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Original article

Comparing the antioxidant enzymes, osmotic regulators and photosynthetic pigments activities of two barley cultivars in Sistan region under salinity-stress conditions

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Extended abstract

Introduction

Barley is one of the most important crops in cereals, which shows the wide range of adaptation to different environments. Plant growth is severely influenced by environmental stresses such as drought, high salinity and extreme temperatures. Environmental stresses trigger a wide range of plant responses, like change in the gene expression to variability in cellular metabolism and growth. One of the most important harmful factors is the production of crops in different areas of salinity, which has a negative impact on all aspects of plant growth and production. Also, in the plants exposed to salinity the photosynthetic apparatus activities were damaged or impaired, leading to a decrease of photosynthetic capacity and lipid oxidation is increased in these conditions and on the other hand Cause disturbance of the balance between production of reactive oxygen species and antioxidant defense and thereby causing oxidative stress. Due to the increase in water salinity and its damages on plant production, evaluation of salinity effects on crop plants, is very important. The study of biochemical and physiological variations under salinity stress is a suitable solution that can help to identify the effective factors in tolerating this stress and selecting resistant cultivars. Therefore the aim of the present study was, investigate and compare photosynthetic pigments, the changes in water status, osmotic regulators and activity of antioxidant enzymes in leaf tissue of two native barley cultivars of Sistan region under Salinity stress.

Materials and methods

Two native barley cultivars of Sistan region (Nomar and Nimroz) were examined in a factorial experiment (the first factor of cultivar in two levels and the second factor of drought stress in three levels) in a completely randomized design with three replications. The seeds of Numar and Nimroz varieties were prepared from Zabol Agricultural Research Center. 10 seeds were planted in each pot and the thinning was performed after the plants reached the 4-leaf stage and 5 identical plants were kept in each pot. After cultivation and complete establishment of plants in the seedling stage (four leaves), Salinity stress treatment was applied at different levels (Control (0), 150 and 300 mm NaCl) for two weeks. Sampling of all plant leaves was performed at a specific time and then the studied traits were measured. The studied traits were included the activity of antioxidant enzymes (catalase (CAT),

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polyphenol oxidase (PPO), ascorbate peroxidase (APX)), photosynthetic pigments (chlorophyll a, chlorophyll b, total chlorophyll and carotenoids), protein content, relative leaf water content (RWC) and some regulators Osmotic (proline and carbohydrate). After measuring the traits, the obtained data were analyzed by Duncan's method.

Results and disscussion

Analysis of variance showed that the effect of cultivar, drought stress and cultivar interaction and drought stress were significant at 1% probability levels, on all studied traits. According to the results of interactions, it was found that salinity stress in both barley cultivars reduced physiological traits such as photosynthetic pigments, relative leaf water content, protein and increased content of carbohydrates and proline, carotenoids and the activity of catalase, ascorbate Peroxidase and polyphenol oxidase. In normal conditions, Nomar cultivar compared to Nimroz cultivar had the highest amount of chlorophyll a, b, total and carotenoids, relative content of leaf water, protein and proline. Also, at salinity of 300 mM, the highest activity of antioxidant enzymes of ascorbate, peroxidase, polyphenol oxidase, catalase, protein, photosynthetic pigments was related to Nomar cultivar, while the highest amount of carbohydrates and carotenoids was related to Nimroz cultivar at salinity of 300 mM.

Conclusion

In generally, according to the results of this study, it can be said that among the cultivars under study, in vegetative phase, Nomar cultivar had higher capacity and function to salt stress tolerate than another cultivar.

***Keywords*:** Antioxidant defense system, Genotype, Relative leaf water content, Soluble proteins

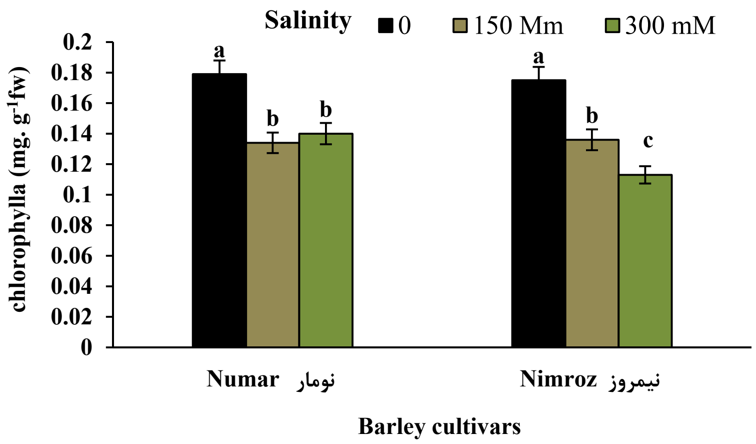

Fig. 1. Interaction effect of salinity stress and cultivar on the amount of chlorophyll a Numar and Nimroz cultivars

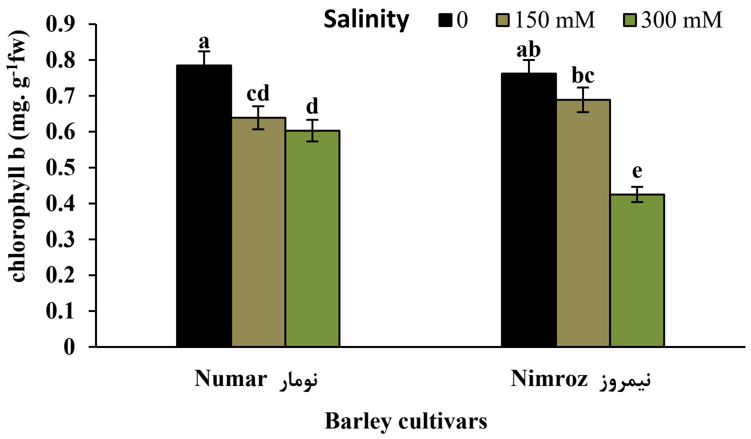

Fig. 2. Interaction effect of salinity stress and cultivar on the amount of chlorophyll b Numar and Nimroz cultivars

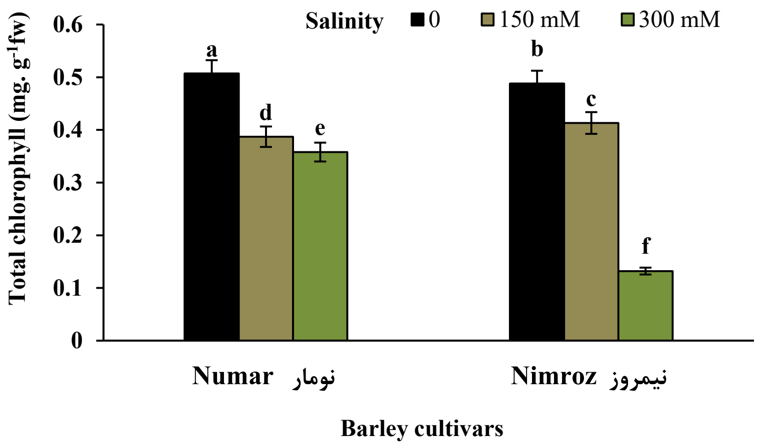

Fig. 3. Interaction effect of salinity stress and cultivar on the amount of total chlorophyll Numar and Nimroz cultivars

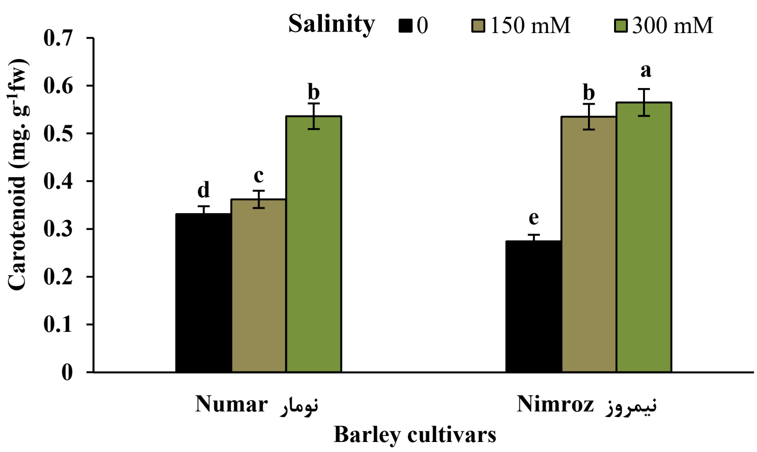

Fig. 4. Interaction effect of salinity stress and cultivar on the amount of carotenoid Numar and Nimroz cultivars

Table 1. Results of analysis of variance effect of cultivar and salinity stress on the amount of photosynthetic pigments, protein and relative leaf water content Numar and Nimroz cultivars

S.O.V	df	Chlorophyll a	Chlorophyll b	Chlorophyll T	Carotenoids	Protein	Relative water content
Salt stress (S)	2	0.0043**	0.26**	0.096**	0.093**	0.861**	0.21**
Cultivar (C)	1	0.0023**	0.15**	0.036**	0.01**	0.099**	0.012**
S×C	3	0.00046**	0.098**	0.02**	0.0203**	0.032**	0.0045**
Error	12	0.000053	0.0021	0.000066	0.00021	0.0068	11.65
CV%		5.01	7.63	2.14	3.38	6.44	5.5

ns,* and **: Non–significant and significant at 5% and 1% probability levels, respectively

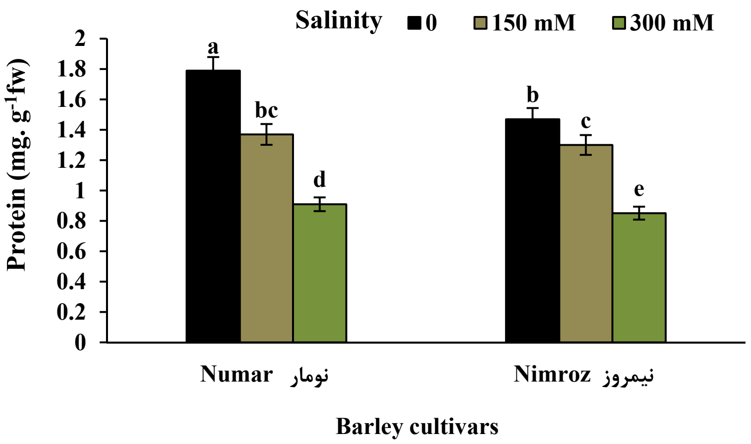

Fig. 5. Effect of irrigation regime and plant density on pod per plant. A1-A8 different irrigation and 30,40 and 50 density plant

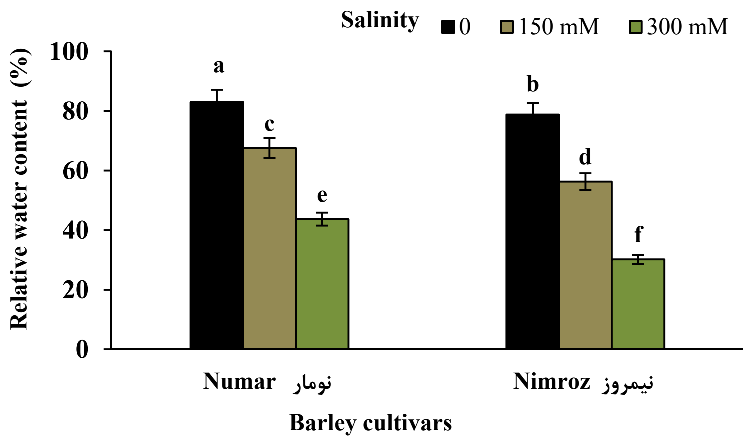

Fig. 6. Interaction effect of salinity stress and cultivar on the amount of relative leaf water content Numar and Nimroz cultivars

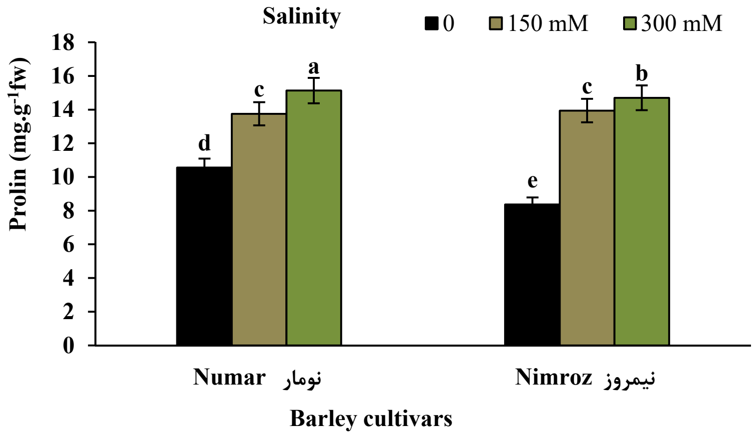

Fig. 7. Interaction effect of salinity stress and cultivar on the amount of prolin Numar and Nimroz cultivars

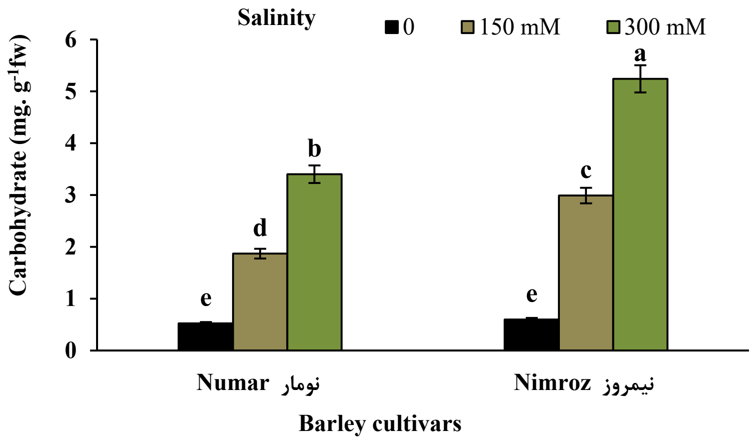

Fig. 8. Interaction effect of salinity stress and cultivar on the amount of carbohydrate Numar and Nimroz cultivars

Table 2. Results of analysis of variance effect of cultivar and salinity stress on the amount of some osmotic regulators and antioxidant enzymes Numar and Nimroz cultivars

S.O.V	df	Carbohydrate	Prolin	Catalase	Ascorbate Peroxidase	polyphenol oxidase
Salt stress (S)	2	21.21**	50.07**	0.456**	0.776**	0.18**
Cultivars (C)	1	4.61**	1.23**	0.087**	0.0012**	0.0034**
S×C	3	1.18*	3.15**	0.209**	0.0162**	0.025**
Error	12	0.116	0.049	0.0015	0.00012	0.00014
CV%		13.97	1.74	6.17	1.39	4.71

ns,* and **: Non–significant and significant at 5% and 1% probability levels, respectively

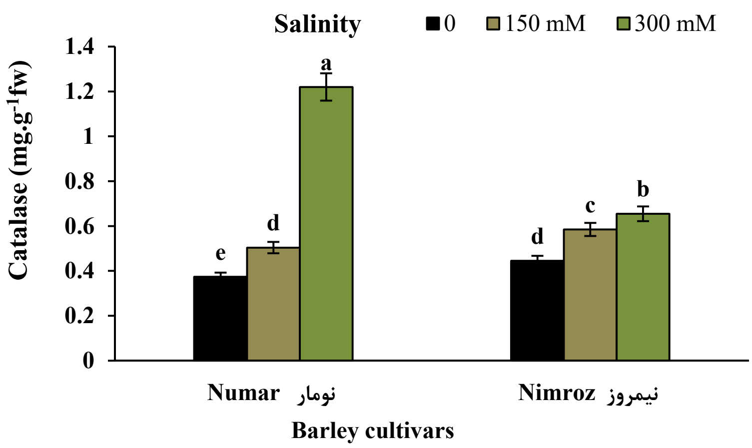

Fig. 9. Interaction effect of salinity stress and cultivar on the amount of catalase enzyme Numar and Nimroz cultivars

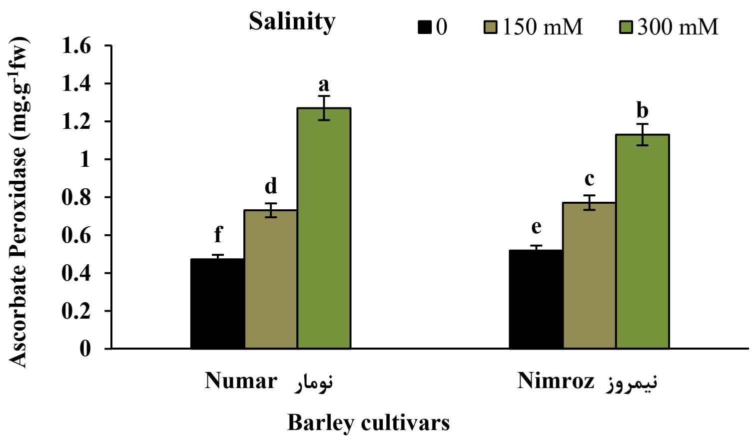

Fig. 10. Interaction effect of salinity stress and cultivar on the amount of Ascorbate peroxide enzyme Numar and Nimroz cultivars

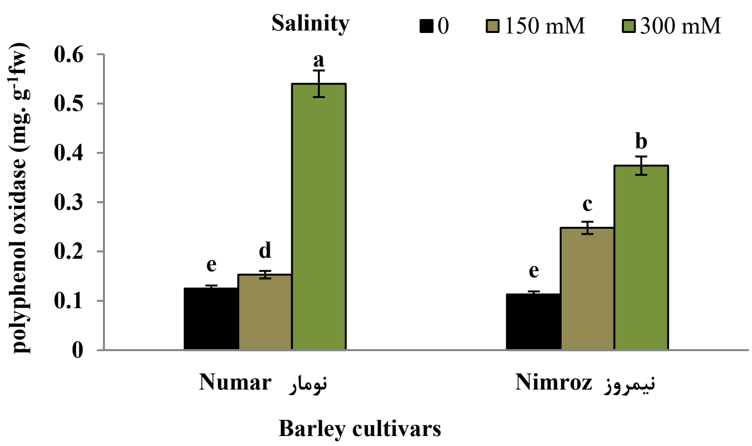

Fig. 11. Interaction effect of salinity stress and cultivar on the amount of Polyphenol oxidase enzyme Numar and Nimroz cultivars