

Evaluation of salinity levels on yield and changes of antioxidant enzymes in soybean

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ABSTRACT: To investigate the effects of salinity on chemical and biochemical activities of three soybean varieties, greenhouse experiment was performed as split plot in a randomized complete block design (CRD). In this experiment, the salinity levels included three levels of ($S_1=50$), ($S_2=100$) and ($S_3=150$) MM and cultivars consisted of 3-digit of L_{17} , Zan and 033. Based on the results, the antioxidant activity of both enzymes increased under salinity stress in all cultivars that indicate the activation of the antioxidant defense system in them. The cultivar L_{17} produced the highest grain yield (2869/17 and 636/29 kg ha) in normal conditions, while the cultivar 033 *Zan showed the highest amount of yield (634/97 and 249/19 kg ha) at level of severe stress (S_3). This cultivar between the other cultivars had the lowest amount of grain yield from the favorable conditions of irrigation to severe stress level. This cultivar in the part of chemical and biochemical results compared to the other varieties from the favorable conditions of irrigation to severe stress of salinity had respectively the highest and the lowest increase in antioxidant. It can be concluded from the mentioned results which this cultivar is likely better than other varieties in terms of physiological and agronomic traits.

Keywords: Stress, Antioxidants, Salinity, Yield, Soybean.

INTRODUCTION

Soybean is one of the most important oilseed crops in Iran that because of semi-arid climatic of country and being in the crop pattern as the second crop and the existence of competing products in its developmental stages constantly are exposed to salt stress and reducing the performance and finally reduce the rate of photosynthesis. Plants in dealing with stressors attempt to activate various defense mechanisms such as production of the antioxidant enzymes (Goupta and Koomar, 2003).

MATERIALS AND METHODS

This experiment was conducted as split plot in a randomized complete block design in four replications. Irrigation levels included three levels of (Irrigation after 50, 100 and 150 mm evaporation from evaporation pan class A) and the cultivars included L_{17} , Zan and 033. Planting was performed in pots containing specific salinity. In this experiment, measuring the superoxide dismutase enzyme was performed by method (Misra and Fridovich, 1972) and Glutathione peroxidase by method Paglia and Valentine, (1997). Calculation of grain yield with removing the marginal effects, harvesting the plants in the middle of each plot, seeds withdrawal of their pods and weighed, data variance analyzing using SAS and Excel software and significant difference between treatments and their interactions were performed through the F-test and using the least significant difference (LSD) at probability level of 1% and 5%.

RESULTS AND DISCUSSION

Grain yield

The results of the analysis of variance showed the interaction between salinity and cultivars on grain yield was significant at the one percent level ($P < 0.01$). The results of the means comparison by Duncan's test at 5% level

showed that the highest and lowest grain yield under full irrigation was respectively obtained from L₁₇ varieties and Zan with production 2869/17 and 2002/83 kg ha. The interaction of cultivars with severe water deficit stress was observed that the highest and lowest grain yield with 634/97 kg ha had respectively belonged to cultivars 033 and Zan. Reduction of grain yield consequently salinity stress and irrigation intervals increase has recorded by (Ohashi *et al.*, 2009). In this report, the main reasons for the decrease in yield under stress condition, reduction of growing season, reduction of photosynthetic organs (leaves), reducing the number of flowers (main and reproductive organs) and grain yield is mentioned (Due to reduced transmission Asmylat and current photosynthesis). Simple correlation analysis showed that, there was significant and positive correlation between grain yield and oil yield at 1% level ($P < 0.01$) and significant and negative correlation between biochemical biomarkers and oil percentage at 5% ($P < 0.05$).

Antioxidant enzyme superoxide dismutase:

Results showed that the interaction between salinity at cultivar on the rate of superoxide dismutase enzyme was significant at 1% level ($0.01 < P$). Mean comparison showed that the highest activity of this antioxidant with the 2803/13, international units on mg protein had obtained from cultivar 033 from severe salinity stress (S₃). The lowest levels of superoxide dismutase activity with 1307/57 international units on mg protein had obtained from cultivar Zan and salinity stress (S₁). With mean comparison of the interaction between salinity and cultivars at three salinity levels, it is clear that in salinity condition (S₁) the cultivar L₁₇ and in both moderate and severe salt stress (S₂ and S₃), the cultivar 033 had the highest antioxidant activity. The results of this research are consistent with (Selote and Khanna-Chopra, 2004). They stated that more resistant species to adapt and more cope raise the level of this enzyme. So with determining the level of activity of this enzyme, it can be determined the resistant to salt species in plants. Study of correlation coefficients showed that, there was significant and positive correlation between the antioxidant activity with glutathione peroxidase ($P < 0.01$).

Antioxidant glutathione peroxidase

At this experiment, the effect of salinity * cultivar on glutathione peroxidase activity was significant at 1% level ($P < 0.01$). It was also observed that with increasing salinity levels, increased the level of this antioxidant so that, the highest rate of this enzyme was observed at level of the severe drought salinity. At the salinity level (S₁), cultivar L₁₇ and in both moderate and severe salt stress (S₂ and S₃); varieties 033 were the highest level of GPX. Studies of Nayyar and Kaushal, (2002) revealed that glutathione peroxidase activity increased under salt stress at soybean. Simple correlation analysis showed that there was significant and positive correlation between the activity of glutathione peroxidase and super oxide dismutase ($P < 0.01$).

CONCLUSION

Activation of the antioxidant defense system of plants under oxidative stress when placing them (Such as salt) has announced at various reports. Of course, the rate of activation is different depending on the susceptibility of different cultivars (Manavalan *et al.*, 2009). In this experiment was observed that all soybean cultivars showed reaction to salt stress and with activation of their antioxidant defense system were going to fight free radicals caused by salinity. At water deficit conditions, cultivars with higher levels of antioxidants (033) had lower rates of lipid degradation and ultimately had the higher grain yield. Finally, this experiment indicated that it is better to use cultivar L₁₇ in normal condition and use cultivar 033 in salinity stress condition.

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