University of Birjand

تنشهای محیطی در علوم زراعی
Environmental Stresses In Crop Sciences
Vol. 14, No. 3, pp. 783-791
Fall 2021
http://dx.doi.org/10.22077/escs.2020.3176.1811

Original article

Evaluation of activity of antioxidant enzymes and grain yield in barley (*Hordeum vulgare* L.) cultivars under salinity stress

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Received 18 February 2020; Accepted 11 May 2020

Extended abstract

Introduction

Drought, cold, high-salinity and heat are major abiotic stresses that severely reduce the yield of food crops worldwide (Mantri et al., 2012). Iran with 6.8 million hectares of the state after India and Pakistan is considered in the first rank for threats of salinity stress (Moameni, 2010). High salinity can cause ionic toxicity, osmotic stress and oxidative stress, leading to gradual lipid peroxidation, protein oxidation and inactivation of antioxidant enzymes (Tanou et al 2009). Ascorbate peroxidase has several basic roles in plant physiological processes such as growth, development and metabolism and acts as a regenerative agent for many free radicals, especially hydrogen peroxide. Therefore, the damage caused by oxidative stress is minimized (Kocsy et al 2005). The superoxide dismutase enzyme converts free oxygen radical (O^{2-}) into hydrogen peroxide (H_2O_2) and oxygen (O_2), which is the first reaction to detoxify ROS. In the next step, hydrogen peroxide produced by the catalase enzyme and several other peroxides are eliminated (DaCosta & Huang 2007). Most results have shown that antioxidant enzymes system activity in barely acts to reduce the caused oxidative stress by salinity and reducing the cellular damage degree (Kim et al 2005).

The aim of this study was to evaluate salt tolerant and susceptible varieties of barley cultivars through grain yield and to evaluate the activity of some antioxidant enzymes to evaluate their potential in breeding programs as an indirect selection tool.

Materials and methods

In this research, a factorial experiment was conducted in a randomized complete block design with three replications. The first factor consisted of 7 barley cultivars (Afzal, Kavir, Valfajr and Nosrat as tolerant; Yoosef, Sahara and Reihan as susceptible) and the second factor was different salinity levels (0, 8 and 12 $dS.m^{-1}$). This research cultivated in vases in greenhouse of Islamic Azad University, Ardabil, Iran during 2016-17.

Ascorbate peroxidase enzyme activity was measured by Nakano & Asada (1981), Catalase enzyme activity was measured by Chance and Maehly (1955) and Superoxide dismutase enzyme activity was

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measured by Gianopulotis and Reis (1977) methods. MSTATC, SPSS, and Excel softwares were used for statistical analyses.

Results

Analysis of variance showed significant differences among cultivars and salinity levels and interaction of genotype × salinity on activity of ascorbate peroxidase, catalase, superoxide dismutase enzymes and grain yield in plant. Investigation of changes in activity of antioxidant enzymes at different salinity levels showed that their activity increased significantly with increasing salinity level from 0 to 8 and 12 dS and it was higher in tolerant and semi-tolerant cultivars. Evaluation of changes in grain yield at different salinity levels showed that their grain yield decreased significantly with increasing salinity level from 0 to 8 and 12 $dS.m^{-1}$ and it was higher in susceptible cultivars. Correlation of ascorbate peroxidase enzyme with grain yield was positive and significant. Results showed that Nosrat and Kavir cultivars had the highest tolerance index (STI) and in terms of other traits studied, they were in better condition and they can be used in barley breeding programs.

Conclusions

The results of this study showed that salt tolerant cultivars were superior to other cultivars in terms of studied traits. Also, Nosrat and Kavir cultivars had higher antioxidant enzymes activity and yield under salinity stress, which could be considered in barley breeding programs for salinity tolerance.

***Keywords*:** Ascorbate Peroxidase, Catalase, Superoxide Dismutase, Salinity Stress

Table 1. Origin and pedigree of the studied barley cultivars

Cultivars	Tolerance	Origin/ Pedigree
Afzal	Semi-tolerant	Chahafzal
Nosrat	Tolerant	Karoon/Kavir, Iran
Valfajr	Semi-tolerant	CI-108985, Egypt
Kavir	Tolerant	Arivat, USA
Rihane	Sensitive	Atlas 46 /Arivat //Athenais ICB76-2L-1AP-0AP, ICARDA
Sahra	Sensitive	L.B. LRAN/ Una8271// Giorias "s" Com, CIMMYT
Yoosef	Sensitive	Ligne527/chn-01//Gustoe/4/Rhn-08/3/DeirAlla 106//DI71/strain 205

Table 2. Analysis of variance for effect of salinity stress on studied traits

S.O.V	df	APX	CAT	SOD	Grain yield
Genotype (G)	6	1323.2**	8.88**	3.804**	2.327**
Salinity (S)	2	1336.7**	28.99**	12.058**	20.78**
G × S	12	197.6**	0.592**	0.813**	0.156**
Erorr	42	48.98	0.181	0.091	0.047
C.V (%)		9.83	11.52	13.64	7.07

^{ns}, * and **: Non-significant, significant at 0.05 and 0.01 proability levels, respectively

Table 3. Mean Comparison of studied traits in different levels of salinity

salinity	APX	CAT	SOD	Grain Yield per plant
ds/m	---------- Unit/mg Fresh Weight ----------			gr
0	63.1 ^{c}	2.5 ^{c}	1.4 ^{c}	4.002 ^{a}
8	71.3 ^{b}	3.8 ^{b}	2.3 ^{b}	3.175 ^{b}
12	79.1 ^{a}	4.8 ^{a}	2.9 ^{a}	2.021 ^{c}

Means in each column and trait followed by non-similar letters are significantly different at 5% probability level using duncan test

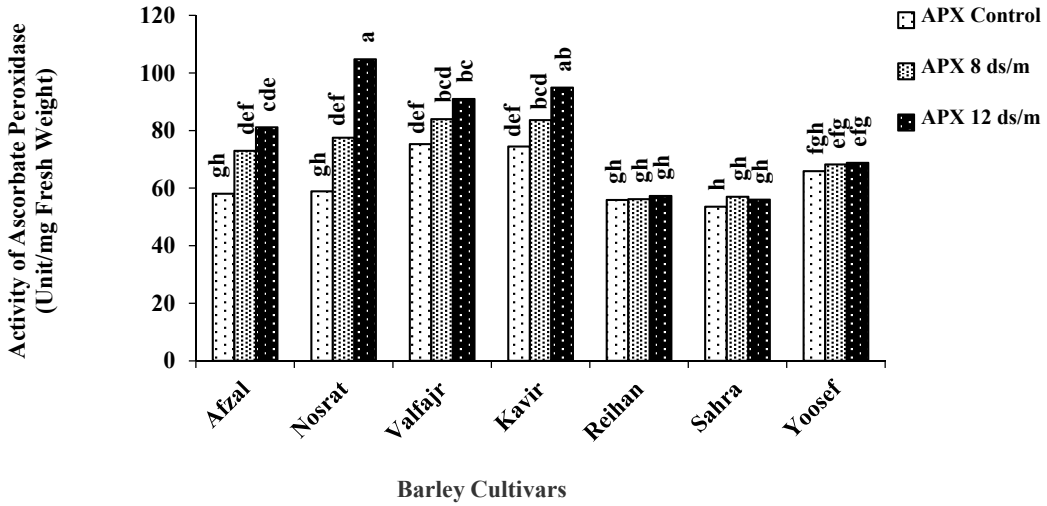

Fig. 1. **Interaction effect of genotype × salinity on activity of ascorbate peroxidase**

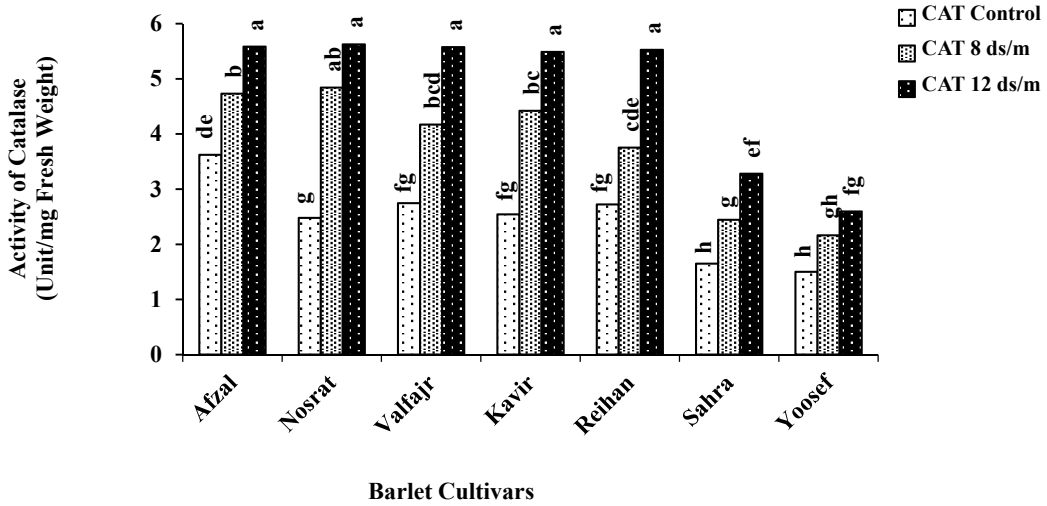

Fig. 2. Interaction effect of genotype × salinity on activity of catalase

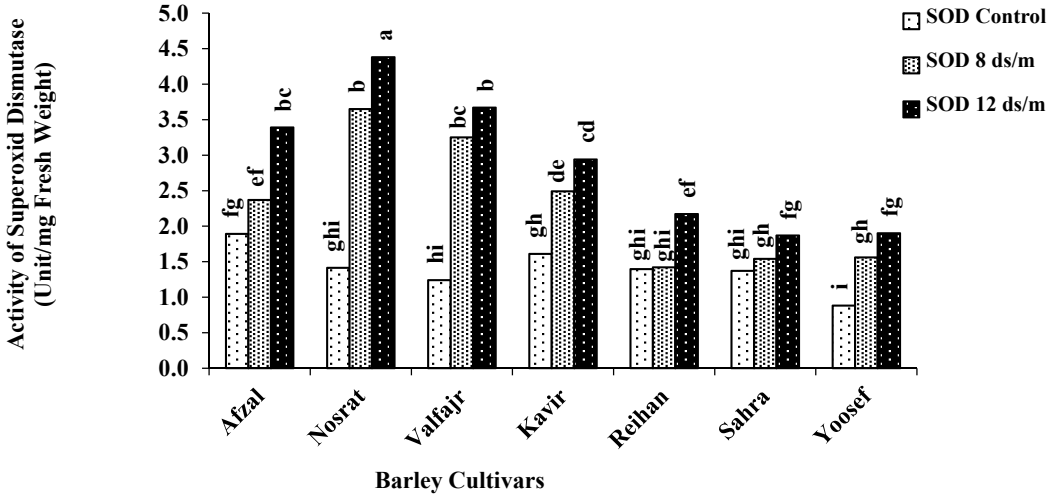

Fig. 3. Interaction effect of genotype × salinity on activity of superoxide dismutase

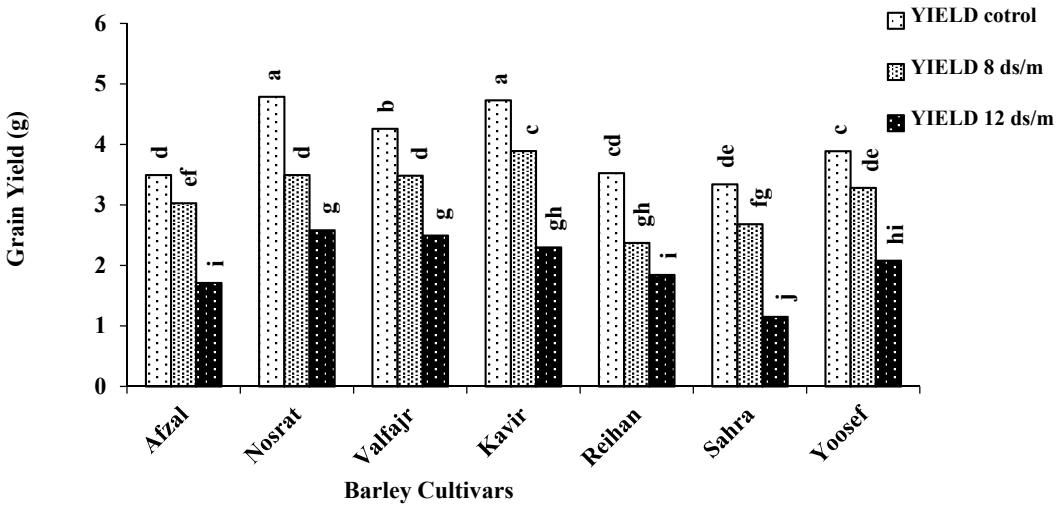

Fig. 4. Interaction effect of genotype × salinity on grain yield

Table 4. Correlation coefficients between antioxidant enzymes activity and grain yield

	APX	CAT	SOD	Grain Yield
APX	1			
CAT	0.52 ^{ns}	1		
SOD	0.78*	0.78 *	1	
Grain Yield	0.94**	0.37 ^{ns}	0.68 ^{ns}	1

^{ns}, * and **: Non-significant, significant at 0.05 and 0.01 proability levels, respectively

Table 5 .Stress tolerance index (STI)

Cultivars	Afzal	Nosrat	Valfajr	Kavir	Reihan	Sahra	Yoosef
STI (8 ds/m)	0.66	1.04	0.93	1.15	0.52	0.56	0.80
STI (12 ds/m)	0.37	0.77	0.66	0.68	0.41	0.24	0.50