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Effect of salinity and priming on seed germination of *catharanthus roseus*

Azadeh Mousavi Bazaz[1], Hajar Nemati[1]
[1]*Department of Horticultural Science and Landscape, Faculty of Agriculture, Ferdowsi University of Mashhad, Mashhad, Iran*
**mousaviba@um.ac.ir*

Abstract
A factorial experiment with three replications and a fully randomized design was carried out. The factors include four salinity levels using sodium chloride and five priming levels. The results showed seed priming was effective in modulating the effect of stress at all salinity levels. Potassium nitrate priming was more effective than ascorbic acid. In treatment without salt stress, the application of priming in some levels, increased seedling length and seedling vigor index compared to the control.
Keywords: Periwinkle; Potassium nitrate; Salinity, Ascorbic acid

INTRODUCTION

One of the abiotic factors that significantly restricts the growth and development of plants in green spaces is salinity stress [1]. This stress causes a delay in germination, a drop in the percentage of germination, and a decrease in seedling growth, all of which have an adverse influence on the crop's growth and production [2].

Saline water irrigation of green spaces has increased due to population growth and reduced access to clean water, which presents significant challenges for plant establishment in these areas [3]. The stage of germination and plant establishment in the soil is one of the most delicate times in a plant's life [1]. Salinity inhibits plant establishment, growth, and seed germination [4]. It has been noted that seed priming is an effective tactic for reducing the effects of salt stress in a variety of plants [5].

Seed priming can boost resistance to abiotic stressors including drought and salinity and improve the activity of antioxidant enzymes [6].

Using KCl and 2 CaCl2 in seed haloprime for wheat enhanced germination, reduced proline and Na+ levels, boosted antioxidant activity under salt stress, and strengthened plant resilience to stress [5]. It is well known that ascorbic acid strengthens plants' defenses against salt stress [7].

Ascorbic acid priming increased radish under drought stress in terms of germination indexes and enzyme activity [8]. Additionally, kale (Brassica oleracea var. capitata) [9], caper (spinosa Capparis) [10], and Cannabis sativa [11] were found to benefit from prime combined with potassium nitrate.

Madagascar periwinkle (Catharanthus roseus) belongs to the Apocynaceae family, which is an important ornamental plant in gardens and green spaces, which is cultivated as a pot, border and cover. This plant is sensitive to some environmental stresses such as salinity and drought stress, and in terms of growth and beauty, the plant undergoes a significant decline under stress conditions [12,13].

Because of the Madagascar periwinkle's aesthetic value in green spaces and its primary method of propagation through seeds, irrigation of green spaces with saline water is necessary due to a shortage of high-quality water and a lack of knowledge regarding the impact of priming on seed germination. This study was carried out to find out how priming affected plant seed germination under salt stress circumstances since the plant is under salinity stress.

MATERIALS AND METHODS

This research was conducted in 1402 in the Physiology Laboratory of Horticultural Sciences and Green Space Engineering, Faculty of Agriculture, Ferdowsi University of Mashhad.

This study was conducted as a factorial experiment based on a completely randomized design with three replications. The first factors included four salinity levels (0, 4, 8 and 12 deci-Siemens/m) and five levels of seed priming (potassium nitrate 100 and 200 mg/l and ascorbic acid 100 and 200 mg/l and distilled water).

After disinfecting the seeds, 25 seeds were placed in each petri dish with a diameter of 9 cm and placed on two Whatman filter papers, salinity for each petri dish were applied. Then, the Petri dishes were closed by parafilm and placed in the germinator with a temperature of 25oc and 12 hours light/dark period.

Germinated seeds were counted daily. The criterion for germination was 2 mm of radicle exit from the seed. At the end of the experiment, the length of the root and stem were measured.

The parameter evaluated in this experiment were:

Germination percentage $GP=(n/N) *100$ (1)

GP: germination percentage, n: number of germinated seeds, N: total number of seeds [14].

Germination rate $GS = \Sigma (ni / Ti)$ (2)

GS: the germination rate, ni: the number of germinated seeds per count, Ti: the number of days until count [15].

Seedling length

Seedling vigor index $SVl= GP\% \times SL (mm)/100$ (4)

SVI: the seedling vigor index, GP: the percentage of germination, SL: the average seedling length [16].

The data was analyzed by SAS software version 9.4 and comparison of means was done through LSD test at the five percent probability level.

RESULTS

The analysis of variance revealed that salinity stress significantly impacted all investigated traits, such as germination percentage, germination rate, average daily germination, and seedling length index (Table 1) at a 1% probability level.

Table 1. Analysis of variance for germination and seedling growth characteristics of Madagascar periwinkle under priming and salinity stress

		Mean square			
Sources of variation	df	Germination percentage	Germination rate	Seedling length	Seedling vigor index
Salinity stress (A)	3	9570.40^{**}	67.78^{**}	6294.73^{**}	8722.81^{**}
Priming (B)	4	115.73^{ns}	0.19^{ns}	57.81^{**}	98.96^{**}
Interaction AB	12	112.18^{ns}	0.45^{ns}	101.57^{**}	134.37^{**}
Error	40	6026.67	23.49	1862.67	2109.19
CV (%)		17.42	16.67	16.04	18.98

*, ** and ns are statistically significant at the probability levels of 5, 1% and not significant, respectively.

Germination percentage and Germination rate

When salinity levels rise, both seed germination percentage and rate decrease. It is important to note that there was a significant difference between salinity levels, with the lowest germination observed at 12 des/m salinity (Fig. 1 A, B).

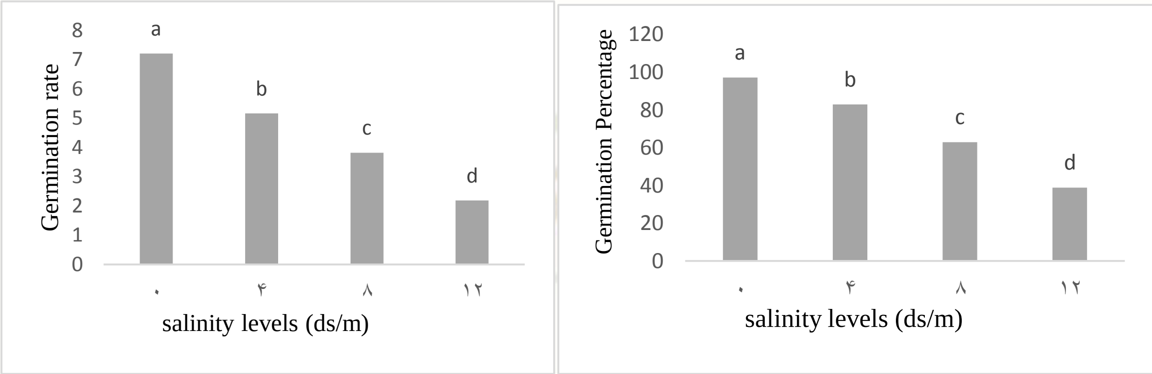

Figure 1. Mean comparison of germination percentage (A) and germination rate (B) in Madagascar periwinkle, similar letters have no significant difference at 5% probability

Seedling vigor index

The interaction effect of salinity stress and priming was significant at the 5% probability level for seedling length index (Table 1). The seedling length index decreased as salinity levels increased. At each salinity level, a significant difference was observed between different levels of priming (Fig. 2). Application of 100 ppm ascorbic acid at 0 des/m salinity stress resulted in the highest amount of this trait, followed by 100 ppm potassium nitrate. At 4, 8 and 12 des/m salinity, the seedling length index was lower at the control level (water priming) compared to the priming with potassium nitrate and ascorbic acid. At the level of 4 des/m, the highest value for seedling length index was observed at 100 ppm of potassium nitrate, which was significantly different from the control level (Fig. 2). At 8 and 12 des/m salinity, application of 200 and then 100 ppm potassium nitrate had the highest amount for the seedling length index compared to other levels (Fig. 2).

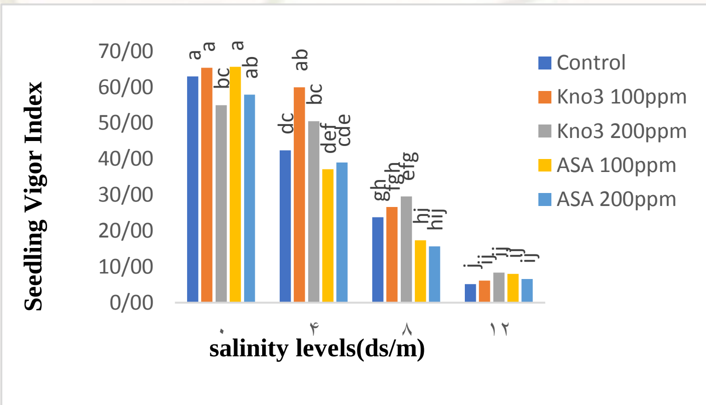

Figure 2. Interaction effect of seed priming and salinity stress on Madagascar periwinkle seedling vigor index, similar letters have no significant difference at 5% probability

Seedling length

The analysis of variance (Table1) revealed that salinity stress, priming, and the interaction of salinity and priming significantly affected seedling length at a 1% probability level (Table 1). With increasing salinity level, seedling length decreased. Application of priming at different salinity levels, led to significant difference for seedling length compared to the control (priming with distilled water). At 4 des/m salinity, priming with 100 and 200 ppm of potassium nitrate had longer seedling length than the control, and also at 8 des/m salinity, priming with 200 ppm Potassium nitrate was more than the control and had a significant difference with each other (Fig. 3). Among the different treatments, the highest amount of seedling length was observed at 100 ppm ascorbic acid and at the o des/m salinity, and the lowest amount was observed at the control and 12 des/m salinity (Fig. 3).

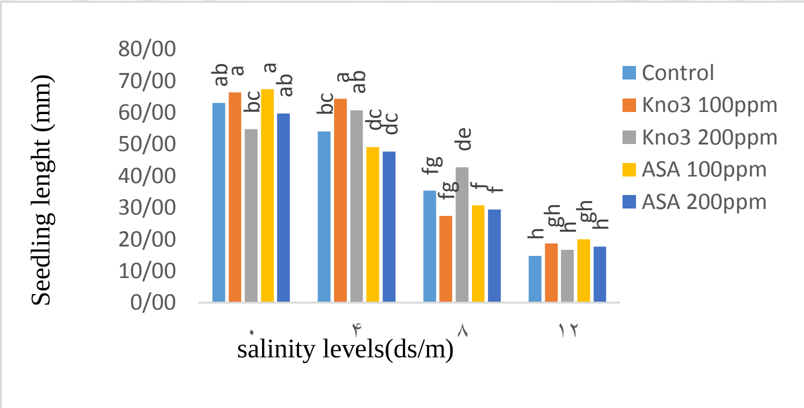

Figure 3. Interaction effect of seed priming and salinity stress on Madagascar periwinkle seedling length, similar letters have no significant difference at 5% probability

DISCUSSION

Plant growth, germination, and weight decrease with rising saline levels [7, 17, 18], which is consistent with the findings of this experiment. Salinity slows down the absorption of water, which has an impact on germination [17]. Salinity-induced reduction in seedling length has also been noted in other plants, such as *Cassia fistula* [4], mung bean (*Vigna radiata*), and soybean (*Glycine max*) [5]. In response to salt stress, plants slow down their growth in two stages: first, they use energy to deal with the stress and salt solutions; second, the buildup and toxicity of salt in components such mitochondria and chloroplasts causes the growth to be slowed down. Growth and development are hindered as a result [19].

Application of potassium nitrate and ascorbic acid at all salinity levels, had positive effect on the growth of seedlings, and the seeds primed with these compounds had better growth, and in the meantime, priming with potassium nitrate was more effective than ascorbic acid. The effective use of potassium nitrate on germination components has also been reported by Ahmadvand et al [1].

In general, based on the results obtained from this experiment, it was found that different levels of priming with potassium nitrate and ascorbic acid had a positive effect on the seedling vigor index.

The benefits of priming may result from the seedling axis's increased enzyme activity, which facilitates the transfer of substances like proteins and amino acids to the axis [1].

CONCLOSION

According to the study's findings, priming increased seedling length and vigor index. It appears that priming had an impact on the components following seed germination and on the growth parameters, but it had no influence on the components of the germination rate or germination percentage. It appears that potassium nitrate is a more efficient priming agent than ascorbic acid.

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