Response of tomato genotypes against salinity stress at germination and seedling stage.

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Abstract: Salt stress is one of the major abiotic constraints that causes the reduction in crops growth in the arid and semi-arid region of the world. The presence of high level of salts in the irrigation water and soil put harmful impacts at germination and growth stages in tomato because of ion toxicity and osmotic stress. In most genotypes reduction in germination and growth occurs in the presence of salt stress however some genotypes perform well in this condition. The aim of the study was to evaluate the germination capabilities and growth of seedling in 30 different tomato genotypes under saline conditions. The research was conducted under factorial design in complete randomized design with three replications. Data related to germination rate, germination percentage, shoot length, root length, shoot fresh weight and root fresh weight under salt stress were taken for the comparison of 30 different tomato genotypes. A significant interaction was showed between genotype x environment for all traits. A significant reduction in germination percentage occurred with the increase in salt stress. At germination stage, performance of two genotypes (Naqeeb and Marmande) were well. Reduction in the growth of seedlings was observed because of extra salt stress. A significant difference was observed in LA2661, SP-6 and SP-5 for the length of root and in Nagina for the length of shoot under different saline conditions. Tomato shoots looked more sensitive in comparison with tomato roots. It is proposed that elongation of roots and shoots may be used for the selection of tolerant cultivars against saltiness.

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1. Introduction:

Each plant displays to different kinds of environmental stresses and they try to tolerate them for survival. Generally, these stresses are of two types; biotic and abiotic stresses. These stresses caused by living organisms are known as biotic stresses while other stresses due to increase, decrease or influenced by non-living components of the ecosystem like temperature, drought stress, water logging, salinity, nutrient deficient, gaseous pollution, metal toxicity, and UV radiations are known as abiotic stresses. Drought and salinity are two main causes of crop losses throughout the world. Soil salinity level reduced the productivity of many crops including vegetables (Jogendre et al., 2012). The scarcity of fresh water, high temperature and high evapotranspiration result in the loss of water with the accumulation of salts at exchangeable sites in soils. Among different abiotic stresses, salinity has become a major threat to confirm food security by affecting about one-third of the irrigated land on earth (Ali, 2014). The term salt affected soils refers to saline or sodic soils that comprise about 6% of total land. About 45 million hectares of irrigated areas and 32 million hectares of dry areas are salt affected (Munns, 2002). Salt stress affects many physiological and biochemical aspects of plant growth. Salt stress can lead to osmotic stress and ionic stress thus impairing the critical cellular functions. Osmotic stress results in reduced availability of water causing dehydration, stomatal closure, reduced CO2 supply, the slower rate of biochemical reactions are some of the factors that prevail during periods of dehydration. (Munn.s 2002; Kao et al, 2003; Sayed, 2003). Salinity affects some of the physiological mechanisms of plants such as increased respiration rate, changes in the plant growth, and changes in mineral distribution. Membrane instability and failure in the maintenance of turgor pressure (Closet et al. 1996; Hasegawa et al. 2000; Muranaka et al. 2002; Murphy & Durako 2003). Shoot growth is reduced by salinity due to the inhibitory effect of salt on cell division and cell enlargement in growing points. Early flowering reduces dry matter, leaf size and increases root/shoot (ratio) caused by salinity may be considered as possible ways of yield reduction in the plant under salt stress conditions

while most crop plants die (Maghsoudi & Maghsoudi, 2008).

In many crops, seed germination and early seedling growth are most sensitive stages towards environmental stresses (Jones, 1986). USDA report indicated that out of all vegetables, tomato (*Solanum lycopersicum*), is moderately sensitive to salinity. High salt concentration in the germination media (150 mM NaCl and 15 mM CaCl2) significantly delays onset as well as reduces the rate of germination (Jones, 1986; Foolad & Lin, 1997, 1998). Al-Harbi et al., (2008) reported the positive correlation between seedling and mature plant response towards salt stress. While the absence of a genetic relationship between germination and vegetative growth towards salt stress in tomato was found by Foolad & Lin (1997). The screening of tomato plants at seedling stage for salt tolerance may not be reliable to predict seedling as sensitive or tolerant although it is required to test them in all growth stages to know whether they have any genetic tolerance to the saline condition. Tolerance towards salt stress is critical during the life cycle of any species.

Plants adopt different mechanisms for salt tolerance which are either high-complexity or low-complexity mechanisms. Low-complexity mechanisms thought to involve in altering the many biochemical pathways. It is believed that for the preservation of complex processes, low-complexity mechanisms must induce coordinately (Bohnert et al., 1995). High-complexity mechanisms involve the protection of major processes like respiration and photosynthesis, along with this, preservation of important features such as, cell wall or cell wall-plasma membrane interactions, cytoskeleton (Botella et al., 1994) and chromatin structural changes like polyploidization, DNA methylation, DNA elimination or amplification of specific sequences (Walbot & Cullis, 1985. Although, many of these soils cannot be recovered due to economic reasons or scarcity of fresh water. So, conventional approaches and breeding of cultivars for saline soils are used to address the salinity problem. The only feasible possibility is the development of salinity tolerant cultivars (Hollington, 1998). Salt-tolerant cultivars may be developed through selection and breeding, but success depends on the variation present within crop species.

Genetic variations of tolerance to salt exist among available tomato germplasm. However, salinity tolerance breeding programs face restrictions by the complexity of the trait, insufficient physiological and genetic knowledge of tolerance-related traits, and deficiency of efficient selection domain. Most commercial cultivars of tomato are sensitive towards moderate salinity level up to 2.5 dSm-1, without significant reduction in yield. Optimizing saline condition in field and greenhouse would be temporary and expensive while selection and breeding for salt tolerance can be a wise solution to diminish salinity effects as well as improve yield efficiency. So, breeding for salt tolerant cultivars of tomato is required. Genetic characterization of useful germplasm is the first step toward releasing tolerant cultivars. This present study is devised to find the response of different tomato genotypes under salinity stress at germination and seedling stages. It has resulted that crops which show tolerance at seedling stage also show good salinity tolerance at adult stage (Akinci et al. 2004).

2. Materials and Methods:

The research was conducted in the glasshouse at the department of Plant Breeding and Genetics, University of Agriculture Faisalabad, Pakistan (31.4289° N, 73.0750° E). The minimum and maximum day time temperature range between 25- 32 ℃, everyday light period were 11 hours.

Table 1. Tomato genotypes tested at 0mM, 100mM, and 150mM NaCl

Sr. No	Genotypes	Sr. No	Genotypes
1	LA-3847	16	WAYA HEAD
2	LA-3310	17	NTH-242
3	DEBARO	18	SP-18
4	LA-2661	19	SP-17
5	MARION	20	SP-5
6	LA-3296	21	SP-11
7	MARMANDE	22	SP-13
8	NATACHA CHERRY	23	SP-20
9	NEPAL	24	SP-6
10	MONEY MAKER	25	SP-38
11	PAKIT	26	SP-58
12	NAQEEB	27	SP-3
13	RIO GRANDE	28	SP-10
14	ROMA	29	SP-4
15	NAGINA	30	SP-47

Out of 30 tomato genotypes, 17 genotypes were collected from Vegetable Research Institute Faisalabad and rest were collected from the department of PBG, University of Agriculture Faisalabad, Pakistan. To check the effect of salinity on germination, tomato seeds were first surface sterilized with 2% sodium hypochlorite for 15 minutes and rinsed with distilled water for three times. For germination, petri dishes with two layers of filter paper were used. In each petri dish, 10 seeds were placed. Petri dishes were placed in complete randomized design with three replications. Petri dishes were kept moistened with 0mM, 100mM, and 150mM NaCl concentration. Average temperature during the experiment was 25°C. At germination stages following two characters were studied.

GP = SNG/SNO × 100%

Where: GP is germination percentage, SNG is the number of germinated seeds, and SNO is the number of experimental seeds with viability (Close & Wilson, 2002).

2.1. Germination rate:

In order that from the third day to 10th once a 24hours counted germinated seeds and its rate was determined by Maguire equation (1962. M = n1/t1 + n2/t2 +… + n7/t7; where n1, n2… n7 are the number of germinated seeds at times t1, t2… t7 (in days). For screening of tomato genotypes against salinity stress at seedling stages plastic cups with (16 cm height × 16 cm top diameter × 11 cm bottom diameter) filled with fine sand were used for plant growth medium. Cups were arranged in complete randomized design (CRD). Before sowing of tomato seeds into plastic cups, seeds were surface sterilized with 2% sodium hypochlorite for 15 minutes then washed with distilled water for three times. Seeds were sown in plastic cups. 10 seeds/cup were sown in 6 replicates with 3 treatments as under.

T0= Control distilled water, T2= 100mM, T3= 150mM

Seeds were germinated after 7 days of sowing. After 10 days of germination, seedlings were thinned out to 2 seedlings per cup remained. Salt stress starts to apply 3 weeks after germination. Stress was applied for two weeks. At the end of the experiment cups were washed out in a tub filled with water to avoid the damage of roots. Then root length, shoot length, root fresh weight and shoot fresh weight were taken. For roots dry weight and shoots dry weight, roots and shoots were placed in the oven at 75°C for 24 hours.

3. Result and Discussion

Analysis of variance (Table 2) shows significant differences among treatments, genotype × environment interaction (GEI) for all traits under study while genotypes for germination rate only does not show significant difference. Mean values of thirty tomato genotypes for germination rate, germination percentage, root length, shoot length, fresh weight and shoot fresh weight under three different salinity levels are presented in (Table 3). Mean comparison showed that Nagina had the highest mean value for shoot length under T1 and SP-5 had highest value for root length and shoot fresh weight under T1. SP-10 had lowest mean value for root length under T2 and SP-20 had lowest mean value for shoot length under T3. Genotypes were not superior for all traits and also not poor for all traits showed by the genotypic mean performance which highlighted the use of interactive approach for genotypes performance under three saline conditions for thee specific trait. For interaction evaluation of genotypes under different saline conditions, we use AMMI biplot (for interactive evaluation of genotypes under saline environments).

Table 2. Mean square analysis of tomato genotypes under different salinity levels

SOV	Df	Gr %	Gr rate	Rt Wt	St Wt	Root length	Shoot length			
Salinity	2	1890.77**	109.80**	38.670**	166.2341**	1458.61**	1260.505**			
Genotypes	29	9.41519**	0.076343ns	0.569405*	0.907427*			33.01248*	3.17089*	14.55*
S x G	58	2.14201**	0.401852*	0.084976*	0.205435*					2.917792*
Residual	180	0.93703	0.16738	0.0345	0.037858	1.958056	0.804634			

Abbreviations: Gr%= Germination percentage, Gr rate= Germination rate, Rt Wt= Root Weight, St Wt= Shoot weight.

Distance from the origin (0, 0) in AMMI biplot showed the interaction of genotype x environments/environment over genotypes. AMMI biplot analysis for all three salinity levels (T1, T2, and T3) explained that PC1 and PC2 collectively had highest value for interaction (86%). AMMI biplot analysis for all the traits under studied against all salinity levels (T1, T2, and T3) revealed that F1 and F2 collectively had the highest value for interaction (75.42%, 94.90% and 95.98% for T1, T2 and T3 respectively.

The genotypes which are present near the origin reflected that these genotypes were not sensitive to environmental interaction. Interaction of environment and genotype can be determined by plotting project for genotype marker on environment vector. If genotype projection falls on environmental vector, then concerned genotype has positive interaction and Genotypes present on the opposite side of the environment vector showed negative interaction.

Genotypes Sp-5 and Sp-10 were present near origin in Fig.1, it means that these genotypes were

insensitive to salinity stress regarding germination percentage in control conditions.

Table 2. Mean values for studied traits of tomato genotypes under three different salinity treatments.

	Germination Rate			Germination %			Root Length			Shoot Length			Root Fresh Weight			Shoot Fresh weight		
Genotypes	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
Naqeeb	2.41	2	0.66	96.6	80	26.6	20.13	17.43	14.9	14.8	14.8	10.2	1.56	0.99	0.96	3.36	2.26	1.96
Marmande	2.41	0.91	0.5	96.6	76.66	20	21.1	19.1	17.43	14.62	13.4	10.5	1.53	1.01	1.03	3.53	2.14	1.76
LA-2661	2.41	1.83	0.41	96.6	73.33	16.6	20.5	19.53	16.46	14.56	12.5	10	1.6	1.03	0.9	3.4	2.17	1.55
SP-5	2.5	1.75	0.33	100	70	13.3	24.13	19.4	18.9	16.96	12.8	11	1.73	1.07	0.96	3.73	2.61	1.96
SP-6	2.33	1.91	0.25	93.3	76.66	10	24.63	19.4	16.96	16.9	12.5	11.1	1.63	1.41	0.86	3.63	2.19	1.92
Nagina	2.33	1.66	0.08	93.3	66.66	3.33	22.86	21	18	16.1	14.9	11.3	1.63	1.1	1.03	3.63	2.43	1.88
Rio Grande	2.41	1.41	0.00	96.6	56.66	0	22.86	13.43	11.93	14.43	8.43	6.3	1.5	0.3	0.17	1.5	1.8	0.67
LA-3296	2.33	1.08	0.00	93.3	43.33	0	19.7	12.63	11.46	13.4	8.4	7.1	1.36	0.19	0.07	3.36	1.45	0.57
Nepal	2.5	0.91	0.00	100	36.67	0	21.16	13	12.63	14.06	8.63	6.5	1.46	0.27	0.12	3.46	1.77	0.57
SP-11	2.33	1	0.00	93.3	40	0	20.23	14.4	11.53	15.9	9.2	8.1	1.36	0.29	0.07	3.36	1.67	0.46
Debaro	2.33	1	0.00	93.3	40	0	20.2	14.93	11.63	14.4	9.8	6.3	1.5	0.19	0.06	3.5	1.55	0.46
SP-58	2.25	1	0.00	90	40	0	19.23	15.2	11.9	15.2	10	6.2	1.5	0.22	0.1	3.53	1.63	0.47
SP-10	2.41	0.83	0.00	96.6	28.33	0	18.8	14.36	11.36	15.5	9.4	8.2	1.43	0.19	0.06	3.43	1.35	0.56
Marion	2.5	0.66	0.00	100	26.66	0	20.53	15.06	12.63	13	13.8	7.73	1.46	0.41	0.12	3.46	1.58	0.62
SP-18	2.41	0.75	0.00	96.6	30	0	18.8	13.06	11.4	14.8	8.06	5.9	1.33	0.18	0.05	3.33	1.68	0.46
Pakit	2.33	0.83	0.00	93.3	33.33	0	19.26	14.46	12.5	15.2	9.3	7.4	1.43	0.23	0.1	3.43	1.73	0.54
LA-3310	2.25	0.83	0.00	90	33.33	0	19.2	14.26	12.9	13.3	8.9	8.4	1.53	0.18	0.06	3.53	1.6	0.52
NTH-242	2.16	0.91	0.00	86.6	36.66	0	22.86	13.76	11.73	15.6	8.7	6.3	1.53	0.23	0.17	3.53	1.68	0.54
SP-47	2.33	0.75	0.00	93.3	30	0	17.8	12.4	11.9	16.3	7.7	6.9	1.06	0.33	0.14	3	1.28	0.26
LA-3847	2.25	0.75	0.00	90	30	0	20	13.73	11.66	15	8.5	6.2	1.46	0.2	0.06	3.46	1.7	0.56
Natcha Cherry	2.41	0.58	0.00	96.6	23.33	0	20.46	14.43	12.43	15.06	9	7.1	1.53	0.26	0.13	3.53	1.36	0.4
Money Maker	2.25	0.66	0.00	90	26.66	0	21.56	13.5	11.53	15.3	8.8	6.1	1.4	0.29	0.11	3.43	1.72	0.55
Roma	2.25	0.58	0.00	90	23.33	0	20.4	14.93	12.53	15.3	9.9	7.9	1.4	0.4	0.16	3.43	1.85	0.6
SP-20	2.25	0.58	0.00	90	23.33	0	17.26	14.56	12.03	16.5	10.5	9.4	1.3	0.22	0.7	3.3	1.7	0.57
SP-3	2.25	0.5	0.00	93.3	20	0	23.6	14.8	12.7	15.5	9.5	7.6	1.6	0.32	0.13	3.6	1.82	0.82
Waya Head	2.25	0.5	0.00	90	20	0	19.63	13.56	11.43	14.3	8.3	6.4	1.5	0.14	0.05	3.5	1.46	0.48
SP-17	2.25	0.5	0.00	90	20	0	21.2	14.1	12	15	9.3	6.3	1.5	0.3	0.1	3.5	1.8	0.3
SP-13	2.41	0.33	0.00	96.6	13.33	0	22.4	14.46	12.8	16.1	10.1	8.3	1.56	0.3	0.16	3.56	1.42	0.35
SP-38	2.16	0.33	0.00	86.6	13.33	0	20.4	13.1	11.93	15.4	10.4	8.2	1.36	0.29	0.09	3.36	1.55	0.52
SP-4	2.25	0.66	0.00	90	26.66	0	11.36	13.73	12.7	15.9	10	7.7	1.43	0.28	0.11	3.26	1.35	0.3
St. Error	0.13	0.22	0.05	5.57	8.9	2.19	1.22	0.78	0.56	0.67	0.52	0.25	0.17	0.04	0.02	0.17	0.08	0.03

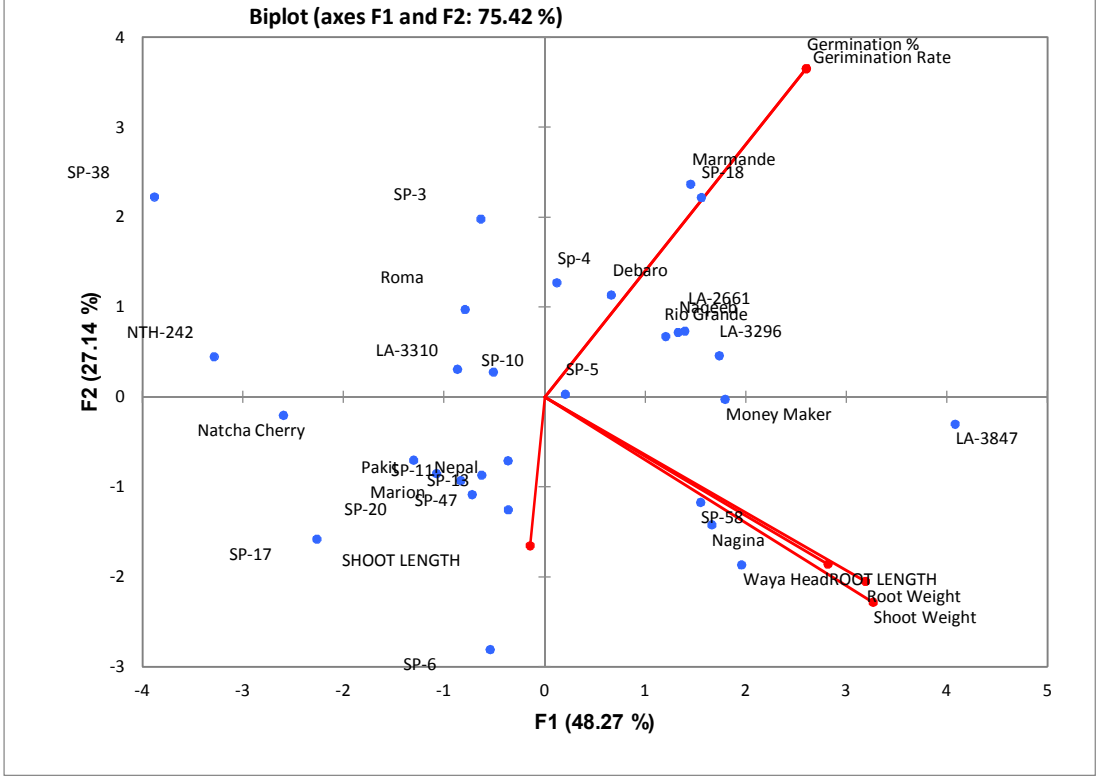

Fig. 1 T1 (control level)

But in T2 and T3 all genotypes are away from the origin it means the genotypes are sensitive to salinity level regarding germination percentage. Spoke length of germination percentage was longest among all treatment vectors, therefore, proved as most interactive. Genotypes Marmande, SP-18, LA-3296 and Debaro had strong positive interaction with T1 for germination percentage vector.

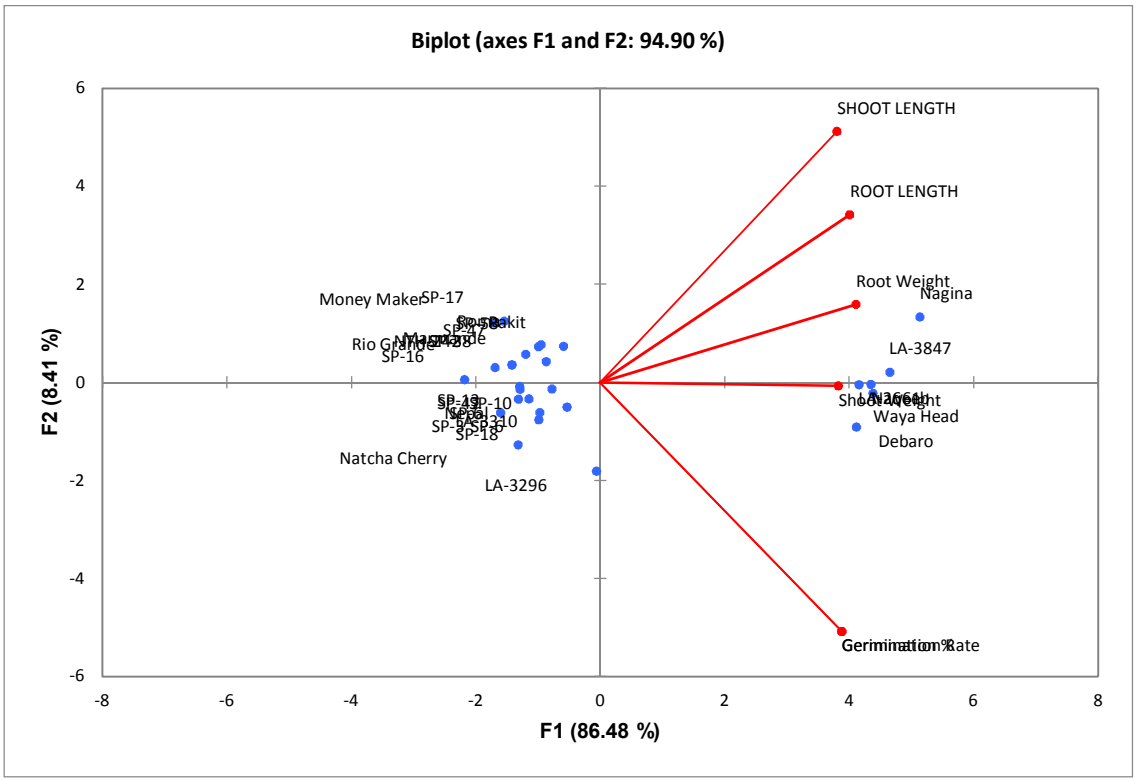

Fig.2 (T2)

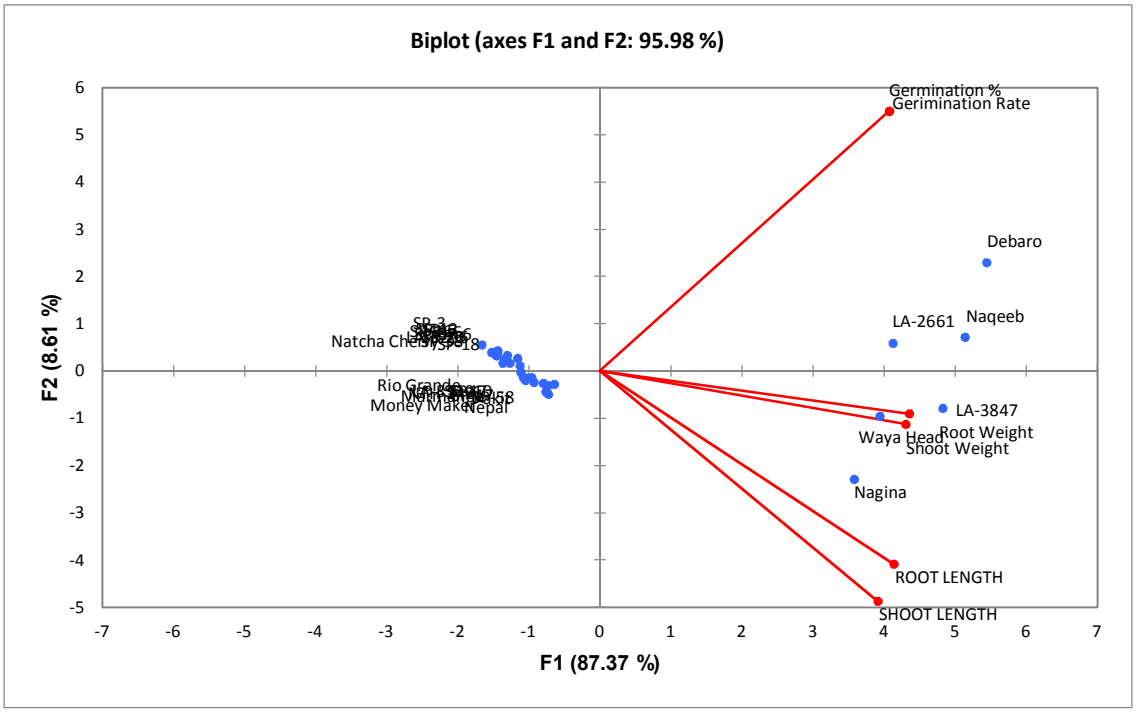

Fig.3 (T3)

Most of the varieties are near the origin and show little negative to null interaction for germination percentage at T2 and T3. Genotypes which are present closer together have similar interactive responses. In Fig.1 at control level varieties are scattered along the in every block of graph show different interactive response for all the vectors. In Fig.2 and Fig.3 most of the varieties are clustered in opposite direction illustrating similar negative interaction to the vectors. Germination rate and germination percentage vector show similar behavior in T2 and T3 as germination rate and germination percentage vectors lie on the same line. Smaller angle between vectors represents similar interactive responses while larger angle shows different interactive responses. Spoke length of germination rate was longest among all treatment vectors, therefore, proved as most interactive. Genotypes Marmande, sp18, and Debaro had strong positive interaction with T1 for germination rate. Genotypes which are present closer together have similar interactive responses. In Fig.1 at control level varieties are scattered in every block of graph show different interactive response for all the vectors. In Fig.2 and Fig.3 most of the varieties are clustered in opposite direction illustrating similar negative interaction to the vectors.

In the case of root length, under control condition Waya head, sp-58 and Nagina showed strong positive interaction to root length vector. While SP-38, NTH-242, SP-3, and Roma lie on the opposite side of the vector direction determining strong negative interaction regarding root length vector. For root length, SP-5 is near the origin so interpreted as insensitive under control condition. Under T2 Nagina was the only variety found to be positively related to root length. Most of the varieties were clustered opposite to root length vector showing same negative interaction. Nagina, LA-3847 and Waya head gave strong positive interaction to root length vector under T3 shown in Fig.3. While other varieties formed strong allay against root length showing similar behavior for root length vector. Therefore, these varieties show negative interaction.

Vector length is also known as spoke length is the important factor which tells how much strong interactive force is there. Under control condition spoke length for shoot length is relatively small but a number of varieties had strong positive interaction with it. SP-47, SP-11, SP-20, and Nepal which showed strong positive interaction for shoot length. Marmande, SP-18, and SP-3 displayed strong negative interaction with shoot length under control condition. Under T2 only Nagina showed positive interaction while other formed a cluster and showed the similar interactive response. As this cluster is opposite to shoot length vector so there is negative interaction for shoot length. In figure no 3 under T3 Nagina, LA-3847 and Waya head showed strong positive interaction for shoot length.

While other made a knot opposite to shoot length vector representing similar negative behavior for shoot length. Shoot length had the close angle with root length and root weight under T2 exhibiting these behaved in the same way. Under T3 shoot length and root length have very small angle revealing close relationship.

Under control conditions for root weight vectors the genotypes Waya Head, SP-58 and Nagina showed strong positive interaction. SP-38, NTH-242, SP-3, and Roma lie on the opposite side of the vector direction determining strong negative interaction for root weight. For root weight, SP-5 is near the origin so interpreted as insensitive under control condition. Under T2 Nagina, LA-3847, LA-2661, Debaro revealed strong positive interaction. Rest of the varieties made a mass opposite to root weight vector presenting them for negative interaction. LA-3847, Nagina and Waya Head under T3 had the strong positive relation for root weight vector. Remaining varieties made junk on the opposite sides of root weight vector and manifested themselves to be negatively interacted with it. Under T1 root weight, shoot weight and root length have the similar interaction because the angle between them is very small. While angle between root weight and germination percentage is broad suggesting that they behaved differently. Under control conditions Waya Head, SP-58 and Nagina showed strong positive interaction for shoot weight vector. SP-38, NTH-242, SP-3, and Roma lie on the opposite side of the vector direction determining strong negative interaction for shoot weight. For shoot weight, SP-5 is near the origin so interpreted as insensitive under control condition. Under T2 LA-2661, Waya Head, Debaro revealed strong positive interaction. Rest of the varieties made a mass opposition to shoot weight vector presenting them for negative interaction. LA-3847, Nagina, and Waya Head at the T3 level of salinity had the strong positive relation for shoot weight vector. Remaining varieties made junk on the opposite side shoot weight vector and manifested themselves to have negatively interacted with it. To study genotype × environment interaction (GEI) several methods have been extensively used by researchers such as univariate methods i.e. Plaisted and Peterson's mean variance component for pair-wise G × E Interactions, Francis and Kannenberg's coefficient of variability, Shukla's stability variance, Perkins and Jinks's regression coefficient (Rao et al., 2011). When more number of accessions are needed to be tested at multiple

locations, environments, years, and seasons, this poses the problem of clear cut view of genotypic responses (Yan et al., 2001). Biplot analysis solved the above-mentioned problems and confers two-dimensional graphic displays which depict the interrelationship among genotypes, environments and genotype-environment interaction. Biplot analysis is of two types: (I) Additive main and multiplicative interaction (AMMI) and, (II) Genotype & Genotype × Environment (GGE). AMMI and GGE biplots integrate certain characteristics on the basis of joint regression and type B genetic correlation but also have some differences which help in their manipulation. GGE biplot is referred to environment centered principal component analysis (PCA) while AMMI biplot analysis is based on double centered principle component analysis (Rao et al., 2011).

AMMI is an effective analysis for GEI estimation and genotypic selection under versatile environments (Aina et al., 2007). In this study AMMI biplot analysis was used to study the stability in the performance of genotypes at different saline environments (0, 10, and 15 ds/m). There is an advantage of using AMMI analysis because it is capable of splitting G (genotype) from GE (genotype × environment) which is not feasible in case of GGE biplot (Gauch et al., 2008). AMMI biplot analysis is simple, easy, provides information about genotypic behavior, phenotypic stability, environment with optimum performance and degree of divergence among accessions (Miranda et al., 2009). Under variable environmental conditions, change in performance of cultivars is associated with genotype × environment interaction. The ranking of genotypes based on performance keeps on changing when grown under different environmental conditions; this causes confusion about the superiority of genotype. This may be solved using AMMI biplot analysis as genotypes showing non-sensitive behavior for most of the traits were considered to have broader adaptability or more stability to the changing environments (0, 10 and 15 ds/m). Non-sensitive behavior represents non-significant change with the change in environmental conditions. Salinity stress was also previously reported to be harmful to the variable extent for growth and development of crop plants (Aslam et al., 2013; Aslam et al., 2015). Debaro and LA-2661 showed positive strong interaction with T1, T2 and T3 respectively for germination percentage. It means that these varieties may show better germination under saline condition. For root length under all salinity levels, Nagina exhibited strong interaction at all salinity levels. Higher root length is responsible for plant health, higher nutrient uptake and better water take up. Shoot length under T2 and T3 is interacting with Nagina. It means this variety can give good biomass and higher yield. For Root weight and shoot weight LA-3847 and Nagina performs well. Greater biomass is the indication of higher assimilation and photosynthetic activity. It is concluded that environment interacts with various traits of genotypes differently and alters their performances. AMMI model of biplot is very important tool for exploitation of interaction. Tomato genotypes showed positive interaction for certain environments which indicated that their performance was better for that typical environment whereas, genotypes with negative interaction indicated the poor performance for the typical environment. Stable performance of genotypes indicated that their responses were not affected by environment. Differences in the genotypic responses are due to differences in their genetic makeup which regulate the plant physiology and morphology to allow them to respond in a certain way.

4. Conclusion:

In the present study, for all investigated traits best level of salinity were controlled. Salt stress had an adverse effect on germination rate, germination percentage, root length, shoot length, root fresh weight and shoot fresh weight of 30 genotypes of tomato. In all studied genotypes of tomato, significant variation in salt tolerance was observed. In arid and semi-arid land, the acceptable growth of plants which are under exposure to salt stress is due to best germination of seeds under unfavorable conditions. So at early growth stage evaluation of salinity tolerant genotype is important. In this research with attention to that genotypes, Naqeeb and Marmande had performed well at germination stage. SP-5, SP-6, LA-2661, and Nagina had highest root length and shoot length. Therefore, could be rated as salt tolerant genotypes whereas SP-47 and LA-3847 are most sensitive genotypes against salinity stress.

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