EFFECTS OF NaCl ON DIFFERENT YIELD COMPONENTS OF TOMATO (*Lycopersicon esculentum* Mill)

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In order to study whether salt tolerance at the initial growth stage is conferred at the adult stage and to evaluate the estimates of genetic variability parameters, heritability and genetic advance, three tolerant (CLN2498A, BL1176 and CLN1621L) and two non-tolerant (17902 and LO2875) tomato genotypes, selected at the initial growth stage were tested for both absolute and relative values of growth at three levels of NaCl (control, 10dS m^{-1} and 15dS m^{-1}) for various flowering and maturity parameters. Significant differences were found for all the traits such as plant height, number of trusses/plant, number of flowers/truss, fruit length, fruit width, average fruit weight, Na^+ concentration, K^+ concentration and K^+/Na^+ ratio. It was observed that salinity caused reduction in all the yield components of tomato genotypes but least reduction was noted in CLN2498A, BL1176 and CLN1621L.High heritability estimates for plant height and K^+ concentration coupled with high genetic advance in both low (10dS m^{-1}) and high (15dS m^{-1}) salinities suggested a potential for genetic improvement through breeding and selection.
Keywords: Salinity tolerance; tomato genotypes; heritability, genetic advance

INTRODUCTION

Salt stress is a major challenge to plants. It limits agriculture all over the world, particularly on irrigated farmlands (Rausch, 1996). As more land becomes salinized by poor irrigation practices, the impact of salinity is becoming more important (Winicov, 1998). Plants in natural environments are being exposed to increasing amounts of salinity. One-third of the land being irrigated worldwide is affected by salinity, but salinity also occurs in non-irrigated land (Allen *et al*., 1994). In fact, no continent is free from salt affected soils. The term salt-affected refers to soils that are saline or sodic, and these cover over 400 mha, which is 6% of the world land area. Out of current 230 mha of irrigated land, 45 mha are salt-affected (19.5%), and of the 1,500 m ha under dry land agriculture, 32 m ha (2.1%) are salt- affected to varying degrees (Munns, 2002).

The problem of salinity can be tackled by different techniques. Rehabilitation of the salt-affected wasteland can be accomplished by adopting reclamation measures involving physical, chemical and hydrological approaches. Since, many of these soils are beyond the reach of conventional reclamation techniques, either for economic reason or for lack of fresh water. A major possibility, which appears to be more feasible, is the development of crop cultivars suitable for the areas affected by salinity, called “biological/genetic approach.” This approach is cheaper, and has been emphasized by many workers (Qureshi *et al*., 1990; Hollington, 1998). Saline agriculture is another concept of generating income by using saline lands without spending huge amount of funds on drainage and reclamation work. This approach had been demonstrated successfully by planting economically important salt tolerant trees and shrubs, e.g. Atriplex and Eucalyptus on-farm trials in areas affected by salinity (Qureshi, 1993). This suggested that improvement in salt tolerance in different plant species would be possible through selection and breeding.

The success of developing salt tolerant plant material, through selection and genetic modification, depends on the existence of heritable variation within the crop species in response to salt stress. There is ample information reported on salt tolerance which reveals that variability in salinity tolerance does exist both between and within plant species e.g. tomato (Hassan *et al*., 1999; Shaaban *et al*., 2004), wheat (Sarwar *et al*., 2003; Ali *et.al,* 2007), rice (Alam *et al*., 2004; Gain *et al*., 2004) and other crop plants.

In Pakistan tomato is cultivatd on an area of 2.4740 thousand hectare with total production of 28.2482 thousand tones (Agricultural statistics of Pakistan, 2004-05). According to a survey report on the kitchen crops, the annual per capita consumption of tomato is 1.88 kg per head and has been estimated to reach more than 2.89 kg per head for about 188.5 million population of the Pakistan by the year 2010. Approximate current seed requirement of tomato is 2.8 tones per annum and will be more than 14 tones per annum by 2010 (Survey report, 1997).

Keeping in view the increasing consumption, there is need to utilize huge acreage of wastelands for agricultural purposes, and certainly, cultivation of crops in the areas affected by salinity would contribute towards increasing tomato production. Therefore, the present studies were undertaken in order to study the genetic potential for improving salinity tolerance, following conventional breeding approach.

MATERIALS AND METHODS

The five accessions (three salt tolerant, BL1176 CLN2498A and CLN1621L and two salt sensitive, 17902 and LO2875) were used in this study. The experiment was conducted in three soil beds with size of 2100 x 105 x 25 cm. the salinity was developed by adding NaCl salt randomly in the beds to get the required salinity levels of 10dSm^{-1} , 15dSm^{-1} and control. Each of the three beds was equally divided in three compartments, which represented three replications of each treatment. The 10 seeds of each accession were space-planted in each of three replication using completely randomized design. All other agronomic and cultural practices were kept uniform to reduce the experimental error. The data were collected at appropriate time for the following plant characters.

Plant height (cm)

Plant height of six plants in each replication was measured (cm) from the ground level to the apex.

Number of trusses per plant

Number of trusses per plant was counted for six plants in each replication and their average value was used for further analysis.

Number of flowers per truss

Three trusses on a plant were selected at random and number of flowers per truss was counted. Averages of these three trusses were taken as an individual entry of the plant. Data for six plants in each replication were taken and average value was used for the analysis.

Fruit length (cm)

A sample of five tomato fruits were taken at random from each replication and their length (cm) was recorded with the help of vernier caliper. Average value of these five fruits was used for further analysis.

Fruit width (cm)

A sample of five tomato fruits were taken at random from each replication and their width (cm) was recorded with the help of vernier caliper. Average value of these five fruits was used for statistical analysis.

Average fruit weight (g)

Five randomly taken fruits from each replication were weighed on the electrical balance and fruit weight (g) was recorded. Average value of these five fruits was used for further analysis.

Determination of Na^+ and K^+ concentration

In order to study the concentration of Na^+ and K^+ in fully expanded young leaves of each genotype grown under stress and non-stress conditions were taken. These samples were stored for one week in deep freezer. The cell sap was extracted using the standard technique of centrifugation (Gorham *et al.*, 1984). The cell sap was diluted by adding de-ionized water. The concentrations of Na^+ and K^+ ions in the samples were measured with the help of flame photometer. Contents of potassium in relation to sodium (K^+/Na^+) were also computed using data of Na^+ and K^+ ions.

Statistical analysis

The data regarding all the traits both for absolute and relative values were analyzed using analysis of variance technique (Steel *et al*, 1996) in order to see the significance of genotypic responses to salinity. Heritability in broad sense was estimated according to the technique given by Burton and Vane (1953). Genetic advance was calculated at 10% selection intensity using formula given by Poehlman and Sleeper (1995).

RESULTS

The mean values of plant height, number of trusses per plant, number of flowers per truss, fruit length, fruit width, average fruit weight, Na^+ concentration, K^+ concentration and K^+/Na^+ ratio of five genotypes (three tolerant and two non-tolerant) in control and two NaCl levels of 10 and 15 dS m^{-1}, are given in Table-2. The results of analyses of variance for absolute salt tolerance showed significant genotypic differences at $P \leq 0.01$ for all the traits studied (Table 1). Differences between the three NaCl concentrations were also significant at $P \leq 0.01$. The Genotype × Salinity interaction terms were significant at $P \leq 0.01$ for all the traits except number of flowers per truss revealing that genotypes responded differently to increasing salinity levels in the growing medium except number of flowers per truss.
The mean values of salt tolerance (Table. 2) showed that plant height of three tolerant genotypes measured in control differed from non-tolerant genotypes. It was maximum in CLN2498A (91.47 cm) followed by BL1176 (88.91) and CLN1621L (77.42 cm) By contrast, plant height of non-tolerant lines 17902 and LO2875 in control were shorter, measuring 66.15 and 69.07 respectively. When means of plant height measured in two salinities were compared, the non-tolerant genotypes 17902 and LO2875 were affected the most due to NaCl stress, having plant heights of 33.86 and 39.36 cm respectively. In contrast, mean

Table 1. Mean squares of absolute values for various physio-morphological traits of 5 accessions (3 tolerant and 2 non-tolerant) in control and two NaCl concentrations

SOV	DF	Plant height	No. of trusses/ plant	No. of flowers/ truss	Fruit length	Fruit width	Avg. fruit weight	Na^+	K^+	K^+/Na^+ ratio
Accessions (Acc.)	4	13329.6**	3911**	117.06**	9.62**	6.32**	2055.3**	999.88**	11704**	15.6**
Concentrations (Conc.)	2	20098.7**	7941.11*	228.62**	137.33**	110.99**	11562.9*	387245**	277758**	7600.9**
Acc. × Conc.	8	353.62**	94.57**	3.725ns	1.06**	0.46**	57.1**	433.08**	1318.4**	15.4**
Error	255	57.640	19.148	2.091	0.111	0.036	13.523	5.685	15.915	1.237

*, ** and NS indicates differences significant at p≤0.01, p≤0.05 and non-significant respectively.

Table 2. Mean squares of relative values for various physio-morphological traits of 5 accessions (3 tolerant and 2 non-tolerant) in control and 2 NaCl concentrations

SOV	df	Plant Height	No. of Trusses/ plant	No. of flowers/ truss	Fruit length	Fruit width	Avg. fruit weight	Na^+	K^+	K^+/Na^+ ratio
Accessions (Acc.)	4	6851.48**	8013.11**	7151.07**	4284.77**	2331.95**	4149.86**	1995149**	2657.10**	75.98**
Concentrations (Conc.)	2	13045.09**	11220.42**	14045.48**	4510.22**	10200.03**	7169.76**	17240085**	140607.7**	1756.81**
Acc. × Conc.	8	106.85ns	41.80ns	582.20ns	122.32ns	157.74**	117.08ns	106842.5**	483.12**	33.10**
Error	255	85.07	107.36	565.92	76.65	27.643	67.57	22263.83	6.17	0.30

plant height of tolerant genotypes CLN2498A, BL1176 and CLN1621L in two salinities were 73.57, 70.10 and 60.29 respectively.

Similar to plant height, number of trusses per plant of tolerant genotypes also differed in control solution as compared to non-tolerant genotypes. Number of trusses per plant was maximum in tolerant genotypes BL1176 (47.82 cm), CLN2498A (45.25 cm) and CLN1621L (39.33 cm). While in case of non-tolerant lines 17902 and LO2875, the number of trusses per plant was 32.5 and 36 respectively. When means in two salinities were compared, then again number of trusses per plant was affected the most due to NaCl stress.

Based upon number of flowers per truss the differences in the genotypes were also present. Table 2 shows that tolerant lines BL1176 (5.54), CLN2498A (4.10) and CLN1621L (3.17) produced highest number of flowers per truss whereas; non-tolerant genotypes 17902 and LO2875 produced the lowest number of flowers per truss 1.78 and 1.93 under the two salinities.

Data on fruit length fruit width and average fruit weight (Table 2) showed that decrease in tolerant genotypes were low as compared to non-tolerant genotypes for all these traits under increasing salt stress.

Regarding the leaf Na^+ concentration, it increased with an increase in external salt concentration in all genotypes. In control solution, the non-tolerant line LO2875 accumulated more Na^+ (8.22 mM) as compared to salt tolerant line CLN1621L (7.82 mM). While under two salt concentrations, the tolerant genotypes accumulated lower Na^+ in leaves as compared to non-tolerant genotypes.

Leaf K^+ was higher in the leaves of the salt tolerant lines than that in the non-tolerant lines at both salt concentrations and under the means of two salinity levels.

Addition of NaCl to the growth medium reduced significantly leaf K^+/Na^+ ratio in all five genotypes differing in salt tolerance. In general, salt tolerant genotypes had slightly higher leaf K^+/Na^+ ratios than the non-tolerant genotypes at both NaCl levels. The salt tolerant genotypes maintained K^+/Na^+ ratio greater than one at 10 dS m^{-1} external salt treatment, a ratio below which normal functioning of plants may be perturbed under saline conditions (Wyn Jones, 1981).

Comparison of salt tolerance of genotypes may be made as percentage of growth or yield in non-salinized control conditions, the relative yield (Maas, 1986). In order to compare responses to salinity, relative salt tolerance of three tolerant and two non-tolerant genotypes were calculated for two salinity levels i.e. 10 and 15 dS m^{-1}, and are given in Table-4. The relative salt tolerance based upon plant height, number of trusses per plant, number of flowers per truss. Fruit length, fruit width, average fruit weight, Na^+ concentration, K^+ concentration and K^+/Na^+ ratio were subjected to ordinary analysis of variance, and the mean squares are given in Table-2. The statistical differences between the five genotypes measured for the nine characters were highly significant at $P \leq 0.01$. Differences in two salinity levels were also significant at

Table 3. Absolute mean values of tolerant and non-tolerant genotypes for various traits

Genotypes	Plant height (cm)	No. of Trusses/ plant	Flowers/ Truss	Fruit length (cm)	Fruit width (cm)	Average fruit wt. (g)	K^+ conc. (mM)	Na^+ conc. (mM)	K^{+}/Na^{+} ratio
CLN2498A	91.47	45.25	6.3	4.54	4.26	47.92	147.65	8.57	17.41
CLN1621L	77.42	39.33	5.16	4.37	4.13	42.43	140.88	7.82	18.29
BL1176	88.91	47.82	8.03	4.43	4.21	46.81	144.31	10.15	14.25
17902	66.15	32.5	4.9	4.12	3.8	37.04	121.67	7.16	17.16
LO2875	69.07	36	5.04	4.23	3.97	39.71	129.24	8.22	15.95
10dS m^{-1}									
CLN2498A	79.95	36.92	4.97	3.12	2.95	34.27	126.52	77.54	1.63
CLN1621L	65.33	29.17	3.64	2.58	2.78	29.07	113.76	82.43	1.38
BL1176	79.21	39.68	6.54	2.96	2.62	32.4	129.47	88.73	1.46
17902	40.13	15.92	2.03	1.74	2.04	16.69	76.38	97.48	0.78
LO2875	45.92	18.89	2.21	1.85	2.23	19.75	84.19	93.64	0.90
15dS m^{-1}									
CLN2498A	67.19	29.14	3.24	2.46	2.35	27.43	35.93	134.41	0.27
CLN1621L	55.26	23.11	2.71	2.24	2.13	21.73	32.8	135.75	0.27
BL1176	61	30.75	4.55	2.37	2.29	26.52	37.22	132.48	0.27
17902	27.6	11.67	1.54	1.44	1.31	26.52	17.29	146.33	0.12
LO2875	32.81	13.71	1.65	1.56	1.52	15.43	21.4	143.52	0.15

Table 4. Relative mean values of tolerant and non-tolerant genotypes for various traits

Genotypes	Plant height	No. of Trusses/ plant	Flowers/ Truss	Fruit length	Fruit width	Average fruit wt	K^+ conc.	Na^+ conc.	K^{+}/Na^{+} ratio
CLN2498A	87.0	81.2	77.3	68.7	69.4	71.4	85.6	914.9	9.4
CLN1621L	84.2	73.7	70.9	59.1	67.3	68.5	80.7	1069.3	7.6
BL1176	89.0	83.1	80.4	66.7	62.6	69.4	89.8	1069.3	10.2
17902	60.6	49.0	42.8	42.3	53.8	45.5	62.7	1373.4	4.6
LO2875	66.3	53.5	46.4	43.7	56.1	49.9	65.1	1153.8	5.7
15dS m^{-1}									
CLN2498A	73.3	64.1	49.5	54.1	55.2	57.3	24.3	1584.0	1.5
CLN1621L	71.3	58.6	54.5	51.2	51.5	51.0	23.2	1760.3	1.5
BL1176	68.5	64.5	56.6	53.4	54.3	56.4	25.7	1307.8	1.9
17902	41.7	36.0	33.8	34.9	34.7	37.8	14.1	2062.1	0.6
LO2875	47.4	38.4	35.1	36.8	38.2	39.0	17.1	2062.1	0.9

$P \leq 0.01$. The Genotype × Salinity interaction terms were significant at $P \geq 0.05$ for fruit width, Na^+ concentration, K^+concentration and K^+/Na^+ ratio suggesting that the five genotypes differed significantly under 10 and 15 dSm^{-1}.

The relative values of salt tolerance (Table-4) showed that, plant height of three tolerant genotypes measured in 10dSm^{-1} differed from non-tolerant genotypes. It was maximum in BL1176 (89 %) followed by CLN2498A (87%) and CLN1621L (84.2 %) By contrast, plant height of non-tolerant lines 17902 and LO2875 in control were shorter, measuring 60.6% and 66.3% respectively.

Similar to relative plant height, for relative number of trusses per plant all five genotypes also responded differently in 10dS m^{-1} and 15dS m^{-1} solutions. Relative value of number of trusses per plant in 15dS m^{-1} salinity level was recorded maximum in tolerant genotypes BL1176 (64.5%), CLN2498A (64.1%) and CLN1621L (58.6%). While in case of non-tolerant lines 17902 and LO2875, the relative number of trusses per plant was 38.4% and 36% respectively.

Based on relative number of flowers per truss, the differences in the genotypes were also apparent. Table-4 shows that highest relative number of flowers per truss was produced by tolerant lines BL1176

(69.05%), CLN2498A (65.15%) and CLN1621L (61.53%) whereas, non-tolerant genotypes 17902 and LO2875 produced the lowest relative number of flowers per truss 36.42% and 38.29% under the two salinities.

Relative values of fruit length, fruit width and average fruit weight showed that percent decrease in tolerant genotypes were low as compared to non-tolerant genotypes for all these four traits under two salinity levels.

Regarding the relative value of leaf Na^+ concentration, it increased with an increase in external salt concentration in all genotypes. In 10dS m^{-1} solution, the non-tolerant line 17902 accumulated more Na^+ as compared to all salt tolerant salt tolerant lines. While under two salt concentrations, the tolerant genotypes accumulated lower Na^+ in leaves as compared to non-tolerant genotypes. Relative value of K^+ concentration in leaf was higher in the leaves of the salt tolerant lines than that in the non-tolerant lines at both salt concentrations. Additional concentration of NaCl to the growth medium reduced relative leaf K^+/Na^+ ratio in all five genotypes differing in salt tolerance.

In general, salt tolerant genotypes had slightly higher leaf K^+/Na^+ ratios than the non-tolerant genotypes at both NaCl levels. The salt tolerant genotypes maintained K^+/Na^+ ratio greater than one at 10dS m^{-1} and 15dS m^{-1} external salt treatments, a ratio below which normal functioning of plants may be perturbed under saline conditions (Wyn Jones, 1981).

Estimation of Heritability and Genetic Advance

Absolute values of salt tolerance were used for the estimation of broad sense heritability and genetic advance in the plant characters measured in non-salinized and salinized conditions, and are given in Table 3. For plant height, estimates of h^2_B are high in control (0.85), 10 dS m^{-1} (0.82) and 15 dS m^{-1} (0.79). Broad sense heritability of number of trusses per plant in control and two salinity levels are 0.73, 0.85 and 0.74 respectively. For number of flowers per truss the estimations of h^2_B were moderate in control (0.52) and 10 dS m^{-1} (0.57) but low in 15 dS m^{-1} (0.39). For fruit length, broad sense heritability was moderate in control (0.43) and 15 dSm^{-1} (0.59) but high in 10 dSm^{-1} (0.72). Moderate to high estimates of heritabilities ranging from 0.47-0.84 were calculated for fruit width in tomato. Broad sense heritability of average fruit weight ranged from 0.62-0.80 in the three NaCl levels. The uptakes of Na^+ and K^+ showed high heritabilities in control and stress environments ranging from 0.64-0.75 and 0.86-0.97 respectively. In contrast K^+/Na^+ ratio indicated low to high heritabilities ranging from 0.38-0.98 in three NaCl concentrations.

Based upon the estimates of H^2, genetic advances were highest in plant height (18.39), K^+ concentration (17.75) number of trusses per plant (9.47), average fruit weight (6.28) and fruit length (1.85) in non-stressed conditions. In low salinity, highest genetic advance was expected in K^+ concentration, plant height (29.21), number of trusses per plant (17.09) and Na^+ concentration (13.71) whilst in 15dSm^{-1}, it was 27.33 and 14.68 in plant height and K^+ concentration respectively.

Estimates of broad sense heritability and genetic advances using indices of salt tolerance are given in Table-6. Under low salinity stress (10dSm^{-1}), the estimates of H^2 for plant height, number of trusses per plant, number of flowers per truss, fruit length, fruit width, average fruit weight, Na^+ concentration, K^+ concentration and K^+/Na^+ ratio were low to high being 0.67, 0.76, 0.34, 0.66, 0.56, 0.66, 0.75, 0.96 and 0.90 respectively. Based upon the estimates of H^2 of all the characters in 10dS m^{-1}, the amount of expected advance varied, it is minimum for K^+/Na^+ ratio (4.02) and high for number of trusses per plant (23.96), K^+ concentration (21.04) and plant height (18.46). It ranged from 17.21-17.55 in average fruit weight, number of flowers per truss and fruit length. For fruit width and Na^+ concentration, it was 8.79 and 301.4 respectively. Under 15dS m^{-1}, the estimates of H^2 appeared to be appreciable for all the traits, ranging from 0.53-0.91 except the trait, number of trusses per plant, which showed low heritability (0.12), and accordingly the amount of genetic advance to be expected ranged from 0.84- 403.62.

DISCUSSION

For an effective selection, it is crucial to determine the salt tolerance at different growth stages of crop species, because it has been observed in a number of plant species that selection at initial growth stage did not produce salt tolerant adults, e.g., Wheat (Kingsbury and Epstein, 1984; Shannon, 1984) and Sugarbeet (Bernstein and Hayward, 1958). In contrast, in some other crops, consistency in salt tolerance was maintained throughout the life cycle, e.g., alfalfa (Noble *et al*., 1984; Ashraf *et al.,* 1987 Al-Khatib *et al*., 1993), seven grass species (Ashraf *et al.,* 1986), mungbean (Ashraf and Rasool, 1988). It has been emphasized that a species or a cultivar maintaining degree of salt tolerance consistently at all developmental stages would be of considerable importance in terms of selection and breeding than that possessing varying degree of salt tolerance (Blumm, 1985; Ashraf, 1994). However, in order to confirm whether salt tolerance at the initial growth stages is conferred at the adult stage, five cultivars/lines differing in salt tolerance were tested at the adult stage. Three salt tolerant CLN2498A,

Table 5. Estimates of broad sense heritability and genetic advance of absolute values for various Physio-morphological taits in control and two NaCl concentrations

Traits	Broad sense Heritability			Genetic Advance %		
	Control	10dS m^{-1}	15dS m^{-1}	Control	10dS m^{-1}	15dS m^{-1}
Plant height	0.85	0.82	0.79	18.39	29.21	27.33
No of trusses/plant	0.73	0.85	0.74	9.47	17.09	13.11
No of flowers/truss	0.52	0.57	0.39	1.64	2.49	1.31
Fruit length	0.43	0.72	0.59	1.85	0.93	0.63
Fruit width	0.47	0.80	0.84	0.22	0.59	0.75
Avg. fruit weight	0.62	0.80	0.73	6.28	12.22	9.21
Na^+	0.64	0.93	0.75	1.54	13.71	9.17
K^+	0.86	0.97	0.86	17.75	42.22	14.68
K^+/Na^+ ratio	0.38	0.98	0.89	1.61	0.64	0.12

Table 6. Estimates of broad sense heritability and genetic advance of relative values for various Physio-morphological traits in control and two NaCl concentrations

Traits	Broad sense Heritability		Genetic Advance %	
	10 dS m^{-1}	15 dS m^{-1}	10 dS m^{-1}	15 dS m^{-1}
Plant height	0.67	0.70	18.46	21.45
No of trusses/plant	0.76	0.58	23.96	18.41
No of flowers/truss	0.34	0.12	17.27	5.66
Fruit length	0.66	0.53	17.55	11.74
Fruit width	0.56	0.81	8.79	15.07
Avg. fruit weight	0.66	0.58	17.21	12.28
Na^+	0.75	0.71	301.04	403.62
K^+	0.96	0.78	21.04	7.73
K^+/Na^+ ratio	0.90	0.91	4.02	0.84

BL1176 and CLN1621L and two salt sensitive 17902 and LO2875, selected at the initial growth stages, maintained their specific tolerance in terms of yield related characteristics. The salt tolerant lines showed more plant height, number of trusses per plant, number of flowers per truss as compared to salt sensitive genotypes. Data on fruit length, fruit width and average fruit weight showed that decrease in tolerant genotypes were low as compared to non-tolerant genotypes. Regarding the leaf Na^+ concentration, salt tolerant genotypes accumulated more Na^+ as compared to non-tolerant genotypes. In case of leaf K^+ and K^+ /Na+ ratio, it was maximum in salt tolerant genotypes.

Heritability estimates are used for predicting the progress from selection. Broad sense heritability indicates the ratio of total genetic variance to the total phenotypic variance whereas, the narrow sense heritability is the ratio of additive genetic variance to the phenotypic variance. Higher estimates of genetic advance indicates that the character is governed by additive genes and genetic variance is fixable and selection would be useful for the improvements of traits (Singh and Narayanan, 2000). It is obvious from the Table 3 that all the traits showed moderate to high values for broad sense heritability; it indicated that the characters were less ifluenced by the environmental factors.

CONCLUSION

Summing up the results of the study, it is possible to conclude that salt tolerance in tomato does not vary at different stages of life cycle, so selection at the early stages may provide genotypes tolerant as adults and high heritability estimates for plant height, number of trusses per plant, average fruit weight and K^+ concentration in coupled with high genetic advance in both low (10dS m^{-1}) and high (15dS m^{-1}) salinities suggested a potential for genetic improvement of tomato through breeding and selection.

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