Available online at http://www.ijabbr.com

International journal of Advanced Biological and Biomedical Research

Volume 1, Issue 12, 2013: 1543-1550

Effect of Salinity Stress on Germination in *Lycopersicon esculentum* L. var *Cal-ji*

Ali Salehi Sardoei[1*], Mostafa Nik zad[2], Morteza Sabaee Fazel[2], Behnam Azizi Gerdeh[2], Mostafa shahvardi[3]

[1] *Young Researchers and Elite Club, Islamic Azad University, Branch Jiroft, Jiroft, Iran.*

[2] *MS.c student, Department of Agroecology, University of Jiroft, Iran.*

[3] *MS.c Student, Lorestan Agricultural & Natural Recourses University, Lorestan, Iran.*

ABSTRACT

The response of tomato genotype *Cal-ji* against five salinity levels (distilled water as control, 25, 50, 75 and 100 mM) were studied at germination and early seedling stages. An experiment with conducted by using a completely randomized design (CRD) with three replications. Shoot and root length, shoot and root fresh weight, seed vigor, mean germination time, germination percentage and rate measured 14 days after germination. Results of data analysis showed that, there were significant differences between salinity stress levels for all investigated traits except mean germination time. Results of data analysis showed that, that the maximum germination percentage during the test was related to the control treatment (Distilled water), and 25 mM. maximum germination percentage at day 14, with an average of 98.76 and 96.57%, were related to the Distilled water and 25 mM treatments. The maximum root length, at day 14 of the test, was from the 25 mM treatment, which did not show a significant statistical difference with the observer treatment. In the entire measured traits, we achieved better results from the control (Distilled water) and 25 mM treatments, in comparison to the 50 mM density, which indicates that the *Cal ji* tomato genotype could grow properly in low-saline conditions, but this growth faces an extremely significant decrease with the increased salt densities.

Key words: Germination, Seed vigor, Salinity Stress, Tomato.

INTRODUCTION

During their growth crop plants usually exposed to different environmental stresses which limits their growth and productivity. Among these, salinity is the most severe ones (Kaymakanova, 2009). Salinity becomes a concern when an “excessive” amount or concentration of soluble salts occurs in the soil, either

Corresponding Author E-mail: alisalehisardoei1987@yahoo.com

naturally or as a result of mismanaged irrigation water. The major inhibitory effect of salinity on plant growth and development has been attributed to osmotic inhibition of water availability as well as the toxic effect of salt ions responsible for salinization. Nutritional imbalance caused by such ions leads to reduction in photosynthetic efficiency and other physiological disorders (Hakim et al., 2010). In arid and semi arid regions, limited water and hot dry climates frequently cause salinity problem that limit or prevent crop production. It has also been reported that under saline conditions, germination ability of seeds differ from one crop to another and even a significant variation is observed amongst the different varieties of the same crop (Jamil et al., 2005). Salt stress affects many physiological aspects of plant growth. Shoot growth was reduced by salinity due to inhibitory effect of salt on cell division and enlargement in growing point. Early flowering reduced dry matter, increased root: shoot ratio and leaf size caused by salinity may be considered as possible ways of decreasing yield in plant under salt stress condition (Maghsoudi Moud and Maghsoudi 2008). Seed germination is usually the most critical stage in seedling establishment, determining successful crop and seed quality (Khajeh-Hosseini et al., 2003). It is necessary to identify the sensitivity and tolerance level of a production (Bhattacharjee, 2008). Crop establishment depend on an interaction between seedbed environment variety at early seedling stages for successful crop production in a saline environment (Hakim et al., 2010).The present study was therefore, conducted with the objectives to determine the response of tomato genotype to salinity stress at germination and seedling stages under controlled conditions. Moreover, NaCl was used for salinity stress induction in tomato.

MATERIALS AND METHODS

In order to study the effects of salinity stress on germination and early seedling growth in tomato genotype, an experiment was conducted using a completely randomized design (CRD) with three replications. In this experiment, genotype inclusive *Cal-ji* were evaluated in five levels of salinity treatment (distilled water as control, 25, 50, 75 and 100 mM) by using different NaCl concentrations. This experiment was carried out at horticulture Laboratory, Department of Agriculture, University of Jiroft Branch, Iran. The seeds were sterilized by soaking in a 5% solution of hypochlorite sodium for 5 min. After the treatment, the seeds were washed several times with distilled water. 30 seeds were put in each petridish (with 9 cm diameter) on filter paper moistened with respective treatment in three replications. The petridishes were covered to prevent the loss of moisture by evaporation. The petridishes were put into an incubator for 14 days at 25 centigrade degrees temperature and 65% relative humidity. Every 24 hours after soaking, germination percentage and other traits were recorded daily. After 14 days of incubation, shoot and root length, shoot and root fresh weight, seed vigor, mean germination time, germination percentage and rate was measured. Seeds were considered germinated when the emergent root reached 2 mm length. Rate of germination, germination percentage and mean germination time were calculated using the following formulas (Mostafavi, 2011):

$GP = SNG/SNO \times 100\%$

Where: GC is germination percentage, SNG is the number of germinated seeds, and SNO is the number of experimental seeds with viability (Close and Wilson, 2002; Danthu et al., 2003).

$GR=\Sigma N/\Sigma(n\times g)$

Where: GR: Germination race; n: number of germinated seed on gth day and g: Number of total germinated

Seed Vigor = [seedling length (cm) × germination percentage]

Analysis of variance was performed using standard techniques and differences between the means were compared through Duncan's multiple Significant Difference test ($P < 0.05$) using SAS release 9.1 (SAS, 2002) software package.

RESULTS AND DISCUSSIONS

Results of the mean data comparison, indicate that the maximum germination percentage during the test was related to the observer treatment (Distilled water), and 25 mM. The maximum germination percentage at day 14, with an average of 98.76 and 96.57%, were related to the pure water and 25 mM treatments (table 1). Maggio et al., (2007) found out in their studies that by increasing the salinity, the percentage and speed of the germination decreases (Maggio et al., 2007). The maximum germination speed was seen in both the observer (Distilled water) and 25 mM treatments, which also their germination speed decreased further into the test (table 2).

Table 1- Mean comparison of different salinity levels of studied trait Germination Percentage (day)

Salinity Levels (mM)	Germination Percentage (day)				
	6	8	10	12	14
0	75.45a	91a	97.66a	97.66a	98.76a
25	66.6a	86.58a	97.66a	97.66a	96.57a
50	0b	22.17b	35.49b	38.82b	39.96b
75	0b	0c	0c	0c	0c
100	0b	0c	0c	0c	0c

Table 2- Mean comparison of different salinity levels of studied trait Germination rate (day)

Salinity Levels (mM)	Germination rate (day)				
	6	8	10	12	14
0	3.44a	3.41a	2.93a	2.47a	2.11a
25	3.32a	3.24a	2.86a	2.41a	2.07a
50	0b	0.83b	1.06b	0.96b	0.85b
75	0b	0c	0c	0c	0c
100	0b	0c	0c	0c	0c

According to Ayaz et al., (2000), decrease of seed germination under salinity stress conditions is due to occur of some metabolically disorders. It seems that, decrease of germination percentage and germination rate is related to reduction in water absorption into the seeds at imbibitions and seed turgescence stages (Mostafavi, 2011).

Some studies referred that salinity stress can contribute to improve germination rate and seedling emergence in different plant species by increasing the expression of aquaporins (Janmohammadi et al., 2008), enhancement of ATPase activity, RNA and acid phosphathase synthesis (Abbasdokht *et al*., 2010), also by increase of amylases, proteases or lipases activity (Ashraf and Foolad, 2005).The maximum root length, at day 14 of the test, was from the 25 mM treatment, which did not show a significant statistical difference with the observer treatment, also the highest root length in other days of the test was still owned by the 25 mM treatment, which reached its height in comparison to other treatments, at day 14 35.68 cm (table 3). (Mortezai-Nejad and Rezai, 2009) in a test they inducted on 5 varieties of tomato, found out that by increasing the salinity.

Table 3-Mean comparison of different salinity levels of studied trait and root lengths decrease.
Root length (cm)

Salinity Levels (mM)	Root length (cm)				
	6	8	10	12	14
0	0.40a	5.54ab	12.96ab	18.53a	32.36a
25	0.66a	12.33a	18.14a	21.89a	35.68a
50	0b	3.43ab	4.35bc	5.54b	6.77b
75	0b	0b	0c	0b	0b
100	0b	0b	0c	0b	0b

The results from table (4) indicate that the maximum shoot length is achieved at days 10 and 12 of the test, from the 25 mM density, and at day 14 for the observer (Distilled water) treatment (table 4). Maximum wet weight of the root was from the 25 mM treatment, and the maximum shoot fresh weight was from the observer (Distilled water) treatment (table 4). (Zahedi and Alam-Zadeh, 1390) reported that the wet weight of the fresh and root in the cowpea reduces, by increasing the salinity density.

Table 4-Mean comparison of different salinity levels of studied trait Shoot length and shoot and root Fresh weight

Salinity Levels (mM)	Shoot length (cm)			shoot Fresh weight (g)	root Fresh weight (g)
	10	12	14		
0	3.17b	4.02b	24.04a	0.066ab	0.032b
25	13.51a	15.82a	20.84a	0.15a	0.083a
50	2.03b	7.97ab	10.04b	0.02a	0.026b
75	0b	0b	0b	0b	0b
100	0b	0b	0b	0b	0b

Results indicated that by increasing the test time, the average germination period also increases, which its height could be seen at the observer (Distilled water) treatment, and its least from the 50 mM treatment, which indicated a significant statistical difference with each other. The maximum germination time was at day 14, related to the observer (Distilled water), and 25 mM treatments, which did not show a significant statistical difference with each other (table 5).

Table 5- Mean comparison of different salinity levels of studied trait Mean Germination Time

Salinity Levels (mM)	Mean Germination Time				
	6	8	10	12	14
0	4.38a	7.28a	9.11a	11.86a	13.84a
25	4.01a	6.95a	8.92a	11.60a	13.53a
50	0b	1.77b	2.66b	4.66b	5.59b
75	0b	0c	0c	0c	0c
100	0b	0c	0c	0c	0c

It seems that, NaCl consentration (salinity Stress) affects on seed germination via limitation of water absorption by seeds (Dodd and Donovan, 1999), excessive use of nutrient pool (Bybordi and Tabatabaei, 2009) and creation of disorders in protein synthesis.With the test time passing, the seed vigor stamina. Its height was at days 10 and 14 of the test, in the 25 mM treatment. At day 12 of the test, it was owned by the observer (Distilled water) treatment. There was no significant difference between the observer and 25 mM treatments. The results of the data mean comparisons indicated that the observer (Distilled water) treatment had the least germination percentage 50%, and its height was from the 50 mM treatment (table 6).

Table 6- Mean comparison of different salinity levels of studied trait seed vigor and Germination Percentage 50%

Salinity Levels (mM)	seed vigor			
	8	10	14	Germination Percentage 50%
0	289.90a	398.73a	570.17a	3.98
25	330.87a	366.46a	614.53a	4.65
50	0b	89.58b	107.43b	18.21
75	0b	0b	0b	0
100	0b	0b	0b	0

NaCl causes osmotic stress and could be used as a salinity simulator (Mostafavi, 2011). In the present experiment NaCl was used to create the osmotic stress, as most of the researchers (Hu and Jones, 2004) utilized it for the development of water salinity environment in laboratory studies. The variation among

genotype showed that germination percentage decreased with the increase in NaCl concentration in all the genotype *cal-ji*.Present study the findings are very similar to the former case, in which germination decreased due to the increase in NaCl concentration. Present study strongly supports that germination percentage and root to shoot ratio can be utilized to screen tomato genotype for salinity tolerance. There are many reports which are in agreement with the present findings indicating that salinity stress severely reducing the seed germination and early seedling growth. But the varieties having genetic potential to maintain the higher growth under stress conditions are saline tolerant. In this study, we analyzed the effect of NaCl salt, on the tomato's germination and bud growth indicators. In this study, the percentage and speed of the germination was analyzed as an index for the tomato seed's germination, and the plumule and radicle's wet weight and length as a criterion for the tomato bud's growth. As it was mentioned in the result section, the tomato's growth criterions follow a decreasing trend in various slat densities, which match the results achieved by other researchers. Furthermore, other researchers also reported a negative impact from the salinity on the germination of various plants, such as canola, soy, beans, cowpea, pea and tomato. Many saline inhibitors have be also reported (Dudeck et al.,1993; Dudeck et al., 1984; Egan et al., 1997 and Egan et al., 1998). Foolad and Jones (1991) also reported that the tomato varieties power for fast germination in the saline conditions, independent from the growth potency, is more in the growing stage, also a disaffiliation has been reported in other studies, between the saline resistance in one stage of growth. In this study, we analyzed the effect of NaCl salt, on the tomato seed's germination, stamina, and capability to achieve a 50% germination rate. In this research, the tomato seed's average germination and stamina are analyzed as a criterion for the tomato seed's germination. As mentioned in the results section, in various salt densities, the tomato seed's germination and stamina faced a decreasing trend, which matches the reports from other researchers. Furthermore, other researchers also reported a negative impact from the salinity on the germination of various plants, such as canola, soy, beans, cowpea, pea and tomato. The saline-resistant types could benefit from the dilution mechanisms and its accumulation in the vacuoles, and therefore partially protect themselves from their ill-effects (Atmtan and sanders, 1999).

Conclusions

In the entire measured traits, we achieved better results from the observer (pure water) and 25 mM treatments, in comparison to the 50 mM density, which indicates that the Cal ji tomato variety could grow properly in low-saline conditions, but this growth faces an extremely significant decrease with the increased salt densities.

REFERENCES

Abbasdokht H., Edalatpishe M.R and Gholami A (2010). The Effect of Hydropriming and Halopriming on Germination and Early Growth Stage of Wheat (*Triticum aestivum* L.). World Academy of Science, Engineering and Technology, 68: 974-978.

Ashraf, M and Foolad M.R (2005). Pre-sowing seed treatment-a shotgun approach to improve germination growth and crop yield under saline and none-saline conditions, Advan. Agron., 88: 223-271.

Ayaz, F.A., Kadioglu, A and Urgut, R.T (2000). Water stess effects on the content of low molecular weight carbohydrates and phenolic acids in cienanthe setosa. Canadian. J. Plant Sci., 80: 373-378.

Atmtan, A and sanders, D (1999). Mechanism of na+ uptake by plant cell. Advance botany research 29:112-115.

Bhattacharjee, S (2008). Triadimefon pretreatment protects newly assembled membrane system and causes upregulation of stress proteins in salinity stressed Amaranthus lividus L. during early germination. J. Environ. Biol., 29: 805-810.

Bybordi, A and Tabatabaei, J (2009). Effect of Salinity Stress on Germination and Seedling Properties in Canola Cultivars (*Brassica napus* L.). Not. Bot. Hort. Agrobot. Cluj., 37(1): 71-76.

Dodd, G.L and Donovan, L.A (1999). Water potential and ionic effects on germination and seedling growth of two cold desert shrubs. Am. J. Bot., 86: 1146-1153.

Dudeck AE, peacock CH and Wildmon JC. 1993. physiological and growth responses of St.Augustinegrass cultivars to salinity. HortSci .28:46-48.

Dudeck, A.E., Singh, S., Giordano, T.A., Nell, A and McConnell, D.B (1984). Effects of sodium chloride on cynodon turfgrass. Agron. J. 75:927-930.

Egan, T.P., Ungar, I.A and Meekins, J.F (1997). The effect of different salts of sodium and potassium on the germination of Atriplexprostrata (chenopodiaceae). plant Nutr. 20:1723-1730.

Egan, T.P and Ungar, I.A (1998). Effect of different salts of sodium and potassium on the growth of Atriplex prostrate(chenopdiaceae). J. plantNutr. 21:2193-2205.

Foolad, M.R and Jones, R.A (1991). Genetic analysis of salt tolerance duringgermination in Lycopersicon .The Applied Genetic 81: 821-326.

Hakim, M.A., Juraimi, A.S., Begum, M., Hanafi., M.M., Ismail., M.R and Selamat, A (2010). Effect of salt stress on germination and early seedling growth of rice (*Oryza sativa* L.). African Journal of Biotechnology, 9(13): 1911-1918.

Hu, F.D and Jones, R.J (2004). Effects of plant extracts of Bothriochloa pertusa and Urochloa mosambicensis on seed germination and seedling growth of Stylosanthes hamata cv. Verano and Stylosanthes scabra cv. Seca. Aust. J. Agric. Res., 48: 1257-1264.

Janmohammadi, M., Moradi Dezfuli, P and Sharifzadeh, F (2008). Seed Invigoration Techniquse to Improve Germination and Early Growth of Inbred Line of Maize under Salinity and Drought Stress. plant physiology, 34(3-4): 215-226.

Jamil, M., Bae Lee, D., Yong Jung, K., Ashraf, M., Lee, S.C and Shik Rha, Y (2006). Effect of salt (NaCl) stress on germination and early seedling growth of four vegetabales specpies. Journal Centeral European Agriculture, 2: 273-282.

Kaymakanova, M (2009). Effect of salinity on germination and seed physiology in Bean (*Phaseolus Vulgaris* L.). XI Anniversary Scientific Conference, pp: 326-329.

Khaje-hosseini, M., Powell, A.A and Bingham, I.J (2003). The interaction between salinity stress and seed vigour during germination of soybean seeds, Seed Sci. Technol., 31: 715-725.

Maghsoudi Moud, A and Maghsoudi, K (2008). Salt Stress Effects on Respiration and Growth of Germinated Seeds of Different Wheat (*Triticum aestivum* L.) Cultivars. World Journal of Agricultural Sciences, 4(3): 351-358.

Maggio, A., Raimondi, G., Martino, A and De Pascale, S (2007). Salt stress response in tomato beyond the salinity tolerance threshold.Environmental and Experimental Botany. 59: 276–282.

Mortezai nejad, F and Rezai, P (2009). Evaluation of salt tolerance in five varieties of tomatoes. Agricultural Research Letters, Volume 1, Issue 2.

Mostafavi, K., Sadeghi Geive, H., Dadresan, M and Zarabi, M (2011). Effects of drought stress on germination indices of corn hybrids (*Zea mays* L.). International Journal of AgriScience, 1(2): 10-18.

SAS. (2002). SAS/STAT® user's guide, SAS Institute, Cary, NC, USA. 9.1.

Zahedi, M and Alamzade Ansari, N (2011). The effect of salinity on germination and early growth of cowpea, the seventh congress of Horticultural Science, pp: 1082-1086