Int.J.Curr.Microbiol.App.Sci (2017) *6*(4): 2197-2205

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 4 (2017) pp. 2197-2205**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.604.257

Genotypic Response of Chilli (*Capsicum annuum* L.) on Germination and Seedling Characters to Different Salinity Levels

D. Balasankar[1]*, S. Praneetha[1], T. Arumugam[1], P. Jeyakumar[2], N. Manivannan[3] and K. Arulmozhiselvan[4]

[1]Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, India
[2]Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore, India
[3]Plant Breeding, Department of Oil Seeds, Tamil Nadu Agricultural University, Coimbatore, India
[4]Department of Soil Science and Agricultural Chemistry, Tamil Nadu Agricultural University, Coimbatore, India
**Corresponding author*

Keywords

Chilli, Seed germination, NaCl salt stress, Seedling growth, Vigour index.

Article Info

Accepted:
20 March 2017
Available Online:
10 April 2017

A B S T R A C T

This study was conducted to evaluate the effect of salinity on germination and emergence of chilli cultivars and to investigate the ability for genetic salt tolerance during germination and seedling growth. Although some of the chilli genotypes have salinity tolerance to some extent, more attention is required to assess the cultivars for salinity resistance/tolerance so as to screen them and select best types suitable to cultivate under areas prone to soil salinity. In the present study, germination percentage, vigour index, stress tolerant index, seedling length, seedling fresh weight and seedling dry weight were assayed at three salinity levels *viz.*, 25mM NaCl, 50mM NaCl and 100mM NaCl and compared with control (0mM NaCl) on 14th day after sowing. It was found that when salinity concentration increased, the seedling growth decreased. When salt concentration increased, germination percentage of chilli seed was reduced and the time required to complete germination lengthened. Salt stress significantly decreased the shoot and root length, seedling height, seedling fresh and dry weight of chilli genotypes. Based on the results of the experiment, the varieties CO1, K1, Jayanthi, Arka Suphal and the accession EC467636 were found to be tolerant to salinity and could be used as genetic resources for developing saline tolerant hybrids.

Introduction

Globally chilli (*Capsicum annuum* L.), is the second most important solanaceous vegetable, accounting for a production of 170.03 MT from 19,83,000 ha with productivity of 1900 kg per hectare in India (Horticultural Statistics, 2015). In Tamil Nadu, it is cultivated in an area of 289 ha with a production and productivity of 8.67 MT and 506 kg/ha respectively (NHB, 2014-15). Generally the production and productivity of the crops are adversely affected due to various abiotic stresses. Salinity affects almost all the aspect of physiology and biochemistry of plants and significantly reduces yield. Salinity tolerance is critical during the life cycle of any crop species (Munns and Tester, 2008). As saline soils and saline waters are commonly seen in most part of the world, great effort has been devoted to understand the physiological aspects of tolerance to salinity in plants, as a basis for plant breeders to develop salinity tolerant genotypes. Large genetic variation of tolerance to salinity level exists among the chilli genotypes. However, breeding programs on salt tolerance have been restricted by the complexity of the trait, insufficient genetic and physiological knowledge of tolerance related traits and lack of efficient selection domain. Correcting saline condition in field and greenhouse would be expensive and temporary, while selection and breeding for salt tolerance can be a viable solution to minimize salinity effects as well as improve the production efficiency.

Genetic characterization of useful germplasm is the first step towards developing tolerant cultivars. Salt stress affects some major processes such as germination, speed of germination, root/shoot dry weight and $Na^{(+)}/K^{(+)}$ ratio in root and shoot which in turn may lead to uneven establishment, uneven crop stand and reduced yield (Parida and Das, 2005). One of the most effective ways to overcome salinity problems is the introduction of salt tolerant crops available or to breed salt tolerant varieties/hybrids. It has been reported that differences in salt tolerance exists not only among different species, but also within certain species (Chartzoulakis and Klapaki, 2000). In India, most of the regions where cultivation of chilli is predominant are characterized by the presence of moderately high level of salts and high water table. There is about 7 million ha of salt affected soil (saline and sodic) in India. Like other crops the growth and yield of chilli are also adversely affected by salinity (Zhani *et al.*, 2012). Munns and Tester (2008) reported a 14% reduction in chilli yield with each increasing unit of salinity.

The specific stages throughout the ontogeny of the plant, such as germination and emergence, seedling survival and growth and vegetative and reproductive growth should be evaluated separately during the assessment of genotypes for salt tolerance. Such assessments may facilitate to develop cultivars with salt-tolerant characteristics throughout the ontogeny of the plant (Foolad and Lin, 1997). The crops which are tolerant at seedling stage also show improved salinity tolerance at adult stage (Akinci *et al.*, 2004). The present study has been initiated with the objective to investigate the response of chilli genotypes to increased salinity levels during the germination and seedling emergence.

Materials and Methods

The seed germination and seedling growth of chilli at different salinity levels was carried out during 2016 in the Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. A total number of seventy two genetically diverse chilli genotypes were collected from various national institutions and research stations *viz.*, NBPGR New Delhi, IIVR Varanasi, IIHR Bangalore, KAU Kerala, PAU Ludhiana, HRS Guntur, local types of Tamil Nadu and maintained in the Department of Vegetable Crops, Tamil Nadu Agricultural University, Coimbatore were used for this study. All genotypes were evaluated in laboratory in Completely Randomized Block Design.

Germination assays

A total number of 25 seeds in each genotype were used for germination study. The salinity level was created by using sodium chloride (NaCl) in three different concentrations as treatments with distilled water one treatment as T_1; Control with distilled water where no NaCl added (0 mM) T_2; 25 mM, T_3; 50 mM and T_4; 100 mM. The seeds were soaked in distilled water and in respective concentration of sodium chloride solution for 10 minutes. Then the solution was drained and the soaked seeds were used to conduct the germination test in the laboratory under roll towel method. Each genotype with three different concentrations of NaCl and in distilled water were rolled separately and kept in germination chamber (±20ºC with RH 80-85 per cent). The whole set up was replicated twice. Once in three days the solution with different NaCl concentration and distilled water (25mM, 50mM, 100mM and 0mM,) was poured on the respective roll towel. On the 14th day of the experiment, germination (%), shoot length (cm), root length (cm), fresh weight (g) of shoot and root, dry weight (g) of root and shoot, vigour index and stress tolerant index (%) were measured. From the recorded observation the mean values were derived. The recorded data were analysed with two-way analysis of variance (ANOVA) using the GLIM procedure of SAS (SAS, 1985).

Results and Discussion

Effect of salinity on germination

The results of the germination percentage of chilli genotypes as influenced by NaCl revealed significant differences in all the treatments. Out of 72 genotypes the mean values on germination, seedling length and seedling fresh weight for the best performing 20 genotypes are given in table 1. Irrespective of genotypes and treatments, the germination percentage of chilli was highly influenced by salt stress at higher concentration (100 mM of NaCl). The mean of germination percentage ranged from 9.00 % to 41.50 % (100mM of NaCl) and 83.50 % to 94.00 % (control). The highest germination percentage was observed in the variety CO 1 (41.5%) followed by K1 and Jayanthi (36.50 %) and was on par with the accession EC497636 (36.00%) under 100 mM of NaCl treatment. The genotypes which are least affected could be a potential source of salinity tolerance for vegetable breeding (Hamed *et al.*, 2011). The effect of external salinity on seed germination may be partially osmotic or ion toxicity, which can alter physiological processes such as enzyme activities (Essa and Al-Ani, 2001). The salt stress causes specific toxicity by higher accumulation of Na(+) and Cl(-) ions in the embryo in addition to a mineral imbalance (Guerrier, 1984). In extreme case, death of embryo can take place due to an inhibition of metabolic process (Bliss *et al.*, 1986). This finding is similar to those observed by Keshavarzi *et al.,* (2011) in spinach and Zhani *et al.,* (2012) in chilli.

Shoot and root length

The results of the shoot and root length of chilli genotypes as influenced by NaCl revealed significant differences in all the treatments. Out of 72 genotypes, the mean values on shoot length for the best performing 20 genotypes are presented in figure 1. The mean of shoot length was ranged from 3.10cm to 4.85cm (100mM of NaCl) and 4.75cm to 6.35cm in control. Among the genotypes produced shoots in T_1 (control), the shoot length varied from 4.75 cm by the variety Utkal Ava to 6.35 cm by the variety CO1. At the highest NaCl stress level, the variety CO1 and the accession EC497636 recorded the highest shoot length of 2.75 cm followed by the variety Jayanthi (2.70 cm) which was on par with the variety Arka Suphal (2.65 cm). The lowest shoot length of 1.45 cm at the highest stress level (100mM of NaCl) was recorded by the variety PKM 1.

The root length of best performing varieties is given in figure 2. The mean of root length was ranged from 1.25cm to 3.20cm in

100mM of NaCl and 4.90 cm to 7.35 cm in the treatment with distilled water (control). It was observed that there was a decrease in root length with increase in salt concentration. Among the genotypes produced root in the treatment with distilled water (control) the root length varied from 4.90 cm (variety Punjab Lal) to 7.35 cm (variety CO1). At the highest salt stress level of 100mM NaCl, the varieties Jayanthi and Arka Suphal (3.20 cm) and CO1 (3.10 cm) produced longer roots. Samira *et al.,* (2012) and Zhani *et al.,* (2012) obtained similar results for increased root length in chilli.

Root length and shoot length are the important traits to be given consideration under any abiotic stress condition. In general a variety with longer root growth has ability to withstand under drought (Leishman and Westoby, 1994). Under high salt concentration level (100Mm NaCl) the shoot and root length were reduced in all the genotypes studied. Decrease in the external osmotic potential due to salinity causes reduction in morphological growth of plants (Radhouane, 2007). It was confirmed in tomato (Kulkarni and Deshpande, 2007) and in cucumber (Yildirim *et al.,* 2008).

Seedling height

The mean of plant height ranged from 3.00 to 5.90 cm in 100mM of NaCl and 9.15 to 13.65 cm in control (Table 1). The longest plant height was observed in the treatment control by the variety CO1 (13.65 cm) followed by K1 which recorded 13.45 cm. At the highest salt stress level (100mM of NaCl) the variety Jayanthi recorded the highest plant height of 5.90 cm followed by the variety Arka Suphal (5.85cm) and CO1 (5.85 cm). The reason behind the reduction of seedling length under high salt stress condition might be due to the reduction of cell elongation by low water potential which was created by NaCl. Cell elongation is mainly based on turgidity of the cell which is reduced by salt stress, causing reduction of shoot and root length (Sekhon and Singh, 1994). Similar findings were reported by Akinci *et al.,* (2004) in eggplant and Jogendra Singh *et al.,* (2012) in tomato and Zhani *et al.,* (2012) in chilli.

Fresh and dry weight of seedlings

Significant differences were observed for fresh weight of seedling in all the treatments. The seedling fresh and dry weight, vigour index and stress tolerant index for the best 20 genotypes out of the evaluated 72 are given in tables 1 and 2. The mean seedling fresh weight ranged from 0.021g to 0.077g in 100mM of NaCl and it ranged from 0.116 g to 0.178g in control (T_1). The maximum fresh weight of seedlings were recorded in all the treatments by the variety CO1 Under treatment with distilled water (T_1) fresh weight of seedling was recorded as 0.178 g by the variety CO1 and under 100mM of NaCl treatment the variety CO1 recorded the highest fresh weight of 0.077 g. The shoot and root fresh and dry biomass of the genotypes were significantly reduced with increased NaCl concentration. Reduced root and shoot growth under salt stress is a common phenomenon (Raza *et al.,* 2007) which also leads to reduction of shoot and root dry weight. The highest dry weight of seedlings were observed both under the treatment with distilled water (T_1) and highest salt concentration level (100mM of NaCl) the variety CO1 which recorded 0.059 g and 0.021 g respectively. The reduction of both shoot and root weight under high saline conditions may lead to decreased water uptake by plant due to increased osmotic pressure (Jamil *et al.,* 2007). The results are similar to those reported by Akinci *et al.,* (2004) in eggplant and Khan *et al.,* (2009) in chilli. The decreased tissue water content resulted in reduction of cellular growth and development.

Table.1 Variation in germination and seedling characters of chilli genotypes to increasing levels of salinity

Genotypes	Germination (%)				Seedling length (cm)				Seedling fresh weight (g)			
	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
CO1	92.50	86.50	67.00	41.50	13.65	12.45	8.95	5.85	0.178	0.147	0.115	0.077
CO 4	87.00	81.00	61.00	12.50	9.95	8.70	6.65	4.75	0.136	0.120	0.078	0.051
PKM 1	86.00	78.00	62.50	12.50	9.15	7.75	5.50	3.10	0.121	0.099	0.064	0.050
K 1	94.00	84.50	66.00	36.50	13.45	12.00	9.00	5.05	0.178	0.148	0.100	0.062
GNT 341	91.00	82.50	62.00	17.50	11.90	9.80	7.05	3.80	0.146	0.128	0.088	0.052
KMD/PYR	83.50	74.00	61.50	17.50	10.60	8.55	6.90	3.65	0.130	0.113	0.075	0.027
LCA 639	86.50	79.00	61.00	22.50	11.15	9.60	6.95	3.65	0.138	0.122	0.083	0.051
LCA 334	89.00	75.50	61.00	22.50	12.15	10.75	7.30	4.00	0.153	0.118	0.071	0.045
CA7	89.00	84.00	62.00	22.50	12.10	10.70	7.95	5.10	0.148	0.119	0.079	0.041
Anugraha	85.50	78.00	61.50	12.50	10.95	10.20	7.45	4.40	0.129	0.111	0.077	0.042
IC 119546	86.50	77.50	64.00	22.00	11.95	10.70	6.90	4.00	0.129	0.111	0.065	0.039
EC 391083	89.00	81.00	62.50	14.00	11.15	9.60	7.45	3.00	0.118	0.096	0.065	0.024
Punjab Lal	85.00	76.50	64.00	14.50	9.95	8.50	6.70	4.25	0.116	0.099	0.054	0.029
Pant C1	86.00	78.00	63.50	9.00	10.45	9.40	6.65	3.65	0.118	0.098	0.059	0.026
Jayanthi	91.00	82.50	69.00	36.00	13.40	12.35	8.90	5.90	0.148	0.122	0.069	0.042
Utkal Ava	84.50	73.50	65.50	10.00	10.00	8.75	6.60	3.80	0.118	0.094	0.061	0.024
Ac10	89.00	78.00	65.50	16.50	10.90	9.75	6.80	4.85	0.125	0.109	0.063	0.021
EC 497636	93.50	83.00	69.00	36.50	13.35	12.20	9.10	5.80	0.159	0.127	0.080	0.045
Arka Suphal	91.00	80.50	67.50	35.50	12.90	11.95	9.10	5.85	0.145	0.118	0.074	0.037
Arka Abhir	86.50	72.50	64.00	24.00	10.85	9.60	7.75	5.10	0.135	0.103	0.065	0.029
Mean	**88.30**	**79.30**	**64.00**	**21.80**	**11.49**	**10.16**	**7.48**	**4.47**	**0.138**	**0.115**	**0.074**	**0.040**

Factor	G	T	G x T	G	T	G x T	G	T	G x T
SEd	**1.34**	**0.60**	**2.69**	**0.18**	**0.08**	**0.36**	**0.002**	**0.001**	**0.005**
CD (0.05)	**2.67**	**1.19**	**5.35**	**0.36**	**0.16**	**0.73**	**0.005**	**0.002**	**0.011**

T_1- Control with distilled water (0 mM) T_2 - 25 mM NaCl, T_3 - 50 mM NaCl and T_4 - 100 mM NaCl

Table.2 Variation in seedling characters of chilli genotypes to increasing levels of salinity

Genotypes	Dry weight of seedling (g)				Vigour Index				Stress tolerant index (%)			
	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
CO1	0.059	0.044	0.030	0.021	1283.10	1052.03	590.70	213.53	100.00	81.99	46.01	16.64
CO 4	0.039	0.028	0.017	0.007	865.75	704.70	405.65	59.38	100.00	81.41	46.88	6.86
PKM 1	0.039	0.029	0.019	0.010	786.90	604.50	343.75	38.75	100.00	76.82	43.77	4.92
K 1	0.055	0.041	0.027	0.017	1244.13	1038.00	603.00	209.58	100.00	83.43	48.51	16.85
GNT 341	0.042	0.030	0.020	0.009	1082.90	808.50	437.10	66.50	100.00	74.66	40.35	6.14
KMD/PYR	0.040	0.026	0.018	0.008	885.10	632.70	424.35	63.88	100.00	71.48	48.08	7.22
LCA 639	0.049	0.035	0.023	0.013	964.58	758.40	423.95	82.13	100.00	78.63	44.19	8.51
LCA 334	0.042	0.032	0.023	0.011	1081.45	811.63	445.30	90.00	100.00	75.06	41.18	8.32
CA7	0.045	0.033	0.022	0.013	1076.90	898.80	492.90	114.75	100.00	83.46	45.75	10.66
Anugraha	0.038	0.024	0.015	0.008	936.23	795.60	458.18	55.00	100.00	84.98	48.95	5.87
IC 119546	0.039	0.029	0.014	0.007	1033.68	829.25	441.60	88.00	100.00	80.22	42.67	8.51
EC 391083	0.034	0.022	0.014	0.006	992.35	777.60	465.63	42.00	100.00	78.36	46.94	4.23
Punjab Lal	0.031	0.022	0.014	0.005	845.75	650.25	428.80	61.63	100.00	76.88	50.92	7.29
Pant C1	0.036	0.028	0.019	0.008	898.70	733.20	422.28	32.85	100.00	81.58	46.97	3.66
Jayanthi	0.049	0.036	0.026	0.017	1219.40	1018.88	614.10	218.30	100.00	83.56	50.43	17.90
Utkal Ava	0.030	0.022	0.014	0.009	845.00	643.13	432.30	38.00	100.00	76.11	51.43	4.50
Ac10	0.038	0.025	0.013	0.008	970.10	760.50	445.40	80.03	100.00	78.39	45.91	8.25
EC 497636	0.051	0.039	0.028	0.018	1248.23	1012.60	627.90	211.70	100.00	81.12	50.32	16.96
Arka Suphal	0.050	0.035	0.022	0.013	1173.90	961.98	614.25	207.68	100.00	81.95	52.31	17.69
Arka Abhir	0.047	0.032	0.020	0.013	938.53	696.00	496.00	122.10	100.00	74.16	53.02	13.01
Mean	**0.042**	**0.030**	**0.019**	**0.011**	**1018.60**	**809.43**	**480.63**	**104.75**	**100.00**	**79.21**	**47.22**	**9.69**

Factor	G	T	G x T	G	T	G x T	G	T	G x T
SEd	**0.0005**	**0.0002**	**0.0011**	**17.76**	**7.94**	**35.53**	**1.58**	**0.70**	**3.16**
CD (0.05)	**0.0011**	**0.0005**	**0.0022**	**35.36**	**15.81**	**70.72**	**3.15**	**1.40**	**6.30**

T_1- Control with distilled water (0 mM) T_2 - 25 mM NaCl, T_3 - 50 mM NaCl and T_4 – 100 mM NaCl

Fig.1 Variation in shoot length of chilli genotypes to increasing levels of salinity

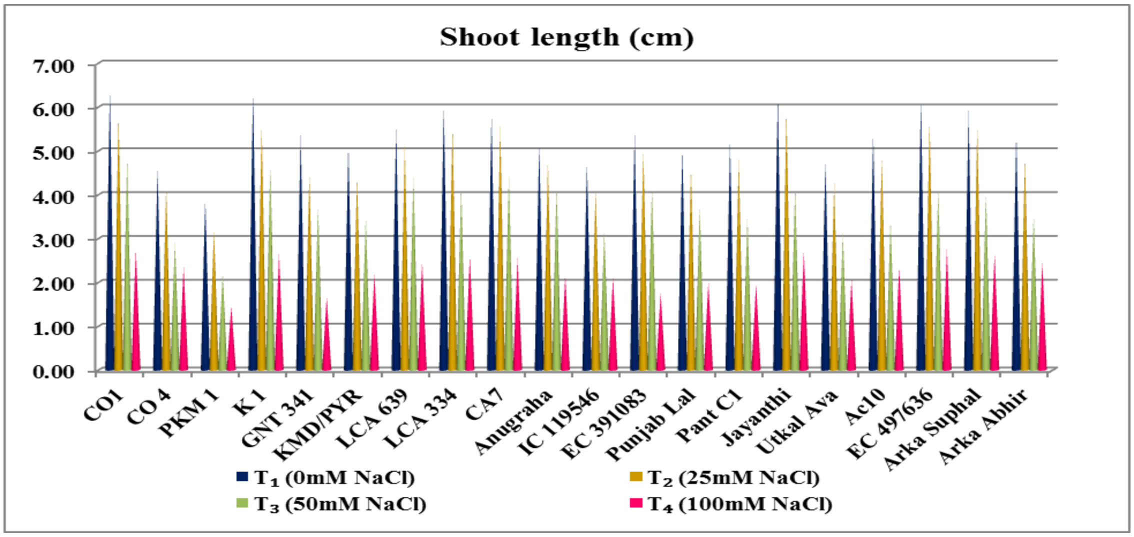
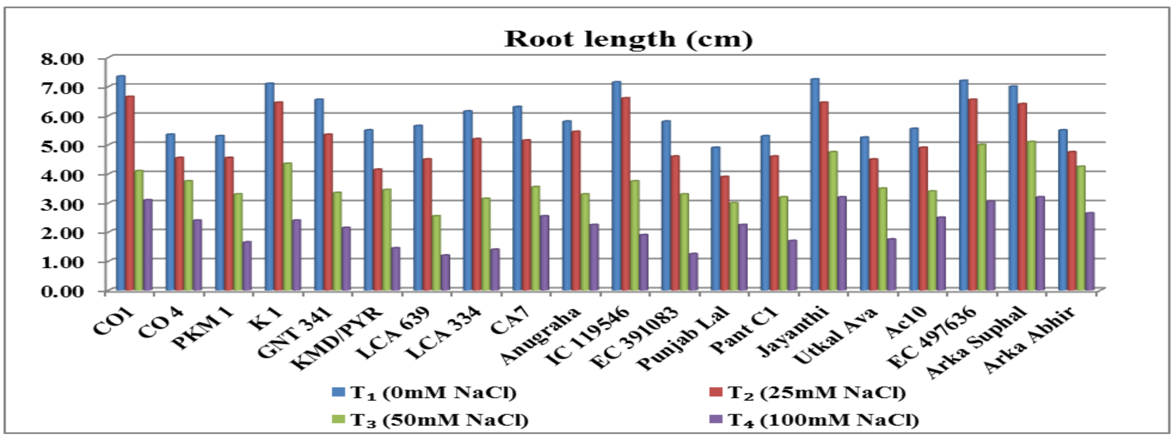


Fig.2 Variation in root length of chilli genotypes to increasing levels of salinity



Vigour index

Vigour index is the product of germination percentage and seedling length (Table 2). Irrespective of genotypes and treatments, the analysis of vigour index indicated that the variety CO1 under the treatment 1 with distilled water exhibited highest mean value of 1283.10 followed by the accession EC497636 (1248.2) under the highest salt concentration level (100 mM of NaCl) also the variety Jayanthi recorded the highest mean value of 218.30 followed by CO 1 (213.53) for this trait. All the genotypes treated with distilled water showed improved vigour index as compared to the NaCl treated seeds which were due to increased shoot and root length of seedlings than seeds treated with NaCl. They are much more vigorous than the NaCl seeds. The results are in confirmation with Hajer *et al.,* (2006). The vigour index was significantly affected by salinity stress which caused a greater adverse effect. Similar findings were reported in tomato by Al-Harbi *et al.,* (2008)

Stress Tolerant Index (STI)

Stress tolerance index is a more stable character and can be considered as a useful tool to screen abiotic stress tolerant genotypes (Dutta and Bera, 2008). The mean percentage of stress tolerant index in the treatment 1 with distilled water is 100.00 per cent. Among the treatments with 25 and 100 mM of NaCl the variety Jayanthi showed significantly higher mean value of 83.56 and 17.90 per cent followed by the varieties CO1 and K1 and the 50mM of NaCl treatment the variety Arka Abhir recorded the highest mean value with 53.02 per cent. The variety Utkal Ava showed the lowest value of tolerant index with 4.50 per cent in 100mM of NaCl treatment. Based on the results of stress tolerant index the variety Jayanthi, CO1, K1, Arka Suphal and the accession EC497636 showed better tolerant index compared to other genotypes. The high STI might be due to higher germination percentage with elevated root and shoot length leading to higher vigour index.

In conclusion the results of the study on genotypic response of chilli to various salinity levels revealed that the NaCl affects some of the physiological process in chilli germination and seedling growth. The increase in salinity level decreased the growth and germination characters. In the present study, the varieties CO1 followed by K1, Jayanthi, Arka Suphal and accession EC497636 were found to be high saline tolerant genotypes among the evaluated varieties and accessions. The salt-tolerant chilli genotypes identified from the present work were further evaluated for their field appraisal. Such a tolerant genotype can also be used in breeding programs for developing superior and saline tolerant hybrids and also for cultivation in the field with high salinity.

References

Akinci, I.E., S. Akinci, K. Yilmaz and H. Dikici. 2004. Response of eggplant varieties (*Solanum melongena*) to salinity in germination and seedling stages, *New Zealand J. Crop and Hort. Sci.,* 32(2): 193-200

Al-Harbi, A.R., M.A. Wahb-Allah and S.S. Abu Muriefah. 2008. Salinity and Nitrogen level affects germination emergence and seedling growth of tomato. *Int. J. Veg. Sci.,* 14(4): 380-392.

Bliss, R.D., K.A. Platt-Aloia and W.W. Thomson. 1986. Osmotic sensitivity in relation to sensitivity in germination barely seeds. *Plant, Cell and Environ.,* 9: 727-733.

Chartzoulakis, K. and G. Klapaki. 2000. Response of two greenhouse pepper hybrids to NaCl salinity during different growth stages. *Scientia Hort.,* 86: 247-260.

Dutta, P. and A.K. Bera. 2008. Screening of mung bean genotypes for drought tolerance. *Legume Res.,* 31(2): 145-148.

Essa, A.T. and D.H. Al-Ani. 2001. Effect of salt stress on the performance of six soybean genotypes. *Pak J. Biol. Sci.,* 4: 175–177.

Foolad, M.R. and G.Y. Lin. 1997. Absence of a genetic relationship between salt tolerance during seed germination and vegetative growth in tomato. *Plant Breed,* 116(4): 363-367

Guerrier, G. 1984. Selectivité de fixation du sodium au niveau des embryons et des jeunes plantes sensible ou tolerante au NaCl. *Canadian J. Bot.,* 62(9): 1791-1798.

Hajer, A.S., A.A. Malibari, H.S. Al-Zahrani and O.A. Almaghrabi. 2006. Responses of three tomato cultivars to sea water salinity and effect of salinity on the seedling growth. *African J. Biotec.,* 5: 855-861.

Hamed, K., N. Hossein, F. Mohammad and V.J. Safieh. 2011. How salinity affect germination and emergence of tomato lines. *J. Biol. Environ. Sci.,* 5(15): 159–163

Horticulture Statistics at a Glance. 2015.

Jamil, M., D.B. Lee, K.Y. Jung, M. Ashraf, S.C. Lee and S.E. Rha. 2006. Effect of salt (NaCl) stress on germination and early seedling growth of four vegetable species. *J. Central European Agric.,* 7(2): 273-282.

Jogendra Singh, E.V. Divakar Sastry and Vijayata Singh. 2012. Effect of salinity on tomato (*Lycopersicon esculentum* Mill.) during seed germination stage. *Physiol. Mol. Biol. Plants*, 18(1): 45–50.

Keshavarzi, M.H.B., S. Mehrnaz, R.S. Ohadi, M. Mohsen and L. Amir. 2011. Effect of salt (NaCl) stress on germination and early seedling growth of Spinach (*Spinacia oleracea* L.). *Annals of Biol. Res.*, 2(4): 490-497.

Khan, H.A., M.A. Pervez, C.M. Ayub, K. Ziaf, R.M. Balal, M.A. Shahid and N. Akhtar. 2009. Hormonal priming alleviates salt stress in hot Pepper (*Capsicum annuum* L.). *Soil and Environ.*, 28(2): 130-135.

Kulkarni, M. and U. Deshpande. 2007. In vitro screening of tomato genotypes for drought resistance using polyethylene glycol. *African J. Biotech.*, 6(6): 691-696.

Leishman, M.R. and M. Westoby. 1994. The role of seed size in seedling establishment in dry soil conditions-experimental evidence from semi-arid species. *J. Ecol.*, 82(2): 249-258.

Munns, R. and M. Tester. 2008. Mechanisms of salinity tolerance, *Annual Rev. Plant Biol.*, 59: 651-681

National Horticultural Board. 2014.

Parida, A.K., A.B. Das. 2005. Salt tolerance and salinity effects on plant: a review. *Ecotoxicol. Environ. Safety*, 60: 324–349.

Radhouane, L. 2007. Response of Tunisian autochthoanous pearl millet (*Pennisetum glaucum* R. Br.) to drought stress induced by polyethylene glycol (PEG) 6000. *African J. Biotech.*, 6(9): 1102-1105.

Raza, S.H., H.R. Athar, M. Ashraf and A. Hameed. 2007. Glycine betaine-induced modulation of antioxidant enzymes activities and ion accumulation in two wheat cultivars differing in salt tolerance. *Environ. Exp. Bot.*, 60: 368-376.

Samira, I.M., B. Dridi-Mouhandes, S. Mansour-Gueddes and M. Denden. 2012. 24 Epibrassinolide ameliorates the adverse effect of salt stress (NaCl) on pepper (*Capsicum annuum* L.). *J. Stress Physiol. Biochem.*, 8: 232-240.

SAS. 1985. SAS Introductory Guide, 3rd Edition, NC, USA, p 99.

Sekhon, N.K. and G. Singh. 1994. Effect of growth regulators and date of sowing on grain development in wheat. *Indian J. Plant Physiol.*, 37: 1-4.

Yildirim, E., M. Turan and I. Guvenc. 2008. Effect of foliar salicylic acid applications on growth, chlorophyll, and mineral content of cucumber grown under salt stress. *J. Plant Nutri.*, 31: 593-612.

Zhani, K., M.A. Elouer, H. Aloui and C. Hannachi. 2012. Selection of a salt tolerant Tunisian cultivar of chilli pepper (*Capsicum frutescens*). *Eurasia J. Bio Sci.*, 6: 47-59.

How to cite this article:

Balasankar, D., S. Praneetha, T. Arumugam, P. Jeyakumar, N. Manivannan and Arulmozhiselvan, K. 2017. Genotypic Response of Chilli (*Capsicum annuum* L.) on Germination and Seedling Characters to Different Salinity Levels. *Int.J.Curr.Microbiol.App.Sci.* 6(4): 2197-2205.
doi: https://doi.org/10.20546/ijcmas.2017.604.257