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Original article

The Effect of drought stress on seed germination chlorophyll, proline and antioxidant enzyme activity in two cultivars of rapeseed (*Brassica napus* L.)

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Extended abstract

Introduction

Drought is one of the most important environmental stresses and occurs for several reasons, including low rainfall, salinity, high and low temperatures, and high intensity of light. Drought stress causes changes in the physiological, morphological, biochemical, and molecular traits in plants. In Iran, many regions suffer from water stress. Moreover, rapeseed is one of the best crops for rotation with wheat. So, and the culture of rapeseed has been increasing recently in Iran. However, rapeseed often suffers from many stresses, such as salinity, cold and drought, which cause great yield loss every year. Since the rapeseed is an economical crop in Iran and drought stress is a limiting factor for crop production, this study was performed to compare some drought resistance mechanisms in sensitive and tolerent cultivars of rapeseed.

Materials and methods

This research was designed to identify some drought resistance mechanisms in two cultivars of rapeseed. (Sensitive and tolerant) in germination (with five drought levels) and vegetative stages (zero, low, moderate and severe levels). Polyethylene glycol 6000 (PEG) was used to induced drought. Finally, pigment photosynthesis, proline content, and activity of guaiacol peroxidase was determined. The data obtained undergone a two-way analysis of variance and the mean differences were compared and tested by Duncan test using SPSS v. 2016 software from three replications. Differences at $P \leq 0.05$ were considered significant.

Result and Discussion

In the low level of drought stress, the significant difference was not observed between cultivars at the germination stage. However, the results showed that with increasing drought, germination percentage and shoot length decreased so that it reached zero at the lowest water potential, while root length increased at -0.14 MPa osmotic potential and then decreased at the lower water potential. In the second stage of experiments, the amount of photosynthetic pigments enhanced with reduction of water potential and it was more under moderate and severe stress in sensitive and tolerant cultivar, respectively. Also, the proline content increased to the level of moderate drought stress, which was significantly higher in the tolerant cultivar than the sensitive cultivar. Except for severe drought, the activity of guaiacol peroxidase enzyme was not statistically significant between other treatments and it was more in the roots of tolerant plants compared to sensitive plants. In general, due to the high amount

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of photosynthetic pigments and proline and guaiacol peroxidase activity in resistant cultivars, it can be suggested that increased efficiency of photosynthesis under stress as a result of more photosynthetic pigments, effective removal of ROS due to high activity of guaiacol peroxidase enzyme and higher compatibility as a result of osmotic regulation by proline accumulation, are part of the mechanisms of coping with dehydration in tolerant canola cultivars.

Conclusion

The results of this study showed that just germination factors could not confirm the sensitivity and resistance of rapeseed cultivars, and more experiments in the hydroponic culture medium is a better way to identify resistant cultivar.

***Keywords*:** Canola, Chlorophyll, Drought stress, Guaiacol peroxidase, PEG 6000, Proline

Table 1. The effect of PEG-induced drought stress on percentage of seed germination, radical and pedicel length (mm) in two tolerant and sensitive cultivar of canola (B. napus)

Factor	Plant	Control	-0.14 MPa	-0.48 MPa	-0.71 MPa	-1.17 MPa
Germination%	Ag	100^{a}	100^{a}	83.3^{b}	71.7^{c}	0^{d}
	Po4	100^{a}	97^{a}	80.3^{b}	70.6^{c}	0^{d}
Pedicel length (mm)	Ag	17.2^{a}	16.1^{a}	1.3^{b}	1.2^{b}	0^{b}
	Po4	20.4^{a}	14.8^{b}	2.1^{c}	1.1^{c}	0^{c}
Radical length (mm)	Ag	46.7^{b}	53.7^{a}	11.6^{c}	9.5^{c}	0^{d}
	Po4	49.2^{b}	58.7^{a}	21.6^{c}	19.8^{c}	0^{d}

Each point is mean. Significant differences between means ($p < 0.05$) are indicated with different letters in each row using Duncan's ($P<0.05$).

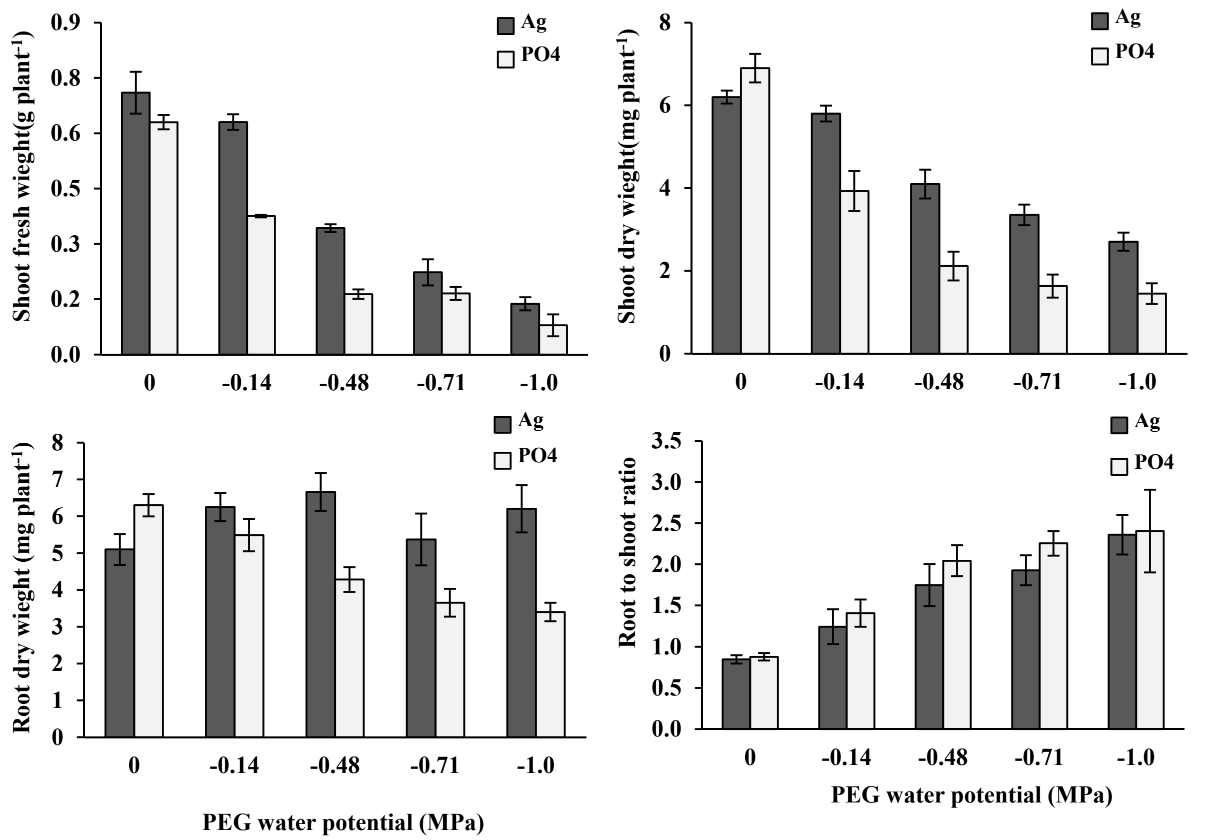

Fig. 1. Effect of PEG-induced drought stress on shoot fresh weight (A), shoot dry weight (B), root dry weight (C) and root to shoot ratio (D) in two tolerant and sensitive cultivar of canola (B. napus). Bars show the standard error.

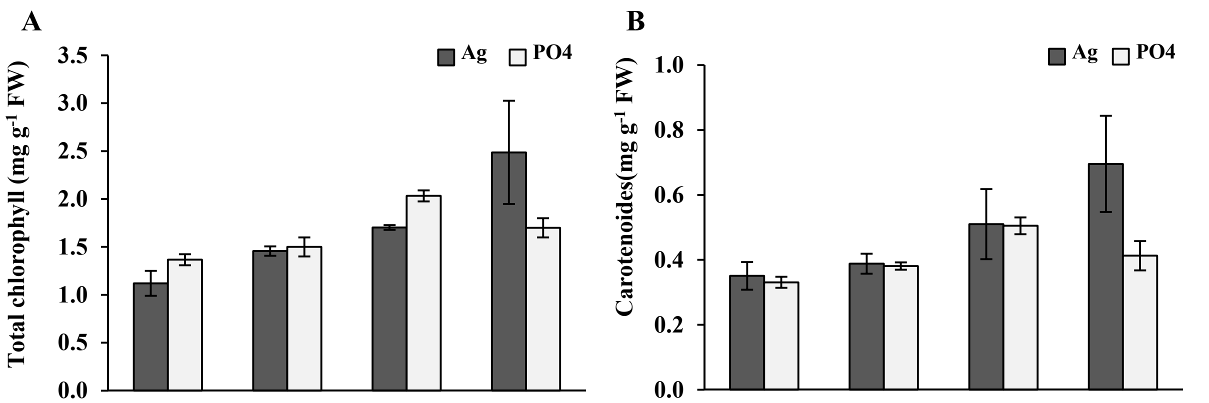

Fig. 2. Effect of PEG-induced drought stress on the concentration of total chlorophyll (A) and the concentration of carotenoids (B) in two tolerant and sensitive cultivar of canola (B. napus). Bars show the standard error

Table 2. The analysis of variance (Mean of square) of drought, variety and their interaction on germination, vegetative traits and chlorophyll pigments, proline content and peroxidases activity

S.O.V	df	Germination percentage	Root length	Hypocotyl length	Shoot fresh weight	Shoot dry weight	Root dry weight
Drought (D)	4	10129.8***	3414.1***	482.9***	0.323***	21.6***	1.8*
Cultivar (C)	1	14.7ns	232.4***	2.1 ns	0.114***	11.4***	14.7***
D × C	4	3.5ns	31.2ns	4.3ns	0.012ns	1.7***	3.9**
Error	20	11.9	11.1	2.7	0.005	0.23	84.2
CV (%)		*9.7*	*15*	*20*	*12.04*	*9.3*	*4.4*

Table 2. Continued

S.O.V	df	Total chlorophyll	Carotenoid content	Proline content	POD activity in shoot	POD activity in root
Drought (D)	3	0.88***	0.06***	4750.8***	0.002***	0.006***
Cultivar (C)	1	0.01 ns	0.02ns	7812***	0.001***	0.00003 ns
D × C	3	0.39**	0.04**	1541.2***	0.00003 ns	0.005***
Error	16	0.04	0.004	53.5	0.00002	0.00008
CV (%)		*5.4*	*5.96*	*13.9*	*9.86*	*3.5*

ns, *, ** and ***: non-significant, significant at probability level 5%, 1% and 0.1% respectively

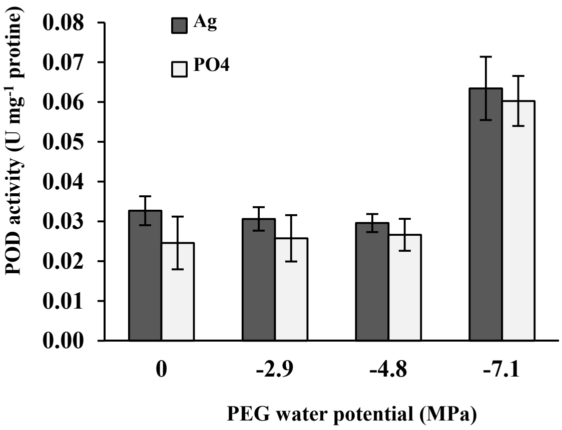

Fig. 4. Effect of PEG-induced drought stress on the activities guaiacol peroxidase (POD) of leaves, in two tolerant and sensitive cultivar of canola (B. napus). Bars show the standard error

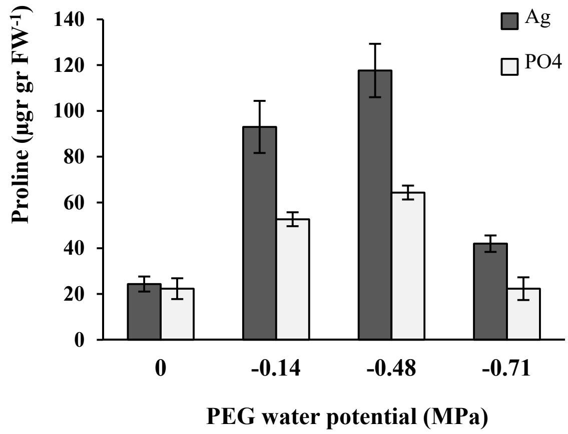

Fig. 3. Effect of PEG-induced drought stress on the concentration of proline in two tolerant and sensitive cultivar of canola (B. napus). Bars show the standard error.

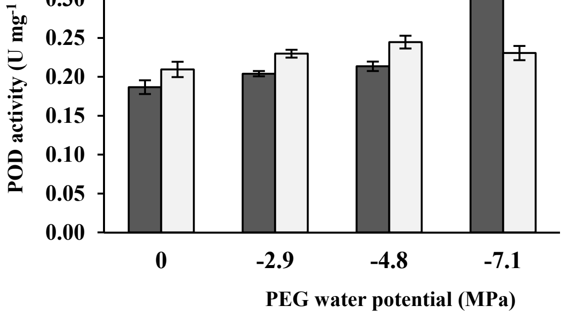

Fig. 5. Effect of PEG-induced drought stress on the activities guaiacol peroxidase (POD) of roots, in two tolerant and sensitive cultivar of canola (B. napus). Bars show the standard error.