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Seed priming affected physiology and grain yield of chickpea under salt stress

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Abstract

In order to study the effect of priming and salinity on seed germination, physiological characteristics and grain yield of chickpea, an experiment was carried out under hydroponic condition. Results showed that germination percentage and rate significantly reduced under salt stress. KNO3 was proper trait than that of hydro-priming to improving germination rate. Leaf area index (LAI) and membrane stability index (MSI) reduced under salt stress specially sever salt level (S3). Seed priming had no effect on LAI and MSI. In contract, primed plants significantly increased leaf water content (LWC). KNO3 under sever salinity condition improved LWC of chickpea. Loss of grain yield under sever salt stress in comparison to control was 76%. Priming seed by water and KNO3 enhanced grain yield approximately 13% and 27%, respectively in comparison to control. As a result of this research chickpea was sensitive plant to salinity and priming especially by KNO3 can be improved physiological characteristic and grain yield of this plant.

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Introduction

Chickpea (*Cicer arietinum* L.) is an annual grain legume crop grown mainly for human consumption. It plays an important role in human nutrition as a source of protein, energy, fiber, vitamins and minerals for large population sectors in the developing world and is considered a healthy food in many developed countries (Abbo *et al*., 2003).

According to the studies %7 of the world lands is saline and %3 is high saline, because of low precipitation, high evaporation and irrigation by saline waters, soil salinity is getting increased (Teimouri *et al*, 2009). Salinity reduces the ability of plants to take up water and this quickly causes reductions in growth rate, along with a suite of metabolic changes identical to those caused by water stress (Abbasdokht, 2011).

Salinity is a common problem in Iran, which causes poor crop development. Different techniques could be used to improve chickpea yield under salt stress condition. One of the efficient practices which can improve seedling vigour and establishment and consequently crop performance is seed priming. Priming causes occurrence a series of biochemical changes in seeds which is associated with a more successful start of germination, seed dormancy breaking, increasing inhibitors metabolism and activating enzymes involved in germination (Ajouri *et al*., 2004). Naturally, when speed and percentage emergence of germinating seeds are being high, growing sources like light, water and nutrient will be more used (Barsa *et al*., 2006). The main objective of this study was to investigate the effect of priming techniques (hydro-priming and priming by KNO3) on some physiological and grain yield of chickpea under salt stress.

Material and methods

This experiment was arranged as factorial, based on RCB design with three replications. Treatments were priming (Control, hydro-priming and 0.8% KNO3) and salinity levels (0, 4, 8 dS.m^{-1}). Seeds of chickpea were divided into three subsamples, one of which was kept as control (unprimed) and two other sub-samples were prepared for priming. A sub-sample was soaked in tab water with electrical conductivity of 0.8dSm^{-1} and another one was pretreated with 0.8% KNO3 solution with electrical conductivity of 12.1dSm^{-1} at 20^{o}C for 6 hours. After priming, seeds dried back to primary moisture. 15 seeds were sown 3 cm deep in each pot filled with 1500 g, using 27 pots. Salinity treatments (0, 4, 8 dS.m^{-1}) were applied immediately after sowing. Tap water and saline solutions were added to the pots in accordance with the treatments to achieve 100% FC. After emergence, seedling emergence percentage and rate was counted daily and calculated according to Ellis and Roberts (1980). During the growth period, the pots were weighed and the losses were made up with Hoagland solution.

In flowering stages two plants harvested and Leaf area index was measured by LI-COR model 3100 LI Area Meter. Then, leaf membrane stability index (MSI) was determined according to the method of Premchandra *et al*. (1990) as modified by Sairam (1994). Leaf discs (100 mg) were thoroughly washed in running tap water followed by washing with double distilled water thereafter the discs were heated in 10 ml of double distilled water at 400C for 30 min. Then electrical conductivity (C1) was recorded by EC (Electrical Conductivity) meter. Subsequently the same samples were placed in a boiling water bath (100 0C) for 10 min and their electrical conductivity was also recorded (C2). The MSI was calculated as:

Membrane stability index (MSI) = [1 - (C1/ C2)] × 100.

Three leaves of a plant from each plot were cut and weighed. Samples were then dried in an oven with 75°C for 48 h. Dry samples were weighed and water percentage in leaves was determined. At maturity, plants from each pot were harvested and grain yields were determined. Analysis of variance of the data was carried out using SAS 9.1 software. Duncan test was applied to compare means of each trait at p≤0.05.

Results and dissuasion

Germination percentage and rate significantly inhibited by increasing of salt levels especially in S3. Priming had no effect on germination percentage. Germination rate significantly affected by priming. The least germination rate was showed in unprimed seeds. Priming by KNO3 had the most effect on germination rate (Tab 1). Sarmadi *et al.*, (2014) shows the positive effect of potassium nitrate on characteristics percentage of germination rate. In priming, seeds are exposed to restricted water availability under controlled conditions which allows some of the physiological processes of germination to occur and then, before germination is completed, the seeds are usually re-dried for short term storage before sowing (Halmer, 2003). Rapid and uniform field emergence is essential to achieve high yield with respect to both quantity and quality in annual crops (Subedi and Ma, 2005).

Table 1. Means of emergence percentage and rate of chickpea affected by salinity treatments.

Treatments	Emergence percentage (%)	Emergence rate (per day)
Salt stress		
S1	92.2 a	0.64 a
S2	88.3 ab	0.53 b
S3	81.14 b	0.51 b
Priming		
Control	96.32 a	0.55 c
Hydro-priming	96.66 a	0.58 b
KNO3	97.21 a	0.65 a

Different letter indicate significant difference at P≤0.05.

Leaf area index (LAI) and membrane stability index (MSI) significantly reduced by increasing salt stress. The lowest amount of LAI and MSI was showed under sever saline condition (S3) (Figs 1). As a result of this research MSI was very sensitive to salt stress. Gosset and Lucas (1994) reported that NaCl highly reduced total leaf area and fresh weight of salt sensitive cotton cultivar compared to salt tolerant cultivars. Since, membranes damage increased with increase in salinity level so MSI can be considered as very significant tool for evaluating the salt tolerance potential in pea genotypes. Similarly Shahid *et al* (2012) showed that Membrane stability index (MSI) decreased under salt stress in all the tested pea genotypes at all NaCl treatments.

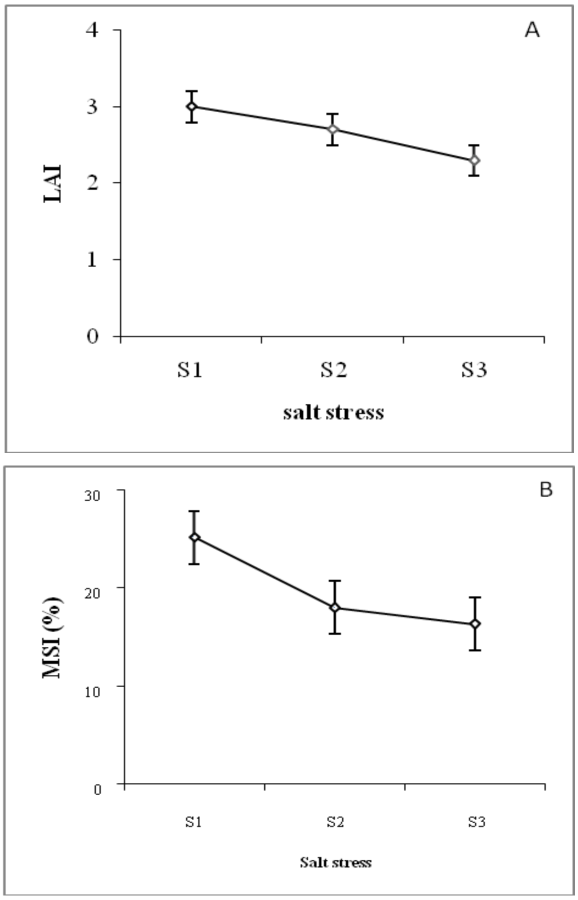

Fig. 1. Effects of salt stress (0, 4 and 8 dS/m; S1, S2 and S3, respectively) on Leaf area index (LAI) (A) and Membrane stability index (MSI) (B). Bar=±SE. P≤0.05.

Interaction of salt stress and priming was significant for Leaf water content (LWC). In all plant form primed and non-primed seed LWC declined by increasing salt levels. LWC of plants of hydro-priming under S1 was higher than that of plants of KNO3, but this variation was not statically significant. In contrast, under salt stress conditions (S2 and S3) LWC of primed plants by KNO3 was higher in comparison to S1 (Fig 2). Many important physiological and morphological processes, such as leaf enlargement, stomatal opening, and associated leaf photosynthesis are directly affected by the reduction of leaf turgor potential which accompanies the loss of water from leaf tissue (Jones and Turner, 1978). They reported that although RWC was decreased, leaf osmolality increased the slow development of water deficits resulted not only in osmotic adjustment, but also a decrease in leaf tissue elasticity.

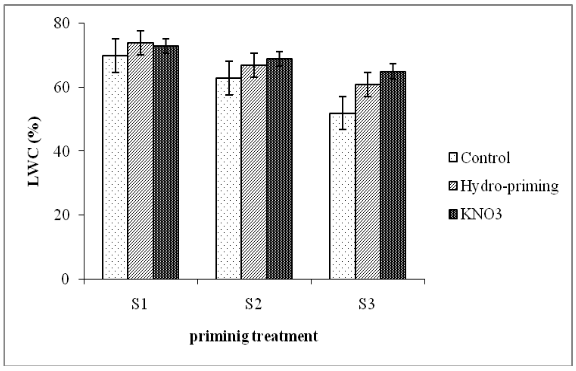

Fig. 2. Interaction of salt stress (0, 4 and 8 dS/m; S1, S2 and S3, respectively) and priming (hydro-priming and KNO3) on Leaf water content (LWC). Bar=±SE. P≤0.05.

Salt stress and priming had significantly effect on grain yield. Maximum grain yield was obtained from plants that primed by water and KNO3. Loss of grain yield under S2 and S3 in comparison to S1 was 13.55% and 76%, respectively. Grain yield of chickpea under hydro-priming and primed by KNO3 was 13% and 27%, respectively, more than that of control plant (Figs 3). Kaur *et al* (2002) expressed that the primed chickpea is a factor that increases the number of branches and leaves. In their research mentioned that enzyme activity of in verities acid at the end of the branch is the reason of increasing the number of branches and the main stems. According to McDonald (2000), primed seeds can rapidly imbibe and revive the seed metabolism, enhancing germination rate and uniformity. Salt stress at reproductive stage can cause a decrease in the photosynthate mobilization to grains and thereby decreasing grain weight [Sadeghipour, 2008]. Ghassemi-Golezani *et al* [2009] reported that grain filling duration decreased with increasing salinity which resulted in decreasing final grain weight.

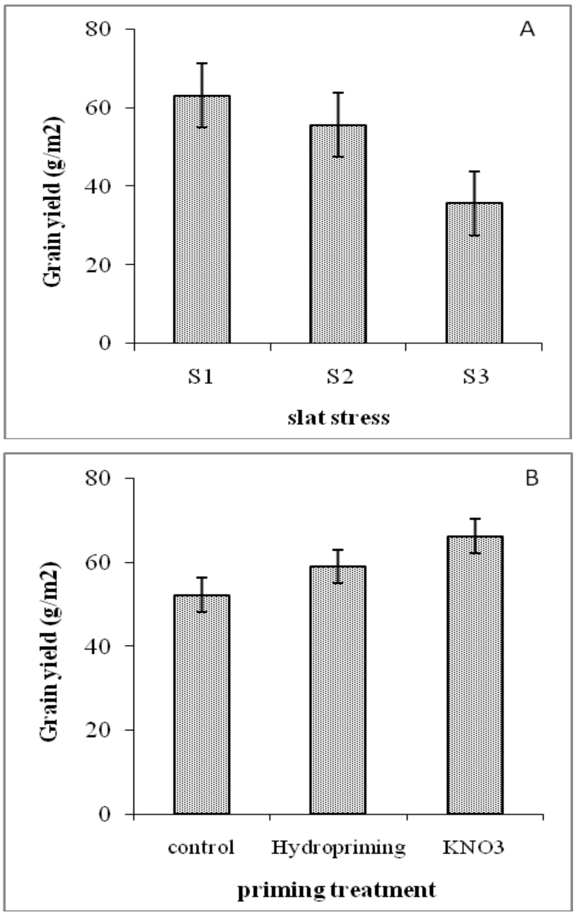

Fig. 3. Effects of salt stress (0, 4 and 8 dS/m; S1, S2 and S3, respectively) (A) and Priming (B) on grain yield of chickpea. Bar=±SE. P≤0.05.

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