Effects of Some Presowing Treatments on Germination of Eggplant (*Solanum melongena* L.) Under Salt Stress

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Abstract: This research was carried out to determine effects of gibberellic acid (GA) (25, 50 and 100 ppm), kinetin (K) (10, 25 and 50 ppm), ascorbic acid (AA) (0.50, 0.75 and 1.00 mM) and hydropriming on germination of eggplant under salt stress (0 mM, 60 mM and 120 mM NaCl) in Atatürk University, Faculty of Agriculture, Department of Horticulture. Seeds were kept in distilled water, GA, K and AA solutions for 24 h. Then, 50 seeds were put petri dishes with 0 mM, 60 mM and 120 mM NaCl. In the study, it was determined that salt stress negatively affected germination percentage (GP) and mean germination time (MGT) in eggplant. However, it was found that hormone and water treatments significantly improved GP and MGT compared to control and ameliorated the negative effect of salt stress. The best practice for GP and MGT was hydropriming under salt stress. According to the results obtained from the study, hydropriming and hormone treatments can be used as an alternative method in reducing the negative effects of salt stress in eggplant during germination.

Keywords: Hormone, Salinity, Germination percentage, Hydropriming.

INTRODUCTION

Salinity is reported to be one of the most important factors limiting agricultural production in the world. Ghassemi *et al*. [1] suggested that soil degradation, including salinization, is the main factor that restricts the supply of nutrients to the world. Salinity is a factor affecting the entire metabolism of the plant, including morphology and anatomy [2]. The severity of these effects of salinity can vary depending on both the growth period of the plant and the genotype [3]. For example, plants are most susceptible to salt stress during germination and seedling development stage [4]. On the other hand, Demir *et al*. [5] showed that seedling stage was found to be more sensitive to salt stress than germination stage. In addition, it has been shown that there might be differences in salinity tolerance and sensitivity within the same species [6] and between different species [7].

Eggplant is classified as moderately susceptible to salinity, and salinity threshold is 1.5 dSm^{-1} [8]. Salinity has been expressed to delay and reduce germination in vegetables such as melon [9], tomatoes [10] and eggplant [11]. Reduced seed germination caused by salt may result from induction of dormancy, osmotic stress or specific ion toxicity [3]. Although there have been *in vivo* studies [5, 12], *in vitro* studies to investigate the effects of salt on eggplant is limited [13].

Different strategies are used to maximize plant growth under saline conditions. One is to produce salt-tolerant genotypes of different crops. Attempts to increase salinity tolerance by traditional plant breeding methods are time consuming, laborious, and depend on existing genetic variability. In addition, many attempts have been made to overcome this disorder, including appropriate growth and the external use of plant growth regulators [14].

Phytohormones are chemical precursors produced in one part of the plant and transferred to other parts; where they play a critical role in responding to stress at extremely low concentrations of plant responses. Phytohormones are natural products and are called plant growth regulators when chemically synthesized. Researches indicate that indole acetic acid (IAA), cytokinins (CK), gibberellic acid (GA), brassinosteroids (BR), jasmonates (JA), salicylic acid (SA) and triazoles (TR) may have effects on salt stress in plants [14].

The aim of this study is to determine the effects of hydropriming and plant growth regulators such as GA, K and AA which are applied separately at different concentrations against salt stress on seed germination in eggplant (*Solanum melongena* L.).

MATERIALS AND METHODS

This research was carried out in Atatürk University, Faculty of Agriculture, Department of Horticulture. Eggplant (*Solanum melongena* L.) "Topan 374" cultivar was used as plant material.

After the seeds were disinfected in 1% sodium hypochlorite for 10 minutes, they were washed with tap

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water and then washed with distilled water 2-3 times. The dried seeds were weighed to 5 g and put into plastic boxes (20x10x10 cm) which had two layers of blotting paper underneath. 25 ml of Gibberellic Acid (GA) (25, 50 and 100 ppm), Kinetin (K) (10, 25 and 50 ppm) and Ascorbic Acid (AA) (0.50, 0.75 and 1.00 mM) were then added. In addition, 25 ml of purified water was used as control and dry seeds without any application were used as control. Thus, a total of 10 plastic containers were prepared, including 11 applications with hydropriming and one dry application. In hydropriming treatments distilled water was used. The treated eggplant seeds were laid on blotting paper at room temperature for 24 hours.

The 50 dried seeds were placed in 15 cm petri dishes with double-layered blotting paper underneath for each replication. Petri dishes were soaked with 10 ml of 0 mM, 60 mM and 120 mM NaCl solutions. Petri dishes were randomly placed in a germination cabinet at 25 ± 2 ºC. Germinated seeds were counted and recorded daily. Germination trials continued for 14 days under dark conditions [15].

At the end of germination experiment, germination percentage (GP) and mean germination time (MGT) were determined. GP and MGT were calculated using the formulas given below.

Mean germination time (MGT) = N1 / T1 + N2 / T2 + ………. + Nn / Tn (N: Number of germinated seeds, T: Number of days of germination)

Germination percentage (MP)= number of germinated seeds / 50 × 100

In the experiment, randomized plot design was used and the obtained data were analyzed using SPSS 20 statistical package program. Percentage-related data were subjected to arc-sin transformation before analysis of variance. Data were subjected to variance analysis (ANOVA) and differences of means were determined by Duncan multiple comparison test ($P <0.05$).

RESULTS

In the study, it was found that salt stress negatively affected seed germination percentage (GP) in eggplant and the lowest mean GP was found to be 36.50% in KIN-10 treatment at 120 mM NaCl. Te greatest GP (89.00%) was obtained from GA_3-50 at 0 mM NaCl. Generally, hormone treatments positively affected GP compared to the control at all salinity levels. At 120 NaCl, presowing treatments (except for GA_3-100, KIN-10, KIN-25, AA-0.75) increased the GP compared to non-treated seeds. Moreover, Hormone treatments except GA3-100 improved the GP at 60 NaCl conditions (Figure **1**).

Figure **2** presents effects of pre-sowing treatments on mean germination time (MGT) of eggplant under salt stress. Salinity conditions significantly caused an increase in MGT of eggplant seeds. However, generally seed hormone treatments decreased the MGT compared to non treated control. Under non saline conditions, the least MGT values were obtained from GA_3-100 (4.76). Hydroprimig treatment had the least MGT at 60 mM and 120 NaCl.

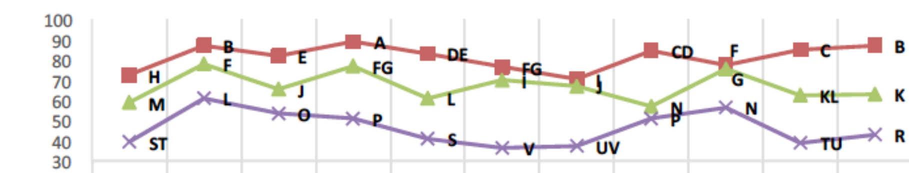
DISCUSSION

Abiotic stresses are recognized as one of the major threats to crop productivity worldwide. Stress conditions that negatively affect plant production cause more than 50% decrease in crop yield [16]. The aim of this study was to determine the effect of pre-sowing seed applications on seed germination under salt stress conditions. In the study, it was determined that different pre-sowing seed and salt stress applications significantly affected seed germination in eggplant. With the increase in salinity GP decreased, and MGT increased. However, it was determined that seed treatments reduced this negative effect caused by salt stress compared to control application (Figure **1**, Figure **2**).

Eggplant has been reported to be moderately susceptible to salt stress [17, 18]. However, tolerance to salt stress varies according to eggplant varieties [8]. Up to 50% yield loss in eggplant was observed at 8.5 dSm^{-1} soil salinity [19]. Chartzoulakis and Loupassiki [12] concluded that the first growth stages, namely germination and seedling stages, are the most susceptible to salinity stress [11].

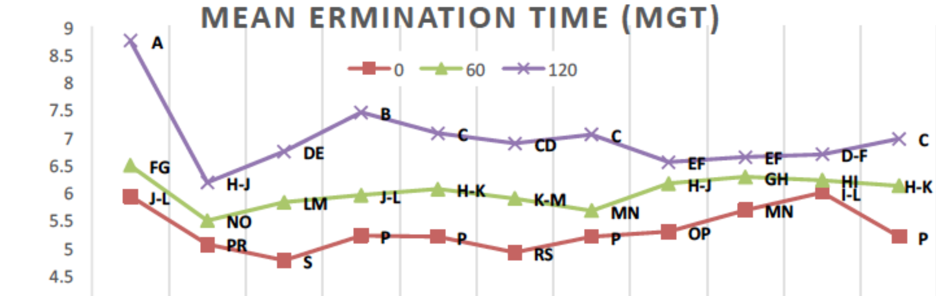
In our study, it was found that seed applications reduced the negative effects of salt stress on eggplant during germination period. In parallel with our findings, tryptophan [20], melatonin [21], GB [22, 23], GA, kinetin and ethylene [24], 24-epibrassinolide (EBR) [25], jasmonic acid (JA) [26] and salicilic acid (SA) [27] treatments have been reported to reduce the negative effect of salt stress on many plant species such as eggplant.

GA stimulates the growth potential of the embryo and weakens the structures surrounding the embryo.



	Dry	Water	GA3-25 ppm	GA3-50 ppm	GA3-100 ppm	KIN-10 ppm	KIN-25 ppm	KIN-50 ppm	AA-0.5 mM	AA-0.75 mM	AA-1.00 mM
0	72.5	87	82	89	83	76.5	70.5	84.5	77.5	85	87
60	59	78	65.5	77	61	70	67	57	75.5	62.5	63
120	39.5	61	53.5	51	41	36.5	37.5	51	56.5	39	43

Figure 1: Effects of different seed treatments on GP of eggplant.
There is no statistical difference between the means indicated by the same letter.



	Dry	Water	GA3-100 ppm	GA3-25 ppm	GA3-50 ppm	KIN-10 ppm	KIN-25 ppm	KIN-50 ppm	AA-0.5 mM	AA-0.75 mM	AA-1.00 mM
0	5.92	5.05	4.76	5.21	5.19	4.9	5.19	5.28	5.67	5.99	5.19
60	6.48	5.48	5.81	5.94	6.05	5.88	5.66	6.15	6.27	6.21	6.11
120	8.74	6.17	6.73	7.44	7.06	[illegible]	7.04	6.54	6.63	6.68	6.96

Figure 2: Effects of different seed treatments on MGT of eggplant.
There is no statistical difference between the means indicated by the same letter.

Endo-β-mannanase produced in the endosperm due to GA may help to germinate by disrupting the endosperm cell walls [28]. Gibberellins play a role in the conversion of starch to sugar to stimulate α-amylase enzyme by stimulating the enzymes involved in seed germination and transporting it from the embryo to the endosperm in the later stage of germination [29, 30].

Salt stress may also have adverse effects on seed germination by inhibiting protein and nucleic acid synthesis [31, 32]. The growth regulators used in this study may have alleviated salt inhibition on germination by increasing nucleic acid and protein synthesis. Indeed, gibberellins [33], cytokinins [34], brassinosteroids [35] and polyamines [36] have been shown to promote nucleic acid and protein synthesis in previous studies.

Gibberellins [37], cytokinins [38], brassinosteroids [39] and polyamines [40] may also alleviate the negative effects of salt stress by promoting cell division. According to the results obtained from the study, it is thought that hydropriming and hormone treatments can be used as an alternative method in reducing the negative effects of salt stress in eggplant.

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