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Effect of Salinity Stress on Plant Green Weight and Nutrient Value of Soybean (*Glycine max* (L.) Merrill) Cultivars

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Soil salinity is a major limitation to crop production in many areas of the world. A pot experiment was carried out with soybean cultivars to investigate the effects of salinity stress on plants growth and nutrient composition at 150 mM NaCl concentration under greenhouse conditions. Twelve soybean cultivars were exposed to salinity treatments (0 and 150 mM NaCl and control). All cultivars were harvested 45 d after plantation. Green parts of 45-day old plant weights were recorded. Soybean cultivar plants were divided into root, shoot and leaf parts for nutrient (K^+, Na^+, Ca^{2+} and Cl^-) content measurements. Salinity stress negatively affected soybean cultivars and the effects varied according to the salt tolerance of the cultivars. Generally, salinity reduced the green weight. Salt stress decreased K^+, Ca^{2+}, contents and K^+/Na^+ rations in plants, but significantly increased Na^+ and Cl^- content in the roots, shoots and leaves of all cultivars. In the salt treatment, K^+, Ca^{2+}, concentration and K^+/Na^+ rations were high in leaf compared with those in roots and shoots. However, the highest increase in Na^+ and Cl^- contents were observed in the roots and shoot of plants. Under salinity, Mancon, Stresland and Althow varieties retained the highest K^+ and Ca^{2+} content in leaves, related to K^+ the varieties were not effected under 150 Mm NaCl treatment.

Key Words: Soybean, *Glycine max* (L), Salt stress, Green weight, Nutrient accumulation.

INTRODUCTION

About 7 % of the world's total land area is affected by salt, as is a similar percentage of its arable land[1,2]. Salinization causes negative effects on plant productivity and poses an increasingly serious threat to the sustainability of agriculture. One of the most widespread agricultural problems in arid and semiarid regions is soil salinity, which renders fields unproductive. In saline soils, NaCl is the most common salt. High salinity may induce imbalances in the soil, plant osmotic relationships[3] and in plant metabolism[4]. According to a report, of the world's irrigated lands, about 20 to 27 % may be salt affected[1]. However, the impact of this menace on human population particularly associated with agriculture is very high, so that communities affected are considerably and economically deprived.

Salinity reduces the ability of plants to take up water. During a short time of salinity, there will be a significant decrease in growth rate, but the decrease may be the same for species that have quite different reputations for salt tolerance. Salinity can affect growth in a number of ways. The first phase of the growth response is due to the osmotic effect of the salt in the soil solution[5], Later there may be an additional effect on growth; if excessive amounts of salt enter the plant they will eventually rise to toxic levels in the older transpiring leaves, causing premature senescence. This will reduce the amount of assimilate that the plant can produce and a reduction in the assimilate transported to the growing tissues may further limit the growth of the plant. This is the second phase of the growth response and is the phase that clearly separates species and genotypes that differ in the ability to tolerate saline soil. Most of the salt stress in nature is due to sodium chloride salts[6]. Salinity can damage the plant through its osmotic effect, which is equivalent to a decrease in water activity, through specific toxic effects of ions and by disturbing the uptake of essential nutrients[6,7].

Previous workers[6,8,9] have reported that ion balance was impaired in the body part of plant in saline stress and increased amount of sodium intake competed with the intake of other mineral substances and caused malnutrition. It suggests that where there is an abundance of sodium chloride in the growth media, plants take the Na^+ and Cl^- ions more than necessary and reductions occur in K^+ ion intake due to the resulting competition, thus resulting in K^+ deficiency. It is a known fact that potassium intake is reduced in the plant in a growth media with high sodium ion. High saline concentrations reduce plant intake and transport of Ca^{2+}, causing calcium deficiency and ion imbalance in the plant. Calcium is an element with positive effects for the plant in saline stress.

Soybean is a major food and oil crop in most countries where salinity problems exist or might develop. Large areas of formerly arable land are being removed from crop production every year due to increasing soil salinity. Use of saline irrigation water and application of fertilizer are the main factors responsible for increasing soil salinity[10]. Reducing the spread of salinization and increasing the salt tolerance of high yielding crops are important global issues. Wild soybean (*Glycine soja*) can survive in highly saline conditions, therefore provides an ideal candidate plant system for salt tolerance gene mining[11]. Soybean is moderately salt tolerant and may be cultivated in a light moderate saline soil[12]. Soybean (*Glycine max* (L) merill) grown in this condition may not only be exposed to salinity stress.

The objectives of the present article are to investigate the effect of salinity on the growth of soybean plant seedlings and to study the nutrient (K^+, Na^+, K^+/Na^+, Ca^{2+} and Cl^-) contents and K^+/Na^+ rations in the successive leaves, shoots and roots under salinity stresses.

EXPERIMENTAL

An experiment was conducted in pots filled with soil in the greenhouse of the Horticulture Department of Agriculture Faculty of Yuzuncu Yil University Van (Turkey) during April-June 2007. The experiment was carried out using a complete randomized design containing of non salinity and sodium chloride application (0 and 150 mM) with 3 replications. Twelve soybean (*Glycine max*) cultivars (Omaha, A-3127, Mancon, Stresland, LN-89-3264, NE-3297, AP-2292, Althow, Irigious, S-4520, Amsoy-71 and Cisne) were used as experimental material. The daily air temperature ranged from 10 to 30 ºC, with the daily average temperature being about 25 ºC. Relative humidity fluctuated between 30 and 85 %, the average value was about 60 %.

Ten seeds of each cultivar were sown directly in plastic pots containing 4 kg of field soil. Thinning was carried out 15 d after planting, leaving four plants in each pot. Surface soil was collected from an agricultural field and passed through a 2 mm mesh screen. The texture of the soil based on sand clay silt, total organic matter 1.96 %, total salt 0.035 %, pH 7.30, total nitrogen 0.9 %, available phosphorus 8.92 ppm in dry soil, exchangeable potassium 480 ppm in dry soil. All pots were fertilized with urea as a nitrogen fertilizer equivalent to 150 kg N ha^{-1} and triple-super phosphate (80 kg P_2O_5 ha^{-1}) were incorporated into the soil before seeding. Salinity treatments, non-salt-treated plants were kept as controls and salt-stressed plants were subjected to 150 mM NaCl 30 d after sowing and all plants, including controls, were then sampled. The salinity treatments were maintained until final harvest. The pots were randomly arranged in a greenhouse and rearranged several times during the growth period. Immediately after sowing, soils were watered and watering was carried out regularly every 2 days during experiment (45 d) and 150 mM NaCl application was given together with water. Plants were irrigated until saturated, with the excess solution allowed to drain into collection pans.

All genotypes were harvested 45 days after planting. Samples were washed in distilled water to remove salts from the tissue surfaces, All green parts were weighed. Roots, shoots and leaves of the soybean plants were separated for nutrient (K^+, Na^+, Ca^{2+} and Cl^-) contents and K/Na^+ measurements.

Nutrient contents: For ion determination, fresh samples of roots, shoots and leaves were extracted in conc. 0.1 N nitric acid. Na^+, K^+ and Ca^{2+} contents were determined by flame photometry in the samples from soybean plants[13]. Relative ion accumulation (Na^+, K^+ and Ca^{2+}) in whole plant was calculated as described by Taleisnik and Grunberg[13]. For chloride determination, Cl^- was determined by the silver ion-titration method with a automatic chloridometer (Buckhler-Cotlove chloridometer) according to Bozcuk[14].

Data were analyzed by an analysis of variance using SAS (1985) software to test the significance of the main effects. Means were compared using LSD multiple range tests.

RESULTS AND DISCUSSION

In the 12 soybean genotypes used in salt treatments, the first marked symptomatic effect of toxic-level of the salt treatment in the soybean genotypes was a reduction in plant growth and therefore in the green weight. According to the result of variance analysis salt stress influenced plant fresh weight significantly ($p < 0.01$).

The effects of 150 mM NaCl treatment on the plant fresh weight of 12 soybean cultivars are shown in Table-1. Growth was significantly reduced by NaCl treatment. Fresh weight varied between 4.38 g and 6.23 g in controls. In general, salt stress was detrimental to plant fresh weight, but the effect ratio differed amongst the genotypes. Plant fresh weight of plants under salt stress at final harvest were significantly reduced compared with those of plants in the control treatment (Table-1). Ne-3297 was affected (25 % reduction compared to controls) more than the other cultivars. Mancon (4.5 % reduction compared controls) and A-3127 (11 % reduction compared controls) showed smaller reductions. The results reported here indicate that the cultivar A-3127 and Mancon are relatively salt-tolerant compared with other cultivars. They can be considered more tolerant to salinity than the other cultivars at the salinity.

Reduction in plant growth as a result of salt stress has also been reported for several other plant species[9,15-18]. The present results confirm these earlier observations of growth reduction due to NaCl treatment. Probably the negative effect of salinity on plants provoke osmotic potential by salt in the culture medium, so root cells do not obtain required water from medium[19]. Therefore in plants the uptake of some mineral nutrients dissolved in water are also restricted. Thus, growth and development of plants are inhibited due to occurring defect in metabolism. Some investigators thought that because of ion accumulation by changing membrane permeability, metabolism was negatively influenced[20,21]. Most crop plants suffer after exposure to saline conditions and showed decline in growth. The deleterious effect of salinity was suggested as a result of water stress, ion toxicities, ion imbalance, or combination of all these factors[22].

Salt stress significantly ($p < 0.01$) influenced nutrient contents in all cultivars. The concentrations of nutrient elements (K^+, Na^+, K^+/Na^+, Ca^+, Cl^-) in leaves, shoots and roots are presented in Table-1.

The K^+ contents of the 12 cultivars were affected differently by NaCl treatment (Table-1). Significant differences were determined between varieties for K^+ content. In related study, it is indicated the difference in nutrient content according to soybean varieties[23]. When compared to control plants, salt treatment caused significant decreases in K^+ content of all varieties with the exception of Mancon, Stresland and Althow varieties. Under salinity, these varieties showing that the highest K^+ content in leaves, not affected under NaCl treatment. The application of salinity caused marked reduction in concentrations of K^+ in roots all varieties except Mancon. However, it was observed in this study that the K^+ concentration in leaves and shoots of some varieties under salinity were slightly lower than those of control plants.

The results indicate that there was a competition between Na^+ and K^+ regarding their uptakes. The salt-tolerant genotype has a greater K^+ accumulation capacity. Similar results were reported with different green bean[24] and soybean varieties[9,17].

In the salinized treatment, the K^+ concentration was highest in leaf compared with root and shoot. There was no difference between root and shoot for salt stress. The K^+ concentrations in shoots and roots of all varieties were decreased under salt stress except Mancon and Stresland varieties. Generally, the concentration of K^+ in the leaves of Amsoy-71 was higher than that in the other cultivars. In this study, the effects of salt stress on roots, shoots and leaves of soybean cultivars were found to be significantly different. Cultivar LN-89-3264 leaf (18 % reduction compared to controls), Ne-3297 cultivar shoot (21 % reduction compared to controls) and AP-2292 cultivars root (29 % reduction compared controls) were affected more than the other cultivars under salt stress. In a related study, it was noticed that accumulation of ion on roots, shoots and leaves changed under salt stressed plants[24]. The K^+ content in plant tissues represents the main cation in plant cells and is an important component of the cell osmotic potential[25]. Generally, in present study soybean cultivars root, shoot and leaf K^+ concentrations were lower at salinity application than control. These results are similar to those reported by previous workers[12,17], who found that K^+ was reduced by salt stress in soybean cultivars. One of the primary plant responses to salinity is the decrease in K^+ concentration in plant tissues[23] and thus the substitution of K^+ by Na^+ may lead to nutritional imbalances. Both these ions might compete for entry into plant root cells. This competition can have significant negative effects on plant growth in saline soils, where concentrations of sodium often exceed those of potassium

Twelve soybean genotypes had a higher Na^+ accumulation in all organs than control when Na^+ accumulation was investigated in genotypes under salt stress. The Na^+ contents in the all organs of the 12 cultivars significantly increased with NaCl treatment (Table-1). When compared to control plants, salt treatment caused significant increases in Na^+ content of all varieties. Under salinity, Mancon, LN-89-3264 and AP-2292 varieties retained the least Na^+ content in leaves among other varieties. Generally, salt-tolerant plants differ from salt-sensitive ones mainly in having a low rate of Na^+. It is suggested that the capacity of ion accumulation of plants is related to their tolerance to salt stress. It was found that tolerant species accumulated lower Na^+ and decreasing of K^+ was lower than sensitive species[9,18,24].

The trend of Na^+ accumulation by the leaves of the cultivars studied was different from that for K^+ accumulation. However, there was less increase in Na^+ deposition in leaves than other organs of cultivars. The highest increase was observed in the roots and shoots of plants. The Na^+ concentration in the leaves was only slightly higher than that in the shoots. The highest Na^+ accumulation was observed in A-3127 cultivar root, Omaha cultivar shoot and Cisne leaf among plants grown under stress (Table-1).

TABLE-1
IN ROOTS, SHOOTS AND LEAVES OF SOYBEAN VARIETIES NUTRIENT ACCUMULATIONS (µg/mg FRESH WEIGHT) AND GREEN WEIGHT UNDER SALT TREATMENT AND NON-SALT TREATMENT

N	PO	T	Omaha	A-3127	Mancon	Stresland	LN-89-3264	Ne-3297	Ap-2292	Althow	Ir?g?ous	S-4520	Amsoy 71	Cisne	T.M	PMO
Na^+	Root	0	1.43 cd	1.61 bd	1.24 d	1.76 bc	1.42 cd	1.29 d	1.35 d	2.32 a	1.30 d	1.84 b	1.35 d	1.36 d	1.52	2.61 A
		150	3.93 b	4.30 a	3.40 c	3.68 bc	3.63 bc	3.68 bc	2.64 d	4.41 a	3.63 bc	3.69 bc	3.62 bc	3.72 bc	3.69	
	Shoot	0	1.48 cd	1.24 d	1.17 d	1.33 d	1.21 d	1.25 d	1.76 c	1.24 d	1.42 cd	1. 44 cd	2.39 b	2.78 a	1.44	2.08 B
		150	3.73 b	3.11 c	2.48 ef	2.83 cd	2.53 df	2.75 de	2.26 fg	2.11 g	2.33 fg	2.23 fg	3.43 b	5.57 a	2.71	
	Leaf	0	1.58 bc	1.51 c	1.50 c	1.85 ac	2.08 a	1.78 ac	1.93 ab	1.64 bc	1.87 ac	1.53c	1.82 ac	1.51 c	1.71	1.99 C
		150	2.43 ac	2.61 ab	1.67 e	2.29 bd	2.15 cd	2.15 cd	2.05 d	2.07 cd	2.25 cd	2.14 cd	2.61 ab	2.75 a	2.27	
K^+	Root	0	21.0 ce	21.6 bd	21.7 ad	22.7 ab	22.9 ab	20.7 de	23.2 a	17.4 g	22.3 ac	21.2 ce	18.7 fg	19.8 ef	21.1	20.2 B
		150	17.5 ef	21.3 ab	22.7 a	19.7 cd	22.6 a	18.6 de	16.5 f	17.2 ef	16.3 f	20.6 bc	19.5 cd	18.6 de	19.3	
	Shoot	0	23.9 ab	18.5 fg	20.6 de	20.0 e	24.0 a	24.6 a	21.6 cd	23.3 ab	19.5 ef	17.6 g	22.4 bc	18.2 fg	21.2	20.3 B
		150	20.8 ab	17.7 d	20.9 a	20.0 ab	21.5 a	19.4 bc	21.4 a	20.6 ab	18.2 cd	17.2 d	17.8 d	18.1 cd	19.5	
	Leaf	0	20.3 df	23.4 a	21.5 ce	18.8 f	21.8 c	20.1 ef	21.7 cd	19.9 f	22.7 bc	19.8 f	24.2 a	21.9 c	21.3	20.9 A
		150	19.4 de	20.4 d	22.1 ab	21.4 bc	18.0 e	18.3 e	21.1 bc	21.4 bc	22.5 ab	19.3 de	23.1 a	18.9 de	20.5	
K^+/Na^+	Root	0	14.7 bc	13.5 cd	17.6 a	12.9 cd	16.3 ab	16.1 ab	17.2 d	7.5 e	17.2 a	11.6 d	13.8 cd	14.6 bc	14.4	9.85 B
		150	4.46 ab	4.95 ab	6.66 a	5.4 ab	6.2 ab	5.1 ab	6.3 ab	3.9 b	4.5 ab	5.6 ab	5.4 ab	5.0 ab	5.3	
	Shoot	0	16.1 bc	14.9 cd	17.6 ab	15.0 cd	19.8 a	19.8 a	12.3 e	18.9 a	13.9 ce	12.4 e	9.4 f	13.4 de	15.3	11.4 A
		150	5.57 cd	5.67 cd	8.5 ab	7.1 bd	8.5 ab	7.1 bd	9.7 a	9.8 a	7.8 ac	7.8 ac	5.2 d	6.5 bd	7.4	
	Leaf	0	12.9 be	15.6 a	14.4 ac	10.1 f	10.6 ef	11.5 df	11.3 df	12.2 cf	12.2 cf	12.9 be	13.5 ad	15.1 ab	12.7	10.9 A
		150	8.05bd	7.79 cd	13.40 a	9.3 bd	8.4 bd	8.7 bd	10.4 b	10.4 b	9.9 bc	9.1 bd	8.9 bd	6.9 d	9.3	
Ca^{2+}	Root	0	0.82 c	0.90 c	0.89 c	0.75 c	0.86 c	0.85 c	1.50 b	1.08 c	0.89 c	1.01 c	0.86 c	1.85 a	1.02	0.95 C
		150	0.75 c	0.75 c	0.79 c	0.88 c	0.75 c	0.73 c	1.58 a	0.84 c	0.61 c	0.89 c	0.69 c	1.20 b	0.88	
	Shoot	0	2.92 b	2.55 c	3.09 b	1.36 f	1.68 e	2.6 c	2.08 d	2.22 d	1.00 g	1.08 fg	4.14 a	2.05 d	2.23	1.85 B
		150	1.48 cd	1.67 c	2.86 a	1.25 de	1.65 c	1.04 ef	2.06 b	0.87 f	1.02 ef	1.23 de	1.76 c	0.74 f	1.47	
	Leaf	0	2.89 cd	3.16 bc	2.73 d	3.31 ab	1.66 g	2.04 f	2.05 f	3.50 a	2.11 ef	3.15 bc	3.35 ab	2.36 e	2.69	2.38 A
		150	2.36 bd	1.85 e	2.42 bc	2.55 b	0.85 g	1.24 f	2.38 bd	2.07 de	2.14 ce	3.15 a	2.50 b	1.25 f	2.06	
Cl^-	Root	0	1.96 e	3.97 a	2.77 cd	3.53 ab	1.84 ef	2.35 de	1.84 ef	3.44 b	3.53 ab	2.34 de	1.34 f	3.16 bc	2.67	4.17 A
		150	6.83 a	6.53 ac	4.26 e	6.14 cd	5.93 d	6.63 ac	4.57 e	7.04 a	6.69 ab	5.79 d	4.41 e	3.42 f	5.68	
	Shoot	0	1.45 ef	2.31 cd	1.34 f	1.76 ef	1.83 df	4.15 a	2.58 c	1.50 ef	1.47 ef	1.91 de	2.6 c	3.43 b	2.19	3.71 B
		150	6.78 b	4.51 d	3.28 e	6.32 b	7.35 a	5.77 c	4.68 d	4.55 d	3.35 e	4.28 d	5.68 c	6.33 b	5.23	
	Leaf	0	1.92 bd	1.55 ce	2.19 ab	2.09 ac	2.17 ab	1.31 e	1.84 be	1.85 be	1.38 de	1.71 be	2.58 a	1.81 be	1.87	2.93 C
		150	5.63 c	7.27 b	2.31 fg	5.13 d	3.42 e	3.69 e	2.85 f	2.11 g	2.66 f	2.53 fg	7.6 ab	2.83 f	4.00	
Green weight		0	5.18 cd	5.03 de	5.25 bd	5.99 de	4.62 ef	5.17 cd	4.43 f	4.56 ef	5.65 bc	5.72 b	6.23 a	4.38 f	5.10	
		150	4.02 cd	4.46 bc	5.03 a	4.79 ab	3.80 d	3.88 d	3.87 d	3.71 d	4.86 ab	4.93 ab	5.30 a	3.86 d	4.38	

Mean values indicated by the same latter are not significant different ($p < 0.05$).
N = Nutrient; PO = Plant organs; T = Treatment; TM = Treatment mean; PMO = Plant organs mean.

Wolf *et al.*[26] with barley, Yasar *et al.*[24] with green bean, Wang and Han[27] with alfalfa and Li *et al.*[17] with soybean, reported similar results and indicated that the distribution of Na^+ ions varied among organs of plants and genotypes that tolerate salt well. High Na^+ content generally disrupts the nutrient balance, thereby causing specific ion toxicity despite disturbing osmotic regulation[8,28]. Preferential accumulation of Na^+, Cl^- or both is known to account for salt tolerance in crop species and specific injury due to the accumulation of these ions rather than osmotic stress was suggested to be the major factor for salt sensitivity[28,29].

The ratio of K^+/Na^+ was influenced significantly by high NaCl treatment. Treatment of soil salinity resulted in decreasing K^+/Na^+ ratios in all cultivars. Generally, higher ratios of K^+/Na^+ were found in Mancon, Ap-2292 and Althow cultivars than the other cultivars under NaCl treatment (Table-1). The postulated that K^+/Na^+ ratios might be a valid selection criteria for assessing salinity tolerance of different crop species. Previous studies have shown that high K^+/Na^+ ratio had a positive relationship with salt tolerance[9,18]. These findings are in agreement with an other report suggesting that salt stress reduces the K^+/Na^+ of green been[24], mellon[18], wheat[30] and Legume[31] plants. These results indicate that salt tolerance mechanisms may display differences according to cultivars. In the salinized treatment, the K^+/Na^+ concentration was highest in leaf compared with root and shoot. There was no difference between leaf and shoot for salt stress. K^+/Na^+ concentrations in roots of all varieties decreased under salt stress.

All saline-stressed plants gave lower Ca^{2+} content compared to control plants. There were significant differences between varieties for Ca^{2+} content. In this study, NaCl treatment decreased significantly Ca^{2+} content in all cultivars, except for Ap-2292, Irigious, S-4520 and Mancon. In these varieties, significant differences between control and NaCl treatment were not found for Ca^{2+} content under salinity. This result showed that those varieties concerned can maintain Ca^{2+} uptake although high salt concentration, as being differed from the other cultivars. Furthermore, Ne-3297 and Cisne varieties had the least Ca^{2+} contents in the all organs than other cultivars under salt conditions (Table-1). These results indicate that salt tolerance mechanisms may display differences according to cultivars. In all organs contents of Ca^{2+} were influenced significantly in result of salinity treatment (Table-1). Compared to the control, Ca^{2+} content in leaf, shoot and root were decreased under salinity. In the salinized treatment, the Ca^{2+} concentration was highest in leaf compared with root and shoot. Concentrations of Ca^{2+} in the roots were lower than shoots and leaves.

Calcium has been shown to ameliorate the adverse effects of salinity on plants[31]. Calcium is well known to have regulatory roles in metabolism[20] and Na^+ ions may compete with Ca^{2+} ions for membrane binding sites. Therefore, it has been suggested that high calcium levels can protect the cell membrane from the adverse effects of salinity.

The effect of salinity on the nutrient composition of plant tissues, especially concentration of Ca^{2+} and K^+, have been extensively investigated and several researchers have confirmed that the deterimental effects of salinity on plant growth may occur through an ionic imbalance, particularly[9,18,24] of Ca^{2+} and K^+. Some species and varieties can maintain higher growth under saline conditions by accumulating fewer toxic ions and maintaining a high tissue Ca^{2+} concentration[9].

There were substantial differences in Cl^- content with NaCl treatment and rate of accumulation among cultivars. Cl^- contents of A-3127 and Amsoy-71 were considerably higher than these of the other varieties in salinity medium. Mancon and AP-2292 cultivars less affected compared with other cultivars under salt stress. In the salinized treatment, the Cl^- concentration was the highest in root compared with leaf and shoot. Generally, salt-tolerant plants differ from salt-sensitive ones mainly in having a low rate of Na^+ and Cl^-. Experiments using different genotypes differing in rates of Na^+ or Cl^- accumulation may be able to distinguish between the effects of salt in the leaf, shoot and root and salt in the soil[6]. In the present study, accumulation of Cl^- in the leaves, shoots and roots of 12 soybean cultivars were significantly increased due to salt stress, while K^+ and Ca^{2+} accumulations were decreased.

Ions at high concentrations in the external solution (*e.g.* Na^+ or Cl^-) are taken up at high rates, which may lead to excessive accumulation in tissues. These ions may inhibit the uptake of other ions into the root and their transportation to the shoot. There is the potential for many nutrient interactions in salt stressed plants which may have important consequences for growth[20]. Some researcher[17,18,30-32] reported that salinity had a major effect on the uptake and internal concentrations of mineral elements and plant grown in many plants.

As a result of this, salt stress significantly decreased plant growth, while some genotypes are affected less than other and grow equally with control plants. It was concluded that one of the most important reasons of the reduction in growth in different soybean genotypes was the Na^+ ion concentration accumulated more than necessary and at toxic level in plant body.

This study demonstrated that under saline conditions, leaf, shoot and root contents of Na^+ and Cl^- increased in soybean, while Ca^{2+}, K^+ and K^+/Na^+ contents decreased. In the light of the findings of this study, it is suggested that the Mancon cultivar is relatively salt tolerant compared with the other cultivars. It is evident that there is a substantial amount of variation in characteristics associated with salt tolerance in these soybean cultivars, for instance Cl^- exclusion and to some extent Na^+ exclusion and the ability to maintain high K^+ and Ca^{2+} levels in the leaf tissues in salt stress. However, further studies by using new techniques should be carried out to reach at more certain realistic results.

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