

Effects of Salt and Potassium on K^+/Na^+ Ratio in Eggplant(*Solanum melongena* L) Plants

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Abstract
Using a Hoahland nutrient solution, after applying NaCl salt stress of 150 mM to the eggplant plants grown in hydroponic culture, the potassium (K^+) ratios of the solution were applied at 106, 136, 166 and 196 ppm. The study was carried out in 16/8 hour light / dark photoperiod, 25 0C and 70% humid climate room in controlled conditions. After germinating the seeds planted in the pumice, the seedlings formed in 2 real leaves were cultured in hydroponics. Sampling for measurements and analyzes was done on the 15th day of salt application. In these samples, total plant weight and root, body and leaves K^+ / Na^+ intake rates were examined. The results showed that K^+ / Na^+ ratios increased as K^+ applications increased, but increased K^+ uptake from roots.

Key Words: Eggplant, Salt stress, K / Na ratio, Total plant weight

1.Introduction

Potassium in the K^+ take from the soil by plants is a macro nutrient that regulates metabolic, physiological and biochemical functions in plants. Potassium helps transport nutrients and photosynthetic products, increases protein coverage, and balances turgor and plant water consumption. Potassium also increases resistance to diseases and pests (Kacar, 2005). Litifi et al. (1992), in a study in which the factors affecting the tolerance of plants to salt were investigated, it was determined that salt tolerance of plants is related to the limitation of Na^+ intake and that potassium plays an important role in this limitation. Plants with salt stress, proline and Na^+ concentrations are increased, while K^+ scopes have been reported to decrease in studies (Özcan et al., 2000). However, many researchers have reported that potassium applications have a beneficial effect on salt stress in their studies with different plant species (Beringer and Trolldenier 1978; Anaç et al. 1998; Bohra and Doerffling 1993; Kaya et al. 2001; Kaya and Higgs 2003). Ion regulation has an important role in the determination of salt tolerance in plants. The formation of higher levels of K+ and Ca^{+2} levels during low Na^+ and Cl^- intake of plant genotypes in salt conditions is the key mechanisms of tolerance. Plants with a tolerance to salt stress generally have the ability to produce a higher K^+ / Na^+ ratio. To determine the tolerance of salt stress in plants (eggplant, beans, melons, tomatoes and peppers), K^+ / Na^+ + and Ca^{+2} / Na^+ concentrations of different plant organs in the determination of Na^+ concentrations in the tissues is an important parameter (Marschner, 1995; Daşgan et al., 2002; Yaşar, 2003; Zeng et al., 2003; Aktaş et al., 2006; Kuşvuran et al., 2007; Daşgan and Koç, 2009).

2.Materıals and Methods

2.1.Plant material and plant growth

Long purple eggplants variety were used as material. The experiment was conducted in a split air-conditioned climate room and water culture, where the normal atmosphere was achieved.

For this purpose, 100 seed seeds were planted in pumice filled plastic germination pots and watered with tap water. The germination containers were placed in a climate chamber with a temperature of 25 ° C and a humidity of 70%. Seedlings formed from real leaves were taken into water culture in plastic containers of size 25x25x18 cm filled with Hoagland nutrient solution. After the seedlings were grown to 4-5 real leaves, salt applications were started. The trial was established according to the test method based on full chance, with three replications and 10 replicates per plant. Eggplant plants grown in hydroponic culture using Hoahland nutrient solution were applied 150 mM NaCl salt and potassium (K +) ratios of the same solution were adjusted at 106, 136, 166 and 196 ppm doses. Sampling for measurements and analyzes was done on the 15th day of salt application. Total plant weights (g) of the plants taken on the 15th day were measured. In addition, K^+ / Na^+ ratios were determined by measuring potassium and sodium deposits of root, stem and leaf samples of plants.

2.2.Determination of ion content

For ion determination, fresh samples of root, shoot, and leaves were extracted in concentrated 0.1N nitric acid. Na and K contents were determined by atomic absorption spectrometry (AAS) flame photometry in the samples from green bean plants (Kacar, 1994). Relative ion accumulation (Na+, K+ and Ca^{+2}) in whole plant (wp) was calculated as described by Taleisnik and Grunberg (1994).

The obtained data, analysis of variance was applied using the SAS statistical program. Important in the group averages were subjected to Duncan's multiple range test.

3.Results

When the total plant weight of eggplant plants applied with different doses of potassium in combination with 150 mM NaCL salt stress, significant differences were observed compared to control plants.

There has been a significant decrease in plant growth with salt application, but as the potassium dose increases, the negative effect of salt is decreased, so we see an increase in plant weight due to dose increase. The highest plant weight after control was found to be 196 ppm K^+ +150 mM NaCl aplication (Table 1).

Table 1 shows the data obtained in terms of K^+ / Na^+ ratio in root, stem and leaf as a result of salt and different doses of potassium in eggplant plants. It has also been observed that the K ion flow to the leaves from the root upwards in terms of the K^+ / Na^+ ratio in the root, body and leaves in the salt treated plants. In addition, there were decreases in roots compared to control due to the increase in potassium doses. However, the decrease in high doses was higher. The K^+ / Na^+ ratio in the root organ decreased in parallel to the dose increase compared to the control, while the body and leaves decreased compared to the control. However, this decrease was lower as the doses of potassium increased, and the highest rate of potassium in the leaf organ was 196 ppm K +150 mM NaCl aplication (Table 1).

Table 1. K/Na ratios determined from root, stem and leaf parts taken from plants after applications and total plant weights (g)

UYGULAMA	Rot K/Na	Stem K/Na	Leaf K/Na	Total Plant Weight (g)
136ppm K+0 mM NaCl	1,866 A c	7,342 A b	14,960 A a	34,55 A
106ppm K+150 mM NaCl	0,863 B b	0,733 D b	0,744 D a	9,38 E
136ppm K +150 mM NaCl	0,582 D c	0,927 CD b	1,617 C a	14,43 D
166ppm K +150 mM NaCl	0,652 CD c	1,783 B b	5,891 B a	18,71 C
196ppm K +150 mM NaCl	0,734 C c	1,808 B b	5,883 B a	24,66 B

The difference between the averages of the same capital in the same column is not significant compared to $P \leq 0.05$.

The difference between the averages with the same lowercase in the same row is insignificant compared to $P \leq 0.05$.

4. Discussion and Conclusion

On the 15th day of administration of different potassium doses with 150 mM NaCl, the highest decrease in the total plant weight of the eggplant plants was at the potassium dose of 106 ppm compared to the control plants. As the dose of potassium increased, there was a significant increase in total plant weight. Yasar, (2003, 2007); Yaşar et al. (2006, 2007, 2013, 2016) found that total plant weights were an important parameter in determining the response to salt stress in their salinity studies. The 106 ppm dose of potassium increased the adverse effect of the salt, while the 166 and 196 ppm doses were positively effective. Our results show that the growth and development of plants decrease in salt environments due to slowing of respiration of plants. As a result of disturbances in the respiratory system, decrease in stoma mobility, hormonal disorders occur in the plant and consequently decrease in the photosynthesis of the plant, consequently decrease in the formation of asimilat and decrease in plant growth and development due to all these (Çakırlar and Topçuoğlu, 1985; Yasar 2003; Yasar, 2007).

One of the most prominent features in determining the tolerance of plants to salt is ion regulation. Plants with high NaCl salt concentration receive excess Na ion. Due to the sodium ion, ionic diameters and electrical charges, the intake of K^+ ion which is very similar is prevented. However, increased K^+ and Ca^{+2} uptake during the uptake of low Na and Cl^- ions in the salt conditions of some plant genotypes is the key to establish the key mechanisms of tolerance.The tissues of plants with better tolerance to salt stress are generally capable of forming a higher K^+/ Na^+ ratio. To determine the tolerance of salt stress in plants (eggplant, beans, melons, tomatoes and peppers), K^+ / Na^+ concentrations in different plant organs in the determination of Na^+ concentrations in tissues is an important parameter (Marschner, 1995; Dashgan et al., 2002 ; Yaşar, 2003; Zeng et al., 2003; Aktaş et al., 2006; Kuşvuran et al., 2007; Daşgan and Koç, 2009).

As a result, because of its very similarity with its ionic diameters and electrical charges, the competition of K and Na ions has turned the advantage of potassium doses into its advantage. It significantly reduced Na intake. The total plant weight showed that the plants have grown at a dose of 196 ppm K in close to control. In addition, the K / Na ratio was higher in the leaves than the potassium dose increase. This situation caused the ion balance in the leaves to increase the rate of photosynthesis and to maintain the plant growth.

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