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Study of salinity effect on germination of tomato (*Lycopersicon esculentum* L.) genotypes

Ali Salehi Sardoei[1*] and Gholam Abbas Mohammadi[2]

[1]*Young Researcher and Elite Club, Jiroft Branch, Islamic Azad University, Jiroft, Iran*
[2]*Department of Plant Science, Jiroft Branch, Islamic Azad University, Jiroft, Iran*

ABSTRACT

The response of tomato genotypes [Cal-ji, Flat Ch irani, Chef Flat Americ, Primo Earily and Chef] a 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 factorial based complete randomize design with three replications. the following data were recorded, Shoot and root length, shoot and root fresh weight, germination percentage and rate measured 14 days after germination. Results obtained in this study indicated that interaction of salt × genotype had significant effect on growth indices in all the cases [P < 0.05]. With increase in salinity level, germination percentage was significantly decreased. Concerning germination percentage, there was no difference between Chef and Cal ji cultivars across all the salt levels; however, in the salt level of 25 mM the two cultivars were significantly different from primo early and chef flat amrica. In the salt level of 25mM cultivar primo early showed 66.27% germination whereas the germination percentage of chef and cal ji was 62.13 and 77.68 respectively. indicates that increased salt level results in reduction of plumule fresh weight indices of flat ch irani, cal ji and chef flat amrica cultivar; however the fresh weight of plumule was not significantly different between cal ji and flat ch irani.

Key words: Germination, Genotypes, Salinity Stress, Tomato.

INTRODUCTION

Tomato is a widely distributed annual vegetable crop which is consumed fresh, cooked or after processing by canning, making into juice, pulp, paste, or as a variety of sauces; being a rich source of phytochemicals such as lycopene, β-carotene, flavonoids, vitamin C and essential nutrients [3]. Abiotic stresses are major constraints for global crop production. Among various abiotic stresses, salinity has become a severe threat to ensure food security by affecting about one-third of the irrigated land on earth [18]. 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 [13]. Salinity becomes a concern when an "excessive" amount or concentration of soluble salts occurs in the soil, either 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 [11]. 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 [12]. 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 [17]. Seed germination is usually the most critical stage in seedling establishment, determining successful crop and seed quality [14]. It is necessary to identify the sensitivity and tolerance level of a production [2]. Crop establishment depend on an interaction between seedbed environment variety at early seedling stages for successful crop production in a saline environment [11]. The present study was therefore, conducted with the objectives to determine the response of tomato genotypes 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 genotypes, an experiment was conducted using a factorial based complete randomize design with three replications. In this experiment, genotype inclusive genotypes [Cal-ji, Flat Ch irani, Chef Flat Americ, Primo Earily and Chef] 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 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 [16]:

GP = SNG/SNO × 100%

Where: GC is germination percentage, SNG is the number of germinated seeds, and SNO is the number of experimental seeds with viability [16].

GR=$\Sigma N/\Sigma$ [n×g]

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

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 [19] software package

RESULTS AND DISCUSSION

Effect of salinity

According to table [1], with increase in salt concentration all the indices were reduced and in the salinity of 100mM plant growth was completely inhibited. Effect of salinity level up to 25mM was negligible and there was no difference between treated and control groups. Above this, all the indices were considerably influenced by salinity. Salt levels of 75 mM and 100 mM had negative significant effect on growth indices.

Effect of cultivar

Ignoring salinity, there was significant difference among evaluated indices of different cultivars of tomato. The cultivar primo earl had the highest indices of germination, plumule length and radicle length which were significantly different from those of other cultivars [table 1]. Different growth and development rate under the same condition is a common phenomenon among various plant varieties resulting from difference in plant genetics [12].

Table 1-Mean comparison of different salinity levels on Germination in genotypes *Lycopersicon esculentum* L.

	Germination Percentage (%)	Germination rate	Root length (cm)	Shoot length (cm)	shoot Fresh weight (g)	root Fresh weight (g)
Salinity Levels (mM)						
0	78.78a	2.82a	12.33a	8.06a	0.22a	0.04a
25	79.45a	2.78a	10.09b	3.81b	0.21a	0.04b
50	52.61b	2.07a	4.75c	2.28c	0.13b	0.02c
75	41.19c	1.75b	1.83d	0.63d	0.11b	0.02c
100	0d	0c	0e	0e	0c	0d
genotypes						
Flat Ch irani	51.28b	2.49a	1c	0.61d	0.21a	0.03a
Chef	53.47b	2.47a	1.02c	1.21c	0.14b	0.02b
Cal-ji	52.14b	2.4b	0.99c	1.02c	0.22a	0.03a
Primo Earily	65.46a	1.4c	19.12a	9.11a	0.04c	0.02b
Chef Flat Americ	30.83c	0.65d	6.87b	2.82b	0.04c	0.01c

**Means separated by Duncans multiple ranges test at the P< 0.01 level*

Salt and cultivar interaction

Results obtained in this study indicated that interaction of salt × genotype had significant effect on growth indices in all the cases [p<0.01]. With increase in salinity level, germination percentage was significantly decreased [table 1]. Concerning germination percentage, there was no difference between Chef and Cal ji cultivars across all the salt levels; however, in the salt level of 25 mM the two cultivars were significantly different from primo early and chef flat amrica. In the salt level of 25mM cultivar primo early showed 66.27% germination whereas the germination percentage of chef and cal ji was 62.13 and 77.68 respectively. Regarding interaction of salt × cultivar, it can be seen that primo early had higher germination percentage compared to other cultivars. By increasing salt concentration from 25 to 75 mM, germination percentage was reduced, which accords with the results reported by Dudeck and Peacock [5]. By increase in salinity, reduction pattern of germination rate was similar to that of germination percentage with an exception that up to salt level of 50mM, germination rates of primo early and flat chirani were significantly different from each other; and in the salt levels above 50mM reduction of germination rates in the two cultivars followed a similar pattern [table 2]. According to Foolad and Jones [10] and Mortezai nejad and Rezai [19] salt stress in germination stage results in reduction and delay of germination, reduced vegetative growth and yield which is in agreement with the results obtained in the present study. Foolad and Jones [10] reported that ability of tomato cultivars for fast germination is independent from further growth in vegetative stage. It was also observed in other studies that salt tolerance in a given growth stage is not related to other stages. In all the salt levels, primo early had the highest germination rate. According to table 1, plumule length is reduced as a result of increase in salinity. Moreover, there was no significant difference for radicle length among cultivars chef, flat chirani and cal ji. Inhibitory effect of salinity has been reported by many authors [4, 5, 6, 7, 8]. Francois and Bernstein [9] showed that salinity [19] reduced plumule length of safflower. Compared to other cultivars, primo early exhibited lower reduction of plumule and radicle length in response to increased salt concentration. Other cultivars were more severely influenced by salinity so that in the salt concentration of 50mM, plumule and radicle length was 8.11 and 19.85 mm in primo early, 1.14 and 1.23 mm in cal ji, 1.1 and 1.26 mm in chef, 0.81 and 1.26 mm in flat chirani, and 0.26 and 0.12 mm in chef flat amrica. Reduction of plumule and radicle lengths due to increased salt concentration observed in this study is in agreement with the results reported by Khaje hosseini et al. [14] and Mortezai nejad and Rezai [19]. Results showed that salt tolerant cultivars possessing longer roots can absorb water more efficiently. The salt tolerant cultivar use salt dilution strategies and its accumulation in vacuoles to get protected against harmful effects of salt [1]. Table 1 indicates that increased salt level results in reduction of plumule fresh weight indices of flat ch irani, cal ji and chef flat amrica cultivar; however the fresh weight of plumule was not significantly different between cal ji and flat ch irani [table1]. The first response of plant to salinity is to reduce leaf area which leads to reduced growth. Reduced fresh weight of root and stem was as a result of salt stress was reported by Mortezai nejad and Rezai [19]. Table 1 shows that by increase in salt concentration, fresh weight of radicle was reduced in all the cultivars. Comparison of tomato cultivars in different salt levels regarding radicle fresh weight indices showed that the cultivars flat ch irani and cal ji had the highest levels of these indices. Moreover, the cultivars chef flat amrica, flat ch irani and cal ji had the highest radicle fresh weight; in salt level of 25mM, cal ji and flat ch irani showed no significant difference with control group. In salt level of 50 mM, the cultivar chef flat amrica had no fresh weight of radicle and showed the highest sensitivity [table2]. Khan et al. [15] showed that in the plant halopyrum novaranatum radicle and plumule fresh weight was reduced by increased salt concentration; however the plant exhibit better growth in lower concentrations of sodium chloride. According to the

results obtained in the present study, it can be concluded that indices of root and shoot growth are those plant growth indices quickly affected by salt stress. That is, by increase in salt concentration these indices are quickly reduced. Based on this, a tolerant genotype is that exhibits higher shoot length and fresh weight in high concentrations of salt. Concerning identical growing condition provide for all the tested cultivars, primo early and chef flat amrica, possessing higher growth indices across different salinity levels, are considered as the tolerant genotypes, whereas the other cultivars exhibited lower tolerance to salt.

Table 2-Mean comparison interaction of different salinity levels on Germination in genotypes *Lycopersicon esculentum* L.

genotypes	Salinity Levels (mM)	Germination Percentage (%)	Germination rate	Root length (cm)	Shoot length (cm)	shoot Fresh weight (g)	root Fresh weight (g)
Flat Ch irani	0	65.46de	3.27ab	1.4e	0.94fghi	0.4a	0.05bc
	25	79.92c	3.66a	1.33e	0.91fghi	0.3b	0.04de
	50	59.94ef	2.99bc	1.26e	0.81ghij	0.19c	0.03ef
	75	51.04gh	2.53cd	1.03e	0.43hij	0.18cd	0.03fg
	100	0i	0i	0e	0j	0g	0j
Chef	0	77.68c	3.55a	1.36e	2.52e	0.14de	0.04cd
	25	77.68c	3.55a	1.33e	1.54fg	0.22c	0.03ef
	50	62.13ef	2.76bcd	1.26e	1.1fghi	0.2c	0.03fgh
	75	49.95gh	2.49cde	0.16e	0.92fghi	0.14de	0.02h
	100	0i	0i	0e	0j	0g	0j
Cal-ji	0	79.92c	3.66a	1.36e	1.8ef	0.42a	0.05b
	25	77.68c	3.22ab	1.33e	1.23fgh	0.3b	0.04de
	50	55.47fg	2.77bcd	1.23e	1.14fghi	0.22c	0.03fg
	75	47.71h	2.38def	1.03e	0.95fghi	0.18cd	0.02gh
	100	0i	0i	0e	0j	0g	0j
Primo Earily	0	88.77ab	1.9fg	29.84b	21.79a	0.03fg	0.02gh
	25	92.1a	1.97efg	39.94a	14.78b	0.11e	0.01i
	50	83.25bc	1.78gh	19.58c	8.11d	0.03fg	0.01i
	75	63.27de	1.35h	5.96d	0.86ghij	0.05f	0.02h
	100	0i	0i	0e	0j	0g	0j
Chef Flat Americ	0	82.11bc	1.75gh	27.71b	13.25c	0.11e	0.05bc
	25	69.93d	1.49gh	6.54d	0.6hij	0.11e	0.07a
	50	2.19i	0.04i	0.12e	0.26ij	0g	0j
	75	0i	0i	0e	0j	0g	0j
	100	0i	0i	0e	0j	0g	0j

**Means separated by Duncans multiple ranges test at the P< 0.01 level*

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