Response of two winter common wheat varieties to drought stress

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Abstract

The sensitivity of two winter common wheat varieties (Nadita and Ailzla) to desiccation and ability to recover after re-watering was evaluated by following the alterations in the pigment content, desiccation-induced lipid peroxidation, generation of reactive oxygen species (H_2O_2) and the level of non-enzymatic and enzymatic antioxidants.

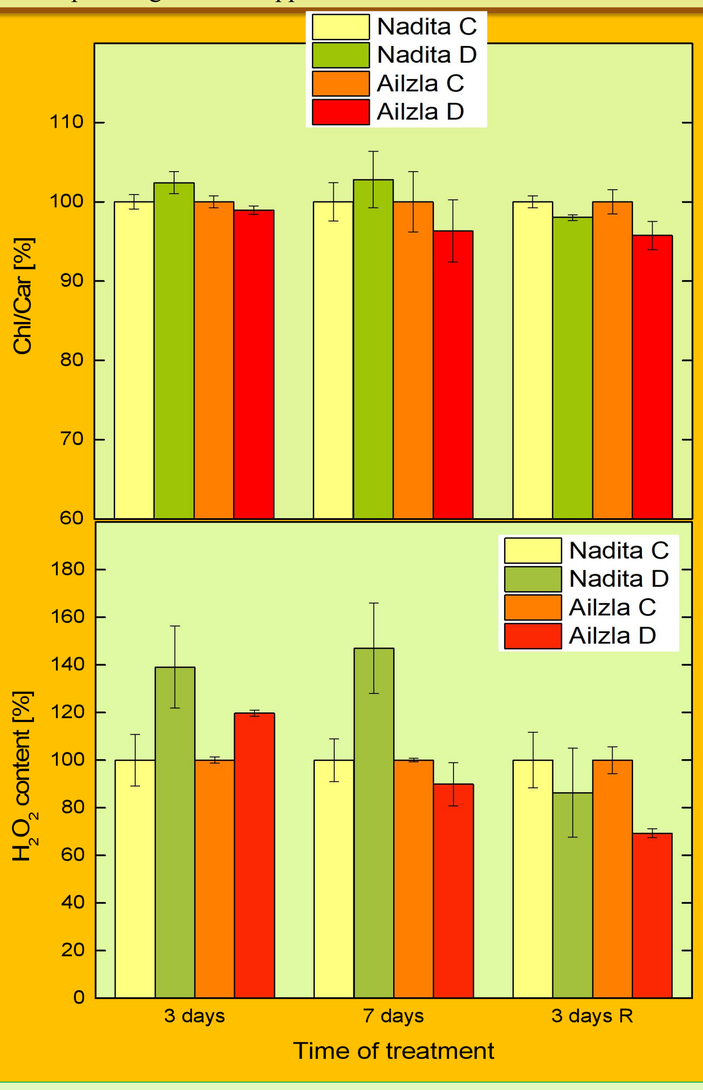
Seeds of two common winter wheat varieties (*Triticum aestivum L.*) were obtained from the Institute of Plant Genetic Resources, Academy of Agriculture, Sadovo, Bulgaria and were sown in pots filled with soil, taken from the region of Sadovo, Bulgaria.

The most prominent alterations in evaluated parameters were observed after 7 days of dehydration. The results in respect to drought sensitivity and ability to recover after stress of both wheat varieties could represent an interest for breathers for creating new and more drought resistant crops for agricultural application.

Materials and Methods

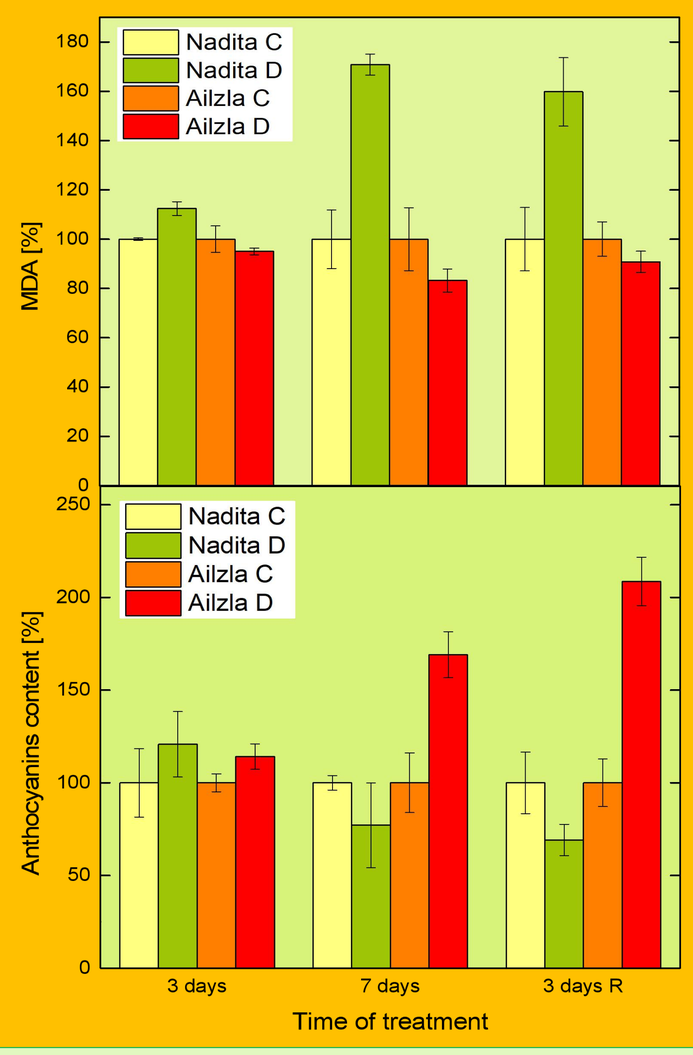
Plants were grown in growth chamber at normal conditions (16/8h day/night photoperiod, illumination 300 µmol photons m^{-2} s^{-1} and 20º/18ºC day/night temperature). Watering of plants was stopped at fully developed third leave for 7 days followed by a period of 3 days re-watering to determine the ability of plants to recover after dehydration stress

Photosynthetic pigment concentration was determined spectrophotometrically by the method of Lichtenthaler (1987). **Lipid peroxidation** was estimated by **MDA** method and concentration of **H_2O_2**. Synthesis of **protective substance** (anthocyanins) was followed by the method described in Murray and Hackett (1991). **Enzyme antioxidant capacity:** Total SOD activity was determined by Giannopolitis and Ries (1977). CAT activity was measured according to Beers and Sizer (1952). APX activity was assayed by Nakano and Asada (1987). GPO activity was determined by Urbanek et al. (1991). **Non enzyme antioxidant capacity:** Free radical-scavenging activity was determined in methanol extract by using colored, free radicals DPPH (1,1-diphenyl-2-picrylhydrazyl) (Tepe et al., 2006). The ferric reducing antioxidant power (FRAP) was monitored by Benzie and Strain (1996). Total phenolic compounds were determined by Pfeffer et al. (1998). Flavonoids were measured by Zwere assay by hishen et al. (1999). Water-soluble (WS-AOM) and lipid-soluble (LS-AOM) antioxidant metabolites, expressed as equivalents of ascorbate and α-tocopherol in water or hexane extract, Prieto et al. (1999).



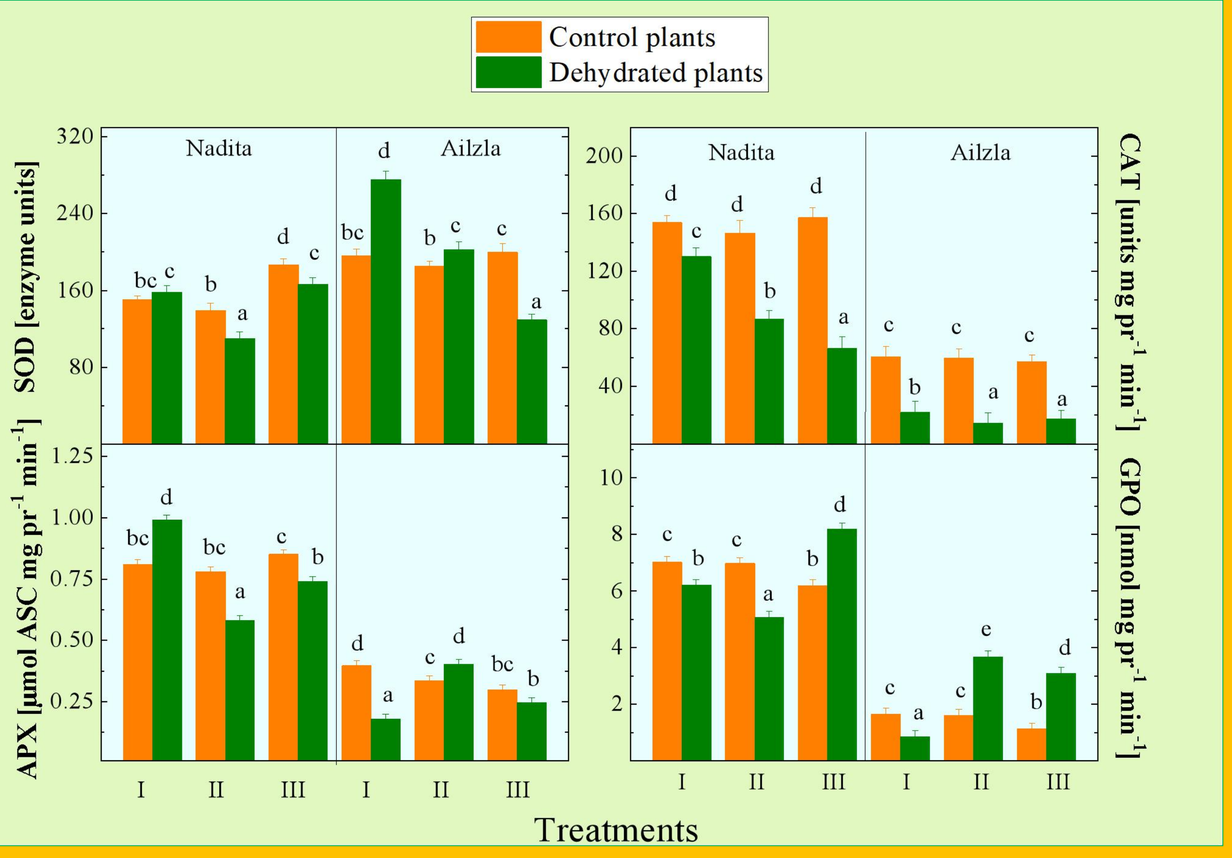
Ratio Chl/Car of photosynthetic pigments of leaves of two common winter wheat cultivars, Nadita and Ailzla, subjected to dehydration stress. Control plants (C) and dehydrated (D) for 3 and 7 days, and after 3 days of re-watering. Photosynthetic pigments were determined spectrophotometrically in 80% acetone extract of plant leaves material, calculated as [mg pigment g^{-1} DW] and presented as percent of respective control, non-treated plants.

Dehydration-induced generation of H_2O_2 in whole leaves of two cultivars of common winter wheat, Nadita and Ailzla. Control plants (C) and dehydrated (D) for 3 and 7 days Values were calculated as [µmol H_2O_2 g^{-1} DW] and presented as percent of respective control, non-treated plants.

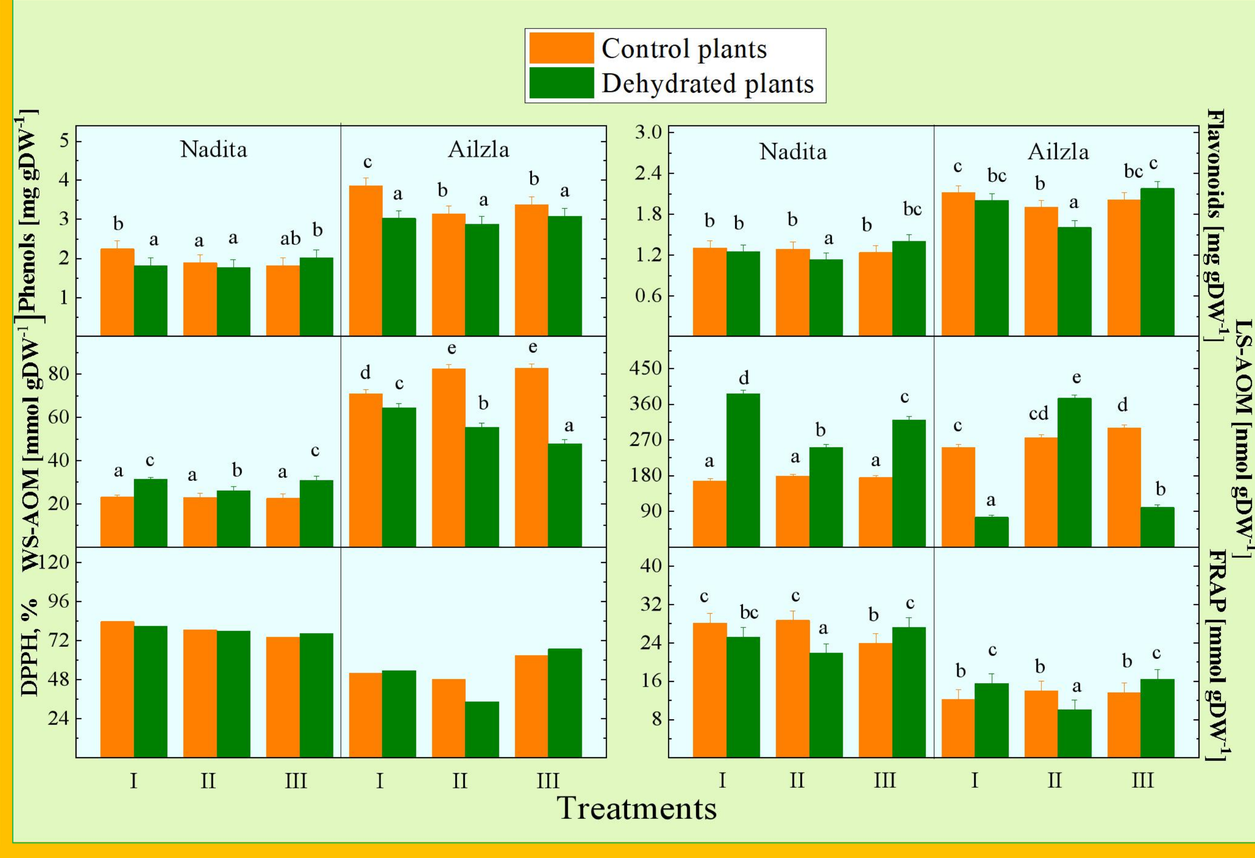


Membrane lipid peroxidation induced by dehydration (D) (3 and 7 days) and after 3 days recovery period, determined by MDA method in leaves of two common winter wheat cultivars, Nadita and Ailzla. Values were calculated as [µmol MDA g^{-1} DW] and presented as percent of respective control, non-treated plants.

Content of protective substances (anthocyanins) as a response to dehydration stress (D) (3 and 7 days) and after 3 days recovery period in two common winter wheat cultivars, Nadita and Ailzla, calculated as [nmol g^{-1} DW] and presented as percent of respective control, non-treated plants.



Activity of catalase (CAT), superoxide dismutase (SOD), guaiacol peroxidase (GPO), and ascorbate peroxidase (APX) in two wheat varieties (Nadita and Ailzla): I – 3 days dehydrated plants; II – 7 days dehydrated plants; III - 3 days re-watered plants.



Content of metabolites with antioxidant power and total antioxidant potential in two wheat varieties (Nadita and Ailzla): I – 3 days dehydrated plants; II – 7 days dehydrated plants; III - 3 days re-watered plants.

Conclutions

In the course of dehydration for 7 days no significant alterations were observed in both investigated wheat cultivars, Nadita and Ailzla, in respect to total content of photosynthetic pigments (Chl a+b and Carotenoids).

The two stress markers, the content of stress-generated H_2O_2 and extent of lipid peroxidation (MDA), showed a well-expressed increase for Nadita, while for Ailzla a certain increase in H_2O_2 content was observed only on the third day of dehydration. Moreover, after 3 days of re-set of watering the level of lipid peroxidation did not show a significant reduction for Ailzla.

In respect to accumulation of protective substances (anthocyanins), Ailzla demonstrated a significant increase on the 7th day of water deprivation, as well as after 3 days recovery .

The activities of antioxidant enzymes (SOD, APX and CAT) in Nadita showed a well pronounced time-dependent decrease during the process of dehydration. In Ailzla a dehydration-induced elevation of enzyme activity was observed for APX and GPO, while the activities of SOD and CAT, similar to Nadita, were decreased.

In respect to accumulation of metabolites in the process of dehydration, the amount of phenols was not changed while the amount of WS-AOM, DPPH, flavonoids and FRAP was significantly reduced in both cultivars. A different response to dehydration between Nadita and Ailzla was observed in LS-AOM – in Nadita amount was reduced, while in Ailzla was increased.

The two common winter wheat cultivars – Nadita and Ailzla responded to dehydration for 7 days in a different manner. It can be supposed that the cultivar Ailzla is more resistant to dehydration.

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