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Effect of salinity on seed germination and seedling parameters of different tomato genotypes

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Abstract
A laboratory experiment was laid out in Completely Randomized Block Design consist of 50 tomato genotypes were tested in roll towel method and impose the salinity level of 0mM, 20mM, 40mM, 60mM, 80mM, 100mM and 120mM with three replication. In the investigation work were carried out at HC & RI, TNAU, Coimbatore. Significant variations were observed in seed germination, seedling growth and root characters and the data were statistically analyzed by ANOVA. In the result of the present study showed that, 38 tomato genotypes were germinated under moderate salinity level of 80mM. The highest seed germination percentage (66.66), shoot length (6.60) and root length (7.70) were observed in LE-1respectively. Whereas, LE-14 observed in highest seedling length (13.56), seedling fresh weight (0.247), seedling dry weight (0.04) respectively. Fresh seedling tolerant index were noticed in IIVR-88783 (94.3) and dry seedling tolerant index (251.3) in Khasi genotype of tomato. The lowest seed germination and seedling parameters were recorded Pharna Baskar under moderate saline condition. The seven level of salinity treated (0mM to 80mM) with tomato genotypes, seed germination, seedling parameters well in moderate saline level (80mM) and least performance were observed in 100m and 120mM respectively.

Keywords: Genotypes, germination, seedling, salinity, tomato

Introduction

Tomato (*Solanum lycopersicon* L.) belonging to the family Solanaceae, is one of the most important, popular, nutritious and palatable vegetables grown in India. It plays a vital role in providing a remarkable quantity of vitamin- A and vitamin-C in human diet. It can be eaten both in raw as well as ripe and after cooking. Tomato is cultivated all over India due to its adaptability to wide range of soil and climate. High soil salinity, many crop plants, including tomato, are susceptible and cannot survive or can survive only with decreased yields. To alleviate the deleterious effects of salinity, the measures such as the reclamation of salinized lands, the improvement of irrigation with saline water and the cultivation of salt-tolerant variety have been applied (Tuna *et al.*, 2007) [29]. The positive changes in tomato quality have been obtained under certain salinity treatments. The safe and efficient use of saline water for irrigation is to undertake appropriate practices to prevent the development of excessive soil salination for crop production. Many factors should be considered in making management strategies, such as crop cultivars, local climate, soil nutrients, type of salt, salinity levels, irrigation method and water management practices (Datta *et al.*, 2015 and Bustan *et al.*, 1998) [2, 6]. Tomato cultivars are responses to salt stress conditions have been extensively investigated (Niedziela *et al*., 1993) [17]. However, information on the effect of salinity on seed germination, shoot length, root length, seedling length, vigour index etc., is limited (Snapp and Shennan, 1994) [25]. The excess salinity will lead to induced in plant senescence in tomato and the conventional observations of shoot and root lengths are not adequate but root architecture should be considered. The objective of this study was to evaluate the tomato genotypes with different concentration of NaCl and observed the seed germination and seedling parameter.

Materials and Method

A laboratory experiment was laid out in Completely Randomized Block Design consist of 50 tomato genotypes were tested in roll towel method and impose the salinity level of 0mM, 20mM, 40mM, 60mM, 80mM, 100mM and 120mM with three replication. In the investigation work were carried out at HC & RI, TNAU, and Coimbatore. Seeds were kept under different salt concentration and 15 days seed germination and seedling parameters such as., shoot length, root length, are recorded, data were statistically analyzed.

Result and Discussion

Knowledge of salt tolerance in vegetable crops is necessary to increase productivity and profitability. According to USDA report, out of all vegetables, tomato is moderately sensitive to salinity. In the present study, to evaluate the effect of salinity on seed germination and seedling parameters of tomato are analyzed by 50 genotypes and the results were discussed here.

Seed germination

Significant variations were found in different salt concentration in all the tomato genotypes. Seed germination ranges between 93.33% (0mM) to 6.66% (120mM) were recorded in the 50 tomato genotypes. Nasrin and Abdul Mannan (2019) [16] similar kind of result suggested that, the significant effect of seed germination were found in both salinity and variety of tomato. Among the treatment of NaCl, 38 tomato genotypes were germinated under moderate salinity level of 80mM. Highest percentages of germination were recorded in 66.66 (LE-1) and it was followed by EC-88783(62.22), EC-2495 and LE-1020 (57.77) were recorded in 80mM of NaCl concentration. Whereas, LE-1 genotype observed in different saline condition were recorded 91.11 (T_1), 86.66 (T_2), 68.66 (T_3), 62.22 (T_4), 66.66 (T_5), 71.11 (T_6) and 24.44 (T_7). The moderate NaCl concentrations were decrease in the percentage of seed germination around 12 genotypes of tomato. At higher salt concentration, only few genotypes are able to germinate with low percentage of seed germination were recorded. There are differences were found in capacity to germinate in a saline medium within tomato genotypes, which are evident even at moderate saline concentration suggested the possibility of selection within the cultivated varieties. Accordingly, seed germination percentage was high in low salt concentration and drastically declined when concentration increased. (Jogender Singh *et al*., 2012) [11]. The genotypes which are least affected may be potential source of salinity tolerance for tomato breeding (Cuartero and Munoz 1999; Hazer *et al.*, 2006; Amir *et al*., 2011; Hamed *et al*., 2011) [1, 5, 9-10]. The effect of external salinity on seed germination may be partially osmotic or ion toxicity, which can alter physiological processes such as enzyme activities (Croser *et al*. 2001; Essa and Al-Ani 2001) [3, 8].

Shoot length (cm)

Salinity slows tomato shoot growth. In the seedling stage of development, the saline seedlings are found to be less the shoot growth (Dumbroff and Cooper, 1974) [7]. Likewise, the ability to adapt to salinity seems to be higher in older than in younger plants. Because, tomato plants grown with salty water throughout their life show less decrease in shoots relatively (Cruz and Cuartero, 1990) [4]. In this present investigation result showed that, the *per se* performance of shoot length LE-14 was recorded 5.67 (T_1), 7.80 (T_2), 5.83 (T_3), 6.30 (T_4), 6.60 (T_5), 4.20 (T_6) and 0.0 (T_7). Among the 38genotypes of tomato, the highest shoot length was observed LE-1 (6.60) under moderate salinity level. It was followed by LE-1020 (5.67) and LE-1 (4.83) and the lowest shoot length was observed in Pharna Bhaskor (0.17) and P-1 (0.27). The combined effect of genotypes and salinity levels also significant variation was found in respect of shoot length. The highest shoots length (13.43) was recorded in the genotype LE-1 with 20mM salinity level and it was followed by LE-1020 (8.30-T_2) and IIVR-Pb-Khogri (8.27-T_1). Similar kind of results obtained by Nasrin and Abdul Mannan (2019) [16], which was statistically similar to low NaCl concentration and lowest shoot length were recorded in high level of $NacCl_2$. In the result showed that the lowest shoot length were recorded in Punjab Bagkoa (0.70) in 120mM level of salinity. This result was support with the salinisation causes a sudden fall in the leaf water potential, which is not immediately counterbalanced by the slower decrease of leaf osmotic potential. At relatively low salinities this can result in a transient reduction in turgor and leaf growth rate (Sacher and Staples, 1985; Yeo *et al*., 1991) [20, 30].

Root length (cm)

Salt stress leads to change in morphology and physiology of the roots that will in turn change water and ion uptake. The production of signals hormones that can communicate information to the shoot, the whole plant is then affected when roots are growing in a salty medium. Salinised tomato plants are able to produce osmotically active organic substances which help to alleviate the salinity-mediated osmotic stress. Proline accumulation in salt-stressed plants could be due to the low activity of the oxidising enzymes (Sudhakar *et al*., 1993) [27] and proline accumulation in leaves and, mainly, in roots is considered as a salt sensitive trait in tomato that may be used to select plants with different degrees of tolerance. In the present study, the root length in the genotype LE-1 was recorded 7.77 (T_1), 3.07 (T_2), 5.50 (T_3), 8.57 (T_4), 7.70 (T_5), 5.97 (T_6) and 5.90 (T_7). Among the 50 genotypes of tomato, the highest root length was observed LE-1 (7.70) under moderate salinity level. It was followed by LE-1020 (7.43) and IIVR-88783 (7.27) and the lowest root length was observed in P-1 (0.17) and Pharna Bhaskor (0.43). The combined effect of genotypes and salinity levels also significant variation was found in respect of root length. The highest root length (11.53) was recorded in the genotype Kasamer with 0mM salinity level and it was followed by LE-1 (11.50) and IIVR-DN-2016 (10.83-T_2). Tomato root cells can modulate the electrostatic properties of the plasma membrane in response to high external salt concentrations and this may have an effect upon salt uptake (Suhayda *et al*., 1990) [28]. Abrisqueta *et al*. (1991) reported by the various reasons are possible for the reduced root growth under salt stress: cell growth restriction, because of the low water potential of external medium, interference of the saline ions with the plant's nutrition or the toxicity of accumulated ions leading to cell death. Whereas, the lowest root length were recorded in Punjab Bagkoa (1.10) was observed in 120mM level of salinity. Salinity not only slows tomato root growth, but also increases the length of dead roots in those genotypes very sensitive to salt (Snapp and Shennan, 1992) [24].

Seedling length (cm)

In the *per se* performance of seedling length in the genotype LE-14 was recorded 15.13 (T_1), 16.73 (T_2), 14.73 (T_3), 13.00 (T_4), 13.56 (T_5), 7.70 (T_6) and 0.0 (T_7). Among the 50 genotypes of tomato, the highest seedling length was observed LE-14 (13.56) under moderate salinity level. It was followed by LE-1020 (13.10) and LE-1(12.53) and the lowest seedling length was observed in Pharna Bhaskor and LE-231 (0.66). The combined effect of genotypes and salinity levels also significant variation was found in respect of seedling length. The highest seedling length (18.96) was recorded in the genotype IIVR-Pb-Khogri with 0mM salinity level and it was followed by LE-12 (18.00) and Kasamer (17.66). Whereas, the lowest seedling length were recorded in Punjab

Bagkoa (1.80) was observed in 120mM level of salinity. Similar kind of result obtained by Salehi *et al.* (2013), Kazemi *et al*. (2014) [12], Nasrin and Abdul Mannan (2019) [16].

Vigour index

In the *per se* performance of vigour index in the genotype LE-1(G1) was recorded 1208.9 (T_1), 1424.6 (T_2), 670.0 (T_3), 715.8 (T_4), 806.2 (T_5), 673.1 (T_6) and 215.3 (T_7). Among the 50 genotypes of tomato, the highest vigour index was observed LE-1 (806.2) under moderate salinity level. It was followed by LE-1020 (761.7) and IIVR-88783 (671.5) and the lowest vigour index was observed in LE-231 (2.0), P1 (3.1) and Pharna Bhaskor (4.0). Nasrin and Abdul Mannan (2019) [16], reported that the highest seedling vigour index was found in lower salt concentration and the lowest seedling vigour index was observed in higher concentration of salt. The combined effect of genotypes and salinity levels also significant variation was found in respect of vigour index. The highest vigour index (1730.0) was recorded in the genotype IIVR-Pb-Khogri with 0mM salinity level and it was followed by LE-12 (1641.1) and Kasamer (1608.4). Similar kind of results obtained by Nasrin and Abdul Mannan (2019) [16], the highest seedling vigour index was recorded in lowest salinity level and lowest seedling vigour index which was recorded, when salinity increased. Whereas, the lowest vigour index were recorded in Punjab Bagkoa (17.3) was observed in 120mM level of salinity. The result in agreement with Kazemi *et al.* (2014) [12], Nasrin and Abdul Mannan (2019) [16].

Seedling fresh weight (g)

In the *per se* performance of seedling fresh weight in the genotype LE-14 (G11) was recorded 0.303 (T_1), 0.335 (T_2), 0.295 (T_3), 0.260 (T_4), 0.271 (T_5), 0.154 (T_6) and 0.000 (T_7). Among the 50 genotypes of tomato, the highest seedling fresh weight was observed LE-14 (0.271) under moderate salinity level. It was followed by LE-1020 (0.262) and LE-1 (0.251) and the lowest seedling fresh weight was observed in Pharna Bhaskor (0.012). The combined effect of genotypes and salinity levels also significant variation was found in respect of seedling fresh weight. The highest seedling fresh weight (0.379) was recorded in the genotype IIVR-Pb-Khogri with 0mM salinity level and it was followed by LE-12 (0.360) and Kasamer (0.353). Whereas, the lowest seedling fresh weight were recorded in Punjab Bagkoa (0.036) was observed in 120mM level of salinity. Nasrin and Abdul Mannan, (2019) [16] reported that the highest seedling fresh weight was found moderate saline condition and which was followed by lower concentration of salt and varietal behavior. The result consented with Parida and Das (2005) [18].

Seedling dry weight (g)

In the *per se* performance of seedling dry weight in the genotype LE-14 (G11) was recorded 0.045 (T_1), 0.056 (T_2), 049 (T_3), 0.043 (T_4), 0.045 (T_5), 0.026 (T_6) and 0.000 (T_7). Among the 50 genotypes of tomato, the highest seedling dry weight was observed LE-14 (0.045) under moderate salinity level. It was followed by LE-1020 (0.044) and LE-1 (0.042) and the lowest seedling dry weight was observed in Pharna Bhaskor (0.002). The combined effect of genotypes and salinity levels also significant variation was found in respect of seedling dry weight. The highest seedling dry weight (0.057) was recorded in the genotype IIVR-Pb-Khogri with 0mM salinity level and it was followed by LE-1 (0.056), LE-12 (0.54) and Kasamer (0.053). Whereas, the lowest seedling dry weight were recorded in Punjab Bagkoa (0.006) was observed in 120mM level of salinity. In the present results agree with Nasrin and Abdul Mannan (2019) [16], reported that the highest seedling dry weight was found moderate saline condition and which was followed by lower concentration of salt.

Fresh seedling tolerance index

A significant difference was observed among the genotypes. The STI was based on the final germination percentage reflecting the effect of salt stress from the beginning to the end of the experiment. In the present investigation result showed that, the *per se* performance of fresh seedling tolerance index in the genotype IIVR-88783 was recorded 0.0 (T_1), 108.3 (T_2), 93.4 (T_3), 83.6 (T_4), 94.3 (T_5), 24.5 (T_6) and 0.000 (T_7). Among the 38 genotypes of tomato, the highest fresh seedling tolerance index was observed IIVR-88783 (94.3) under moderate salinity level. It was followed by LE-1 (92.5) and LE-104 (92.3) and the lowest fresh seedling tolerance index was observed in LE-231 (4.8). The combined effect of genotypes and salinity levels also significant variation was found in the respect of fresh seedling tolerance index. The highest fresh seedling tolerance index (234.6) was recorded in the genotype Kasi with 60mM salinity level and it was followed by 226.2 (20mM), 165.5 (40mM). Whereas, the lowest fresh seedling tolerance index were recorded in Punjab Bagkoa (13.2) was observed in 120mM level of salinity.

Dry seedling tolerance index

In the *per se* performance of dry seedling tolerance index in the genotype IIVR-88783 was recorded 0.0 (T_1), 120.3 (T_2), 103.8 (T_3), 92.93 (T_4), 104.75 (T_5), 27.27 (T_6) and 0.000 (T_7). Among the 50 genotypes of tomato, the highest dry seedling tolerance index was observed IIVR-88783 (104.75) under moderate salinity level. It was followed by LE-104 (102.53) and H-24 (101.64) and the lowest dry seedling tolerance index was observed in LE-231 (5.28). The combined effect of genotypes and salinity levels also significant variation was found in the respect of dry seedling tolerance index. The highest dry seedling tolerance index (251.3) was recorded in the genotype Kasi with 20mM salinity level and it was followed by 183.9 (40mM), 260.67 (60mM). Whereas, the lowest dry seedling tolerance index were recorded in Punjab Bagkoa (14.63) was observed in 120mM level of salinity. The response of plants to salt stress is a complex phenomenon that involves biochemical and physiological processes as well as morphological and developmental changes (Khan *et al*., 2003; Munns and James 2003) [13, 15]. Difference among species and cultivars for salinity tolerance may depend on their differences in salinity tolerance mechanism. Exploitation of these useful genetic variations in salinity tolerance particularly of crop plants is an economical approach for proper utilization of salt- affected agricultural lands (Perviz *et al*., 2002) [19]. Thus, more research for salt tolerance in these cultivars would involve screening a larger range of germplasm.

Table 1: Effect of salinity level for 80mM to influence the germination and seedling characters of tomato genotypes.

Tomato genotypes	Seed germination %	Shoot length	Root length	Seedling length	Vigour index	Fresh weight	Dry weight	Fresh seedling tolerance index	Dry seedling tolerance index
LE-1	66.66	4.83	7.70	9.73	806.2	0.251	0.042	92.5	86.47
Angarlata	31.11	2.93	2.37	8.80	162.9	0.106	0.018	46.3	51.45
EC-163606	6.66	1.80	3.70	13.10	36.9	0.110	0.018	40.0	44.44
Arka Abhay	11.11	3.50	2.63	0.00	67.3	0.123	0.020	70.6	78.43
EC-164863	4.44	1.73	2.77	13.57	30.0	0.090	0.015	78.9	87.72
LCR-2	11.11	1.23	1.93	6.00	21.1	0.063	0.011	48.7	54.13
P-1	4.44	0.27	0.17	7.97	3.1	0.009	0.001	5.9	6.59
Kashi	0.00	0.00	0.00	6.93	0.0	0.000	0.000	0.0	0.00
CLNR-2123	15.55	4.77	4.97	12.53	148.6	0.195	0.032	86.5	96.12
IIVR-DN-2016	6.66	3.27	5.53	3.40	56.9	0.176	0.029	80.4	89.38
LE-14	46.66	6.60	6.97	9.90	645.1	0.271	0.045	91.3	101.46
LE-1020	57.77	5.67	7.43	5.90	761.7	0.262	0.044	84.5	93.88
LE-411	51.11	4.33	6.50	0.00	554.4	0.217	0.036	70.2	77.97
IIVR-1740047	0.00	0.00	0.00	1.17	0.0	0.000	0.000	0.0	0.00
Swarna	6.66	1.77	3.40	8.90	34.7	0.103	0.017	62.4	69.35
H-24	26.66	3.77	5.80	7.97	250.6	0.191	0.032	91.5	101.64
LE-116	15.56	1.17	2.23	0.60	90.7	0.068	0.011	39.5	43.93
EC-63003	2.22	0.33	0.83	5.17	7.8	0.023	0.004	10.2	11.37
Pharna Bhaskor	2.22	0.17	0.43	5.17	4.0	0.012	0.002	5.8	6.47
F-7-1	0.00	0.00	0.00	5.30	0.0	0.000	0.000	0.0	0.00
IIVR-88783	62.22	3.50	7.27	10.77	671.5	0.215	0.036	94.3	104.75
LE-104	37.77	3.10	6.13	5.50	344.6	0.185	0.031	92.3	102.53
Punjab Bas	11.11	1.77	3.40	9.57	68.9	0.103	0.017	58.1	64.56
IIVR-EC-2798	28.89	2.77	6.13	3.70	260.4	0.178	0.030	75.1	83.45
PKM-1	8.88	0.50	0.70	10.83	8.0	0.024	0.004	8.7	9.66
VGR-89	11.11	1.73	2.30	5.93	53.8	0.081	0.013	44.3	49.18
EC-326146	20.00	3.00	3.07	1.20	119.8	0.121	0.020	49.2	54.72
Pb-Rathak	44.44	3.03	4.93	6.13	351.8	0.159	0.027	52.8	58.61
Azota-1	13.33	1.57	2.13	7.73	61.5	0.074	0.012	29.4	32.72
EC-164838	0.00	3.77	4.20	3.83	0.0	0.159	0.027	52.9	58.83
LE-828	0.00	0.00	0.00	6.07	0.0	0.000	0.000	0.0	0.00
LE-90	0.00	0.00	0.00	0.00	0.0	0.000	0.000	0.0	0.00
IIVR-Pb-Khogri	35.55	3.13	4.60	2.80	272.2	0.155	0.026	40.7	45.21
EC-164677	0.00	2.50	3.43	1.63	0.0	0.119	0.020	55.8	61.94
IIVR-EC-2495	57.77	4.00	5.90	4.03	577.7	0.198	0.033	68.0	75.60
Punjab Bagkoa	33.33	3.20	3.73	1.50	231.3	0.139	0.023	51.8	57.53
Pusatha-2	15.55	2.07	3.43	4.50	89.5	0.110	0.018	38.1	42.33
CH-155	0.00	0.00	0.00	0.00	0.0	0.000	0.000	0.0	0.00
LE-15	0.00	0.00	0.00	0.67	0.0	0.000	0.000	0.0	0.00
LE-470	0.00	0.00	0.00	5.50	0.0	0.000	0.000	0.0	0.00
LE-231	2.22	0.67	0.00	0.00	2.0	0.013	0.002	4.8	5.28
LE-88	0.00	0.00	0.00	9.23	0.0	0.000	0.000	0.0	0.00
IIVR-EC-163894	6.66	0.60	0.90	1.13	8.4	0.030	0.005	15.9	17.65
LE-12	17.78	1.67	2.17	3.17	58.0	0.077	0.013	21.3	23.71
EC-165690	4.44	0.53	1.10	0.00	8.9	0.033	0.005	11.4	12.69
Kasamar	4.44	1.77	4.13	0.43	38.2	0.118	0.020	34.0	37.76
LE-355	4.44	1.03	1.77	0.00	17.8	0.056	0.009	21.4	23.74
LE-70	4.44	1.97	4.03	0.00	40.9	0.120	0.020	40.9	45.41
LE-20	0.00	0.00	0.00	0.00	0.0	0.000	0.000	0.0	0.00
EC-567346	6.66	0.37	0.77	0.00	15.1	0.023	0.004	8.2	9.06
Mean	15.95	1.93	2.83	4.76	139.6	0.095	0.016	39.5	43.56
SEd	5.61	0.75	1.35	2.04	60.0	0.041	0.007	24.1	27.33
CD (0.05)	11.14	1.49	2.68	4.06	119.0	0.081	0.014	47.8	54.23

Summary

In the laboratory experimental trail of the tomato cultivars would be important phenomena for selecting the genotypes for validating the performance under saline condition. The effect of different NaCl concentration on germination and seedling growth of 50 genotypes of tomato were tested in the roll towel method. In this study concluded that, significant differences which were observed in seed germination, seedling growth parameters between the genotypes under saline condition. In the result of the present study showed that, 38 tomato genotypes were germinated under moderate salinity level of 80mM. The highest seed germination percentage (66.66), shoot length (6.60) and root length (7.70) were observed in LE-1respectively. Whereas, LE-14 observed in highest seedling length (13.56), seedling fresh weight (0.247), seedling dry weight (0.04) respectively. Fresh seedling tolerant index were noticed in IIVR-88783 (94.3) and dry seedling tolerant index (251.3) in Khasi genotype of tomato. The lowest seed germination and seedling parameters were recorded Pharna Baskar under moderate saline condition. The seven level of salinity treated (0mM to 80mM) with tomato genotypes, seed germination, seedling parameters well in moderate saline level (80mM) and least performance were observed in 100m and 120mM respectively.

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