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Seedling parameters of some sunflower cultivars as affected by seed priming and salinity stress

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Key words: Sunflower cultivars, Salinity levels, Seed priming, Seedling parameters.

Abstract

In order to study the effect of priming and non-priming seed of some sunflower cultivars *i.e.* Sakha 53, Giza 102, Line S 102 and Line S 1 under different salinity concentrations *i.e.* 0, 5, 10, 15, 20, 25, 30, 35 dSm^{-1} NaCl on early seedling parameters. Seedling parameters *i.e.* shoot and root lengths, shoot and root fresh weights, shoot and root dry weights, seedling height reduction, relative dry weight and relative dry weight were determined. Priming seed in NaCl 1% or KNO_3 0.3% enhanced seedling parameters compared without seed primed. Line S 102 surpassed of Sakha 53, Giza 102 and Line S 1 in shoot length, root length, root fresh and dry weight, and shoot fresh and dry weight. Line S 1 surpassed studied genotypes in seedling height reduction. Cumulative salinity levels from 0 to 35 dSm^{-1} NaCl significantly decreased all studied characters, except seedling height reduction percentage which was increased. The uppermost averages of studied characters were obtained from seed priming under the control treatment of salinity, while the lowest averages of these characters were produced from non-priming under highest salinity level i.e. 35 dSm^{-1} NaCl. It could be summarized that priming seeds of Line S 102 recorded highest seedling parameter under salinity stress that could be put in breeding program for improving sunflower production under newly reclaimed soils.

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Introduction

Sunflower *Helianthus annuus* L. represents the best option for increasing local production of edible oils in Egypt to overcome the shortage of its production. In order to develop practicable strategies for selecting salt tolerance of sunflower cultivars by physiological traits, it is necessary to have better understanding of the physiological mechanisms of salt tolerance genotypes. High salinity is also considered as a major abiotic stress and significant factor affecting crop production all over the world; especially in arid and semi-arid regions, seed priming is one of the physiological methods, which improves seed performance and synchronized germination (Munns and Termaat, 1986 and Sivritepe and Dourado, 1995 and Almansouri *et al*., 2001). Seed priming in NaCl or KNO_3 may be improved germination vigor index and seedling growth of sunflower. A salt tolerance of sunflower cultivar is usually the results of a combination of different physiological mechanisms (Khajeh-Hosseini *et al*., 2003; Moghanibashi *et al*., 2012; Pahoja *et al*., 2013). Bajehbaj (2010) and El-Saidy *et al*. (2011) showed that radicle length, seedling height and dry weight derived from primed seeds were higher compared with un-primed seeds. Farouk and EL Saidy (2013) reported that priming strategies improved the achenling vigor in terms of shoot and root length and dry weights, and shoot to root ratio. Gaballah and El Meseiry (2014) reported that priming using (Osmo-conditioning) is one of the physiological methods that improves seed performance and provides faster, improvement seedling growth.

A salt tolerance of sunflower cultivar is usually the results of a combination of different physiological mechanisms. In this respect, Turhan and Ayaz (2004) found that there were some differences between three sunflower cultivars i.e. Dolunay, Edirne-87 and Turkuaz in terms of seedling emergence. Cultivar Edirne-87 among the cultivars showed the highest performance at higher NaCl. Kaya (2009) showed that Kernel type seeds exhibited higher longer root and shoot length compared to the achene type seeds at all NaCl levels. Both achene and kernel type seeds of cv. Pactol gave the highest root and shoot length.

EL-Saidy *et al*. (2011) concluded that Sakha 53 was better than Giza 102 as an oil source because of its highest content of oleic acid and unsaturated fatty acids percentages. Moghanibashi *et al*. (2012) summarized that Urfloar cultivar had the more root and shoot length and dry weight as compared with cultivar Blazar. Mostafavi and Heidarian (2012) point out that Hisun cultivar had the highest value of plumule dry weight, plumule fresh weight, seedling fresh weight, and plumule length. In addition, Azargol cultivar had the maximum value of radicle dry weight, seedling dry weight and radicle length. Sheidaie *et al*. (2012) concluded that Hysun-36 hybrid have more potential resistance in germination stage compared with Azargol hybrid. Anuradha (2014) summarized that the maximum average shoot length and root was recorded for SFL-07. Maximum shoot fresh weight was recorded in SFL-07, PKVSH-27 and SFL-03. The genotype 234-B was showed 100 % reduction in shoot fresh weight and followed by SFL-03 (96.47%), APSH-11(89.47%).

Regarding to salinity effect, Farhoudi (2012) showed that sunflower seedling fresh weight and seedling growth decrease under salinity condition (0, 40 and 80 mmol NaCl solution) compared control. Moghanibashi *et al*. (2012) concluded that when salinity concentration (6.5, 12.7, 18.4 and 23.5 dSm^{-1} NaCl) increased root and shoot length and dry weight reduced under salinity conditions. Basiri *et al*. (2013) showed that salinity decreased all the studied traits (NaCl or CaC_{l2}) and radicle was more sensitive to salinity stress than plumule. Salinity resulted from NaCl had the greater negative effect on the seedling characteristics than CaCl2 salinity. Anuradha (2014) showed that fresh weight and dry weight of seedlings (root, shoot and total seedling) of all the twelve genotypes decreased significantly with increased salt (NaCl) stress. This may be due to diversion of energy in the process of osmotic adjustment. Shila *et al*. (2016) point out that at higher concentration like 320 mM NaCl root was more affected than shoot. Further study as needed to test the performance of different sunflower genotypes at varying degree of salt stress.

It is very important to study the interaction between seed priming of sunflower cultivars as affected on seed germination and seedling parameter. In this respect, El-Saidy *et al.* (2011) reported that seed sunflower priming improved seedling length and seedling dry weight in both Sakha 53 and Giza 102 cultivars. Gaballah and El Meseiry (2014) showed that the Euroflor cultivar showed further reduction of another one day than the other genotypes when its seeds were primed in 3000 ppm NaCl solution. The Vidoc cultivar seeds showed partial response to priming in saline solution mixed with either Ascorbic or Oxalic using the gradual and direct priming method respectively, whereas negative effect was obtained with other mixture solutions including the Salicylic acid mixture.

It is very important to study the interaction between seed priming and salinity levels on sunflower seed germination characters and seedling parameters. In this respect, Bajehbaj (2010) showed that total emergence of seedlings from both priming and non-priming seeds decreased with increasing NaCl salinity. However, this reduction in total emergence was higher for non-priming seeds, compared to priming seeds. Primed seeds had better efficiency for water absorption from growing media and it is obvious that metabolic activities in seed during germination process commence much earlier than radicle and plumule appearance, that is, emergence. Moghanibashi *et al.* (2012) showed that hydro-priming sunflower seed for 24 h was enhanced seedling growth under stress conditions. Pahoja *et al.* (2013) found that priming, hydro-priming recorded highest mean values for most traits viz. root/shoot length, root/shoot fresh weight and root/shoot relative water content under various concentrations i.e. 0.1, 0.5, 1.0, 1.5 and 2.0% of NaCl. Hydro-priming proved significantly better than the osmo-priming (KNo_3) under the wide range of salinity levels.

It is very important to study the interaction among sunflower cultivar and salinity concentration on germination characters and seedling parameters. In this concern, Turhan and Ayaz (2004) found that growth of sunflower cultivars was decreased with increasing NaCl concentrations. Edirne-87 cultivar among the cultivars showed the highest performance at higher NaCl concentrations (1.5 % NaCl), whereas Dolunay cultivar showed the lowest performance. Moghanibashi *et al.* (2012) reported that signification interaction between cultivars and salt stress levels. Results indicated that more root length, shoot length, root weight and shoot weight. Highest and lowest of these parameters except shoot weight recorded with Urfloar cultivar under control conditions and Blazar cultivar under 23.5 dSm^{-1} salinity levels, respectively. Highest and lowest of shoot weight recorded with Urfloar cultivar under 18.4 dsm^{-1} and Blazar cultivar under 23.5 dsm^{-1} salinity levels, respectively. Mostafavi and Heidarian (2012) indicated that the interaction between sunflower cultivars and salinity concentrations was significant for plumule dry weight, radicale dry weight, radicale fresh weight and plumule fresh weight, seedling fresh weight, plumule length, radicale length and plumule length/radicale length ratio. When saline stress was increased all of the investigated features were decreased in all studied cultivars. Jabeen and Ahmed (2013) reported that Helio cultivar and Non-Spiny cultivars, the increase in salt concentration reduced germination percentage and lower relative water content. Also, Helio cultivar was more as compared to that of cultivars NuSun and Spiny particularly at high salinity concentrations. Pahoja *et al.* (2013) reported that the effect of hydro priming and osmo-priming (KNo_3) on early seedling growth on sunflower hybrid Hysun-33 under (NaCl) salt stress. Therefore, the specific objectives of this investigation was aimed to evaluate performance seed priming of some sunflower cultivars in response to different levels of NaCl salinity. Sunflower germplasms display a spectrum of salt tolerance capability from high too low for increasing oil crops area in newly reclaimed soils.

Materials and methods

The present investigation was conducted at Giza Central Seed Testing laboratory of Central Administration for Seed Testing and Certification (CASC), Ministry of Agriculture, Egypt during May, 2015.

The objective of this study was aimed to investigate the response of some Sunflower genotypes to germinate under seed priming of NaCl or KNO_3 and non-priming treatment at different salinity concentrations and to confirm seedling growth performance for salinity tolerance among Sunflower genotypes.

Treatments and experimental design

A laboratory experiments as conducted out in factorial experiment in Randomized, Complete Block Design (RCBD). The experiment includes three factors, the first one includes three treatments seed priming with NaCl and KNO_3 and non-priming seed. The second one include Sunflower four sunflower genotypes i.e. Sakha53 (C1), Giza 102 (C2), Line S102 (C3), Line S1 (C4) were obtained from Oil Crops Research Institute, ARC, Ministry of Agriculture, Egypt. All studied genotypes seed were stored under normal conditions in paper bags. The pedigree of studied genotypes was shown in Table 1. The third factor included eight different concentrations of NaCl *i.e.* 5, 10, 15, 20, 25, 30 and 35 dSm^{-1}. Seed studied genotypes were division for three parts, first part non-priming, second part primed using NaCl 1% for 12h and third part primed using KNO3 0.3% for 12h. Thereafter, the seeds rinsed with distilled water three times. Twenty treated seeds of uniform size in each treatment for each cultivar were allowed to germinate four replicates of 20 seeds of each cultivar were germinated between rolled filter papers with 15 ml of respective test solutions. The papers replaced every 2 days to prevent accumulation of salts. In order to prevent evaporation, each rolled paper put into a sealed plastic bag. Seeds allowed germinating at 25 ± 1°C in the dark for 10 days. A seed considered germinated when the emerging radicle elongated to 2 mm according to ISTA, 2015 rules.

Studied characters

Seedling Characteristics

After 10 days five seedlings were selected from each replication and evaluated as follows:

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

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

Shoot fresh weight: Weight of five seedling shoots were measured and expressed in gram (mg) as the shoot fresh weight.

Shoot dry weight: Weight of five seedling shoots were recorded and expressed in gram (mg) after oven drying at 72 °c for 48 h according to Ahmadvand *et al.*, (2012).

Root fresh weight: Weight of five seedling roots were measured and expressed in gram (mg) as the root fresh weight.

Root dry weight: Weight of five seedling roots were recorded and expressed in gram (mg) after oven drying at 72 °C for 48 h according to Ahmadvand *et al* (2012).

Seedling height reduction (%): The seedling height reduction (SHR) was calculated according to Islam and Karim (2010) using the following equation:

$$SHR(\%) = \frac{\text{Seedling height at control} - \text{Seedling height at saline condition}}{\text{Seedling height at control condition}} \times 100$$

8-Relative dry weight (%): The relative dry weight (RDW) was calculated according to Islam and Karim (2010) using the following equation:

$$RDW(\%) = \frac{\text{Total dry weight under saline condition}}{\text{Total dry weight under control condition}} \times 100$$

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 Gomez and Gomez (1991).

Combined analysis was done between seed priming and non-priming to obtain the main effect of seed priming and its interaction with other treatments according to Waller and Duncne (1969).

Least Significant Difference (LSD) method was used to test the differences between treatment means at 5 % and 1 % level of probability as described by Snedecor and Cochran (1980).

The data were analyzed statistically following RCBD design by MSTAT-C computer package developed by Russel (1986).

Results and discussion

Effect of seed priming

Results presented in Table 2 showed that highest averages of shoot length, shoot fresh weight, radical fresh weight and relative dry weight were produced from seed priming in NaCl. While, seedling height reduction produced from non-priming seed.

Table 1. Name and pedigree of studied genotypes.

Name of genotypes	Pedigree
Sakhs 53	Output from the hybridization of local strains X class open pollination
Giza 102	Output from the hybridization of local strains X class open pollination
Line S102	Output from the local open pollinated varieties
Line S1	Output from the local open pollinated varieties

Table 2. Means of shoot length, radical length, shoot fresh weight, radical fresh weight, shoot dry weight, radical dry weight, seedling height reduction and relative dry weight as affected by non-priming, priming in NaCl and priming in KNO_3.

Treatments	Shoot length (cm)	Radical Length (cm)	Shoot fresh weight	Shoot dry weight	Radical fresh weight	Radical dry weight	SHR %	RDW %
Non Priming	5.75	5.60	29.32	3.82	5.72	0.37	51.81	73.63
Priming NaCl	6.64	6.57	32.22	3.84	7.11	0.43	49.59	75.95
Priming KNO_3	6.43	7.24	31.95	3.89	6.80	0.46	48.82	74.96
F test	*	**	*	*	*	*	*	*

The results indicated that highest averages of radical length, shoot dry weight and radical dry weight produced from seed priming in KNO_3. It could be stated that priming seed using NaCl surpassed non-priming seed in energy of germination by 8.49% and seedling vigor index by 23.53%, root length by 15.47%, shoot fresh weight by 9.89%, radical fresh weight by 24.3%.

It could be noticed that priming seed using KNo_3 surpassed non-priming seed by 11.42%, radical dry weight by 19.56%. These results in good accordance with those reported by Kaya (2009), Bajehbaj (2010), EL-Saidy *et al.* (2011), Guo-wei *et al.* (2011), Mostafavi *et al.* (2012), Moghanibashi *et al.* (2012) and Kandil *et al.* (2012) on canola Pahoja *et al.* (2013) and Anuradha (2014).

Table 3. Means of shoot length, radical length, shoot fresh weight, radical fresh weight, shoot dry weight, radical dry weight, seedling height reduction and relative dry weight as affected by non-priming, priming in NaCl and priming in KNO_3.

Treatments	Shoot length (cm)	Radical Length (cm)	Shoot fresh weight	Shoot dry weight	Radical fresh weight	Radical dry weight	Seedling height reduction	Relative Dry Weight
Sakha 53	5.68	6.58	32.94	4.05	6.94	0.44	49.52	72.90
Giza 102	6.80	6.54	28.66	3.13	5.47	0.34	50.24	69.51
Line S102	7.31	6.63	34.08	4.38	8.12	0.49	48.73	79.73
Line S1	5.31	6.11	28.97	3.85	5.65	0.41	51.82	77.23
F test	*	**	*	*	*	*	*	*

Cultivars performance

Results presented in Table 3 showed that highest averages of shoot length, radical length were produced from sown Line S 102 cultivar. While, the lowest values of these characters were produced from sown Line S 1. Results indicated that highest averages of shoot fresh weight, shoot dry weight, radical fresh weight, radical dry weight and relative dry weight were produced from sown Line S 102. While, the lowest values of these characters were produced from sown Giza 102 cultivar. Results clearly showed that highest average of seedling height reduction (SHR %) were produced from sown Line S 1. While, the lowest values of these characters were produced from sown Line S 102.

Table 4. Means of shoot length, radical length, shoot fresh weight, radical fresh weight, shoot dry weight, radical dry weight, seedling height reduction and relative dry weight as affected by non-priming, priming in NaCl and priming in KNO_3.

Treatments	Shoot length (cm)	Radical Length (cm)	Shoot fresh weight	Shoot dry weight	Radical fresh weight	Radical dry weight	SHR %	RDW %
0 dsm-1 NaCl	14.64	10.97	61.98	4.92	13.93	0.80	0.00	100.0
5 dsm-1 NaCl	11.95	9.64	49.67	4.46	12.08	0.65	15.91	89.62
10 dsm-1 NaCl	7.96	8.65	38.96	4.19	8.56	055	34.89	83.12
15 dsm-1 NaCl	5.64	7.50	31.41	3.98	6.88	0.46	48.30	77.74
20 dsm-1 NaCl	3.78	5.92	24.84	3.74	4.65	0.37	61.87	72.01
25 dsm-1 NaCl	2.82	4.83	19.14	3.53	3.33	0.27	69.97	66.77
30 dsm-1 NaCl	2.10	3.18	14.32	3.20	2.30	0.19	78.74	59.35
35 dsm-1 NaCl	1.31	1.04	8.98	2.79	0.61	0.08	90.92	50.15
F test	*	**	*	*	*	*	*	*

The results showed that Line S 102 surpassed line S1 in averages of shoot length and radical length by 37.66 and 8.51 %, respectively. The results clearly revealed that Line S 102 surpassed Giza 102 cultivar in averages of shoot fresh weight, shoot dry weight, radical fresh weight, radical dry weight and relative dry weight by 18.91, 39.94, 48.45 and 44.12 %, respectively.

Results showed that Line S 1 cultivar surpassed in seedling height reduction by 6.34 % compared Line S 102 cultivar. These results are in good accordance with those reported by Kaya (2009), Bajehbaj (2010), EL-Saidy *et al.* (2011), Guo-wei *et al.* (2011), Mostafavi *et al.* (2012), Moghanibashi *et al.* (2012) and Kandil *et al.* (2012) on canola Pahoja *et al.* (2013) and Anuradha (2014).

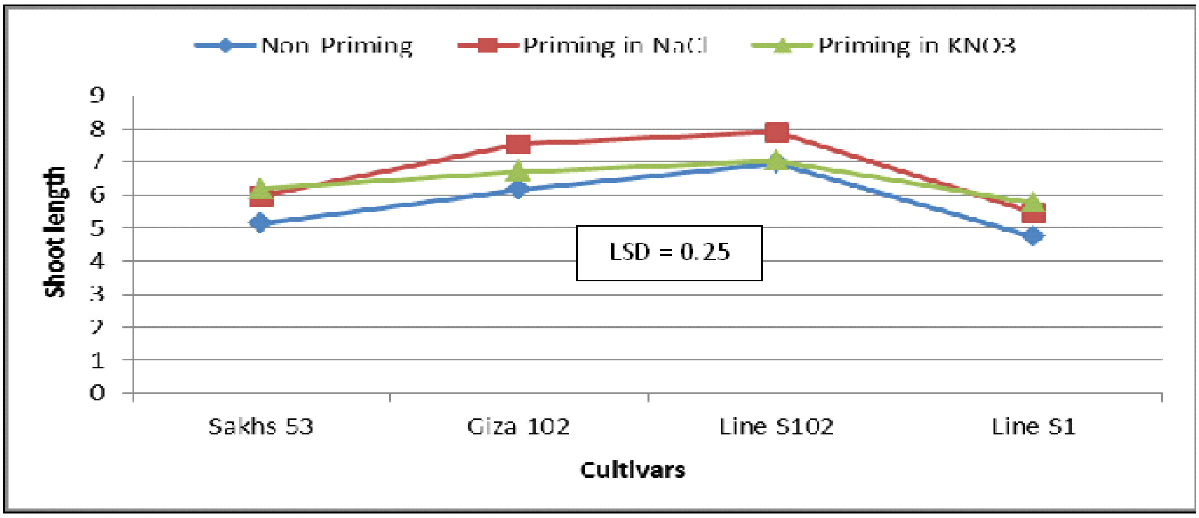

Fig. 1. Means of shoot length as affected by the interaction between priming and non-priming seed and studied cultivars.

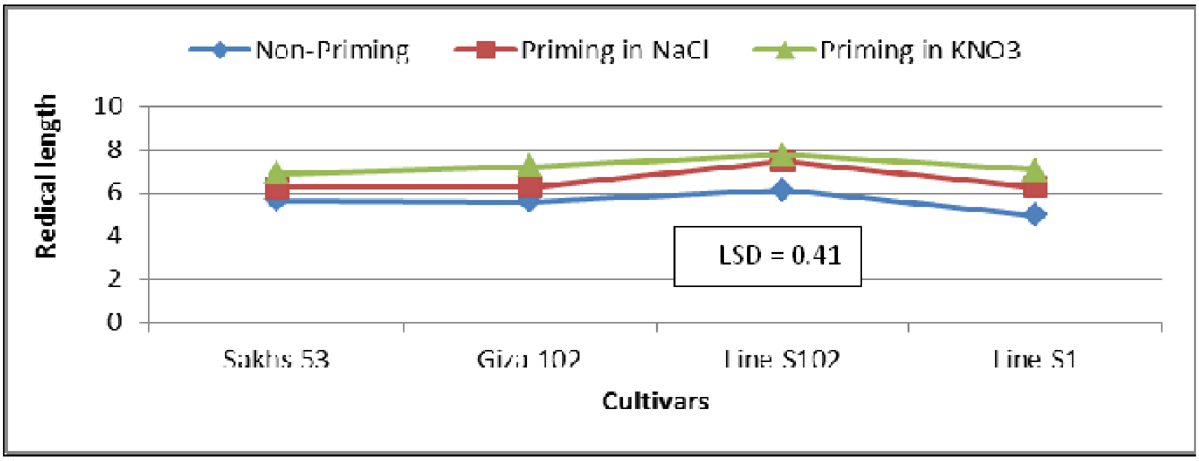

Fig. 2. Means of radical length as affected by the interaction between priming and non-priming seed and studied cultivars.

Salinity concentrations effects

Results presented in Table 4 showed that increasing salinity concentrations from 0 to 35 dSm-1 NaCl significant reduced shoot length, radical length, shoot fresh weight, radical fresh weight, shoot dry weight and radical dry weight. Increasing salinity concentrations from 0 to 35 dSm-1 NaCl gradually decreased shoot length. Tallest shoots (14.64 cm) were produced from the control treatment compared with other salinity levels. Whereas, the highest salinity concentration of 35 dSm-1 NaCl produced the shortest shoots (1.31 cm). Increasing salinity concentrations from 0 to 35 dSm-1 NaCl gradually decreased radical length. Tallest radicals (10.97 cm) were produced from the control treatment.

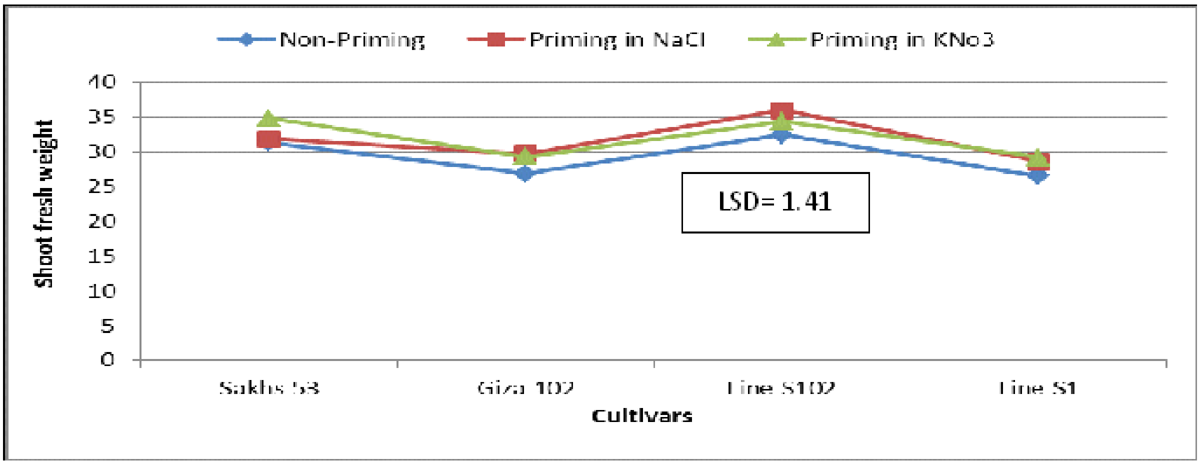

Fig. 3. Means of shoot fresh weight as affected by the interaction between priming and non-priming seed and studied cultivars.

It could be noticed that increasing salinity levels from 5, 10, 15, 20, 25, 30 and 35 dSm-1 NaCl significantly decreased radical length by 12.1, 21.1, 31.6, 46, 55.9, 71 and 90.5 %, respectively compared with the control treatment. Increasing salinity concentrations from 0 to 35 dSm-1 NaCl gradually decreased shoot fresh weight. The highest shoot fresh weight (61.98 mg) was obtained from the control. Whilst, highest salinity concentrations of 35 dSm-1 NaCl recorded the lowest shoot fresh weight (8.98 mg). It could be concluded that increasing salinity levels from 5, 10, 15, 20, 25, 30 and 35 dSm^{-1} NaCl reduced shoot fresh weight by 19.9, 37.1, 49.3, 59.9 69.1, 76.9 and 85.5 %, respectively compared with the control treatment. Highest shoot dry weight (4.92 mg) was obtained from the control treatment.

On the other hand, the highest salinity concentration 35 dSm-1 NaCl recorded the lowest shoot dry weight (2.79 mg).

Results clearly indicated that increasing salinity concentrations from 0 to 35 dSm-1 NaCl gradually decreased averages of radical fresh weight.

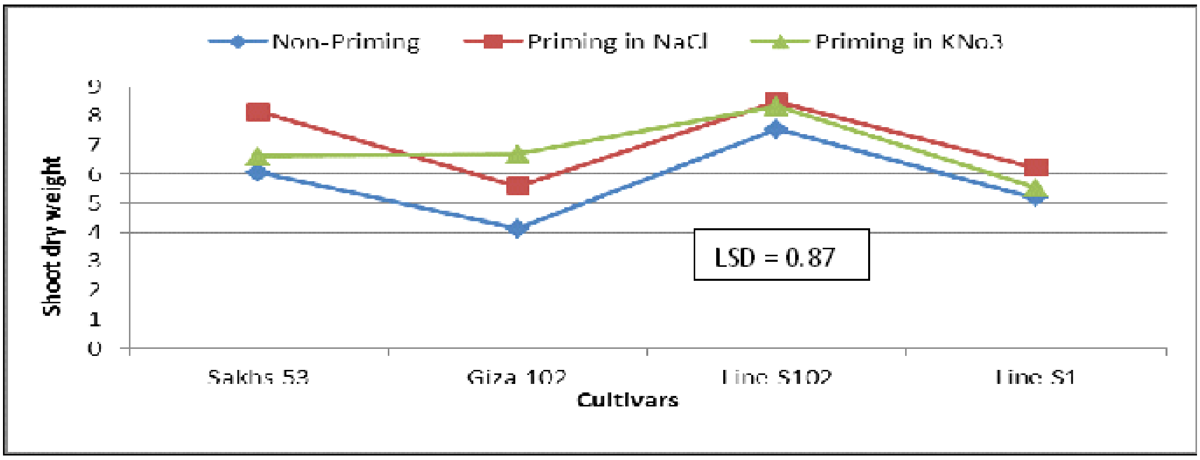

Fig. 4. Means of shoot dry weight as affected by the interaction between priming and non-priming seed and studied cultivars.

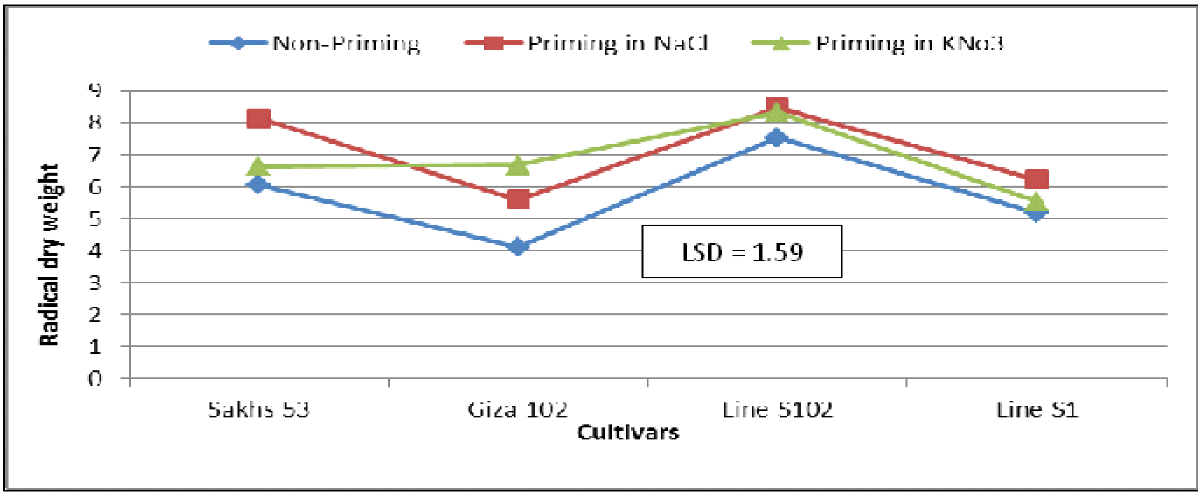

Fig. 5. Means of radical fresh weight as affected by the interaction between priming and non-priming seed and studied cultivars.

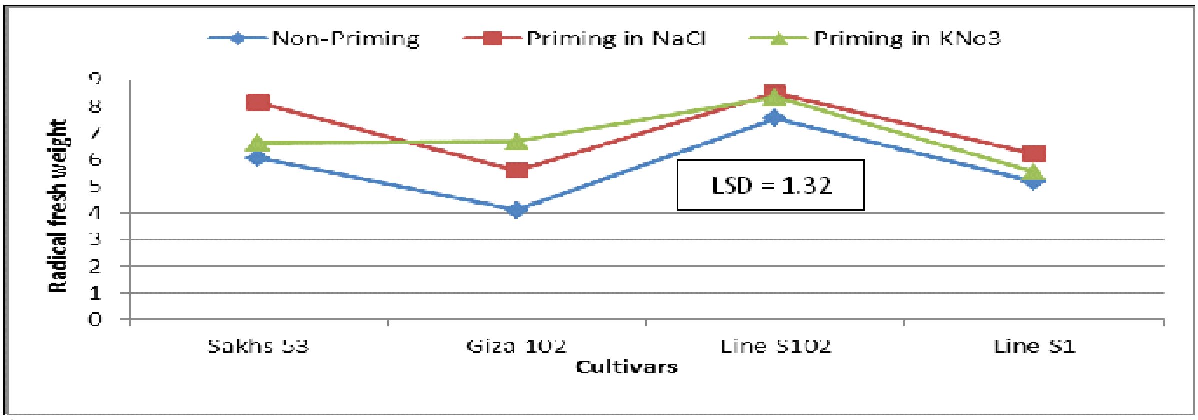

Fig. 6. Means of radical dry weight as affected by the interaction between priming and non-priming seed and studied cultivars.

The highest fresh weight of radical fresh (13.93 mg) was produced from the control treatment. However, the highest salinity concentrations of 35 dSm-1 NaCl recorded the lowest radical fresh weight 0.61 mg.

Results concluded that increasing salinity levels from 5, 10, 15, 20, 25, 30 and 35 dSm^{-1} NaCl significantly reduced radical fresh weight by 13.3, 38.5, 50.6, 66.6, 76, 83.5 and 95.6 %, respectively compared with the control treatment.

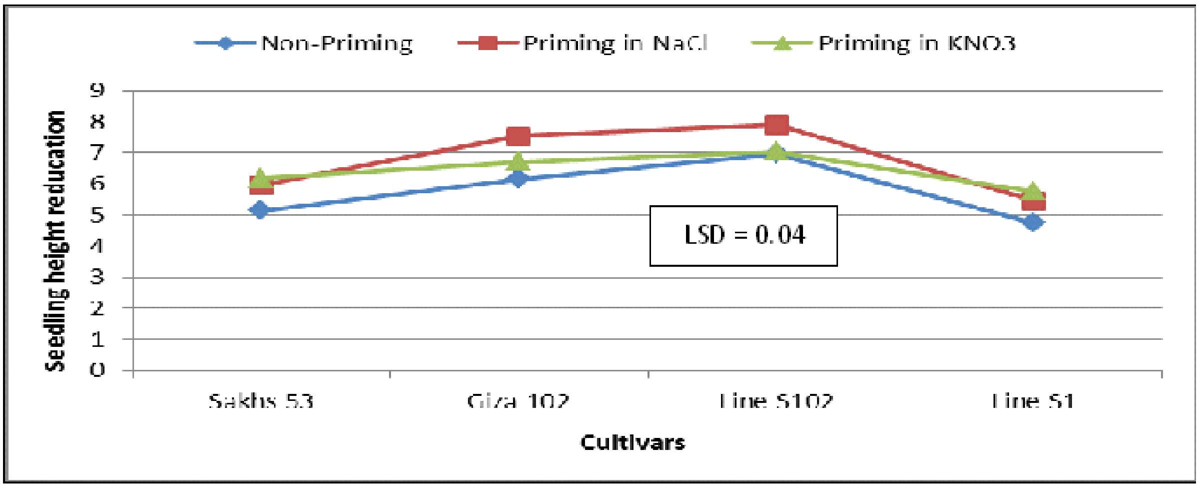

Fig. 7. Means of seedling height reduction as affected by the interaction between priming and non-priming seed and studied cultivars.

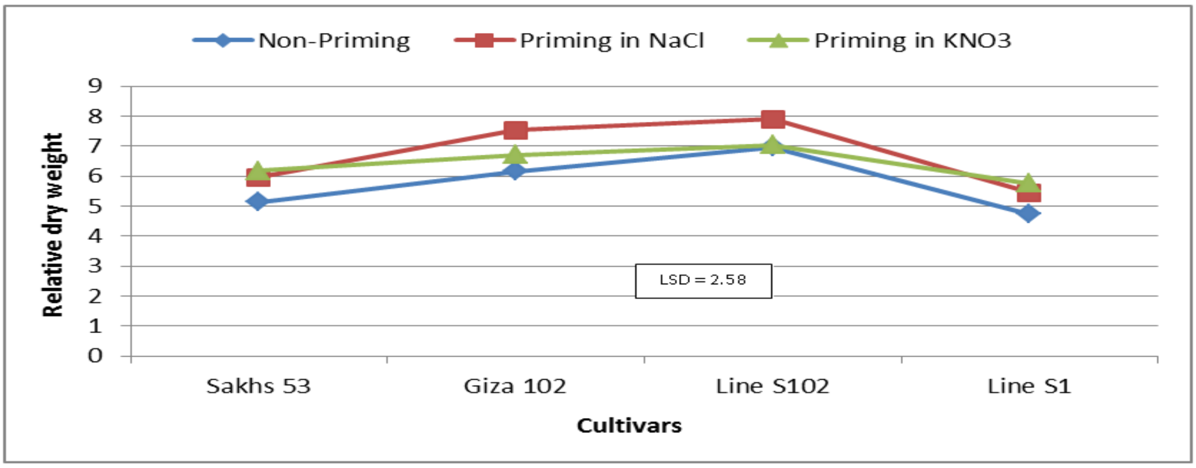

Fig. 8. Means of relative dry weight as affected by the interaction between priming and non-priming seed and studied cultivars.

Results indicated that highest radical dry weight (0.80 mg) was obtained from the control treatment. Increasing salinity levels up to 35 dSm-1 NaCl significantly recorded the lowest radical dry weight, It could be concluded that increasing salinity levels from 5, 10, 15, 20, 25, 30 and 35 dSm^{-1} NaCl significantly reduced radical dry weight by 18.8, 31.3, 42.5, 53.8, 66.3, 76.3 and 90 %, respectively compared with the control treatment. Increasing salinity concentrations from 0 to 35 dSm-1 NaCl gradually increased seedling height reduction.

The lowest seedling height reduction was obtained from without salinity application. However, highest salinity concentration 35 dSm-1 NaCl recorded highest seedling height reduction. Increasing salinity concentrations from 0 to 35 dSm-1 NaCl gradually decreased relative dry weight. The lowest relative dry weight was obtained from salinity level of 35 dSm-1 NaCl. However, without salinity application recorded the highest relative dry weight.

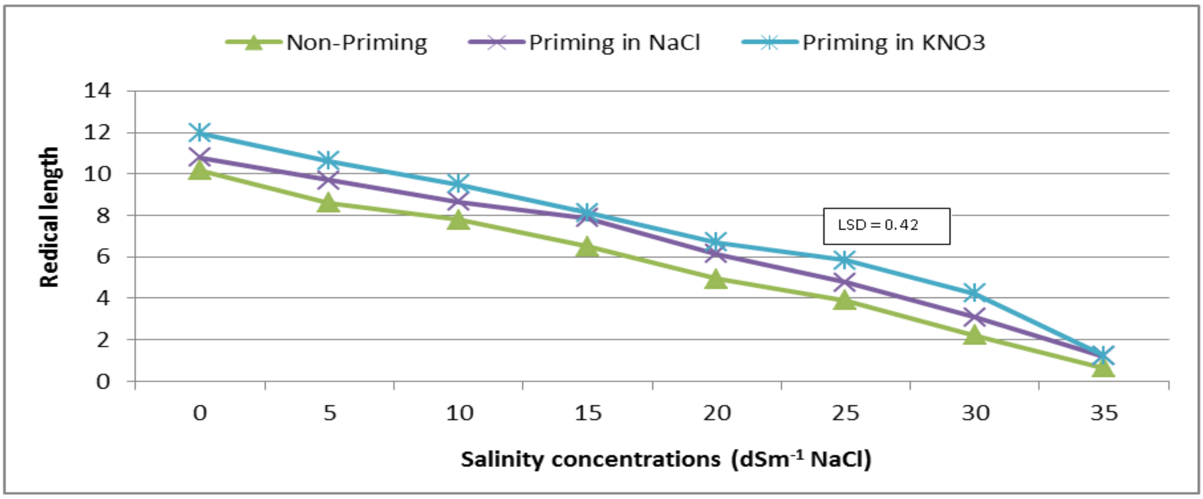

Fig. 9. Means of shoot length as affected by the interaction between priming and non-priming seed and salinity concentrations.

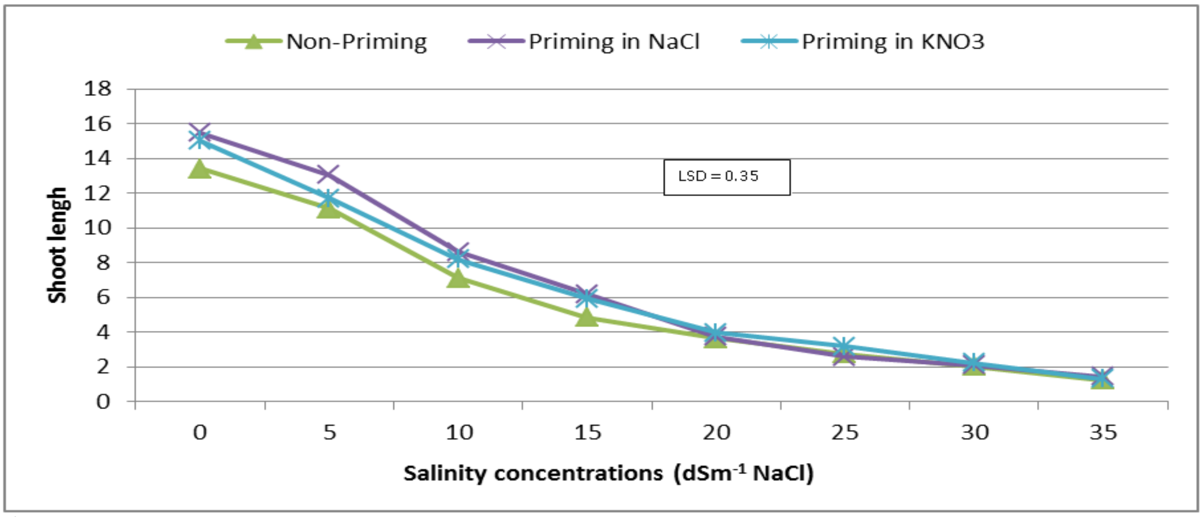

Fig. 10. Means of radical length as affected by the interaction between priming and non-priming seed and salinity concentrations.

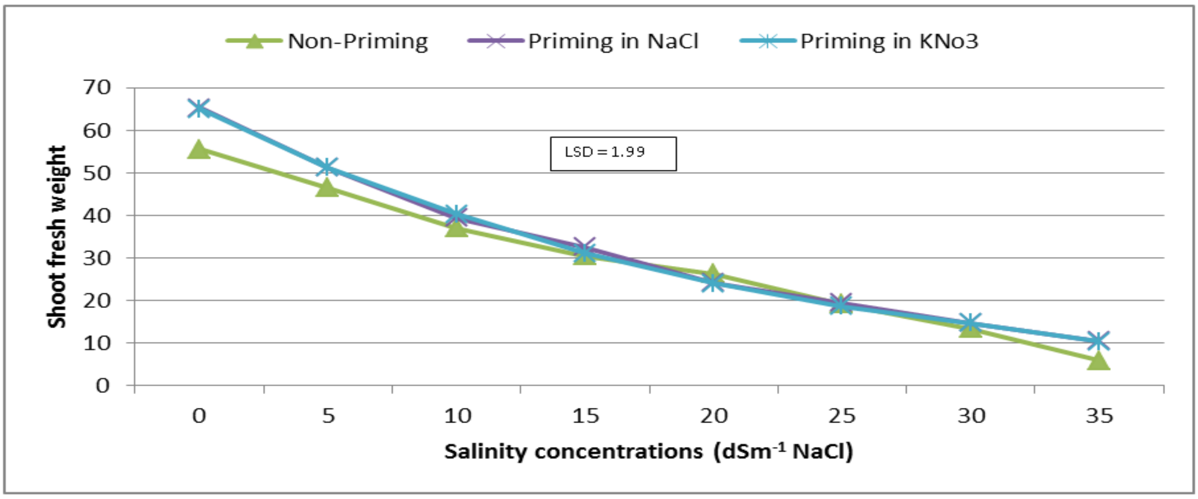

Fig. 11. Means of shoot fresh weight as affected by the interaction between priming and non-priming seed and salinity concentration.

These results in good accordance with those reported by Kaya (2009), Bajehbaj (2010), EL-Saidy *et al.* (2011), Guo-wei *et al.* (2011), Mostafavi *et al.* (2012), Moghanibashi *et al.* (2012) and Kandil *et al.* (2012) on canola Pahoja *et al.* (2013) and Anuradha (2014).

Interaction effects

Regarding to the interaction effects the results illustrated in Fig. 1, Fig. 2, Fig. 3, Fig. 4, Fig. 5, Fig. 6, Fig. 7 and Fig. 8 clearly showed that shoot length, radical length, shoot fresh weight, radical fresh weight, shoot dry weight, radical dry weight, seedling height reduction and relative dry weight were significantly affected by the interaction between seed priming and studied cultivars.

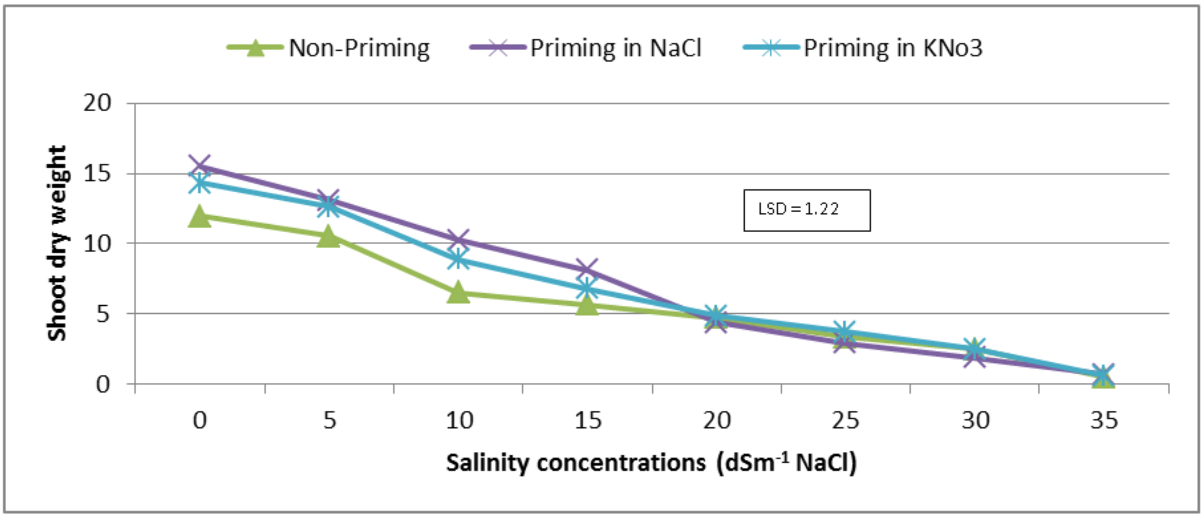

Fig. 12. Means of shoot dry weight as affected by the interaction between priming and non-priming seed and salinity concentrations.

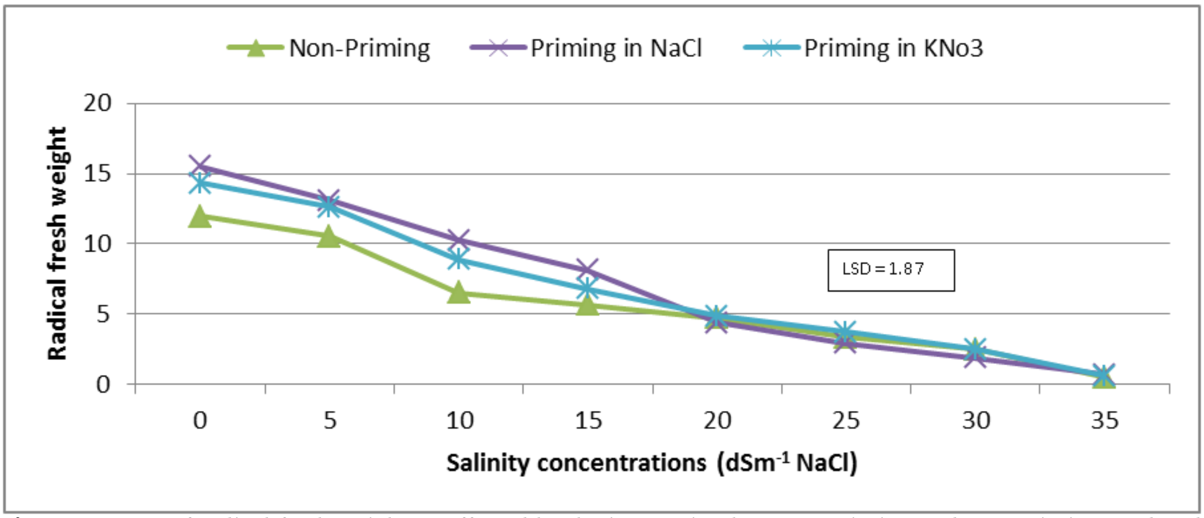

Fig. 13. Means of radical fresh weight as affected by the interaction between priming and non-priming seed and salinity concentrations.

Results clearly indicated that highest shoot dry weight, radical fresh weight, radical dry weight and relative dry weight were produced from seed priming with 1% NaCl or 0.3 % KNo_3 and sown Line S 102 cultivar. While, the lowest shoot dry weight, radical fresh weight, radical dry weight and relative dry weight were obtained from non-priming seed and sown Giza 102 cultivar. The results indicated that highest shoot length, radical length and shoot fresh weight were obtained from seed priming with 1% NaCl and sown Line S 102 While, the lowest shoot length, radical length and shoot fresh weight were produced from non-priming seed and sown Line S 1. The highest percentage of seedling height reduction was obtained from non-priming seed and sown Giza 102 cultivar. While, the lowest seedling height reduction percentage was produced from seed priming and sown Line S 102 cultivar. These results are in good accordance with those reported by Kaya (2009), Bajehbaj (2010), Islam and Karim. (2010), El-Saidy *et al.* (2011), Moghanibashi *et al.* (2012), Mostafavi *et al.* (2012), Pahoja *et al.* (2013) and Anuradha (2014).

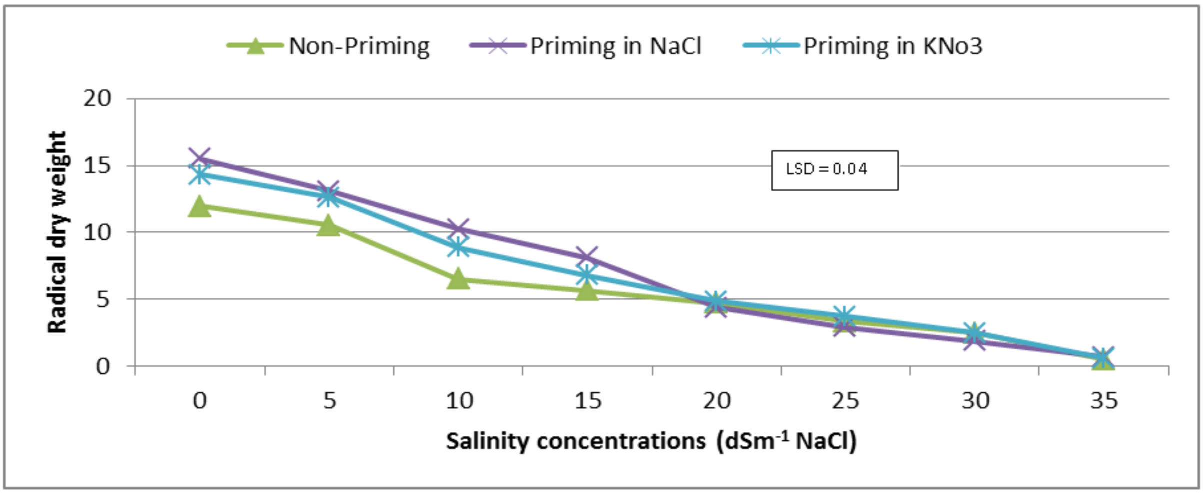

Fig. 14. Means of radical dry weight as affected by the interaction between priming and non-priming seed and salinity concentrations.

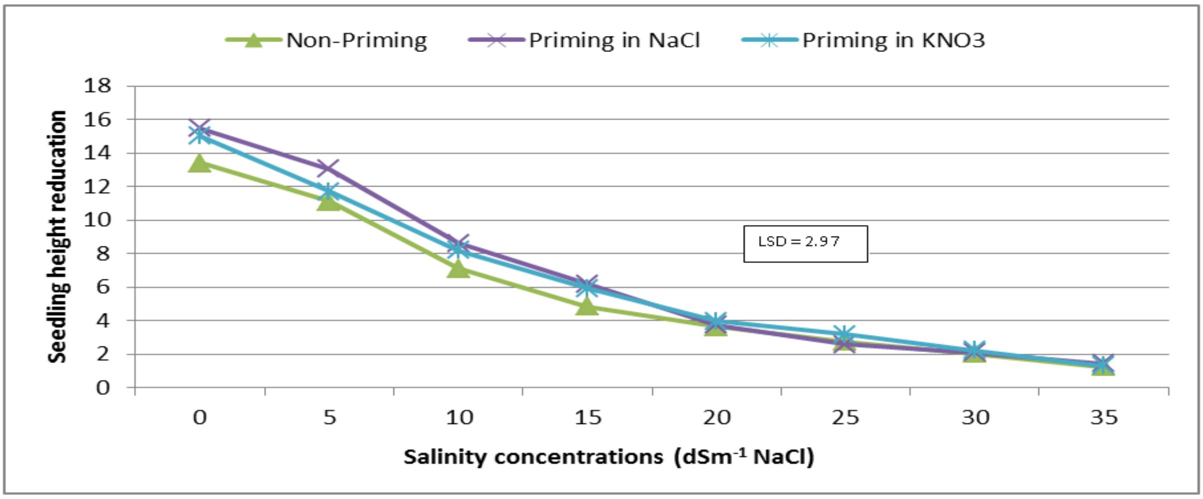

Fig. 15. Means of seedling height reduction as affected by the interaction between priming and non-priming seed and salinity concentrations.

Regarding to the interaction effects the results illustrated in Fig. 9, Fig. 10, Fig. 11, Fig. 12, Fig. 13, Fig. 14 and Fig. 15 clearly showed that shoot length, radical length, shoot fresh weight, radical fresh weight, shoot dry weight, radical dry weight and seedling height reduction were significantly affected by the interaction between priming or non-priming and salinity concentrations.

The results clearly revealed that highest shoot fresh weight and radical dry weight were obtained from seed priming with 1% NaCl or 0.3% KNo_3 and without salinity application. While, the lowest shoot fresh weight and radical dry weight were produced from non-priming seed and highest salinity level at 35 dSm-1 NaCl.

The results clearly showed that highest shoot dry weight was obtained from priming or non-priming seed and without salinity application. While, the lowest shoot dry weight was produced from primed or non-primed seed and highest salinity level at 35 dSm-1 NaCl.

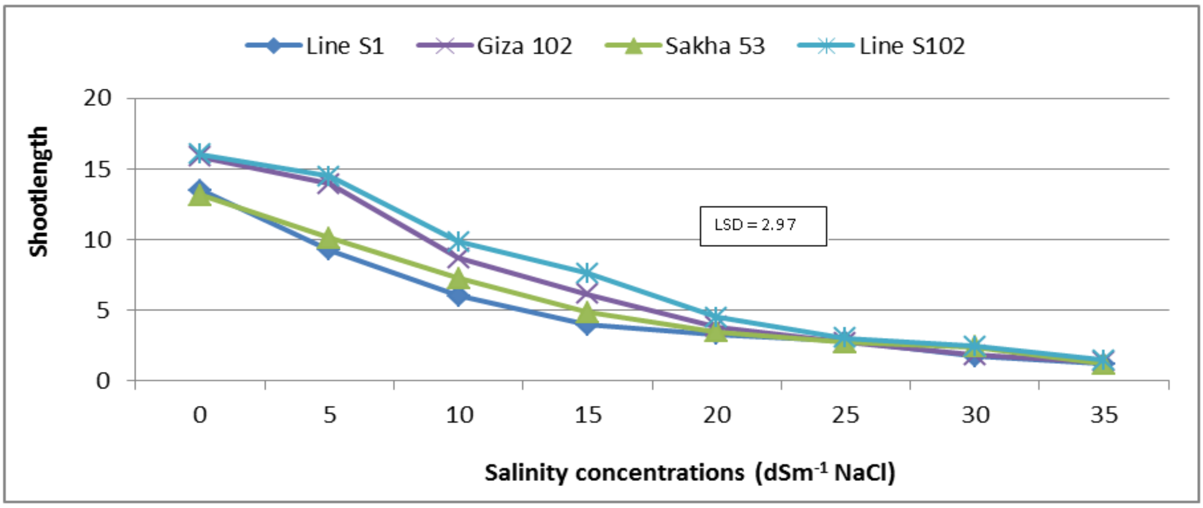

Fig. 16. Means of shoot length as affected by the interaction between studied cultivars and salinity concentrations.

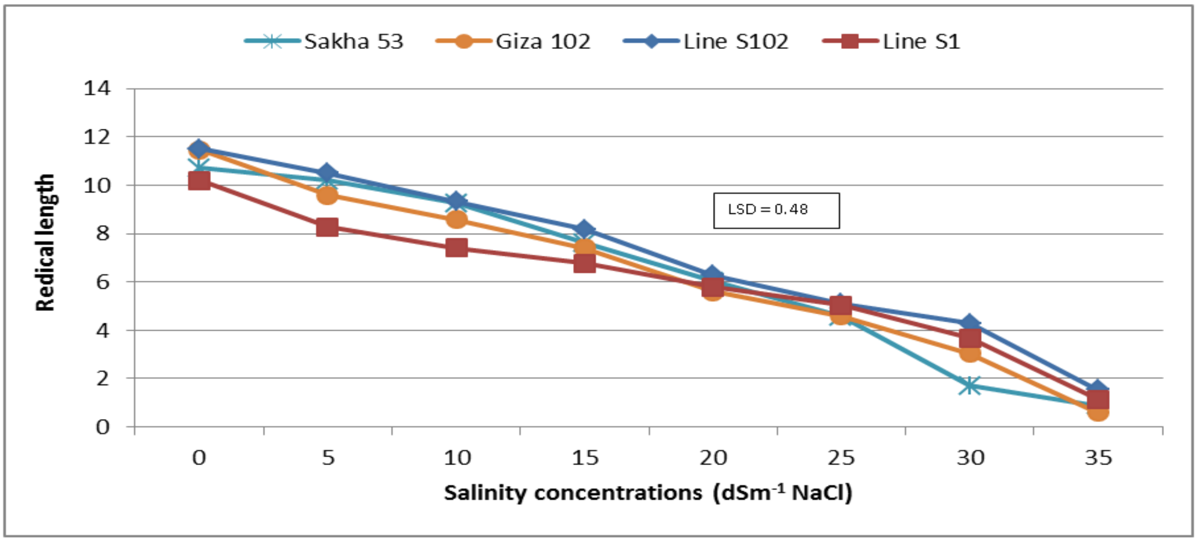

Fig. 17. Means of radical length as affected by the interaction between studied cultivars and salinity concentrations.

The results clearly indicated that highest seedling height reduction was obtained from non- priming seed and highest salinity level at the 35 dSm-1 NaCl. While, the lowest seedling height reduction was produced primed or non-primed seed and without salinity application. The results clearly revealed that tallest shoots and radical fresh weight were obtained from seed priming in NaCl and without salinity application. While, the lowest shoot length and radical fresh weight were produced from seed priming treatments under highest salinity level at 35 dSm-1 NaCl. The results clearly indicated that tallest radical was obtained from seed priming in KNO_3 without salinity application While, the lowest radical length was produced from non-priming under salinity levels of 35 dSm-1 NaCl. These results are in good accordance with those reported by Kaya (2009), Bajehbaj (2010), Islam and Karim. (2010), El-Saidy *et al.* (2011), Moghanibashi *et al.* (2012), Mostafavi *et al.* (2012), Pahoja *et al.* (2013) and Anuradha (2014).

Regarding to the interaction affects the results illustrated in Fig. 16, Fig. 17, Fig. 18, Fig. 19, Fig. 20, Fig. 21 and Fig. 22 clearly showed that shoot length, radical length, shoot fresh weight, radical fresh weight, radical dry weight, seedling height reduction and relative dry weight were significantly affected by the interaction between studied cultivars and salinity concentrations.

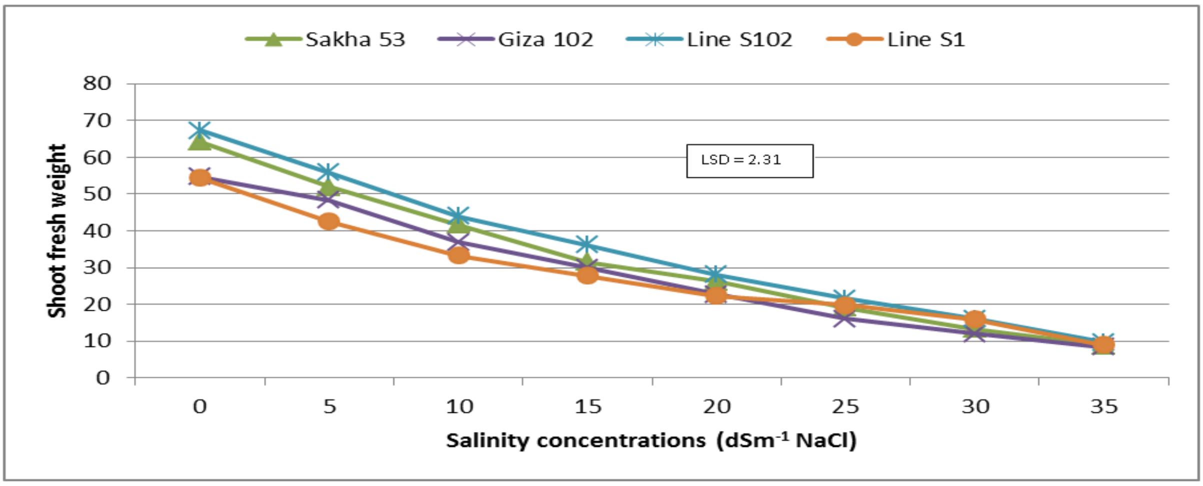

Fig. 18. Means of shoot fresh weight as affected by the interaction between studied cultivars and salinity concentration.

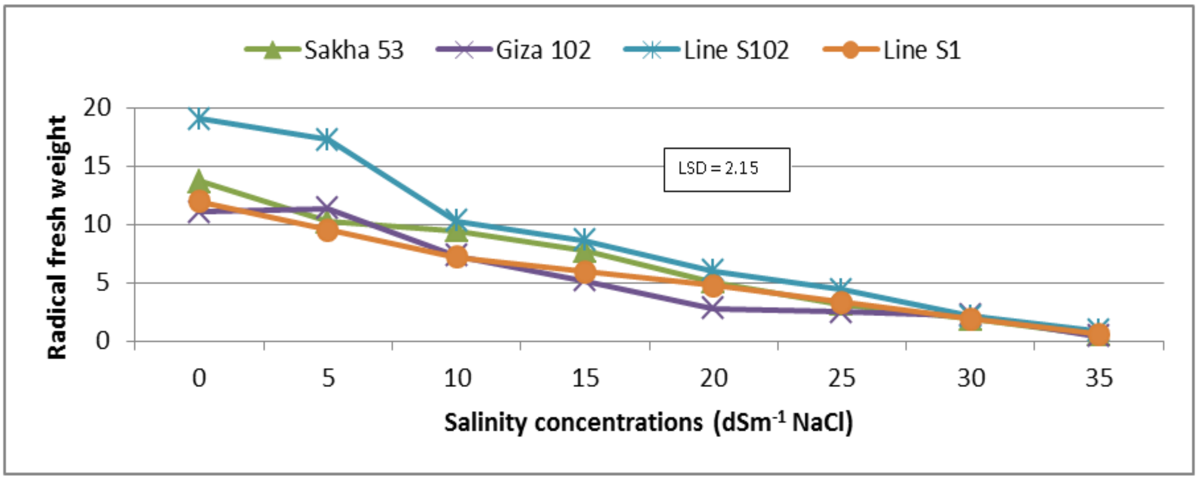

Fig. 19. Means of radical fresh weight as affected by the interaction between studied cultivars and salinity concentrations.

The results clearly indicated that highest shoot length was produced from sown Line S 102 under without salinity application. While, the lowest shoot length was produced from sown Line S 1 at highest salinity level of 35 dSm^{-1} NaCl. Highest radical dry weight was produced from sowing Line S 102 under without salinity application. While, the lowest radical dry weight was obtained from sown all studied cultivars under highest salinity level of 35 dSm^{-1} NaCl. Results revealed that highest radical length, shoot fresh weight, radical fresh weight and relative dry weight were produced from sown Line S 102 and without salinity application. While, the lowest radical length, shoot fresh weight, radical fresh weight and relative dry weight were produced from sown Giza 102 cultivar under highest salinity level of 35 dSm-1 NaCl. The results indicated that highest percentage of seedling height reduction was produced from the salinity level of 35 dSm-1 NaCl and sown Giza 102 cultivar. On contrary, the lowest seedling height reduction was obtained from all studied cultivars under the control treatment.

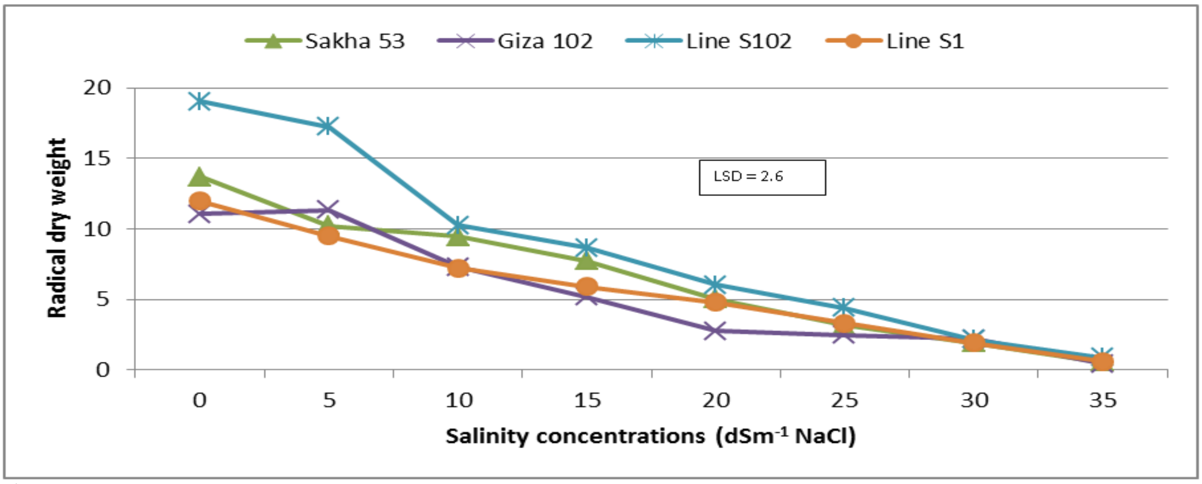

Fig. 20. Means of radical dry weight as affected by the interaction between studied cultivars and salinity concentrations.

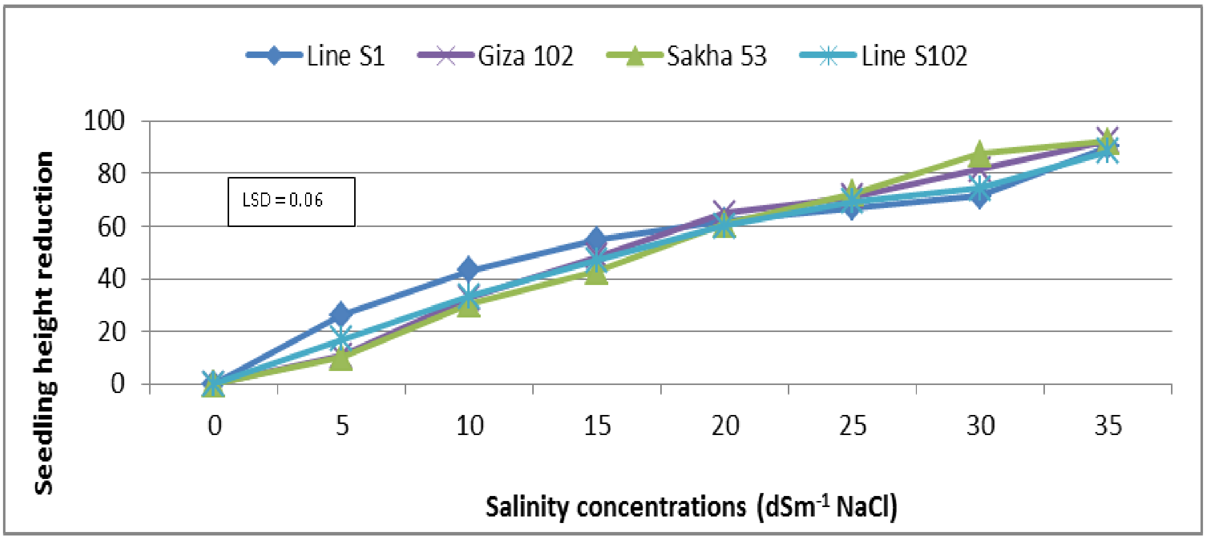

Fig. 21. Means of seedling height reduction as affected by the interaction between studied cultivars and salinity concentrations.

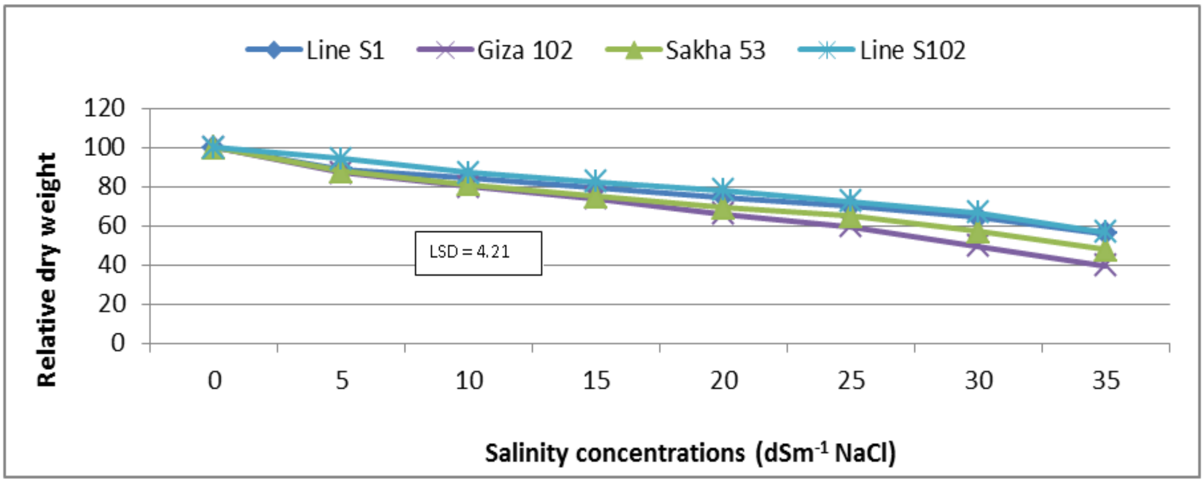

Fig. 22. Means of relative dry weight as affected by the interaction between studied cultivars and salinity concentrations.

These results are in good accordance with those reported by El-Saidy *et al.* (2011), Guo-Wei *et al.* (2011), Kandil *et al.* (2012e), Moghanibashi *et al.* (2012), Mostafavi *et al.* (2012) and Pahoja *et al.* (2013).

Regarding to the interaction affects the results illustrated in Fig. 23, Fig. 24, Fig. 25, Fig. 26 and Fig. 27 clearly showed that shoot length, radical length, shoot fresh weight, seedling height reduction and relative dry weight were significantly affected by the interaction between priming or non-priming seed, studied cultivars and salinity concentrations. Results clearly revealed that highest shoot length was obtained from seed priming in NaCl and sown Line S 102 under the control treatment. While, the lowest germination shoot length was obtained from seed priming in KNo3 and sown Sakha 53 cultivar under salinity level of 35 dSm-1 NaCl. Highest radical length was obtained from seed priming in KNo_3 seed and sown Line S 102 under the control treatment. Whilst, the lowest shoot length was produced from non-primed seed and sown Line S 1 under salinity level of 35 dSm-1 NaCl.

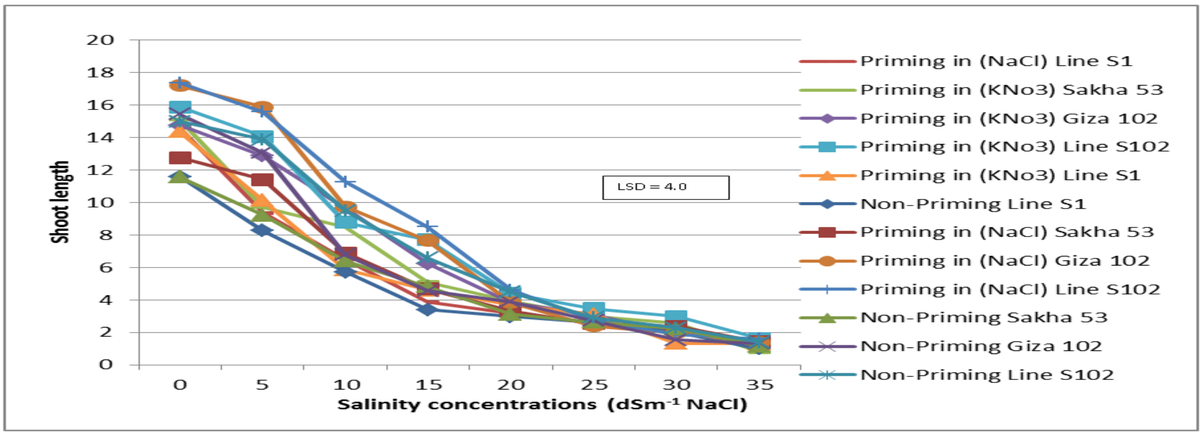

Fig. 23. Means of shoot length as affected by the interaction between primed seed, studied cultivars and salinity concentrations.

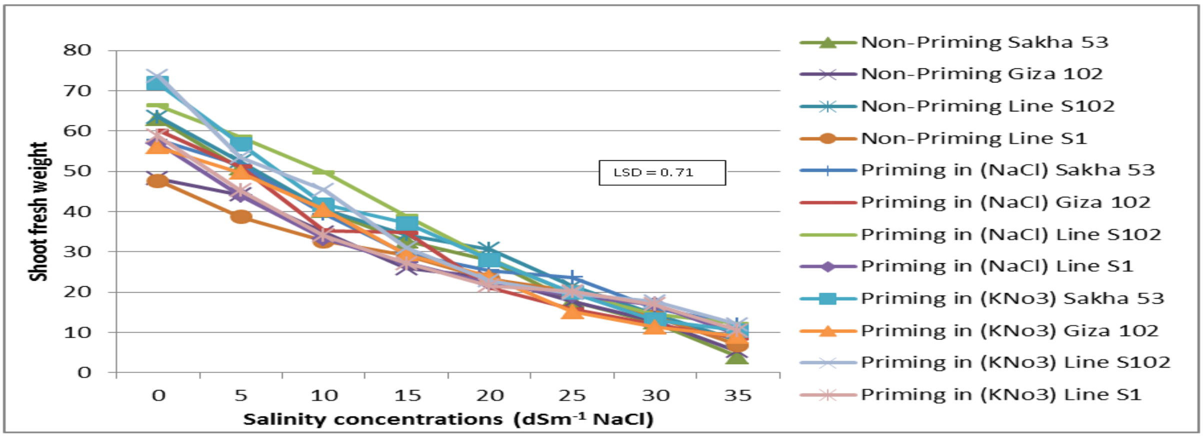

Fig. 24. Means of radical length as affected by the interaction between primed seed, studied cultivars and salinity concentrations.

The results clearly indicated that highest shoot fresh weight was obtained from priming seed in KNo_3 and sown Line S 102 under the control treatment. While, the lowest shoot fresh weight was produced from non- primed seed and sown Sakha 53 cultivar under salinity level of 35 dSm-1 NaCl. Highest seedling height reduction percentage was obtained from non-primed seed and sown Sakha 53 cultivar under salinity level of 35 dSm-1 NaCl. While, the lowest seedling height reduction percentage was obtained from seed priming treatments and sown all cultivars without salinity concentrations. Highest seedling relative dry weight was obtained from seed priming treatments and sown all cultivars under the control treatment. While, the lowest seedling relative dry weight was produced from priming seed in KNo3 and sown Giza 102 cultivar under salinity level of 35 dSm-1 NaCl.

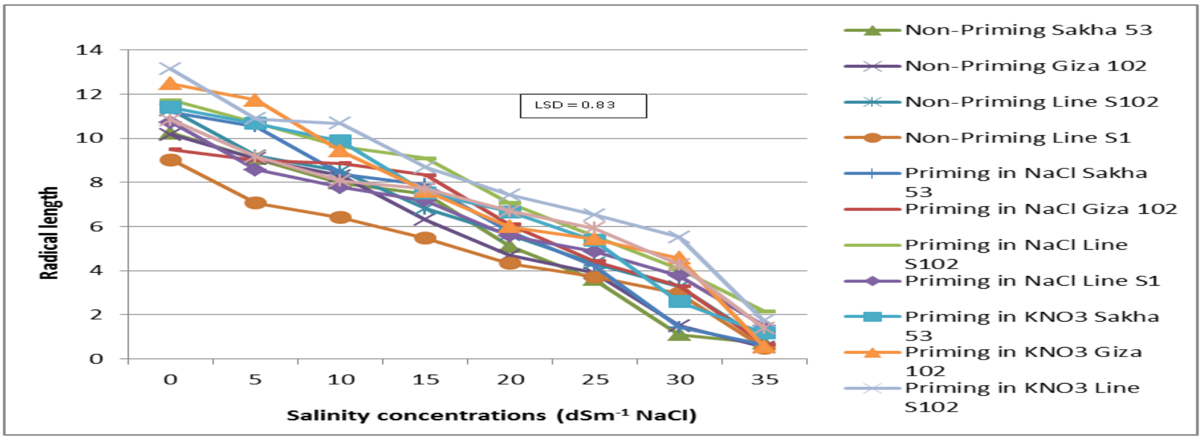

Fig. 25. Means of shoot fresh weight as affected by the interaction between studied cultivars and salinity concentration.

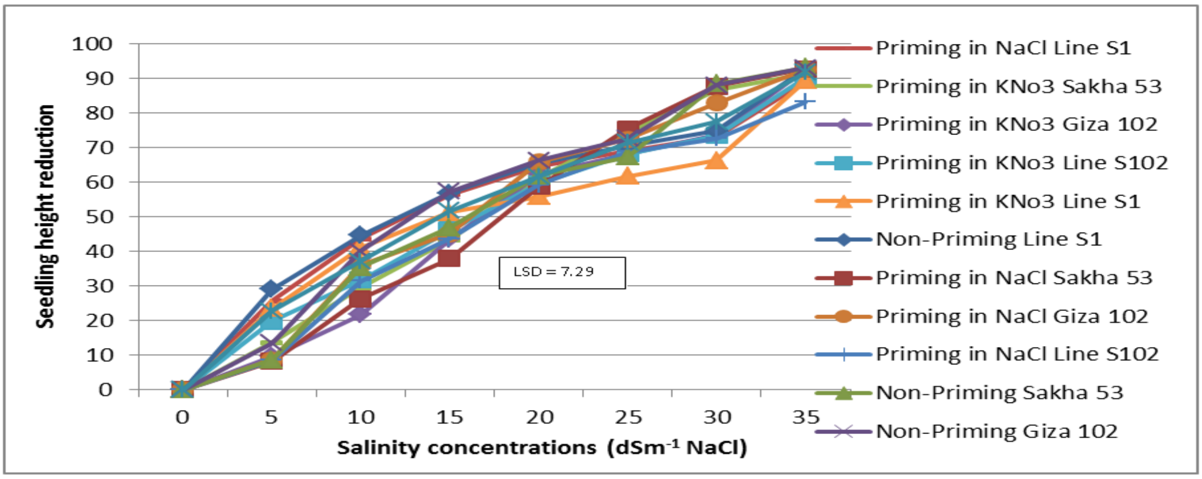

Fig. 26. Means of seedling height reduction as affected by the interaction between studied cultivars and salinity concentrations.

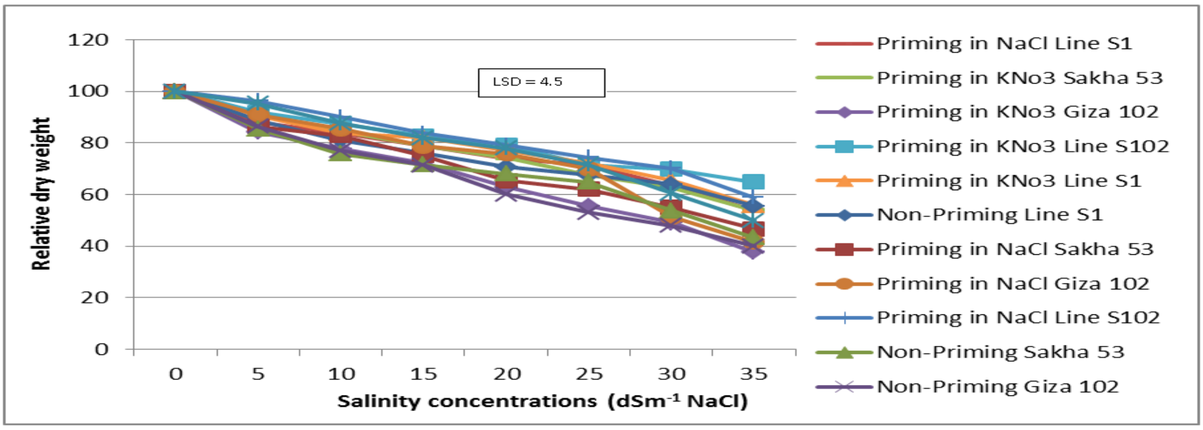

Fig. 27. Means of relative dry weight as affected by the interaction between studied cultivars and salinity concentrations.

These results are in good accordance with those reported by El-Saidy *et al.* (2011), Guo-Wei *et al.* (2011), Kandil *et al.* (2012e), Moghanibashi *et al.* (2012), Mostafavi *et al.* (2012) and Pahoja *et al.* (2013).

Conclusion

It could be concluded that for maximizing sunflower germination characters and seedling parameters under salinity stress are produced from seed priming in 1% NaCl for 12 hour and sown Line S 102 under salinity stress. This cultivar was more tolerant to salinity and recommended to use it in breeding programs for enhancing sunflower production in Egypt.

References

Almansouri M, Kinet JM, Lutts S. 2001. Effect of salt and osmotic stresses on germination in durum wheat *Triticum durum* Desf. Plant Soil. **231,** 243-254.

Anuradha C. 2014. Effect of Salt Stress on Seedling Growth of Sunflower *Helianthus annuus* L. International Journal of Scientific Research **3,** 2277-8179.

Bajehbaj AA. 2010. The effects of NaCl priming on salt tolerance in sunflower germination and seedling grown under salinity conditions. African Journal of Biotechnology **9(12),** 1764-1770.

Basiri HK, Sepehri A, Sedghi M. 2013. Effect of salinity stress on the germination of safflower seeds *Carthamuse tinctorius* L. cv. Poymar. Tech. J. Engin. & App. Sci. **3(11),** 934-937.

Casenave EC, Toselli ME. 2007. Hydro priming as a pre-treatment for cotton germination under thermal and water stress conditions. Seed Science and Technology **35(1),** 88 – 98.

EL-Saidy AEA, Farouk S, Abd EL-Ghany HM. 2011. Evaluation of Different Seed Priming on Seedling Growth, Yield and Quality Components in Two Sunflower *Helianthus annuus* L. Cultivars. Applied Sciences Research **6(9),** 977-991.

Epstein E, Norlyn JD, Rush DW, Kinsbury RW, Kelly DB, Gunningbham GA, Wrona AF. 1980. UNDER SALT STRESS. Saline culture of crops. A genetic Approach. Sci. **210,** 399- 404.

Farooq1 M, Shahzad MAB, Hussain M, Rehman H, Saleem BA. 2007. Incorporation of Polyamines in the Priming Media Enhances the Germination and Early Seedling Growth in Hybrid Sunflower *Helianthus annuus* L., Int. J. Agri. Biol., **9(6),** 868-872.

Farhoudi R. 2012**.** Evaluation Effect of KNO3 Seed Priming on Seedling Growth and Cell Membrane Damage of Sunflower *Helianthus annuus* L. under Salt Stress. American-Eurasian J. Agric. & Environ. Sci. **12(3),** 384-388**.**

Farouk S, EL Saidy AEA. 2013. Seed Invigoration Techniques to Improve Germination and Early Growth of Sunflower Cultivars. Journal of Renewable Agriculture **1(3),** 33-38.

Gaballah MS, El Meseiry T. 2014**.** Effect of Hydro priming on Seed Germination of Sunflower *Helianthus annuus* L. Under salt Condition, Global Journal on Advances in Pure & Applied Sciences **02,** 124-131.

Gomez KA, Gomez AA. 1991. Statistical Procedures in Agricultural Research, John Wiley and Sons, New York.

Guo-Wei Z., Hai-Ling L, Lei Z, Bing-Lin C, Zhi Guo Z. 2011. Salt tolerance evaluation of cotton *Gossypium hirsutum* at its germinating and seedling stages and selection of related indices. Academic Journal **22(8),** 2045 - 2053.

Hopper NW, Overholt JR, Martin JR. 1979. Effect of cultivar, temperature and seed size on the germination and emergence of soy beans *Glycine max* L. Ann. Bot. **44,** 301-308.

Jabeen N, Ahmed R. 2013. Variations in accessions of sunflower and safflower under stress condition. Pak. J. Bot. **45(2),** 383-389.

ISTA Rules. 2015. Germination Section, Chapter 5, Table 5A part **1,** 5 – 25.

Kandil AA, Sharief AE, Nassar ESE. 2012a. Response of some rice *Oryza sativa* L. cultivars to germination under salinity stress. Inter. J. of Agri. Sci. **4(6),** 272 – 277.

Kandil AA, Sharief AE, Elokda MA. 2012b. Germination and seedling characters of different wheat cultivars under salinity stress. J. of Basic and App. Sci. **8,** 585 – 596.

Kandil AA, Sharief AE, Ahmed SRH. 2012c. Germination and seedling growth of some chickpea cultivars *Cicer arietinum* L. under salinity stress. J. of Basic and App. Sci. **8,** 561 – 571.

Kandil AA, Sharief AE, Abido WAE, Awad AM. 2013. Salt tolerance study of six cultivars of sugar beet *Beta vulgaris*, L. during seedling stage. Sky J. of Agri. Res., **2(10),** 138 – 148.

Kandil AA, Sharief AE, Abido WAE, Ibrahim MM. 2012d. Effect of salinity on seed germination and seedling characters of some forage sorghum cultivars. Inter. J. of Agri. Sci. **4(7),** 306 – 311.

Kandil AA, Sharief AE, Abido WAE, Ibrahim MMO. 2012e. Response of some canola cultivars *Brassica napus* L. to salinity stress and its effect on germination and seedling properties. J. of Crop Sci., **3(3),** 95 – 103.

Katarji N, Van Hoorn JW, Hamdy A, Mastrorilli M. 2003. Salinity effect on crop development and yield, analysis of salt tolerance according to several classification methods. Agric. Water Manag., **62,** 37–66.

Kaya MD. 2009. The role of hull in germination and salinity tolerance in some sunflower (*Helianthus annuus* L.) cultivars. African Journal of Biotechnology **8(4),** 597-600.

Kavandi S, Shokoohfar A. 2014. The effect of salinity stress on germination parameter in sunflower cultivars. Indian Journal of Fundamental and Applied Life Sciences **4(S4),** 116-123.

Khajeh-Hosseini, M, Powell AA, Bingham IJ. 2003. The interaction between salinity stress and seed vigour during germination of soybean seeds. Seed Science and Technology **31(11),** 715-725.

Khan A, Iqbal I, Ahmed I, Nawaz H, Nawaz M. 2014. Role of proline to induce salinity tolerance in sunflower *Helianthus annus L.* Sci. Tech. and Dev., **33(2),** 88-93.

Khomari S, Nezhad MS, Sedghi M. 2014. Effect of seed vigour and pretreatment on germ inability and seedling growth of safflower under drought and salinity conditions. Intl J Farm & Alli Sci. **3(12),** 1229-1233.

Maiti RK, Vidyasagar P, Shahapur SC, Seiler GJ. 2006. Studies on genotypic variability and seed dormancy in sunflower genotypes *Helianthus annuus* L. Indian J. Crop Science **1(1-2),** 84-87.

Messaitfa ZH, Shehata AI, El Quraini F, Hazzani R, El-Wahabi MS. 2014. Proteomics analysis of salt stressed Sunflower *Helianthus annuus*. Int. J. Pure. App. Biosci. **2(1),** 6-17.

Moghanibashi M, Karimmojeni H, Nikneshan P, Behrozi D. 2012. Effect of hydro priming on seed germination indices of sunflower *Helianthus annuus* L. under salt and drought conditions. Plant Knowledge Journal, **1(1),** 10-15.

Mohammed EM, Benbella M, Talouizete A. 2002. Effete of sodium chloride on sunflower (*Helianthus annuus* L.) seed germination. HELIA, **25(37),** 51 – 58.

Mostafavi K, Heidarian AR. 2012. Effects of salinity different levels on germination indices in four varieties of sunflower *Helianthus annuus* L. Inter. Res. J. of App. and Basic Sci., **3(10),** 2043 – 2051.

Munns R, Termaat A. 1986. Whole-plant responses to salinity. Aust. J. Plant. Physiol. **13**, l43-l60.

Neumann PM. 1995. Inhibition of root growth by salinity stress: Toxicity or an adaptive biophysical response, p: 299-304. In: Baluska, F., Ciamporova, M., Gasparikova, O., Barlow, P.W. (Eds.). Structure and Function of Roots. The Netherlands: Kluwer Academic Publishers.

Pahoja VM, Siddiqui SH, Narejo M, Umrani JH. 2013. Response of Hydro priming and Osmopriming on Germination and Seedling Growth of Sunflower *Helianthus annuus* L. under Salt Stress. International J. of Agric. Sci. and Research, **3(2),** 71-80.

Shannon MC. 1998. Adaptation of plant to salinity. Adv. Agron. **60,** 75-119.

Sheidaie S, Sadeghi H, Yari L, Oskouei B, Rahmani M. 2012. Effect of seed treatments on germination indices of Sunflower *Helianthus annuus* L. Hybrids under drought stress conditions. Technical Journal of Engineering and Applied Sciences **2(7),** 157-161.

Shila A, Haque MA, Ahmed R, Howlader MHK. 2016. Effect of different levels of salinity on germination and early seedling growth of sunflower. World Research Journal of Agricultural Sciences, **3(1),** 048-053.

Srivastava JP, Jana S. 1984. Screening wheat and barley germplasm for salt tolerance. In: Salinity Tolerance in Plants. Eds. R.C. Staples and G.H. Toenniessen. John Wiley and Sons. New York, 273-283 p.

Turhan H, Ayaz C. 2004. Effect of salinity on seedling emergence and growth of sunflower *Helianthus annuus* L. cultivars. Inter. of Agri. and Biol. **6(1),** 149 – 152.

Xiu-Ling W, Xu C, Gui-Ying L. 2010. Screening sweet sorghum varieties of salt tolerance and correlation analysis among salt tolerance indices in sprout stage. Chinese J. of Eco-Agric., **18(6),** 1239–1244.