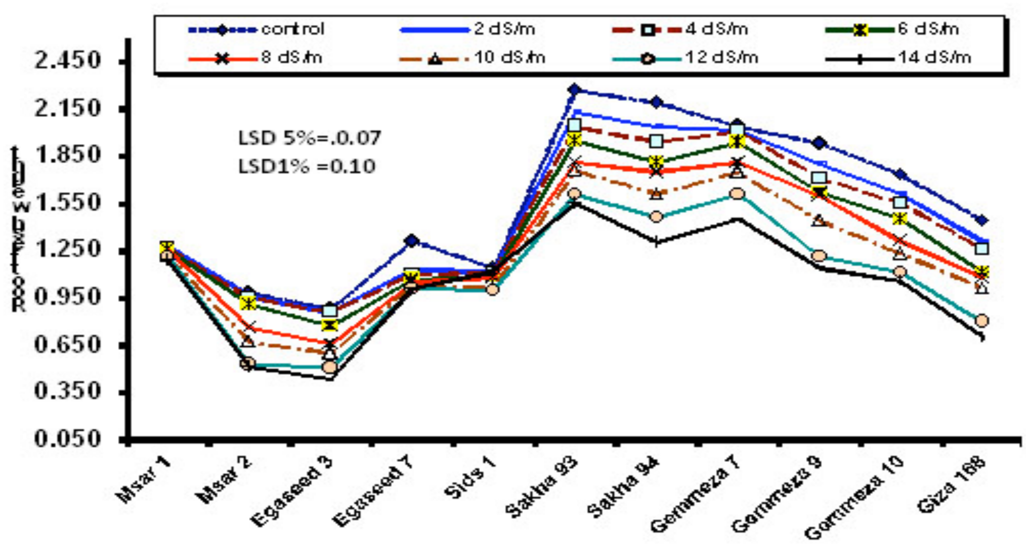

Figure 7: Averages root fresh weight mg as affected by the interaction between cultivars and salinity stress (NaCl ds/m^{-1}).

treatment (1.94g) as illustrated in Figure **7**. Sakha 93 cultivar at control came in the second rank. However, the lowest weight of fresh shoot was obtained from sown Gemmeza 9 and Gemmeza 10 (1.02 and 1.02g, respectively). Highest root dry weight was resulted from sowing Sakha 93, Sakha 94, Gemmeza 7, Gemmeza 9 and Gemmeza 10 cultivars with control treatment without significant differences between them (0.173, 0.163, 0.154, 0.143 and 0.133g, respectively) as illustrated in Figure **8**. Highest percentages of seedling height reduction was resulted from sowing Masr 2 and Masr 1 cultivars and 14 dS/m^{-1} NaCl salinity concentration without significant differences between them (73.43 and 70.56%, respectively) as presented in Figure **9**. On contrary, the lowest seedling height reduction percentages was resulted from sowing Gemmeza 10 and Sids 1 cultivars with14 dS/m^{-1} NaCl salinity concentration without significant differences. Lowest relative dry weight was resulted from sowing Sakha 94 and Masr 1 cultivars with 14 dS/m^{-1} NaCl salinity level without significant differences between them (81.86 and 82.26%, respectively) as illustrated in Figure **10**. Whilst, highest relative dry weight was resulted from sowing Sakha 93, Egaseed 3, Egaseed 7, Giza 168, Gemmeza 7, Gemmeza 9, Gemmeza 10, Sids 1 and Masr 2 cultivars with 14 dS/m^{-1} NaCl salinity level without significant differences (93.56, 93.26, 92.56, 92.33, 91.60, 90.93, 90.10, 89.16 and 86.96%,

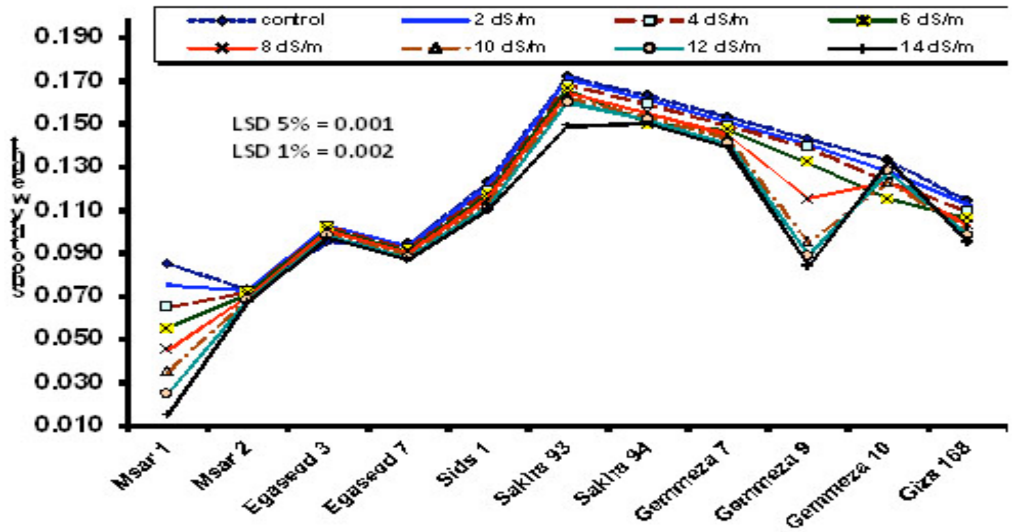

Figure 8: Averages shoot dry weight mg as affected by the interaction between cultivars and salinity stress (NaCl ds/m^{-1}).

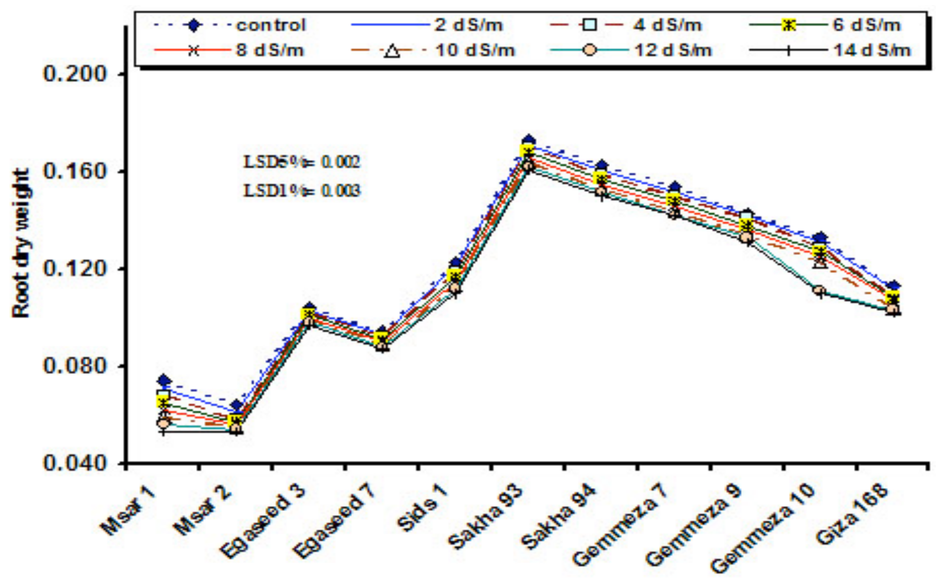

Figure 9: Averages root dry weight mg as affected by the interaction between cultivars and salinity stress (NaCl ds/m^{-1}).

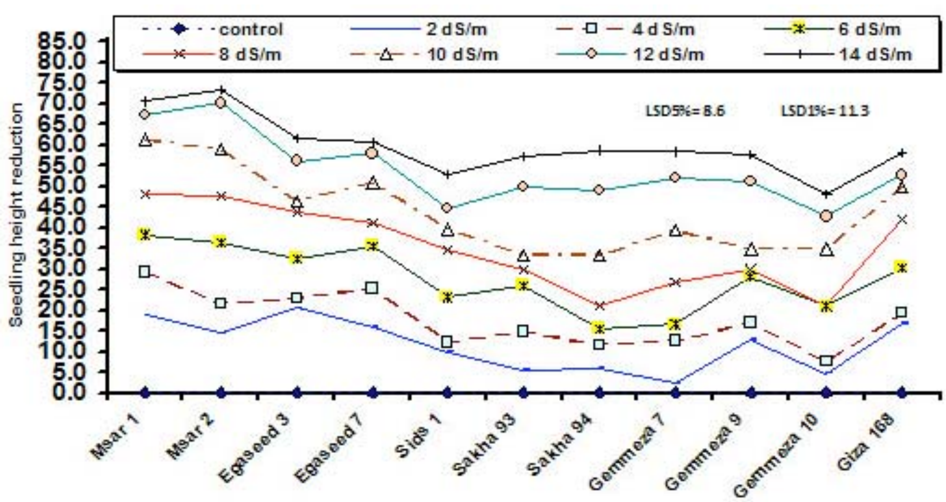

Figure 10: Percentages seedling height reduction % as affected by the interaction between cultivars and salinity stress (NaCl ds/m^{-1}).

respectively). However, Masr 1 cultivar decreased relative dry weight from 97.10 to 93.96% by increase salinity level from 2 dS/m^{-1} to 4 dS/m^{-1} NaCl, respectively and Giza 168 cultivar decreased relative dry weight from 95.33 to 90.86% by increase salinity level from 8 dS/m^{-1} to 10 dS/m^{-1} NaCl level, respectively. These results in good accordance with results reported by [6, 16, 21, 43, 47, 48, 50-52].

CONCLUSION

It could be concluded that for maximizing wheat germination characters and seedling parameters under salinity stress by using wheat Sakha 93 and Sakha 94 cultivars under salinity concentrations levels up to 14 dS/m^{-1}. These cultivars were more tolerant to salinity and recommended to use them in breeding program for enhancing bread wheat production in Egypt.

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