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Effects of Salt Stress on Ion and Lipidperoxidation Content in Green Beans Genotypes

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The response of 13 green bean genotypes used in this study to salt stress was found differently. Taking into consideration of all genotypes, generally, the genotypes showing better growth under salt stress had lower Na, higher K and Ca contents. Of green bean genotypes used this study; Ca contents of genotypes having higher fresh weight was found higher than those of genotypes having lower fresh weight under salt stress. Tolerant genotypes had higher K^+/Na^+ and Ca^{2+}/Na^+ ratios than sensitive genotypes. Differences between MDA contents of 13 green bean genotypes under grown salt stress were found significant. The lowest MDA content was obtained in GS57 showing the best growth under salinity. At the same time, this genotype had the highest K^+ and Ca^{2+} content and the second lowest Na^+ content. ES18 and GB64 genotypes also presented the same behaviours in salinity.

Key Words: Green bean genotypes. Ion accumulation, Lipidperoxidation, Phaseolus vulgaris, Salt stress.

INTRODUCTION

Like other species of Leguminaceae, bean is a sensitive plant to salt stress[1]. Ayers and Westcott[2] reported that when salinity was more than 1.0 dS/m in soil and more than 0.7 dS/m irrigation water, the yield in bean decreased and that when salinity was more than 7 ds/m in soil, there is no beans yield.

In view of tolerance to salt, there are differences among cultivated plant. Cultivars, also included in same species respond differently to salt stress. Bohra and Doffling[3] reported that salt stress caused to ion disorders in root zone of plants and excessive sodium brought on nutrition deficiency by competing with the others nutrient elements. Levitt[4] has stated that when there is too much sodium in soil. Potassium uptake is decreased by competition with sodium therefore, potassium deficiency appears in plants grown in like this soil. The fact that plants genotypes absorb different amount K^+ and Na^+, thus have different ratios of K^+/Na^+ play an important role in salt tolerance mechanism[5-8].

Elevated salt concentration decrease transport and uptake of Ca^{2+}. Therefore, Ca^{2+} deficiency and ion imbalance appear in plants[9,10]. It has been reported that Ca^{2+} has a protective role in disorder of membrane structure under salinity condition. The capacity to retain membrane integrity and ion selectivity under high salinity is essential for maintaining internal homeostasis. Like K^+/Na^+, low Ca^{2+}/Na^+ ratio in salinized plants caused to disorder selectivity of root cell membrane. In the result of this, passive uptake and toxic level accumulation of Na^+ in plants occurs[11].

The generation of active oxygen species (AOS) is a common response to salt stress[12]. AOS cause membrane lipid peroxidation, reducing membrane fluidity and selectivity. Lipid peroxidation measured as MDA (malondialdehyde, a product of lipid peroxidation) content is considered to be indicators of oxidative damage. MDA content appeared to be reliable indices of salt tolerance in rice[13] and eggplant[8].

The aim of present study was to determine case of tolerance and sensitivity of 13 local green bean varieties to salt, in term of some ion and MDA content.

EXPERIMENTAL

In this study, 13 green bean genotypes, 7 of which were selected from Basin of Van Lake, were used. The others 6 genotypes are local varieties grown in different region of Anatolia. Samsun 94, Ferasetsiz 95, 4F-89 Fransiz, Alman Ayse, GS57, ES18, ES5 and GS26 are climbing types; GB69, GB78, GB64, Kirkgünlük and Sazova 1949 are bush types.

Plant growth and treatments: The green bean seeds were germinated in plastic pots (40 × 25 × 5 cm) filled with perlite in growth chamber with 16/8 h light/dark photoperiod, at 25 ± 2ºC and 70 % humidity. After the emergency of first real leaves, seedlings were irrigated with Hoagland nutrient solution. Plants were grown in these pots until the emergency of first two true leaves. Afterwards. Seedlings were transplanted to hydroponics culture. For hydroponics culture, plastic developing dishes (25 × 25 × 5 cm) filled with Hoagland nutrient solution were used. The nutrient solution was renewed at once a week.

Seedlings were grown in control condition until emergency of fourth true leave, at which time salt stress treatment was initiated. In the salt treatment, the first increment of salt, containing 50 mM NaCl was added and additional increments of the some concentration were added daily until the salt concentration reached the final treatment level of 100 mM NaCl. Treatments were replicated four times, each repetition having 15 plants and arranged completely randomized design. Salt treatment after 14 d, six plants were harvested from each genotype at random. The plants were excised at root collar. Roots were removed and green fresh weights of above parts of plants were measured.

Ion contents: N^+, K^+ and Ca^{2+} were determined by flame photometry in samples from first two leaves on top of shots. Samples of leaf (250 mg) was rinsed in deionized double-distilled water and placed in 0.1 N HNO_3 for at least a week. Ion concentration in HNO_3 was determined[14].

Lipid peroxidation: Lipid peroxidation was determined by estimating the malondialdehyde (MDA) content in 250 mg leaf fresh weight according to Lutts *et al.*[13]. MDA is a product of lipid peroxidation by thiobarbituric acid reaction. The concentration of MDA was calculated from the absorbance at 532 nm by using extinction coefficient of 155 mM^{-1} cm^{-1}. Correction was done by subtracting the absorbance at 600 nm for unspecific turbidity.

RESULTS AND DISCUSSION

The response of 13 green bean genotypes used in this study to salt stress was found differently. In term of green fresh weight (G.F.W.), the best growth was observed in GS57 and ES18, while the lowest values were obtained from Sazova and 4F-89 Fransiz genotypes. At the same time, Na^+ contents of GS57 and ES18 was found the lower than those of Sazova and 4F-89 Fransiz genotypes. These results showed Na^+ uptake by roots of green bean (GS57 and ES18) was lower in tolerant genotypes (GS57 and ES18) than sensitive genotypes (Sazova and 4F-89 Fransiz) under salt stress condition. Taking into consideration of all genotypes, generally, the genotypes showing better growth under salt stress had lower Na^+, higher K^+ and Ca^{2+} contents (Table-1). These results are inconsistent with observations from earlier some studies on salt stress. Sacher *et al.*[15] reported that salt tolerance in tomatoes has been partially linked to the regulation of leaf Na^+ concentration. Likewise. Caro *et al.*[16] suggested that leaf Na^+ concentration could be useful as indicators of NaCl tolerance in tomato cultivars.

According to Marschner[17], Ca^{2+} play a crucial role in controlling cell membrane permeability and selectivity. In salinity induced Ca^{2+} deficiency, ion uptake and osmoregulation of plants are imbalanced, thus ion toxicity, osmotic stress and nutritional disruption occur. In this study, Ca^{2+} contents of green bean genotypes having higher fresh weight was found higher than those of genotypes having lower fresh weight under salt stress (Table-1).

Salt tolerance in tomatoes has been linked to selectivity for potassium over sodium[18]. Al-Karaki[19] and Dasgan *et al.*[20] suggested that the control of Na^+ accumulation by exclusion strategy and high K^+/Na^+ and Ca^{2+}/Na^+ ratios in shoot may enhance salt tolerance or resistance in tomato crops. Of green bean genotypes used this study; tolerant genotypes had higher K^+/Na^+ and Ca^{2+}/Na^+ ratios than sensitive genotypes (Table-1).

TABLE-1

FRESH WEIGHT OF GREEN PART OF PLANTS OF GREEN BEAN GENOTYPES (G.F.P.W.) (mg). Na^+, K^+ and Ca^{2+} ACCUMULATION (µg/mg F.W.). K^+/Na^+ AND Ca^{2+}/Na^+ RATIOS AND MALEONDIALDEHIDE (MDA) CONTENT IN FRESH LEAVES (µmol/mg F.W.)

Genotypes	Na^+ (µg/mg FW)	K^+ (µg/mg FW)	Ca^{2+} (µg/mg FW)	K^+/Na^+	Ca^{2+}/Na^+	MDA (µmol/mg FW)	G.F.W. (mg)
G.B.69	5.39de	3.20e	2.59fg	0.60e-g	0.48fh	6.900b	4255.0de
G.B.78	5.89bd	4.13ab	3.25c	0.70ef	0.56ef	5.660c	5739.0c
G.B.64	2.33j	4.07ab	3.38bc	1.75a	1.41a	3.845d	6033.3c
Kırkgünlük	3.43hi	3.88bc	2.31gh	1.00d	0.69d	7.359b	3945.0e
Sazova 1949	6.06bc	3.44d-g	2.15hi	0.57fg	0.36i	7.436b	2577.0f
Samsun94	6.91a	3.55d	3.09cd	0.52g	0.45eg	5.159c	4813.0d
Ferasetsiz 95	5.70cd	3.64cd	2.89de	0.64e-g	0.51e-g	9.391a	6460.0c
4F-89 Fransız	6.28b	3.12e	2.74ef	0.49g	0.49g-I	7.115b	2625.7f
ES18	3.49h	4.26a	2.04hi	1.23c	0.59e	3.806d	7421.0b
G.S.57	2.94i	4.23a	3.75a	1.44b	1.28b	2.973d	9424.0a
E.S.5	4.20g	4.10ab	3.60ab	0.98d	0.86c	4.927c	7213.0b
G.S.26	4.96ef	2.77f	1.90i	0.56fg	0.38hi	5.492c	7210.0b
Alman Ayşe	4.57fg	3.38de	2.33e	0.74f	0.57ef	9.802a	4406.7de

Oxidative stress indicator, the malondialdehyde (MDA) accumulation was tasted as tool for salt stress. Differences between MDA contents of 13 green bean genotypes under grown salt stress were found significant. The lowest MDA content was obtained in GS57 showing the best growth under salinity. At the same time, this genotype had the highest K^+ and Ca^{2+} content and the second lowest Na^+ content. ES18 and GB64 genotypes also presented the same behaviours in salinity. Although being exceptions, generally tolerant genotypes had lower MDA content than sensitive ones (Table-1). Lipid peroxidation, measured as MDA, appeared to be reliable indices of salt tolerance in many plants cultivars[13,21]. Shalata and Tal[22] have shown that less peroxidative damage, measured as MDA, occurs in more tolerant germplasm. Peroxidative damage under high salinity has been associated with antioxidant system in cotton and tomato[21-23]. It is therefore possible that differences in MDA contents among bean genotypes investigated in this study may be associated with their antioxidant activity.

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