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RESEARCH ARTICLE

RESPONSES OF SOME GENOTYPES OF FINGER MILLET (*Eleusine coracana* Gaertn.) FOR THEIR SALT TOLERANCE

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ABSTRACT

Salinity is one of the major abiotic factors which limit the plant growth. The purpose of present investigation is to study the responses of the finger millet genotypes under saline condition at germination and seedling stage. Seeds were sown in Petri-dishes, lined with Whatman filter paper and moistened with 10 ml of saline solutions of different EC levels (viz. 3, 6, 7.2, 10, 12 and 14 dSm^{-1}). The result showed a gradual and significant reduction in % germination at all salinity levels except in cv. Local Hills at 3 EC. Length, fresh and dry weights of root and shoot were also decreased with increase in concentration in saline solutions. Cv. VL-315 registered least reduction (4.7-56.2%) in seedling dry matter whereas cv. Local Hills recorded highest reduction (12.2-71.8%) at all salinity levels. We concluded that cv. VL-315 performed better and proved to be the most promising variety as it had SSI value > 0.8 whereas cv. Local Hills recorded as most sensitive (SSI value < 1.0).

INTRODUCTION

Salinity is one of the major abiotic factors which regulate the efficient utilization of available land resources and adversely affect the crop productivity. Worldwide, approximately 100 millions hectare of arable lands are affected by salinity, which accounts for about 6-7% of total land (Munns and James, 2003), whereas only in India around 13.3 million hectares of land is affected by salinity (Consortium for Unfavorable Rice Environment, IRRI, 2003). Detrimental effects of salinity in general, can be attributed to the decrease in osmotic potential of the medium and disturbance in the mineral nutrition of the plant or direct toxic effects on plant growth and metabolism (Strogonov, 1973; Marschner, 1995 and Dorais *et al.*, 2001). High salt concentration in medium, reduces seed germination and seedling emergence (Ghoulam and Fares, 2001 and Hassan *et al.*, 2010). Zidan and Elawa (1995) observed that during germination cumin could tolerate NaCl salinity up to 200 ml but displayed significant reduction in percent germination at 240 mM NaCl. However, shoot and root length and dry matter of seedling decreased significantly at 200 mM NaCl. Bernstein (1962) and Maliwal and Paliwal (1969) observed that salt tolerance at germination stage may not necessarily be the same as that at later stages of growth, but it is certainly a determining factor in plant growth and crop yield. In case of green vascular plants, salt stress is probably more critical during their seed germination (Al-Karaki, 2000), through induced plasmolysis and /or permeation of toxic salt ions into their embryos (Tobe *et al.*, 1999 and Khajeh-Hosseini *et al.*, 2003).Finger millet (*Eleusine coracana* G.) is an important minor cereal in the Indian sub-continent and commonly known as ragi. It is rich in calcium, dietary fiber and known for its health benefits. Although, ragi is considered as sensitive crop to salinity as compared to other cereals (viz. barley, wheat, sorghum and oat etc). Enormous work has been done on various crops with reference to salinity, however, little information is known regarding the effect of salinity on finger millet. Therefore, the present study was conducted to determine the combined effect of various salts (NaCl, Na_2SO_4, $CaCl_2$ and $NaHCO_3$) at different salinity levels on germination and seedling stage.

MATERIALS AND METHODS

The pure line seeds of the five varieties viz. VL-315, PRM-9812, VL-326, VL-146 and Local Hills of finger millet (*Eleusine coracana* G.) were procured from Govind Ballabh Pant University of Agriculture and Technology, Hill Campus, Ranichauri, Tehri Garhwal, Uttarakhand to test their salt tolerance at germination and early seedling stage. Petri-dish culture was used to study the response of these cultivars under saline conditions. Petri-dishes were sterilized in hot air oven at 80°C for 24 hours. Simultaneously, the healthy and uniform seeds were surface sterilized with 0.01% $HgCl_2$ solution for one minute and then washed repeatedly with distilled water to remove the traces of $HgCl_2$. Each Petri-dish was lined with Whatman No. 1 filter paper in which twenty five seeds were kept at equidistance and moistened with 10 ml of aqueous

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solution of different salinities. The distilled water was used as control. Saline solutions of different electrical conductivities viz. 3, 6, 7.2, 10, 12 and 14 dSm^{-1} were prepared by mixing the salts of NaCl, $CaCl_2$, $NaHCO_3$ and Na_2SO_4 as described by U.S. Salinity Laboratory Staff Handbook (1954). The seeds were allowed to germinate in BOD incubator $28^{\pm}2^{o}C$. This experiment was arranged in a completely randomized design with triplicate to eliminate the experimental error. Germination counts were made on alternate days starting from the beginning of the experiment. The seeds were considered as germinated when plumule or radical had emerged ≥ 0.5 cm.

Ten days after germination, the samples were collected following completely randomized design considering three replicates. Seedlings were cut into shoot and root and their length and fresh weight were measured carefully. The dry weight of root and shoot was measured after keeping the fresh plant samples in hot air oven at $70^{o}C$ for 48 hours. Data were subjected to statistical analysis of the variance by Minitab Statistical programme (Minitab Inc., States College, P. A.). Percent reduction (PR) due to salinity stress in relation to the non stressed environment was also determined for length, fresh and dry weight of root and shoot. Salinity intensity index (SII) was calculated for seedling dry weight of all genotypes with the help of $SII = 1- X_{ss}/X_{ns}$, where X_{ss} and X_{ns} are the means of dry weight of all genotypes under salinity stresses (ss) and non-stressed (ns) environment (Fisher and Maurer, 1978). Salinity susceptibility index (SSI) for seedling dry weight for each genotype was calculated as follows: $SSI = (1-Y_{ss}/Y_{ns})/ SII$, where Y_{ss} and Y_{ns} are the means of total dry weight for a given variety in ss and ns environment respectively. A critical difference (CD) was computed when F-tests indicated statistically significant differences between genotypes using the method described by Bruning and Kintz (1977) at P= 0.05.

RESULTS

Seed germination

The data on % germination are represented in figure (1). Statistical analyses showed significant differences among genotypes under varying salt stresses. Percent germination gradual declined as the concentration of salinity increased from 3 to 14 dSm^{-1} in all cultivars. Statistical data revealed that germination was not affected significantly in cvs. VL-315, PRM-9812, VL-326 and VL-146 at 3 dSm^{-1} except in cv. Local Hills. 100% germination was observed in cv. VL-315 and it ranged between 95-98% in cvs. PRM-9812, VL-326, and VL-146 at 3dSm^{-1}. Cv. Local Hills recorded least percent germination (80%) at same level of salinity. However, all cultivars of finger millet exhibited significant reductions as the levels of salinity increased from 6 to 14 dSm^{-1}. At lower levels of salinity (6 and 7.2 dSm^{-1}), lesser reduction in germination of seeds were noticed (2.0 to 29.4%) in all cultivars, whereas the higher level of salinity exhibited 15.0 to 56.5% reduction in different cultivars when compared with controls. It is interesting to note that cultivars VL-315 and PRM-9812 showed the minimum reduction in germination of seeds which ranged from 0.0 to 39.0% and 0.0 to 40.8% respectively. On the other hand, cv. Local Hills registered 6.0-56.5% and cv. VL-146 expressed 1.0-45.0% reductions.

Seedling growth

Data on seedling growth are presented in Table (1) and Figure (1). The results showed that shoot length significantly reduced in all cultivars at all salinity levels except in cv. Local Hills at 3 dSm^{-1}. All cultivars recorded marginal reductions (4.0-5.5%) at 3 dSm^{-1}. Cultivars VL-315, PRM-9812 and VL-326 exhibited 9.0% reductions while rest of the cultivars exhibited up to 10.7% reductions at 6 dSm^{-1}. At 7 dSm^{-1}, the lowest reduction (3.0%) was registered in cv.VL-315, while highest (16.4%) was noted in Local Hills. When salinity raised, the shoot length in all cultivars was more affected as compared to lower levels of salinity. The reductions ranged between 16.3 to 22.0%, 17.2-37.0% and 27.0-55.4% at 10, 12 and 14 dSm^{-1} respectively. Statistical data indicate that highest reductions were observed in cv. Local Hills (5.4-55.4%) and the lowest in cv.VL-315 (4.0-27.0%). Fresh weight of shoot gradually decreased as the level of salinity increased from 3-14 dSm^{-1}, however, the varieties have evoked differential responses to different salinity levels. Data indicate that fresh weight of shoot significantly declined at all levels of salinity except in cv. VL-315 at 3.0 dSm^{-1} when compared with their respective controls. It is also evident that decrease in fresh weight of shoot at 3.0 to 7.2 dSm^{-1} ranged from 2.0 to 11.4%. At 10 dSm^{-1}, the highest reduction was observed in cv. Local Hills (34.1%) which was followed by VL-146 (33.3%) whereas cv. VL-315, PRM-9812 and VL-326 recorded 12.5%, 15.6% and 26.2% reductions respectively at the same level, compared to control sets. At 12 and 14 dSm^{-1}, cvs. VL- 146 and Local Hills recorded 40.0-47.7% reductions respectively while others showed 20.8-37.8% reductions.

All varieties showed a significant decline in dry weight of shoot as concentration of saline solution increased from 3.0–14.0 dSm^{-1}. In general, 1-10% inhibition in shoot dry weight was observed at 3 dSm^{-1} in all varieties tested. At other lower levels of salinity viz. 6.0 and 7.2 dsm^{-1}, reduction in shoot dry matter ranged from 15.0 to 36.5%. The inhibition becomes more marked at higher salinity level (10-14 dSm^{-1}). The cv.VL-315 showed minimum inhibition in shoot dry matter ranging from 28.7 to 50.7%, followed by PRM-9812 and VL-326 (32.7-59.0% and 41.1-60.9%) whereas the highest reductions were recorded in cv. Local Hills and it was followed by VL-146. Statistical analysis indicates that all cultivars showed significant reductions in root length as concentration of saline solutions increased from 3 to 14 dsm^{-1}. Data revealed that root length in all cultivars have registered less than 10% reduction at 3 dSm^{-1}, and less than 15% in all cultivars at 6 dsm^{-1}. At 7 dSm^{-1}, cultivars VL-315, PRM-9812, VL-326 and VL-146 showed less than 20% reductions in root length except in cv. Local Hills (25.9%). The varieties, which performed better under various salinity regimes have also evoked differential responses. In cultivars VL-315 and PRM-9812, the lowest reductions (18.8 and 19.7%) were registered at 10 dsm^{-1} whereas in cvs. VL-146 and Local Hills recorded highest reductions (27.4 and 36.6%) at same level. As the level of salinity raised to 12 dSm^{-1}, less than 40% reductions were seen in cultivars VL-315, PRM-9812 and VL-326, however, maximum reductions (more than 40%) were obtained in cv. VL-146 and Local Hills. At 14 dSm^{-1}, most of the cultivars exhibited maximum reductions (>40%) or up to 58.5% except in cv. VL-315 (33.1%).

Table 1. Effects of salinity on germination and seedling growth in some cultivars of finger millet (*Eleusine coracana* G.)

Variety	Salinity levels (dSm^{-1})	% germination	Length (cm)		fresh weight (mg)		Dry weight (mg)		Dry weight (mg)	SSI
			Root	Shoot	Root	Shoot	Root	Shoot	Per Seedling	
VL-315	**0**	100	12.03	3.38	25	48	5.5	7.3	12.8	*
	3	100	11.46	3.25	24	47	5.1	7.1	12.2	0.55
	6	98	11.01	3.13	22	45	4.6	6.2	10.8	0.80
	7.2	97	10.64	2.95	19	43	3.9	5.9	9.8	0.76
	10	85	9.76	2.83	17	42	3.0	5.2	8.2	0.80
	12	69	9.25	2.80	14	38	2.6	4.1	6.7	*
	14	61	8.04	2.48	13	35	2.0	3.6	5.6	*
C.D. at 5%		**1.48**	**0.13**	**0.05**	**0.94**	**1.31**	**0.18**	**0.18**	**1.59**	
PRM-9812	**0**	98	10.23	3.15	18	45	4.5	6.1	10.6	*
	3	98	9.75	3.00	17	43	4.1	5.9	10.0	0.67
	6	96	9.32	2.87	15	42	3.7	5.1	8.8	0.87
	7.2	88	9.0	2.73	13	40	3.1	4.9	8.0	0.79
	10	80	8.21	2.63	11	38	2.1	4.1	6.2	0.83
	12	66	6.72	2.43	10	32	1.7	3.3	5.0	*
	14	58	5.85	1.78	9	28	1.4	2.5	3.9	*
C.D. at 5%		**1.62**	**0.17**	**0.14**	**0.76**	**1.02**	**0.09**	**0.14**	**1.43**	
VL-326	**0**	98	8.88	2.89	21	42	5.0	5.1	10.1	*
	3	98	8.23	2.75	19	40	4.5	4.7	9.2	1.1
	6	95	7.82	2.63	17	39	3.9	4.2	8.1	1.0
	7.2	85	7.37	2.46	14	35	3.2	3.8	7.0	0.99
	10	79	7.02	2.27	12	31	2.3	3.0	5.3	1.1
	12	65	5.36	1.95	11	29	1.8	2.6	4.4	*
	14	55	4.41	1.56	10	26	1.5	2.0	3.5	*
C.D. at 5%		**2.41**	**0.15**	**0.08**	**0.87**	**1.45**	**0.09**	**0.17**	**1.59**	
VL-146	**0**	96	9.56	2.95	21	45	4.9	5.3	10.2	*
	3	95	8.82	2.80	18	42	4.2	4.8	9.0	1.3
	6	91	8.23	2.65	16	40	3.8	4.3	8.1	1.0
	7.2	81	7.67	2.49	13	35	2.8	3.5	6.3	1.2
	10	75	6.94	2.31	11	30	2.1	3.0	5.1	1.1
	12	61	5.32	1.88	10	27	1.7	2.4	4.1	*
	14	53	4.23	1.50	8	25	1.2	1.9	3.1	*
C.D. at 5%		**2.23**	**0.11**	**0.12**	**0.69**	**0.85**	**0.09**	**0.18**	**1.48**	
Local Hills	**0**	85	10.25	3.36	16	44	4.4	5.2	9.6	*
	3	80	9.42	3.18	13	41	3.7	4.7	8.4	1.5
	6	78	8.78	3.00	12	39	3.2	4.0	7.2	1.3
	7.2	60	7.59	2.81	9	33	2.5	3.3	5.8	1.3
	10	48	6.5	2.63	8	29	1.8	2.9	4.7	1.1
	12	40	5.06	2.12	7	26	1.5	2.2	3.7	*
	14	37	4.25	1.50	5	23	1.0	1.7	2.7	*
C.D. at 5%		**1.99**	**0.11**	**0.34**	**0.78**	**1.0**	**0.11**	**0.18**	**1.19**	

Fresh weight of root significantly declined as the level of the salinity increased from 3 to 14 dSm^{-1}, however, the magnitude of reductions also varied with salinity levels. Most of the varieties recorded less than 10% reductions except in cv. VL-146 (14.3%) and Local Hills (18.7%) at 3 dSm^{-1}. Reduction in fresh weight of root ranged from 12.0-25.0% at 6 dSm^{-1} and 24.0-43.7% at 7.2 dSm^{-1}. As the salinity level is raised to 10 dSm^{-1} cv. Local Hills exhibited highest reduction (50%) while cv. VL-146 (47.6%) and cv. VL-315 (32%) reduction. The fresh weight of root in all cultivars recorded 44.0-56.2% and 48.0-68.7% inhibition at 12 and 14 dSm^{-1} respectively. The perusal of data indicates a declining trend in root dry weight as level of salinity increases. At 3 dSm^{-1}, cultivars VL-146 and Local Hills showed 14.3% and 15.9% reduction respectively while rest of the cultivars showed marginal reductions (7.2-10.0%). Dry weight also significantly decreased as the salinity raised to 7.2 dSm^{-1}, this decrease being more pronounced in cvs. VL-146 and Local Hills. In contrast, cultivars VL-315 and PRM-9812 recorded 29.1% and 31.1% reductions respectively while other cultivars registered 36.0-43.2% reductions. The varieties have behaved almost similarly considering root dry weight at 10 and 12 dSm^{-1}. More than 50% reductions at 10 dSm^{-1} and more than 60% reduction at 12 dSm^{-1} were noted in cultivars PRM-9812, VL-326, VL-146

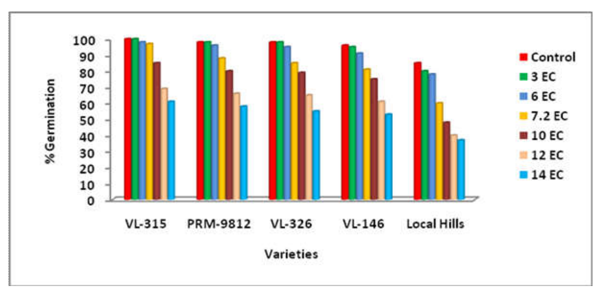

Fig 1: Effect of salinity on percent germination in different varieties of finger millet

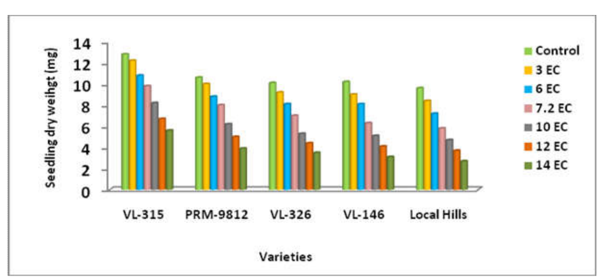

Fig 2: Effect of salinity on seedling dry weight (mg) in different varieties of finger millet

and Local Hills except cv. VL-315, which behaved as most sensitive cultivar as the root growth were affected most adversely. The variety VL-315 administered lesser reductions at 10 and 12 dSm^{-1} which may be kept in the tolerant group. Most of the varieties recorded more than 64-78% reductions in root dry weight at 14 dSm^{-1}. Total seedling dry weight is an important criterion for the assessment of salt tolerance of the varieties at seedling stage. These have been measured by adding root and shoot dry matter. All cultivars have shown non-significant reductions in seedling dry weight at 3 dSm^{-1}. At lower levels of salinity (3 to 7.2 dSm^{-1}) cv. VL-315 registered least reductions (4.7-23.4%) while highest were observed in (12.5-39.6%) in cv. Local Hills. As the level of salinity raised from 6 to 14 dSm^{-1}, all cultivars expressed significantly inhibition in dry weights. At higher levels of salinity (10, 12 and 14 dSm^{-1}), all cultivars expressed 35.9-51.0, 47.6-61.5 and 56.2-71.8% reduction respectively. Cultivar Local Hills recorded maximum reductions (71.8%), and therefore seem to be most sensitive. In contrast to this, cv. VL-315 recorded lesser reductions (56.2%) and thus indicating better tolerance to salinity (Fig-2).

Salt susceptibility index

Salt susceptibility index (SSI) has been used a tool to evaluate the salt tolerance of the varieties at seedling stage. The values for the total dry weight of seedling have been worked out at different salinity levels (6.0, 7.2 and 10 dsm^{-1}) which are depicted in table. On the basis of SSI values, all the cultivars were categorized as tolerant (SSI < 0.8), moderately tolerant (SSI ranging b/w 0.8 - 1.0) and sensitive (SSI > 1.0). Data indicate that cvs. VL-315 and PRM-9812 performed better and proved to be more tolerant than others, as both cultivars had SSI values <0.8 at these salinity levels. The cultivars VL-146 and Local Hills were proved as highly sensitive to salinity stress. These cultivars exhibited SSI values more than one (1.0-1.3). SSI values in cv. VL-326 were observed between 0.8-1.0. Thus, this variety behaved as moderately tolerant.

DISCUSSION

Seed germination is the most crucial and sensitive stage of a plants life cycle, particularly in the presence of environmental stresses. The soluble salts in the rhizosphere, beyond a critical limit, adversely influence germination and subsequent growth. Germination is one of the most salt-sensitive stages of plant growth and is severely inhibited with increasing salinity particularly in glycophytes. Present findings indicate that seed germination in different varieties of finger millet had been differentially affected at different salinity levels. In general, seed germination was not significantly affected at initial level of salinity i.e. 3 dSm^{-1} but significant reductions were noted at 6 to 14 dSm^{-1}. Cv. VL-315 registered highest % germination (100%) while Local Hills recorded least (80%) under different salinity levels. The inhibitory effects of NaCl on seed germination could be due to its direct effect on the growth of the embryo (Al-Taisan, 2010). Salt induced inhibition of seed germination could be attributed to osmotic stress or to specific ion toxicity (Faheed *et al.*, 2005). Germination was also significantly decreased as the level of salinity of the medium increased (Mauromicale and Licandro, 2002). These results are similar in line with Bayuelo-Jimenez *et al.* (2002). Ibrar *et al.* (2003) and Jabeen *et al.* (2003) also reported the adverse effect of NaCl salinity on the germination of *Brassica juncea* and *Vigna mungo* respectively. Seed germination of *Striga hermonthica* was reduced by 79% at 150 mM salinity level. The effect of salinity on seed germination may be due to some biochemical changes occurring within the seeds due to specific ion effects of NaCl rather than osmotic potential on the seeds (Hassan *et al.*, 2010). Germination percentage was reduced by 125mM NaCl salt concentration onwards for almost all varieties except HD-6859 wheat cultivar (Datta *et al.*, 2009).

The findings revealed that length, fresh and dry weight of shoots and roots significantly declined at higher salinity levels. Cv. VL-315 exhibited minimum while cv. Local Hill recorded maximum reductions by salinities. In general, genotypes revealed significant reductions in shoot length at different salinity levels but Local Hills did not express any significant effect at 3 dSm^{-1}. These observations are in accordance with the findings of Subberao *et al.* (1991) for pigeon pea, Jennette *et al.* (2002) for *Phaseolus* species, Meloni *et al.* (2004) for *Prosopis alba,* Jamil and Rha (2004) for sugar beat and cabbage, Mohamedin *et al.* (2006) for sunflower, where increase in salinity levels resulted in reduction of root and shoot length. The length of root of all genotypes reduced to 5-8, 11-26, and 23-51% whereas reduction in shoot length ranged from 4-5, 13-16 and 17-37% at 3, 7.2 and 12 dSm^{-1} levels of salinity respectively. Cv. VL-315 exhibited minimum inhibition (5-33%) in root length as compared to cv. Local Hills (8-58.5%). The same pattern was observed in shoot length where cv. VL-315 recorded lesser reduction (4-27%) than cv. Local Hills (5-55%). Dutta *et al.* (2009) reported that higher levels of salinity had a more pronounced effect on root length with respect to shoot length as roots are directly exposed to salt solution in wheat plants. Al-Taisan (2010) has also reported that root growth was usually more sensitive to the stress than growth of the shoot in seedlings of *Pennisetum divisum*. These results are similar in line with Momayezi *et al.* (2009) in rice, Biswas *et al.* (2010) in *Vigna radiata* and Khatoon *et al.* (2010) in *Zea mays*.

Present findings on fresh and dry weight of root and shoot expressed declining trends same as observed in length of root and shoot. The fresh weight of shoot was recorded minimum in cv. VL-315 (2-27%) over Local Hills (7-48%) when salinity raised from 3dSm^{-1} to 14dSm^{-1}. Cv. VL-315 also observed lesser reduction (3-51%) in shoot dry weight while Local Hills recorded higher inhibition (10-67%). The fresh weight of root was less inhibited in cv.VL-315 (4-48%) whereas Local Hills recorded maximum inhibition (19-69%). Dry weight of root was also noticed minimum in cv. VL-315 (7-64%) while Local Hills recorded maximum (16-77%) when salinity increased from 3 to 14 dSm^{-1}. It was concluded that percent reduction was more pronounced in fresh and dry weight of root as compared to shoot. These observations are similar with Manikandan and Desingh (2009). Statistical Analysis of data showed that dry weights of seedlings significantly declined in all cultivars with increasing salinity levels except at 3 dSm^{-1}. It is clear from findings that cv. VL-315 experienced lesser inhibition (4.0-50%) while cv. Local Hills recorded higher inhibition (12-71%) at all salinity levels (3-14 dSm^{-1}). These findings are similar with Finkelstein and Lynch (2002), Kirnak *et al.* (2001) and Sharma *et al.* (2004) who reported that the increasing NaCl salt concentration declined the dry matter yield. Veeranagamallaiah *et al.* (2008) also reported that salinity treatments reduced seedlings growth and dry mass in foxtail millet. The reduction in seedling dry weight under salt stress may be attributed to the inhibited hydrolysis of reserved food and its translocation to the growing shoot (Singh *et al.*, 2001). Present findings confirmed the earlier reports of Dantas *et al.* (2005) who reported decreased seedling growth in cow pea under NaCl salinity. It was formerly thought that excess of salt retards the absorption of water which suppresses the growth through osmotic effect. Munns (2003) reported that suppression of plant growth under saline condition might either be due to the decreased availability of water or to the increasing toxicity of NaCl with increasing salinity. The tolerance of varieties to salinity stress was also accessed on the basis of SSI (Salt susceptibility index) for their dry weight of seedlings at 6, 7.2 and 10 dSm^{-1} which demonstrated genetic variation. Jeannette *et al.* (2002) pointed that the lower values of SSI implies the greater tolerance to salinity. The present finding indicated that cvs. VL-315 and PRM-9812 performed better and proved to be more tolerant than others, as both genotypes had SSI value <0.8 at these salinity levels. The cultivars VL-146 and Local Hills had inferior seedling growth under salt stress and SSI values were more than one, hence, proved to be more salt sensitive. These results are highly comparable with the range of tolerance observed in tropical grain legumes to salinity (Keating and Fisher, 1985). Our findings are also similar with Srivastava *et al.* (2005), Agarwal *et al.* (2010) and Kumar (2009) who screened the pigeon pea, berseem and oat genotypes respectively for salinity tolerance in terms of SSI. Therefore, on the basis of SSI values for seedling dry matter, cv. VL-315 was most salt promising variety while cv. Local Hills considered as most salt sensitive.

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