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Germination characters as affected by seed priming of some sunflower cultivars under salinity stress

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Key words: Sunflower cultivars, Seed priming, Salinity concentrations, Germination parameters

Abstract

To study the effect of seed priming in 1% NaCl or 0.3% KNO_3 of some sunflower cultivars *i.e.* Sakha 53, Giza 102, Line S 102 and Line S 1 on critical stage of germination under salinity concentrations i.e. 0, 5, 10, 15, 20, 25, 30, 35 dSm^{-1} NaCl. Germination characters i.e. final germination percentage, germination rate, germination index, energy of germination and seedling vigor index were estimated. Highest averages of final germination percentage, germination rate, germination index, energy of germination, seedling vigor index were produced from primed seed in NaCl or KNO_3. Line S 102 surpassed other studied cultivars in final germination percentage, germination rate and germination index, energy of germination and seedling vigor index. Increasing salinity levels from 0 to 5, 10, 15, 20, 25, 30, 35 dSm^{-1} NaCl significantly decreased all studied characters. Final germination percentage, germination rate, germination index, energy of germination and seedling vigor index significantly affected by the interaction between seed priming and cultivars, by the interaction between cultivars and salinity concentrations and by the interaction between seed priming and salinity concentrations. Moreover, final germination percentage, germination rate, germination index, energy of germination and seedling vigor index significantly affected by the interaction among seed priming, cultivars and salinity concentrations. It could be concluded that priming Line S 102 in NaCl or KNO_3 was more tolerant to salinity stress, which must be put in breeding program of sunflower for enhancing cultivars productivity under salinity conditions and to increase its cultivation in newly reclaimed soil in Egypt.

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Introduction

Sunflower *Helianthus annuus* L. constitutes the second most important oil seed crop in the world after soybeans. Sunflower represents the best option for increasing local production of edible oils because it grows well in Egypt. 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. Sunflower was determined as a moderately sensitive crop to salinity. 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 (Sivritepe and Dourado, 1995). 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). The plant growth is ultimately reduced by salinity stress but plant species differ in their saline tolerance (Munns and Termaat, 1986). Salt stress unfavorably affects plant growth and productivity during all developmental stages. Salinity can affect the germination and seedling growth either by creating an osmotic pressure that prevents water uptake of plant roots as well as decrease of germination of plant seeds by ionic toxicity of Na+ and Cl^{-} (Almansouri *et al*., 2001). Maiti *et al*. (2006) concluded that seed priming period of 15 h showed more than 80% germination in several genotypes. In general, 15 h priming period gave higher seedling vigor than that in the control with few exceptions. Faeooq *et al*. (2007) and Bajehbaj (2010) summarized that in earlier emergence and Mean seedling time but the mergence percentage, energy of seedling and emergence index were also improved. El-Saidy *et al*. (2011) and Moghanibashi *et al*. (2012) concluded that seed priming treatments reduced the mean germination time, increased germination percentage, germination energy and germination index in both cultivars under laboratory conditions. It may be concluded that seed priming agents can be used for improving the germination of sunflower seeds. Sheidaie *et al*. (2012), Farouk and EL Saidy (2013) and Pahoja *et al*. (2013) reported that seed priming with KNO_3 reduced mean germination time and had positive effect on germination percentage in sunflower seeds. In contrast, hydro priming seeds for 18 hour had negative effect.

A salt tolerance of sunflower cultivar is usually the results of a combination of different physiological mechanisms. 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. In this respect, Mohammed *et al*. (2002) and Turhan and Ayaz (2004) found that there were some differences between three sunflower cultivars in terms of germination. Kaya (2009) showed that Kernel type seeds exhibited higher germination percentage and lower mean germination time compared to the achene type seeds at all NaCl levels. Both achene and kernel type seeds of cv. Pactol gave the highest germination percentage. Moghanibashi *et al*. (2012) point out that germination parameters that were measured decreased with increasing NaCl levels. Sheidaie *et al*. (2012) concluded that Hysun-36 hybrid have more potential resistance in germination stage compared with Azargol hybrid. Jabeen and Ahmed (2013) stated that in Helio cultivar and Non-Spiny cultivars the increase in salt concentration reduced germination percentage and lower relative water content. Gaballah and El Meseiry (2014) reported that under the tested conditions of saline media Vidoc genotype showed the lower seed germinations percentage, while both Euroflor and Sakha-53 were the higher, with superiority of the latter one. and comparing between the tested genotypes revealed that Sakha-53 showed the least mean time of seed germination, where germination of its seeds attained between four and six days followed by Euroflor and Vidoc.

The latter genotype showed the higher value for extension time (days) of seed germination. Kavandi and Shokoohfar (2014) showed that a significant difference between germination percentage in three cultivars of Record, Sambora, and Azar Gol at 5% level and the highest germination percentage was observed in Record cultivar and then in Sambora cultivar. Shehata *et al.* (2014) point out the effect of salt were positive with appearance of two bands (in 250 mM before and after 18.5 kDa for Abendsoone variety) not observed in control.

In addition, Kaya (2009) found that inhibition in germination at all levels of NaCl was mainly due to osmotic barriers created by the presence of hulls rather than salt toxicity. Farhoudi (2012) showed that sunflower germination percentage decreased under salinity condition (0, 40 and 80 mmol NaCl solution) compared control but mean germination time was increased. Moghanibashi *et al.* (2012) and Basiri *et al.* (2013) showed that salinity decreased all the studied traits under salinity condations. Jabeen and Ahmed (2013) and Anuradha (2014) showed that increasing salt concentrations caused a decrease in germination percentage. The reduction of germination percentage and vigor index was strongest particularly at highest levels of salt concentration compared to the control. Kavandi and Shokoohfar (2014), Gaballah and El Meseiry (2014) and Shila *et al.* (2016) concluded that salinity reduced germination percentage of sunflower and the extent of reduction increased with the increase of the concentration of salinity in the growth medium. 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) and Moghanibashi *et al.* (2012) showed that a signification interaction between cultivar and priming was found for germination rate and days to 50% germination. 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. 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, Farhoudi (2012) and Moghanibashi *et al.* (2012) showed that hydro-priming sunflower seed for 24 h was enhanced germination under stress conditions. Primed seeds produced higher germination rate and percentage, days to 50% germination and germination index under all salinity as compared with non-primed seeds. Primed seeds clearly produced higher germination index, germination rate, days to 50% germination and germination index than non-primed seeds under all salinity levels. Pahoja *et al.* (2013) and Khomari *at el* (2014) showed that high PEG concentration on safflower was always more detrimental to final germination percentage than iso-osmotic concentration of NaCl salt in each priming method, Priming can increase the germination percentage and speed of germination.

It is very important to study the interaction among sunflower cultivar and salinity concentration on germination characters and seedling parameters. In this concern, Mohammed *et al.* (2002) and Turhan and Ayaz (2004) found that growth of sunflower cultivars was decreased with increasing NaCl concentrations. Moghanibashi *et al.* (2012) and Jabeen and Ahmed (2013) indicated that more germination index, germination rate, days to 50% germination, germination index. Recently, Anuradha (2014) showed that there are genetical differences among cultivars in respect of tolerance to salt stress. However, increasing salinity decreased the germination percentage in all cultivars; some of the cultivars were more tolerant than the others. Previous studies on performance of sunflower cultivars under salinity concentrations of primed and non-primed seed and their effect on germination characters. In this respect, Pahoja *et al.* (2013) reported that the effect of hydro priming and osmo-priming (KNO_3) on seed germination on sunflower hybrid Hysun-33 under (NaCl) salt stress. Seed germination percentage was decreased with increases in salinity levels. Gaballah and El Meseiry (2014) showed that the use of saline solution and antioxidant mixture for seed priming gave nearly positive effects, especially when using the Oxalic acid which gave the best results as it is clear from its effect on both Euroflor and Sakha-53 genotypes seeds germinated under the higher saline irrigation water treatment. The objectives of this research were aimed to study the performance of sunflower cultivars under priming and salinity stress and their interactions on germination parameters to increase sunflower production under 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 was 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 were 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 were replaced every 2 days to prevent accumulation of salts. In order to prevent evaporation, each rolled paper was put into a sealed plastic bag. Seeds were allowed to germinate at 25 ± 1^{o}C in the dark for 10 days. A seed was considered germinated when the emerging radicle elongated to 2 mm according to ISTA, 2015 rules.

Studied characters

Germination characteristics

Final germination percentage (FGP): Final germination count was calculated after 12 days from sowing date and expressed as percentage according to the following equation as described by Ellis and Roberts, (1981), Ruan and Tylkowsko (2002).

$$(FGP) = \frac{\text{Number of germinated seeds}}{\text{Total Number of tested seeds}} \times 100$$

Germination Rate (GR): It was calculated according to the following equation described by Ellis and Roberts (1981).

$$GR = \frac{\text{Number of germinated seeds}}{\text{Number of germination days}}$$

Germination Index (%): It was calculated according to Karim *et al.* (1992) as the following equation:

$$GI = \frac{\text{Germination percentage in each treatment}}{\text{Germination percentage in the control}} \times 100$$

Energy of germination (EG): Energy of germination was recorded at the fourth day as the percentage of germinated seeds four days after sowing relative to the number of seeds tested according to Ruan *et al.*, (2002).

$$EG = \frac{\text{Number of germinated seeds after four days}}{\text{Number of seed tested}} X\ 100$$

Seedling Vigor index (SVI): It was calculated as described by Abdel-Baki and Anderson (1973) according to the following equation:

(SVI) = (Average shoot length + Average root length) × Germination %.

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 final germination percentage, germination rate, germination index, energy of germination and seedling vigor index were produced from seed priming.

Table 1. Name and pedigree of studied genotypes.

No	Name of genotypes	Pedigree
1	Sakha 53	Output from the hybridization of local strains X class open pollination
2	Giza 102	Output from the hybridization of local strains X class open pollination
3	Line S102	Output from the local open pollinated varieties
4	Line S1	Output from the local open pollinated varieties

Table 2. Means of final germination percentage (%), germination rate, germination index (%), energy of germination and seedling vigor index as affected by non-priming, priming in NaCl and priming in KNO_3.

Treatments	Germination percentage	Germination rate (day)	Germination index (%)	Energy of germination	Seedling vigor index
Non Priming	75.00	3.0	75.98	48.39	1002.4
Priming (NaCl)	77.87	3.1	77.87	52.50	1175.8
Priming (KNO_3)	75.05	3.0	76.87	51.51	1238.3
F test	**	**	**	**	**

The results showed a significant difference due to seed priming treatments on final germination percentage, germination rate, germination index, energy of germination and seedling vigor index. The results indicated that highest averages of final germination percentage, germination rate, germination index and energy of germination were produced from seed priming in NaCl. The results indicated that the highest average of seedling vigor index produced from seed priming in KNO_3.

These results are in good accordance with those reported by Islam and Karim, (2010), El-Saidy *et al.* (2011), Moghanibashi *et al.* (2012) and Pahoja *et al.* (2013) .

Cultivars performance

Results presented in Table 3 showed that highest averages of final germination percentage, germination rate, germination index, energy of germination and seedling vigor index were produced from seed priming.

The results showed that studied sunflower cultivars significantly effected averages of final germination percentage, germination rate, germination index, energy of germination and seedling vigor index. The results indicated that highest averages of final germination percentage, germination rate, germination index and energy of germination were produced from sown Line S 102 followed by Line S 1 which came in the second rank. While, the lowest values of these characters were produced from sown Giza 102 and Sakha 53 cultivars. Results indicated that highest averages of seedling vigor index was produced from sown Line S 102 cultivar. While, the lowest values of these character were produced from sown Line S 1.

Table 3. Means of final germination percentage (%), germination rate, germination index (%), energy of germination and seedling vigor index as affected by non-priming, priming in NaCl and priming in KNO_3.

Treatments	Germination percentage	Germination rate (day)	Germination index (%)	Energy of germination	Seedling vigor index
Sakha 53	72.29	2.90	73.49	41.74	1108.0
Giza 102	73.54	2.90	74.83	44.93	1169.9
Line S102	80.07	3.20	80.14	59.72	1269.5
Line S1	77.99	3.10	79.16	56.81	1007.9
F test	*	*	*	*	*

Table 4. Means of final germination percentage (%), germination rate, germination index (%), energy of germination and seedling vigor index as affected by non-priming, priming in NaCl and priming in KNO_3.

Treatments	Germination percentage	Germination rate (day)	Germination index (%)	Energy of germination	Seedling vigor index
0 dsm-1 NaCl	98.75	4.00	100.00	89.86	2512.4
5 dsm-1 NaCl	95.00	3.80	96.18	84.44	2044.7
10 dsm-1 NaCl	91.25	3.70	92.52	77.36	1521.3
15 dsm-1 NaCl	87.50	3.50	88.59	69.31	1155.2
20 dsm-1 NaCl	82.92	3.30	83.58	55.00	802.3
25 dsm-1 NaCl	72.22	2.90	73.14	25.69	714.5
30 dsm-1 NaCl	54.58	2.20	55.32	4.72	300.3
35 dsm-1 NaCl	25.56	1.00	25.89	0.00	60.1
F test	*	*	*	*	*

The results revealed that Line S 102 surpassed sakha 53 cultivar in averages of final germination percentage, germination rate, germination index and energy of germination by 10.76%, 10.3%, 9.4 and 43.07 %, respectively. The results showed that Line S 102 surpassed line S1 in averages of seedling vigor index by 25.95%. These results are in good accordance with those reported by Islam and Karim, (2010), El-Saidy *et al.* (2011), Moghanibashi *et al.* (2012) and Pahoja *et al.* (2013).

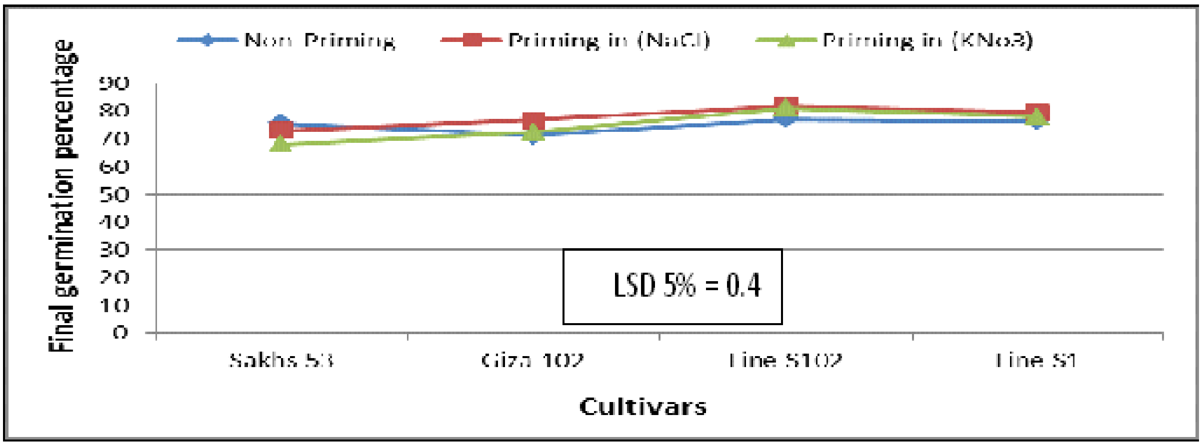

Fig. 1. Means of the final germination percentage as affected by the interaction between priming and non-priming seed and studied cultivars.

Salinity concentrations effects

Results presented in Table 4 showed that highest averages of final germination percentage, germination rate, germination index, energy of germination and seedling vigor index were produced from seed priming.

Concerning salinity concentrations effect, the results showed a significant effect on averages of final germination percentage, germination rate, germination index, energy of germination and seedling vigor index.

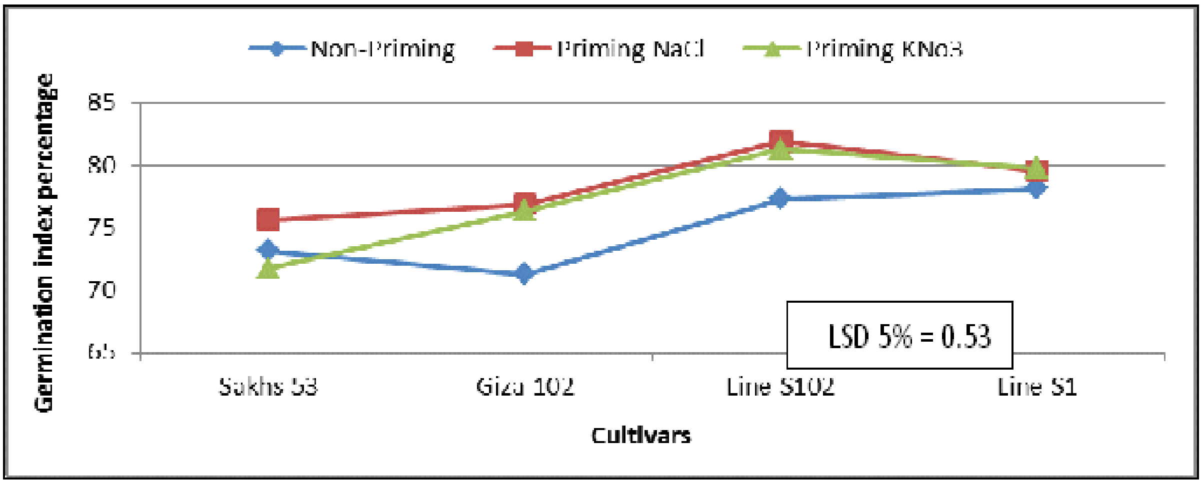

Fig. 2. Means of the germination rate as affected by the interaction between priming and non-priming seed and studied cultivars.

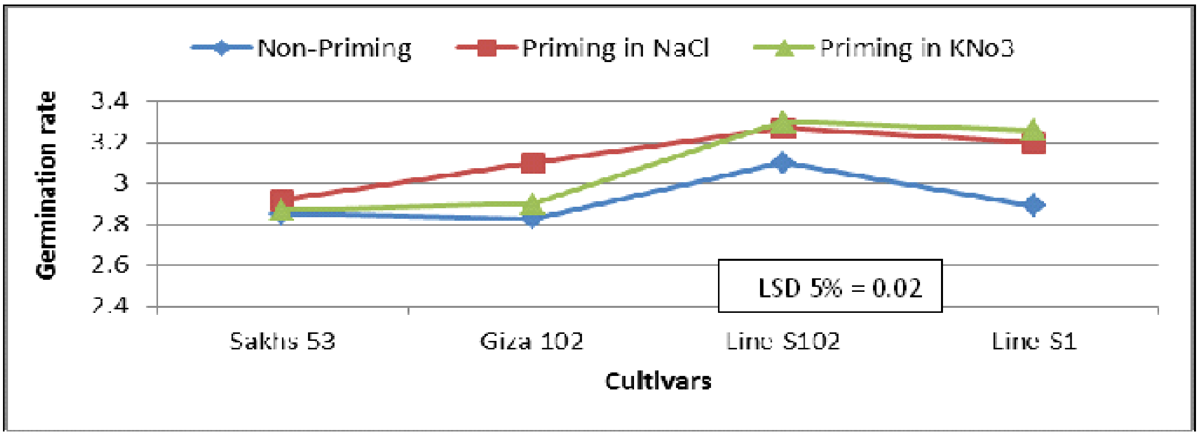

Fig. 3. Means of the germination index as affected by the interaction between priming and non-priming seed and studied cultivars.

Highest averages of final germination percentage, germination rate, germination index, energy of germination and vigor index were produced from the control treatment. Highest salinity concentration of 35 dSm-1 NaCl recorded the lowest averages of these characters. Results concluded that increasing salinity levels from 5, 10, 15, 20, 25, 30 and 35 dSm-1 NaCl significantly reduced final germination percentages by 3.8, 7.6, 11.4, 16.0, 26.9, 44.7 and 74.1 %, respectively compared with the control treatment.

The results clearly revealed that highest number of germination rate (4.0 day) was produced from the control treatment followed by treated seed with 5 dSm-1 NaCl (3.8 day) On the other hand, highest salinity concentration i.e. 35 dSm-1 NaCl recorded the lowest germination rate (1.0 day). The results clearly indicated that highest germination index was produced from the control treatment. However, highest salinity concentration of 35 dSm-1 NaCl recorded the lowest germination index.

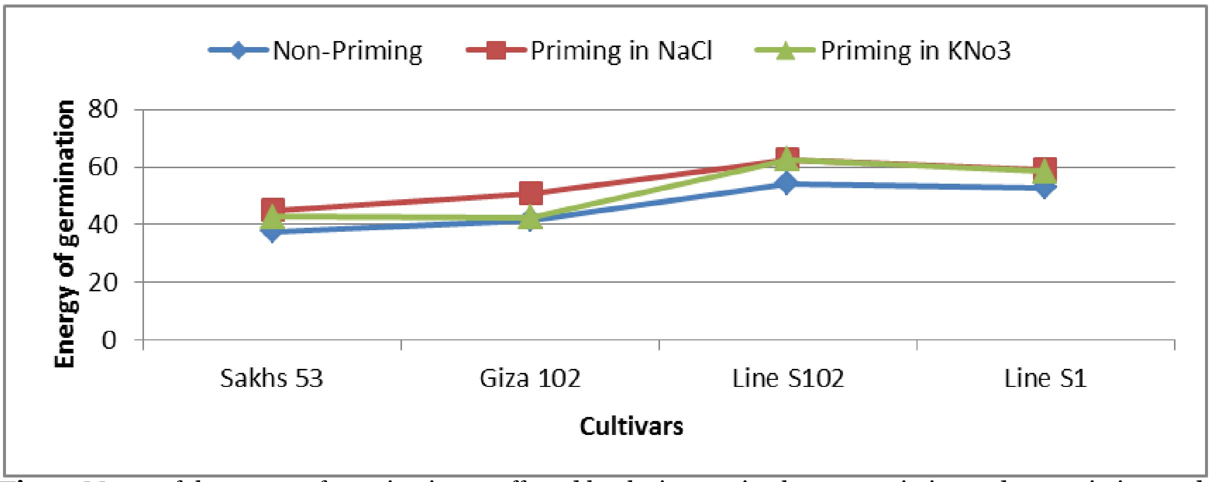

Fig. 4. Means of the energy of germination as affected by the interaction between priming and non-priming seed and studied cultivars.

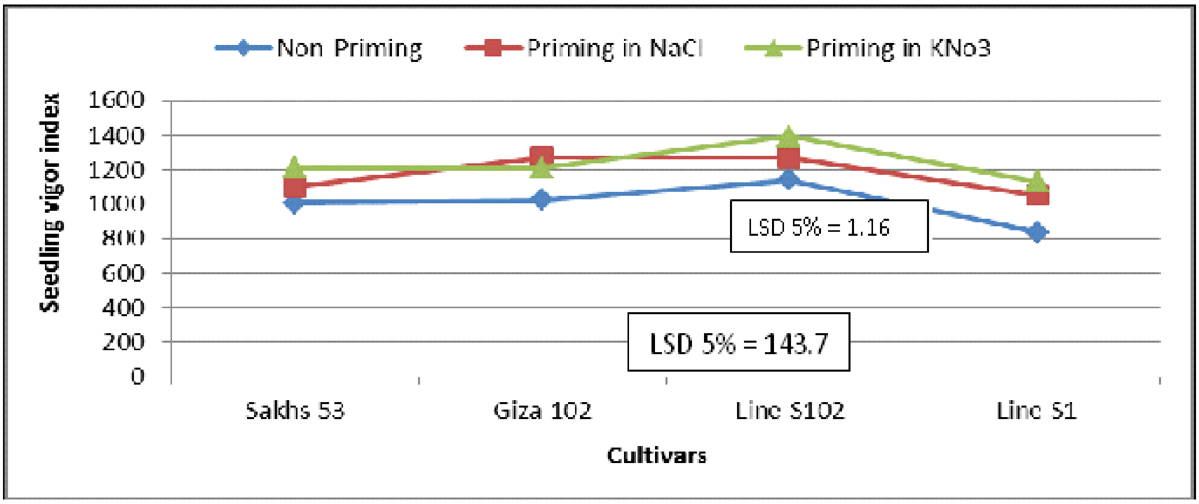

Fig. 5. Means of the seedling vigor index as affected by the interaction between priming and non-priming seed and studied cultivars.

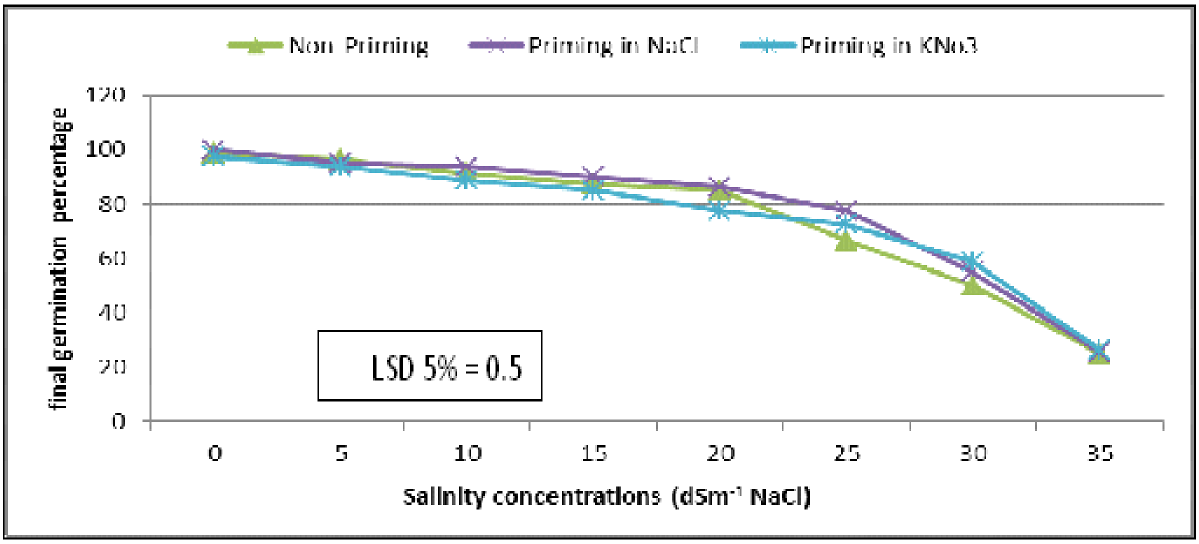

Fig. 6. Means of the final germination percentage as affected by the interaction between priming and non-priming seed and salinity concentrations.

Results indicated that increasing salinity levels from 5, 10, 15 , 20 , 25, 30 and 35 dSm-1 NaCl significantly reduced energy of germination and seedling vigor index by (6.0 and 18.6%), (13.9 and 39.4%), (22.8 and 54%), (38.7 and 68%), (71.4 and 71.6%), (94.7 and 88 %) and (100 and 97.6 %), respectively compared with the control treatment. These results are in good accordance with those reported by Islam and Karim, (2010), El-Saidy *et al.* (2011), Moghanibashi *et al.* (2012) and Pahoja *et al.* (2013)

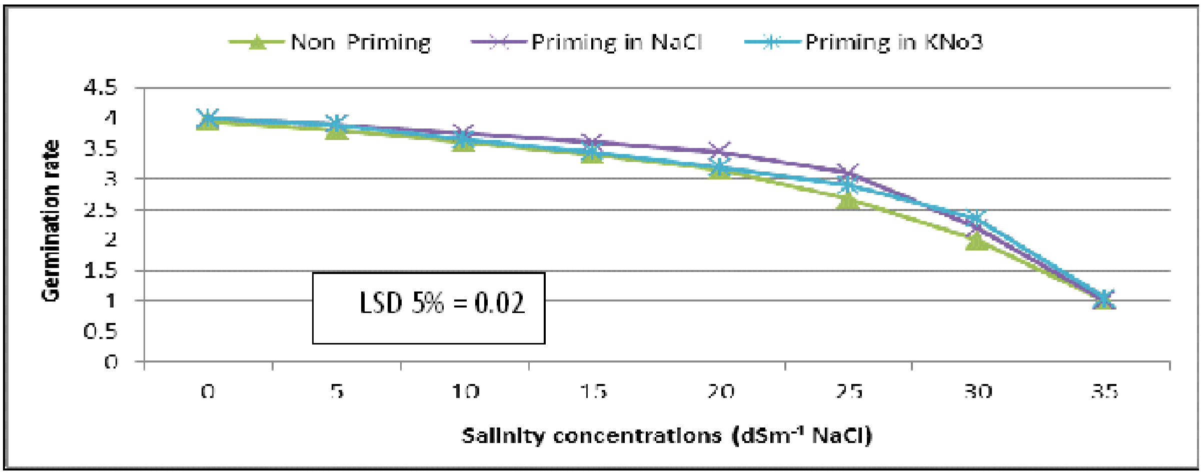

Fig. 7. Means of the germination rate as affected by the interaction between priming and non-priming seed and salinity concentrations.

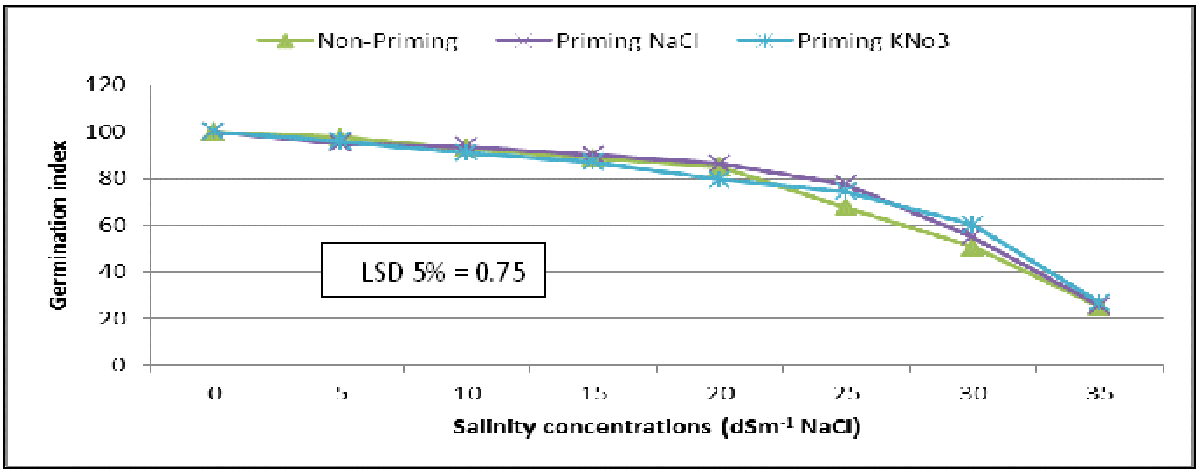

Fig. 8. Means of the germination index as affected by the interaction between priming and non-priming seed and salinity concentration.

Interaction effects

Regarding to the interaction effects the results illustrated in Fig. 1, Fig. 2, Fig. 3, Fig. 4 and Fig. 5 clearly showed that final germination percentage, germination rate, germination index, energy of germination and seedling vigor index were significantly affected by the interaction between seed priming and studied cultivars. Results clearly indicated that highest germination rate and germination index were produced from seed priming with 1% NaCl or 0.3 % KNo_3 and sown Line S 102 cultivar. While, the lowest germination rate and germination index were obtained from non-priming seed and sown Giza 102 cultivar. The results indicated that highest final germination percentage was obtained from the seed priming with NaCl and sown Line S 102 While, lowest final germination percentage was produced from seed priming with KNo_3 and sown Sakha 53 cultivar.

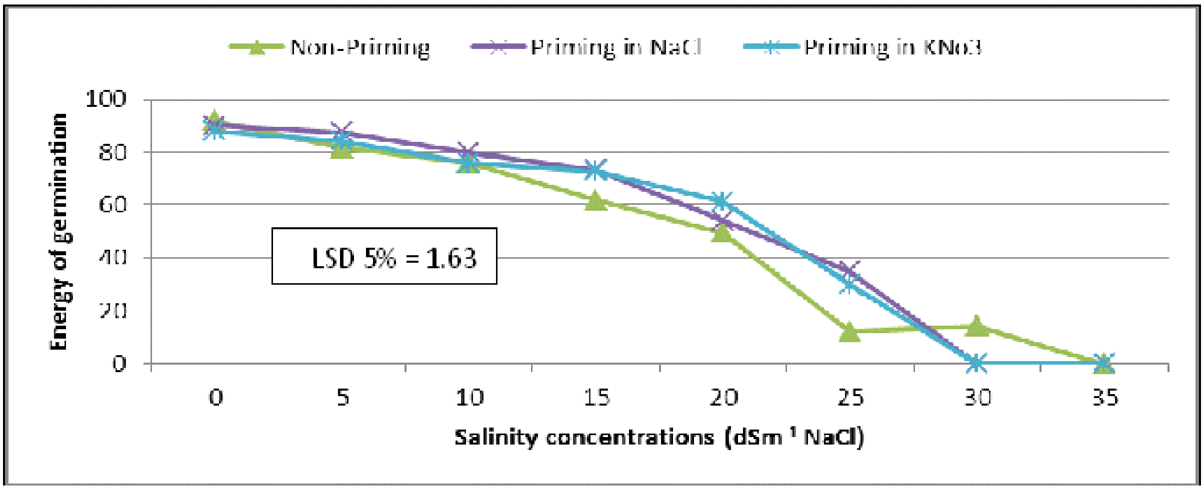

Fig. 9. Means of the energy of germination as affected by the interaction between priming and non-priming seed and salinity concentrations.

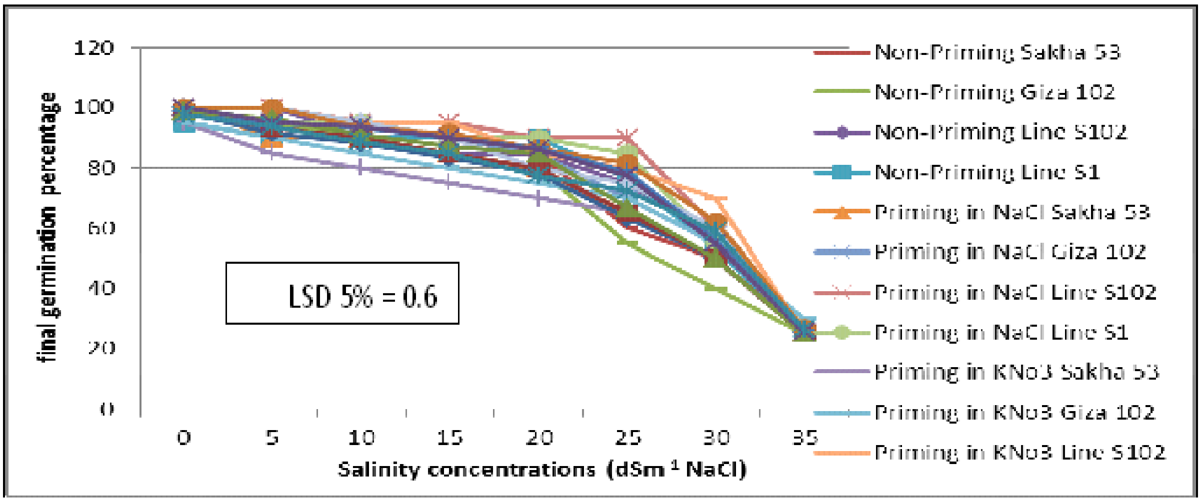

Fig. 10. Means of the final germination percentage as affected by the interaction between studied cultivars and salinity concentrations.

The results reported that highest energy of germination was obtained from seed priming with 1% NaCl and sown Line S 102 while, the lowest energy of germination was produced from non-priming seed and sown Sakha 53 cultivar. These results are in good accordance with those reported by Guo-Wei *et al.* (2011) and Kandil *et al.* (2012) on canola, Moghanibashi *et al.* (2012) and Pahoja *et al.* (2013).

Concerning to the interaction effects the results illustrated in Fig. 6, Fig. 7, Fig. 8 and Fig. 9 clearly showed that final germination percentage, germination rate, germination index and energy of germination were significantly affected by the interaction between priming or non-priming and salinity concentrations. The results clearly revealed that highest final germination percentage was obtained from seed priming with 1% NaCl or 0.3% KNO_3 and without salinity application. While, the lowest final germination percentage was produced from non-priming seed and highest salinity level at 35 dSm^{-1} NaCl (Fig. 6). The results clearly indicated that highest germination rate was obtained from seed priming with 1% NaCl or 0.3 KNO_3 and without salinity application. While, the lowest germination rate was produced from primed and non-primed under highest salinity level at 35 dSm^{-1} NaCl (Fig. 7). The results clearly showed that highest germination index and energy of germination were obtained from priming or non-priming seed and without salinity application.

While, the lowest germination index and energy of germination were produced from primed or non-primed seed and highest salinity level at 35 dSm^{-1} NaCl (Fig. 8 and Fig. 9).

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

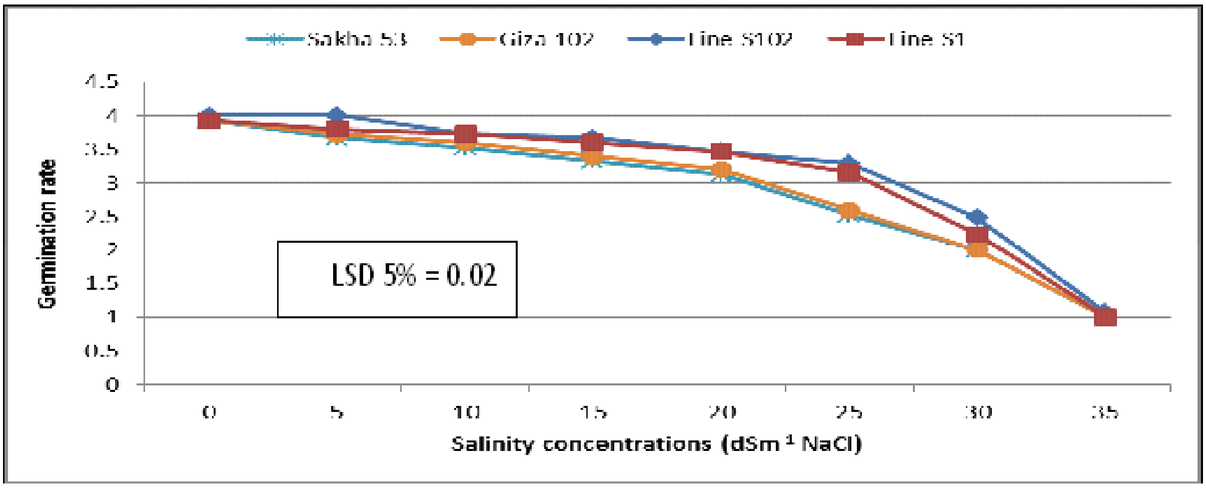

Fig. 11. Means of the germination rate as affected by the interaction between studied cultivars and salinity concentrations.

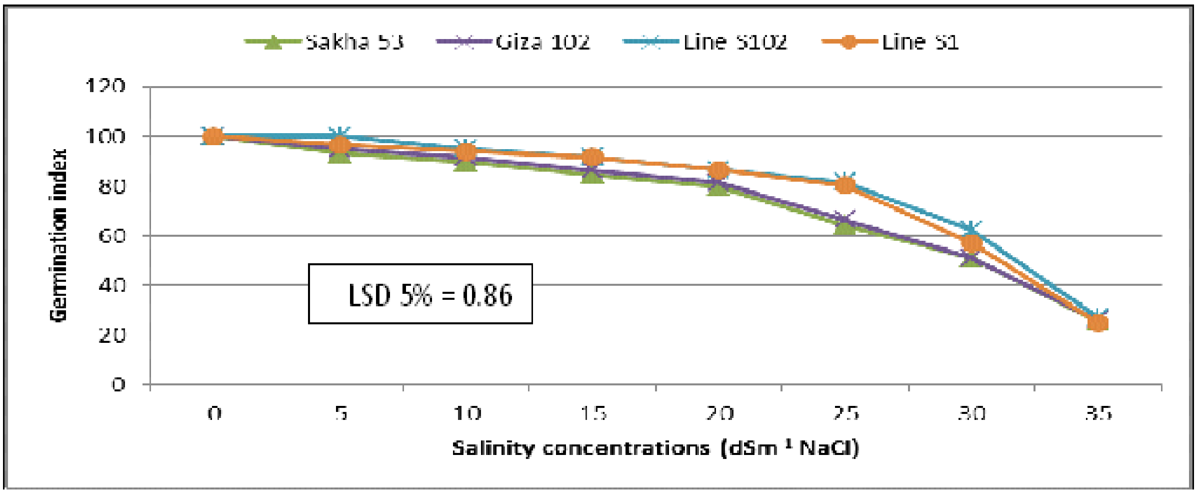

Fig. 12. Means of the germination index as affected by the interaction between studied cultivars and salinity concentration.

With respect to the interaction affects the results illustrated in Fig. 10, Fig. 11, Fig. 12, Fig. 13 and Fig. 14 clearly showed that final germination percentage, germination rate, germination index, energy of germination and seedling vigor index were significantly affected by the interaction between studied cultivars and salinity concentrations. The results clearly indicated that highest final germination percentage and germination rates were produced from sown Line S 102 under without salinity application.

Whereas, the lowest final germination percentage and germination rate were resulted from sowing Sakha 53 and Giza 102 cultivars at highest salinity concentration of 35 dSm^{-1} NaCl (Fig. 10 and Fig. 11). Results clearly indicated that highest germination index was produced from sown Line S 102 under without salinity application. While, the lowest germination index was produced from sown Line S 1 at highest salinity level of 35 dSm^{-1} NaCl (Fig. 12). The results reported that highest germination energy was produced from sowing Line S 102 under without salinity application.

While, the lowest germination energy was obtained from sown all studied cultivars under highest salinity level of 35 dSm^{-1} NaCl (Fig. 13). The results showed that highest seedling vigor index was obtained from sown Line S 102 under without salinity application. While, the lowest seedling vigor index was obtained from sown Sakha 53 cultivar under highest salinity level of 35 dSm^{-1} NaCl (Fig. 14) These results are in good accordance with those reported by Casenave and Toselli (2007) and Kandil *et al.* (2014) on sugar beet.

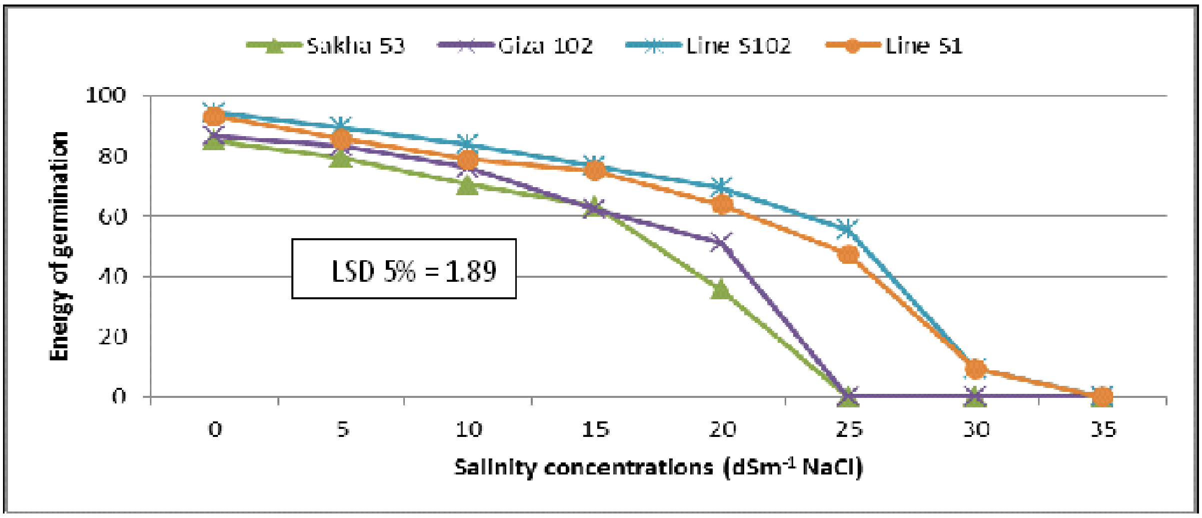

Fig. 13. Means of the energy of germination as affected by the interaction between studied cultivars and salinity concentrations.

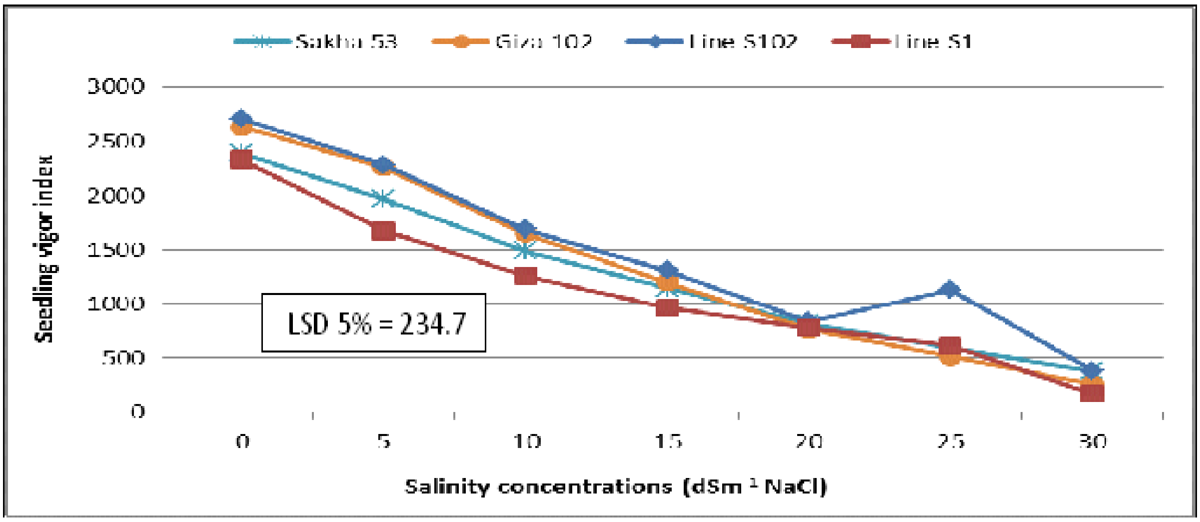

Fig. 14. Means of the seedling vigor index as affected by the interaction between studied cultivars and salinity concentrations.

Concerning to the interaction affects the results illustrated in Fig. 15, Fig. 16, Fig. 17 and Fig. 18 clearly showed that final germination percentage, germination rate, germination index and energy of germination were significantly affected by the interaction between priming or non-priming seed, studied cultivars and salinity concentrations.

Results clearly revealed that highest final germination percentage was obtained from seed priming treatments and sown Line S 102 without salinity concentrations. While, the lowest final germination percentage was produced from seed primed or non-primed and sown all studied cultivars under salinity level of 35 dSm^{-1} NaCl except Line S1 and Giza 102 cultivars (Fig. 15).

Results clearly indicated that highest germination rate was obtained from all treatment and sown all studied cultivars without salinity concentrations except Line S 1. While, the lowest germination rate was produced from seed primed or non-primed and sown all studied cultivars under salinity level of 35 dSm^{-1} NaCl except Line S102 (Fig. 16).

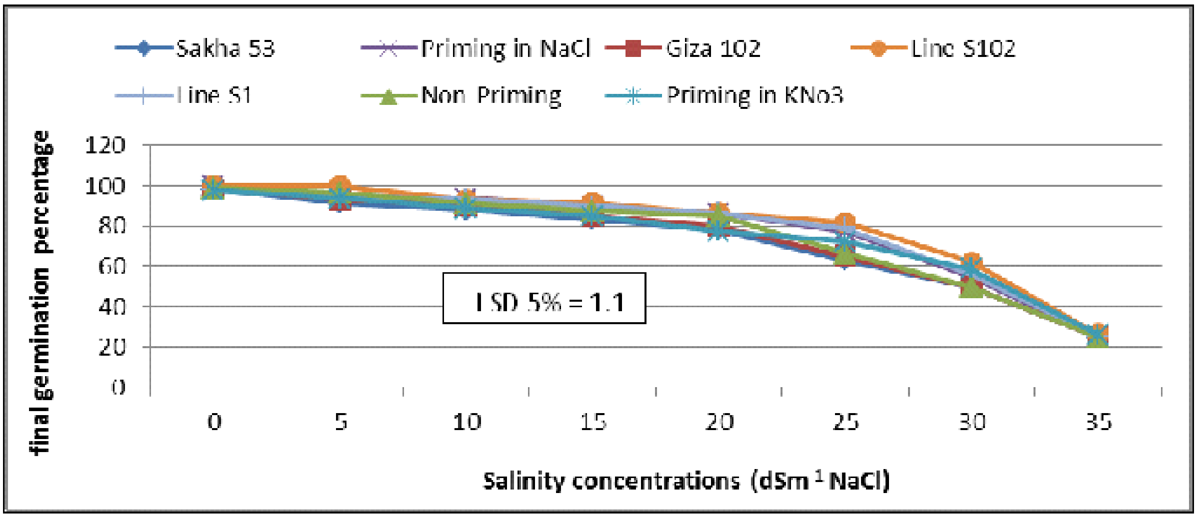

Fig. 15. Means of the final germination percentage as affected by the interaction between primed seed, studied cultivars and salinity concentrations.

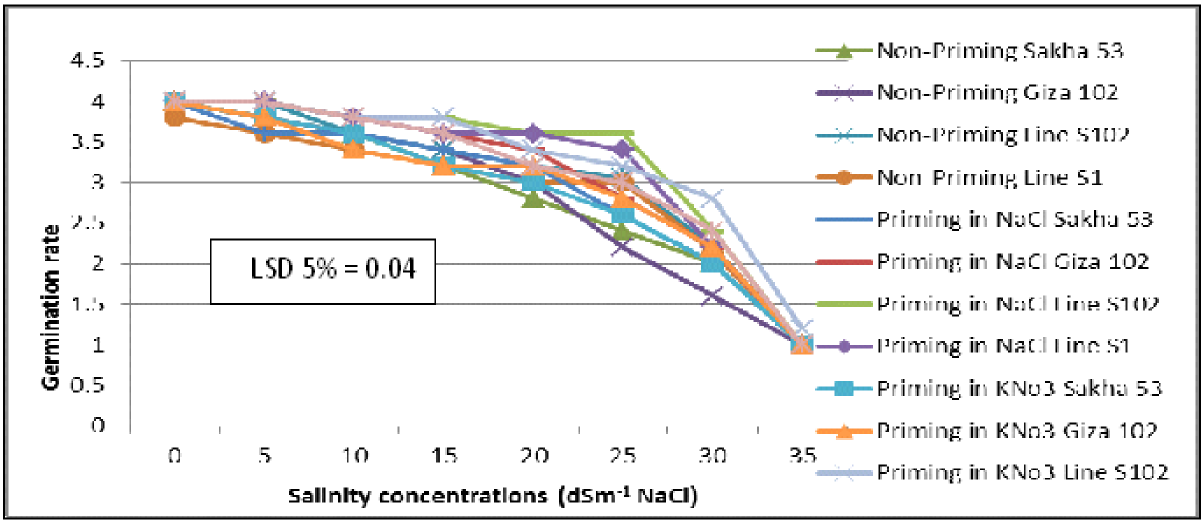

Fig. 16. Means of the germination rate as affected by the interaction between primed seed, studied cultivars and salinity concentrations.

Results clearly indicated that highest germination index produced from seed primed or non-primed of all studied cultivars under the control treatment. While, the lowest germination index was produced from all seed priming treatments and sown Line S 1 cultivar under highest salinity level of 35 dSm^{-1} NaCl (Fig. 17).

The results clearly revealed that highest energy of germination was obtained from priming seed in KNo_3 and sown Line S 102 cultivar under the control treatment. While, the lowest germination energy was produced from primed or non-primed seed and sown all studied cultivars under salinity level of 35 dSm^{-1} NaCl (Fig. 18) These results are in good accordance with those reported by Casenave and Toselli (2007) and Kandil *et al.* (2014) on sugar beet.

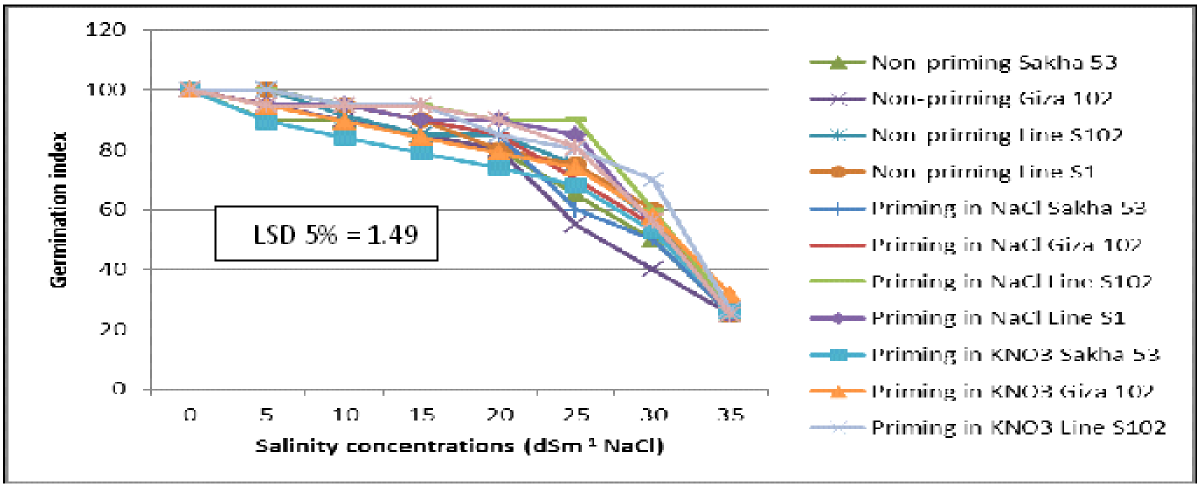

Fig. 17. Means of the germination index as affected by the interaction between studied cultivars and salinity concentration.

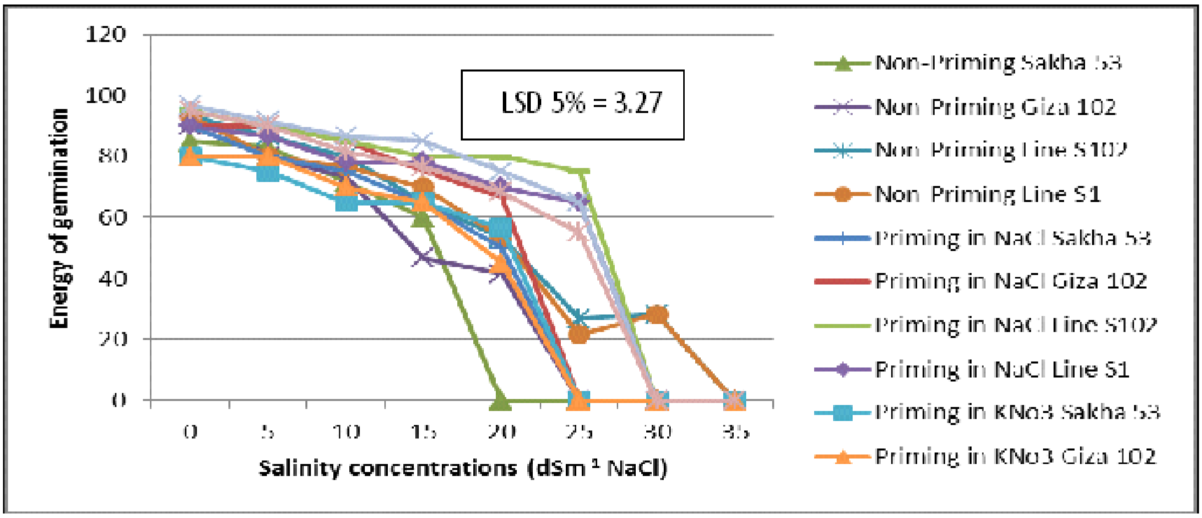

Fig. 18. Means of the energy of germination as affected by the interaction between studied cultivars and salinity concentrations.

Conclusion

It could be concluded that for maximizing sunflower germination characters and seedling parameters under salinity stress. It could be concluded that priming Line S 102 in NaCl or KNO_3 was more tolerant to salinity stress, which must be put in breeding program of sunflower for enhancing cultivars productivity under salinity conditions and to increase its cultivation in newly reclaimed soil in Egypt.

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