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The response of sweet sorghum cultivars to salt stress and accumulation of Na^+, Cl^- and K^+ ions in relation to salinity

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Abstract

Tolerance to high salinity concentrations in sorghum seems to be related to the genotype ability to avoid accumulation of harmful levels of Na^+ and Cl^- and to maintain adequate levels of K^+ especially in shoot. In this study, the effect of salt stress (0, -0.4, -0.8, -1.2, -1.6 and -2 Mpa) on seed germination, seedling growth and Na^+, K^+, and Cl^- concentrations of 18 sweet sorghum cultivars were evaluated. The results showed that Roce, Sumac and IS6973 cultivars had better tolerance to salt stress than other cultivars at germination stage. However, SSV84 had the highest germination percentage up to -1.6 MPa and at seedling growth stage it had the highest biomass than other cultivars. Therefore, it seems that among sweet sorghum cultivars, SSV84 was the most salt tolerant cultivar and it is suggested to be planted in salinity affected agricultural lands. In addition, IS6973 showed the highest seed germination and moderate seedling growth stage and was classified as moderate salt tolerant cultivar. Na^+ and Cl^- concentrations increased in shoots and roots especially in salt sensitive cultivars. Also, K^+ concentration increased in salt tolerant cultivars while decreased in salt sensitive ones. Since K^+/Na^+ ratio concentration increased in salt tolerant cultivars and decreased in salt sensitive ones, it seems that this ratio among other parameters is a better indicator for selection of salt tolerant cultivars.

Key words

Germination, Salt tolerance, Sorghum cultivars, Seedling growth

Introduction

The soil salinity may be due to poor water management, high evapo-transpiration rate submerged irrigation and also due to pre-exposure of lands to sea water (Jin *et al.,* 2007). The extent of soil salinity and sodicity problems vary from 5% to 10% of the world cultivated lands (Eynard *et al.,* 2005). Salt-affected soils affect the growth of the most crop plants is limited by soluble salts. Salts in soils may include chlorides, sulfates, carbonates and bicarbonates of sodium, potassium, magnesium and calcium. Among these sodium chloride adverse by effects the plant growth and development (Patela *et al.,* 2010). The inhibitory effects of salinity on plant growth includes ion toxicity; osmotic influence; nutritional imbalance leading to reduction in photosynthetic efficiency (Patela *et al.,* 2010) and other physiological disorders (Hasegawa *et al.,* 2000). Competition and interactions between Na^+ and other inorganic nutrients in the substrate as well as within the plants frequently lead to ion imbalance that may result in nutrient deficiencies (Silva *et al.,* 2003). Na^+ and Cl^- accumulates in roots and stems as salinity increases (Meneguzzo *et al.,* 2000; Hadi *et al.,* 2007). It is evident that in some plants such as wheat, salt tolerance is associated with low uptake of Na^+ (Santa-Maria and Epstein, 2001), partial exclusion (Colmer *et al.,* 1995) and compartmentalization of salt in the cell and within the plant (Ashraf *et al.,* 2001). So that plants keep endogenous Cl^- and Na^+ ions at low levels while K^+ level is increased (Santa-Maria and Epstein, 2001; Rascio *et al.,* 2001). Salt tolerance in plants varies along a continuum with genetic variation attributable to ion exclusion or accumulation, production of compatible solutes, turgor maintenance, differences in development patterns (e.g. root-shoot ratios), root anatomy and general plant vigor. The difference in plant's response to a given level of salinity is dependent upon the concentration and composition of the ions in solution as well as genotype that is exposed to salinity (Sairam and Tyagi, 2004). Traits used for screening germplasm for salinity tolerance includes Na^+ exclusion, K^+/Na^+ discrimination (Asch *et al.,* 2000). Sweet sorghum (*Sorghum bicolor L. Moench*) is a C_4 crop with a moderate tolerance to salt stress and it is well adapted to semi-arid and arid regions where salinity is a major problem (Almodares *et al.,* 2007, 2008a, 2008b). However, Lacerda *et al.* (2001) reported that salinity reduced the dry matter yield and length of the shoot and root system in sorghum genotypes. Sorghum seems to be able to reduce Na^+ and Cl^- transport from the roots to the shoot or compartmentalize part of these ions in specific places in the stems, roots and leaves (Lacerda *et al.,* 2001; 2003). Deficiency of other nutrients in the soil is due to high concentration of Na^+ that interacts with other environmental factors, such as drought, which exacerbates the problem and reduces plant growth and development (Silberbush and Ben-Asher, 2001). Some plants are sensitive to salinity at seed germination and seedling growth stages, because the mechanism of tolerance to salinity has not yet fully been developed. However, some other plants such as rice and sorghum varieties may also show tolerance to salinity at these stages (Marcum, 1999; Malcolm *et al.*, 2003). There is a need to identify traits associated with salinity tolerance and simple, highly efficient, repeatable screening methods to evaluate large number of genotypes. The objective of present research was to evaluate the effect of salinity stress on seed germination, seedling growth and Na^+, K^+, and Cl^- accumulation in order to find a correlation between ion accumulation and salt tolerance in sweet sorghum and also to introduce the highest salt tolerant genotype.

Materials and Methods

Plant material and experimental design : The experiments were conducted at the Department of Biology, Shiraz University. Seeds of 18 sweet sorghum [*Sorghum bicolor* (L.) Moench] cultivars were procured from Isfahan University Research Station in Iran. The experimental design was factorial with two factors: 18 cultivars (Soav, Vespa, S35, M81E, Mn1500, Sumac, SSV108, Roce, Sofra, Satiro, E36-1, SSV84, IS9639, IS19273, IS6936, IS686, IS2325, IS6973) and five salinity levels (-0.4, -0.8, -1.2, -1.6 and -2.0 Mpa NaCl) with two replications.

Seed germination : Washed grains of sweet sorghum were surface sterilized with 10% hypochlorite sodium solution for 15 min. Seeds were thoroughly rinsed with distilled water and allowed to imbibe in distilled water for 24 hr. Seeds were germinated at 80% relative humidity placed on filter paper in petri dishes at 26 ^{0}C in light for 14 h photoperiod and at 21 ^{0}C in dark for 10 hr photoperiod in a growth chamber (Model E15, Conviron-Canada). After imbibition 100 seeds were placed in a Petri dish containing sterile filter papers, moistened with 20 ml distilled water (control) or 20 ml salt solutions of NaCl (-0.4, -0.8, -1.2, -1.6 and -2.0 Mpa). The number of seeds germinated was counted 7 days after salt treatment and the germination percentage was determined.

Seedling growth *:* Seeds of the above cultivars were imbibed for 24 hr in distilled water. They were then transferred to 500 ml square plastic containers containing vermiculite and Hoagland solution. The seedlings were grown under hydroponic conditions in a greenhouse with 65% humidity during the light period; photoperiod of 16 hr light and 8 hr darkness; temperature of 26 ºC during light and 21ºC during dark. Each container held two seedlings. Hoagland solution was added to the container every 4 days. Seven days after germination, sodium chloride was added gradually to the Hoagland solution to make saline treatments of -0.4, -0.8, -1.2, -1.6 and -2.0 MPa. The seedlings were grown under salt stress conditions for 12 days and the dry weights of roots and shoots were determined.

Estimation of Cl^-, Na^+ and K^+ ions : The concentration of Na^+, K^+ and Cl^- ions within plant tissue were determined using a flame photometer and the anion concentration was determined by potentiometric method according to Chapman and Pratt (1961).

Statistical analyses : Statistical analyses were performed using Statistical Analysis System (SAS) computer program. The means were compared according to Duncan Multiple Range Test (DMRT).

Results and Discussion

Attempts were made to evaluate salt tolerance at the germination and emergence stages in sorghum (Igartua *et al.,* 1994). At different salinity level, cv. Roce (65.4 %), Sumac (64.5 %), SSB84 (61.4 %), SSV108 (55.0 %) and IS6973 (54.9 %) on average showed the highest seed germination percentage. However, the differences in their seed germination percentage were not significant. IS9639 cultivar had the lowest seed germination percentage (10.4%). At -2.0 MPa NaCl, only Sumac (45.0 %), Roce (34.5 %) and IS6973 (23.0 %) cultivars showed highest seed germination percentage but the differences in their seed germination percentage were not significant (Table 1). At this salt concentration, the other cultivars did not germinate or their germination percentage were less than 10 %. Since Roce, Sumac and IS6973 cultivars showed highest seed germination percentage at -2.0 MPa NaCl, it seems that Roce, Sumac and IS6973 cultivars demonstrated a better tolerance to salinity stress at germination stage. The difference in tolerance to salinity may be due to genetic diversities and heredity differences among sweet sorghum cultivars (Maiti *et al.,* 1994). Salt concentration had a negative effect on seed germination and with gradual increase in salt concentration, seed germination percentage

Table 1 : Effects of salt concentrations on relative germination (%) in 18 sweet sorghum cultivars

Cultivars /	Relative germination (%)					
osmotic potential (Mpa)	-0.4	-0.8	-1.2	-1.6	-2	Average %
IS 9639	48^{d}	4^{e}	0^{f}	0^{e}	0^{b}	10.4
Sova	87.5^{abc}	70^{abc}	30^{de}	12.5^{de}	7.5^{b}	41.5
Vespa	80^{abc}	51.5^{bcd}	17^{ef}	3^{de}	0^{b}	30.3
S 35	83^{abc}	74.5^{ab}	54.5^{bcd}	8.5^{de}	3^{b}	44.7
M 81E	73^{bc}	85.5^{a}	$36d^{e}$	0^{e}	0^{b}	38.9
IS 19273	81^{abc}	46.5^{cd}	29.5^{de}	0^{e}	0^{b}	31.4
IS 6936	87abc	77^{a}	33.5^{de}	5^{de}	0^{b}	40.5
MN 1500	72.5^{bc}	47.5^{cd}	20^{ef}	2.5^{de}	0^{b}	28.5
Sumac	100^{a}	62.5^{abcd}	67.5^{abc}	47.5^{ab}	45^{a}	64.5
IS 686	63^{cd}	40^{d}	66^{abc}	14^{de}	0^{b}	36.6
SSV 108	87.5^{abc}	85^{a}	72.5^{ab}	25^{bcde}	5^{b}	55
Roce	87^{abc}	74^{ab}	89.5^{a}	42^{abc}	34.5^{a}	65.4
Sofra	89.5^{ab}	84^{a}	53^{bcd}	23.5^{bcde}	5.5^{b}	51.1
Satiro	95^{ab}	42^{d}	32^{de}	0^{e}	5^{b}	34.8
IS 2325	89.5^{ab}	77^{a}	46^{cd}	28^{bcd}	0^{b}	48.1
E 36-1	62.5^{cd}	42.5^{d}	30^{de}	2.5^{de}	0^{b}	27.5
IS 6973	85.5^{abc}	74.5^{ab}	71.5^{ab}	20^{cde}	23^{ab}	54.9
SSV84	94.5^{ab}	84.5^{a}	64^{bc}	64^{a}	0^{b}	61.4
Relative germination	81.41 %	62.36 %	45.05 %	16.50 %	7.13 %	42.52 %

Letters within each column followed by the same letter are not significantly different at 5% level, using DMRT

showed a reduced trend and the differences were significant at various salinity level (Table 1). These relationships were negative and significant at 1 % level. Somac and IS9639 cultivars had the highest and the lowest seed germination rates under various salt concentrations than other cultivars, respectively (Fig. 1). Also, their regression coefficient (r) between NaCl concentrations and seed germination indicated that IS9639 cultivars had the highest and the lowest seed germination in -0.4 MPa and -1.8 MPa salt solutions, respectively while Somac had the highest and the lowest seed germination in -0.4 MPa and -2 MPa, salt solutions respectively. In addition, regression coefficient (r) line of Somac (-0.85) cultivar was better fitted than IS9639 cultivar (-0.74). The relationship between seed germination and thousand grains weight was not significant.

The variation in whole-plant biomass response to salinity was considered to provide the best means of initial selection of salinity tolerant genotypes (Krishnamurthy *et al.,* 2007). Among cultivars, SSV84 had the highest shoot dry weight (35.3 mg). Although, this cultivar had the highest root dry weight (11.6 mg), however difference was not significant as compared with other cultivar such as IS6973, IS2325, S35, IS6936, SV108, and E36-1 (Table 2). Since plant dry weight is related to salinity tolerance in sorghum (Wambua *et al.,* 2010). Based on the reports, it seems that SSV84 had better salinity tolerance as compared to other sweet sorghum cultivars, because it had the highest shoot dry weight. Also, SUMAC among other cultivars had the lowest shoot dry weight (8.0 mg) and root dry weight (3.0 mg). Although, the difference in its root dry weight was not significant as compared to some other cultivars, it seems that Sumac was more sensitive to salinity stress than other cultivars. In addition, it seems that IS6973, SSV108, IS6936 and E36-1 cultivars were moderately salt tolerant because their shoot and root dry weights were at medium range. The relationship between thousand grain weight and shoot dry weight were positive and significant at 1 % level (Table 3). The regression coefficient (r) between thousand grain weight and shoot dry weight was 0.95. Similarly, the relationship between thousand grain weight and shoot fresh weight were positive and significant at 1 % level with a regression coefficient (r) of 0.88 (data not shown). Since both the relationships between shoot dry weight and shoot fresh weight with respect to salinity and thousand grain weights with shoot dry and fresh weight were positive, it seems that plant salt tolerance was related to thousand grain weight. Thus, the cultivars with larger seed size were more salt tolerant than those with smaller seed size. In this regard, there are several reports indicating that the grain size has direct effect on plant's salinity tolerance, and on plant vigor and photosynthesis efficiency (Mian and Nafziger, 1992; Willenborg *et al.,* 2004; Zhao *et al.,* 2007). Although in contrast to present findings, Kaya *et al.* (2008) reported that in chickpea, small seeds germinated and grew more rapidly under NaCl stress. The study showed that among cultivars, SSV84 and Sumac had the highest and the lowest thousand grain weight and shoot fresh weight, respectively (Table 3). It seems that SSV84 is more tolerant and Sumac was more sensitive to salt stress than other cultivars. In addition among cultivars, E36-1, IS6936, IS6973 and SSV108 were found to be moderately salt tolerant because their thousand grain weights and shoot fresh weight were ranked between salt tolerant and salt sensitive cultivars.

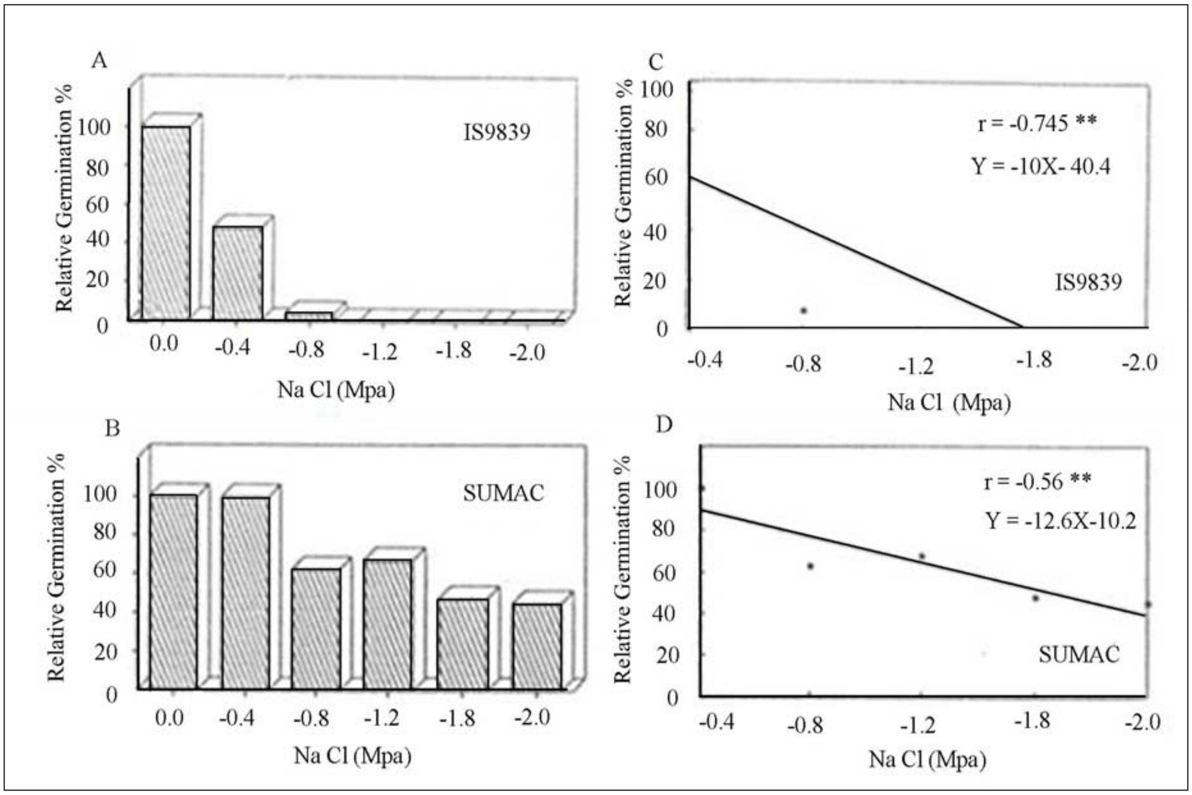

Fig. 1 : Effect of different NaCl concentrations on seed germination alongwith and the regression coefficient ® of IS9639 (A) and Sumac (B)

Table 4 shows that the difference in Na^+ concentration in the roots of sweet sorghum cultivars were not significant at 5% level. It seems that all sweet sorghum cultivars (sensitive, moderate and tolerant) did not accumulate Na^+ ions in their roots but transported them to the shoots. Davenport *et al.* (2005) reported that in durum wheat, Na^+ without being accumulated in roots was transferred to shoots. Na^+ concentration was significant in leaves. IS2325 cultivar showed the lowest Na^+ concentration in leaves. Although, this amount of Na^+ was not significantly high for some cultivars such as SSV84 which was previously suggested as a salt tolerant among other cultivars. Low concentration of Na^+ in the leaves is related to plant salt tolerance (Schachtman and Munns, 1992; Hadi *et al.,* 2007). In this regard, Renault *et al.* (2001) reported that preferential salt accumulation in roots over shoots may act as a mechanism of salt tolerance in at least two ways. First, maintenance of a substantial potential for osmotic water uptake into the roots and second, restricting the movement of Na^+ to shoots. Therefore, it seems that SSV84 tolerated salt stress better than other cultivars. Low concentration of Na^+ in this cultivar indicates that the mechanism of salt tolerance in this cultivar is probably by salt avoidance. On the other hand, the sodium concentration in some sweet sorghum cultivars was higher in roots than in shoots such as in SSV84 which was salt tolerant and E36-1, IS6936, IS6973 and SSV108 which are

Table 2 : Root and shoot dry weights of 18 sweet *Sorghum* cultivars grown under -0.4 MPa NaCl treatments during 12 days period

Cultivar	Root dry weight (mg)	Shoot dry weight (mg)
IS 9639	3.5^{de}	13.5^{h}
Sova	5.3^{bcde}	16.3^{gh}
Vespa	4.0^{cde}	14.5^{gh}
S 35	7.3^{abcde}	24.0^{cde}
M 81E	6.1^{abcde}	15.3^{gh}
IS 19273	7.6^{abcde}	19.6^{efg}
IS 6936	10.3^{ab}	29.6^{b}
MN 1500	7.3^{abcde}	18.0^{fgh}
Sumac	3.0^{e}	8.0^{i}
IS 686	6.0^{abcde}	13.0^{h}
SSV 108	10.0^{ab}	28.0^{be}
Roce	4.6^{bcde}	14.3^{gh}
Sofra	5.5^{bcde}	14.5^{gh}
Satiro	6.5^{bcde}	16.0^{gh}
IS 2325	9.3^{abc}	21.6^{def}
E 36-1	10.0^{ab}	26.6^{bcd}
IS 6973	9.0^{abcd}	28.3^{bc}
SSV84	11.6^{a}	35.3^{a}

Letters within each column followed by same letter are not significantly different at 5% level, using DMRT

Table 3 : Thousand grain weight (g) of 18 sweet sorghum cultivars and shoot fresh weight (mg/20 grain) grown in osmotic potential (-0.4 MPa) of NaCl after 12 day

Cultivar	Thousands grain weight (g)	Shoot dry weight (mg)	Total seedling fresh weight (mg per 20grain)
IS 9639	18.75^{d}	6^{f}	79^{f}
Sova	19.77^{d}	12^{d}	197^{d}
Vespa	15.35^{e}	10de	180de
S 35	30.63^{bc}	18.5^{c}	349^{c}
M 81E	14.59^{e}	9de	127de
IS 19273	27.69^{c}	14.5^{d}	267^{d}
IS 6936	34.33^{b}	20^{b}	418^{b}
MN 1500	24.59^{c}	10.5^{d}	192^{d}
Sumac	12.63^{f}	8.5^{f}	81^{f}
IS 686	17.15^{d}	11^{d}	194^{d}
SSV 108	39.61^{a}	19^{c}	381^{c}
Roce	17.16^{d}	9.5^{de}	159de
Sofra	16.68^{de}	12^{d}	170de
Satiro	15.21^{e}	13.5^{d}	246^{d}
IS 2325	31.35^{bc}	15^{d}	335^{c}
E 36-1	33.33^{b}	23^{b}	434^{b}
IS 6973	38.52^{a}	18^{c}	344^{c}
SSV84	40.05^{a}	26^{a}	524^{a}

Values of letters (a, b...) within each column followed by the same letter are not significantly different at 5% level, using Duncan multiple rang test

moderately salt tolerant. Netondo *et al.* (2004) reported that sorghum plants sequester Na^+ predominantly in roots, stems, leaf sheaths, and older leaf blades sparing the growing tissues as a salt tolerance mechanism. Table 4 shows that MN1500 had the highest sodium concentration in the leaves although it was not significantly different with other cultivars such as Sofra, Roce and M81E. Under saline conditions the salt sensitive sorghum genotypes accumulated more toxic ions, *i.e.* Na^+ and Cl^-, in the leaves than salt tolerant cultivars (Lacerda *et al.,* 2003). It seems that in addition to SUMAC, these cultivars (Sofra, Roce and M81E) were sensitive to salt. Table 4 shows that concentration of Cl^- in the roots and shoots of sweet sorghum cultivars was significant at 5% level.cultivar IS2325 had the lowest Cl^- concentration in the leaves (514 mmol kg^{-1} d. wt.). Although, this concentration of Cl^- was not significant for some cultivars such as SSV84 that was previously suggested as a salt tolerant among other cultivars. Low concentration of Cl^- in the leaves is related to plant salt tolerance (Schachtman and Munns, 1992). Therefore, it seems that SSV84 was better salt tolerance than other cultivars. Based on the plant dry weight, SUMAC was previously suggested as a salt sensitive among other cultivars had higher Cl^- in its roots than other cultivars which confirmed our early suggestions. Cultivar SSV108 had lowest Cl^- concentration in the root (455 mmol kg^{-1} d. wt.). Although, this concentration of Cl^- was not significant for some cultivars such as SSV84 that previously was suggested as a salt tolerant among other cultivars confirming our earlier suggestions. Cultivars IS6973 and SSV108 were previously suggested as moderate salt tolerant had lower Cl^- concentration in the roots and shoots than other cultivars. Lacerda *et al.* (2001) reported that in sorghum the transfer of Na^+ and Cl^- to the shoot was always higher in sensitive genotypes. Therefore, it is expected in sensitive cultivars more Cl^- is accumulated in leaves than in roots. Thus, it seems that MN1500, IS9639, IS686 and Sofra cultivars in addition to SUMAC were characterized as salt sensitive cultivars. The shoot and root dry weights of these cultivars were lower than others which supports our findings. Table 4 shows that SSV84 cultivar had highest K^+ concentration in leaves, although the difference with respect to other cultivars was not significant. Lacerda *et al.* (2003) reported that K^+ concentration in leaves of salt tolerant sorghum was higher than sensitive cultivars which is in agreement with the present results. In wheat a relationship between K^+ ion accumulations and tolerance to salinity has been found (Rascio *et al.,* 2001). Therefore, it seems that SSV84 cultivar with highest K^+ concentration in leaves was most salt tolerant cultivars. K^+ concentration in the leaves of Vespa was lower than other cultivars and therefore it seems it was considered as salt sensitive cultivar. SSV108 and IS9639 had the highest and the lowest K^+ concentration in roots, respectively. So, cultivars SSV108 and IS9639 were moderate and sensitive to salt stress respectively, which is consistent with our earlier findings. Table 4 shows that K^+/Na^+ ratio concentration in shoots was significantly different. This ratio for IS2325 and SSV84 cultivars was higher than other cultivars. In this regard, Lacerda *et al.* (2005) reported that in sorghum, salinity increased Na^+/K^+ ratio, especially in the leaves of salt sensitive genotype. This means that K^+/Na^+ ratio would decrease and therefore it seems that IS2325 and SSV84 cultivars were salt tolerant because Na^+/K^+ ratio in these cultivars was higher than others which is in agreement with previous findings. IS6973 cultivar showed the highest seed germination and

Table 4 : The concentration of ions in shoot and root of 18 sweet sorghum cultivars grown under -0.4 MPa NaCl treatments during 12 days period

Cultivar	Ion/ Dry Weight (mmol/kg) in Root				Ion/Dry Weight (mmol kg^{-1}) in Shoot			
	Cl^-	Na^+	K^+	K^+/Na^+	Cl^-	Na^+	K^+	K^+/Na^+
IS 9639	974abc	2225a	191f	0.22a	1146abc	2044bcde	952.3bcd	0.49b
Sova	755abc	1389a	336def	0.22a	954abcd	1451bcde	899.3bcd	0.77b
Vespa	845abc	1056a	313.3def	0.21a	709bcd	1074de	671.3d	0.62b
S 35	811abc	2242a	525.6abcde	0.28a	1007abcd	2103bcd	1123ab	0.61b
M 81E	1097ab	1696a	231.66ef	0.12a	959abcd	2680ab	725cd	0.25b
IS 19273	779abc	1977a	361.3def	0.17a	864abcd	1718bcde	933bcd	0.62b
IS 6936	521bc	1679a	712abc	0.43a	575cd	1375bcde	735cd	0.61b
MN 1500	543bc	1103a	419.6bcdef	0.37a	1420a	3615a	904bcd	0.30b
Sumac	896abc	1810a	265.3def	0.13a	1147abc	2069bcd	946bcd	0.42b
IS 686	736abc	2083a	543.3abcd	0.26a	1279ab	1679bcde	1087.3ab	0.67b
SSV 108	455c	1501a	750.3a	0.49a	701bcd	1410bcde	1150ab	0.96b
Roce	780abc	1873a	324def	0.17a	939abcd	2561abc	733cd	0.28b
Sofra	708abc	1593a	412cdef	0.29a	1202abc	3336a	1011abc	0.39b
Satiro	592bc	1699a	680abc	0.39a	608cd	1400bcde	763cd	0.54b
IS 2325	614bc	1645a	524abcde	0.34a	514d	703e	1036abc	1.977a
E 36-1	1311a	1945a	571abcd	0.30a	945abcd	1245cde	760cd	0.59b
IS 6973	499bc	2060a	528abcde	0.26a	786bcd	1666bcde	776cd	0.52b
SSV84	496bc	1611a	720ab	0.49a	652bcd	1374bcde	1265a	1.577a

Values of letters (a, b...) within each column followed by the same letter are not significantly different at 5% level, using Duncan multiple rang test

subsequent moderate seedling growth stages. Therefore, it can be classified as moderate salt tolerant cultivar (Hadi et al., 2007). The amount of Na^+, K^+ and Cl^- concentration in plant confirmed our findings. However, K^+/Na^+ ratio index is a better indicator for selecting salt tolerance cultivar.

Based on this study, Roce, Sumac and IS6973 cultivars showed better tolerance to salinity stress than other cultivars at germinating stage. However, SSV84 showed highest germination percentage and at seedling growth stage it had the highest biomass than other cultivars. Therefore, it seems that among sweet sorghum cultivars, SSV84 was the most salt tolerant cultivar and it is suggested to be planted in salt affected agricultural lands.

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