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Effect of salicylic acid on germination and growth seedling of 10 variety barley (*Hordeum Vulgare* L.) under drought Stress

Mohammad Hadi Farzane[1*], Reza Monem[1], Seyed Mehdi Mirtaheri[2], Sasan Farhangian Kashani[1]

[1]*Department of Agronomy, College of Yadegar -E- Imam Khomeini (RAH) Branch, Islamic Azad University, Tehran, Iran*

[2]*Department of Agronomy, Karaj branch, Islamic Azad University, Karaj, Iran*

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Abstract

Salicylic acid is an important signal molecule modulating plant responses to stress. An experiment was, conducted to investigation the effect of salicylic acid on the physiological response of barley varieties under water stress. A factorial experiment based on a completely randomized design with 3 replications was carried out during 2014 in research laboratory of Yadegar -e- Imam Khomeini University. In this research were applied 3 different drought stress, pre-treatments of seed with 100 ppm of salicylic acid and distilled water (as control) for 24 on 10 barley varieties. The results showed that drought stress, application of salicylic acid on seeds and varieties had a significant influence on stomatal resistance and leaf moisture ($P < .01$). Also interaction effect between treatments had a significant effect on these traits ($P < .01$). All applied varieties (except Sajhand and Yosef) showed higher stomatal resistance in drought stress conditions in compared with control conditions. Also in all varieties pre-treatment of barley seeds with salicylic acid led to improving in leaf moisture in severe drought conditions

* **Corresponding Author:** Mohammad Hadi Farzane ✉ s.m.mirtahery@gmail.com

Introduction

Environmental stresses such as salt (NaCl) and drought are among the factors most limiting to plant productivity (Bohnert *et al.,* 1995). Drought stress can affect several physiological processes, from seed germination to plant development. Understanding plant responses to the external environment is of greater importance and also a fundamental part for making the crops stress tolerant (Reddy *et al,* 2004). There were several reports on positive effects of Salicylic Acid on plants during stresses. For example Senaratna *et al* (2000) reported that plants grown from seeds imbibed in aqueous solutions (0.1-0.5 mM) of salicylic acid or acetyl salicylic acid (ASA) displayed enhanced tolerance to heat, chilling and drought stresses and also Borsani *et al* (2001) reported that SA plays a role in the plant response to adverse environmental conditions, such as salt and osmotic stresses. Hayat and Ahmad (2007) documented that phenolic compounds exert their influence on physiological and biochemical processes including, photosynthesis, ion uptake, membrane permeability, enzyme activities, flowering, heat production and growth and development of plants. One, such a natural compound is salicylic acid that may function as plant growth regulator (Arberg, 1981). There are not any reports on reactions of these barley varieties against salicylic acid and in Iran and this study can lead to improvement our knowledge about barley varieties in different conditions. In this work, we show that SA is involved in the plant response to osmotic stress by playing a role in decreasing damage caused by osmotic conditions.

Materials and methods

Ten varieties of barley (*Hordeom vulgar* L.) all in cultivation in Iran, were selected on the basis of greenhouse experiment, that using more than the other varieties. These varieties were including (Abidar, Dastparvaresh, Fajr 30, Kavir, L4salty, Nosrat, Reihan, Roodasht, Sahand and Yousef). A factorial experiment based on a completely randomized design with 3 replications was carried out during 2014 in research laboratory of Yadegar -e- Imam Khomeini University. In this research to determine the effect of 3 different drought stress (40% moisture depletion as control., 60% moisture depletion and 70 % moisture depletion). In order to apply drought stress chalk blocks were used to constantly control the moisture in the plots. In order to study the effect of SA, under laboratory conditions, the seeds were soaked in 100 ppm SA solution for 24 h and then were planted in pods uniformity. One-liter pots were filled with 800 g of mix fertilized peat and vermiculite (1:1). To determination of stomatal resistance in this study we used leaf prometer (Model: SC-1- Decagon).

Data were subjected to analysis of variance (ANOVA) and Duncan's multiple range test (DMRT) using SAS program (Version 9.2, SAS Institute Inc, Cary, NC, USA).

Results of discussions

The results in ANOVA table (Table 1) show that drought stress, application of salicylic acid on seeds and varieties had a significant influence on stomatal resistance and leaf moisture. Also based on the same result (Table 1) interaction effect between treatments had a significant effect on these traits ($P < .01$). Mean and standard deviation values in varieties separately were done and results showed on Figure 1 for stomatal resistance. Based on this results all varieties (except Sahand and Yosef) showed higher stomatal resistance in drought stress conditions in comparison with control conditions. This isin consistence with our knowledge about plants reaction in drought conditions. On the other hand based on the results of leaf mouiture, Sahand and Yosef not showed a meaningful decrease in leaf moisture, therefore these varieties may have a good potentials in drought tolerance and suitable yield in that condition. Amounts of this traits showed that mild drought stress led to an increase in stomatal resistance but in severe drought stress, occurred decrease in compaison with mild stress. According to results of mean comparison (data not shown) verity of Kavir had the highest amounts of stomatal resistance and leaf moisture. Based on the results of leaf moisture all varieties showed higher amounts of leaf moisture in

control conditions and in most of varieties, the lowest amounts of this trait were in severe drought stress (Figure 2). In all varieties pre-treatment of barley seeds with salicylic acid led to improving in leaf moisture in severe drought conditions (figure 2). In varieties of Roodasht and Dashtparvaresh, pre-treatment with salicylic acid led to decrease of stomatal resistance in mild drought stress. The same result showed in severe drought stress for Nosrat and both of drought stress conditions (mild and severe drought stress) for Reihan (Figure 1). Janda *et al* (1999) reported that pre-treatment by SA decreased net photosynthesis, stomatal conductivity and transpiration at the growth temperature (22/20 °C) of maize and suggested that pre-treatment of maize plants with SA at normal growth temperature may induce antioxidant enzymes which lead to increased chilling tolerance.

Table 1. Analysis of variance of the effect of drought and salicylic acid in 10 barley varieties on stomatal resistance and leaf moisture.

S.O.V	df	Stomatal resistance	Leaf moisture
Varity (V)	9	2178768.4ns	19.6108421**
Salicylic acid (SA)	1	3180764.6ns	304.6833920**
SA*V	9	5206448.3**	15.9828798**
Drought Stress (S)	2	76712066.6	314.9076337**
V*S	18	7763980.7**	12.7822179**
SA*S	2	9818153.6**	102.5237745**
SA*V*S	18	2106193.9ns	14.0116039**

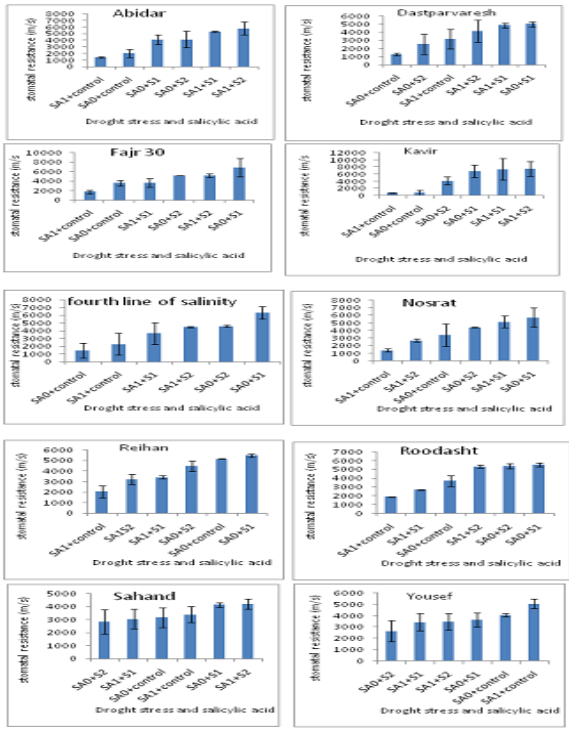

Fig. 1. The effects of drought and Salicylic acid in different varieties of barley on stomatal resistance (based on mean and standard deviation values) SA0= without pre-treatment by salicylic acid, SA1= with pre-treatment by salicylic acid, S1= mild drought stress and S2= severe drought stress.

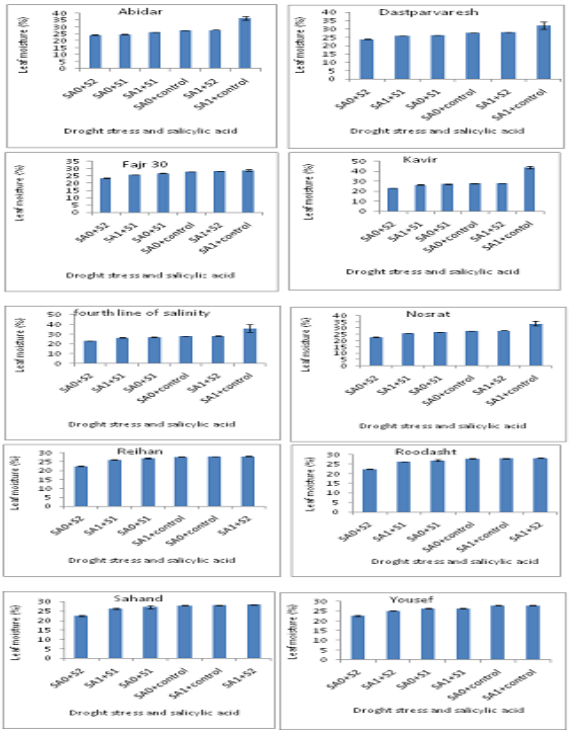

Fig. 2. The effects of drought and Salicylic acid in different varieties of barley on Leaf moisture (based on mean and standard deviation values) SA0= without pre-treatment by salicylic acid, SA1= with pre-treatment by salicylic acid, S1= mild drought stress and S2= severe drought stress.

Conclusions

From the results of the present study, it is obvious that there are differences in the response of stomatal resistance and leaf moisture between barley varieties. Pre-treatment of barley seeds with salicylic acid can improve in leaf moisture in drought conditions therefore application of this signaling molecule in region with drought stress risk can be suitable in decreasing of negative effects of drought stress. Pre-treatment of barley seeds with salicylic acid led to a decrease in stomatal resistance. This result may be a reaction for decreasing of negative effects of drought stress by control of stomatal size and saving water in plants.

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