Morpho-physiological variation and antioxidant response of Bulgarian wheat cultivars after drought stress and subsequent recovery

Anna Dimitrova, Mariyana Georgieva, Iskren Sergiev, Elena Shopova, Valya Vassileva

Institute of Plant Physiology and Genetics, Bulgarian Academy of Sciences, 1113 Sofia, Bulgaria, e-mail: anndim@yahoo.com

Drought is a major constraint to growth, development and productivity of crop plants during current extreme weather threats. Identification of morphological, physiological and biochemical adaptations, modulating plant drought tolerance, is a major challenge for agricultural science. To investigate responses to dehydation and develop early markers for drought tolerance, four Bulgarian winter wheat cultivars (Zlatitsa, Yantar, KM135 and Sadovo-1) were subjected to severe but recoverable drought at the seedling stage. Assessment of stress and recovery levels was based on plant growth parameters and leaf relative water content (RWC). All cultivars showed drought-induced reduction in the leaf RWC with a larger decrease in Zlatitsa. The applied dehydration caused activation of antioxidant defense systems in a cultivar-dependent manner. At the cellular level, drought had opposite effects on the leaves of Zlatitsa and Yantar. Higher stomatal frequency was observed in the dehydrated leaves of Zlatitsa and lower frequency in Yantar. In general, trichome density was high in the leaves of Yantar, decreasing only after the recovery period, whereas Zlatitsa had a lower trichome number that increased after recovery. Thus, the observed differences in drought response and recovery imply for the existence of different adaptation strategies to dehydration in wheat cultivars.

OVERALL GOAL

Study the drought stress responses of four wheat cultivars under dehydration and subsequent recovery, and identify early markers for drought tolerance

MATERIALS AND METHODS

PLANT MATERIAL

Four Bulgarian winter wheat cultivars, Sadovo-1, Yantar, Zlatitsa and KM135 were analysed in this study. Drought stress was imposed on 10-day-old plants with a fully developed second leaf and expanding third leaf by withholding irrigation for a period of 7 days, followed by 4 days of recovery. All analyses were performed on the second fully expanded leaf.

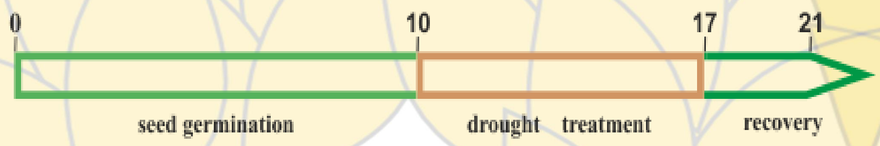

Fig. 1. Design of the drought stress experiment

RESULTS

Fig. 2. Representative plants of the cultivars KM-135 and Zlatitsa grown under optimal watering, drought stress and after recovery

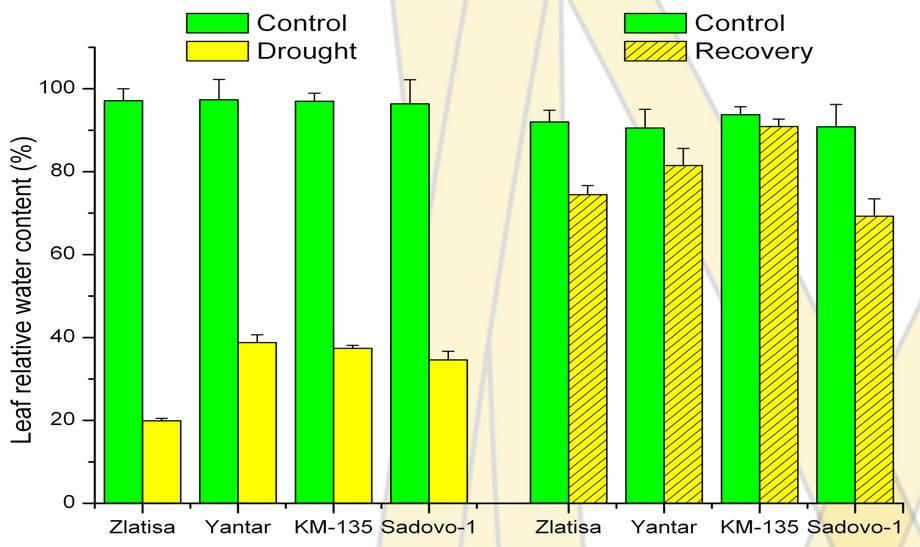

Fig. 3. Relative water content (RWC) in the second fully expanded leaf of four wheat cultivars grown under optimal watering, drought stress and after recovery

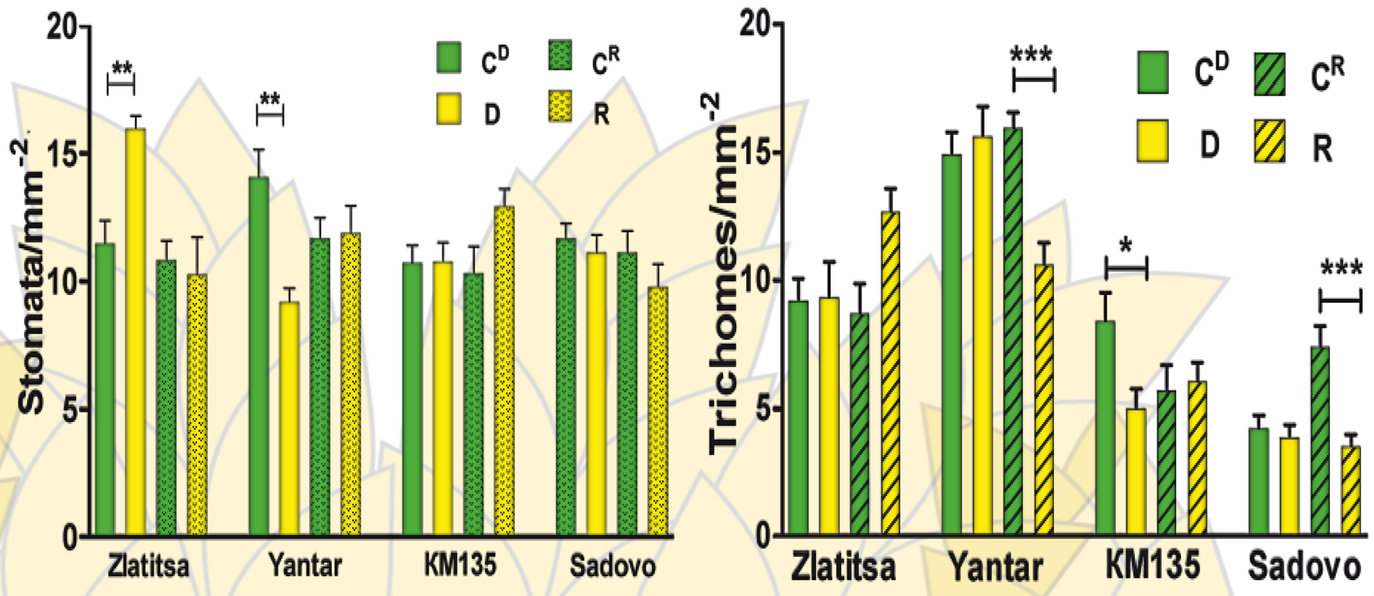

Fig. 4. Stomatal (A) and trichome (B) frequency on the leaf surfaces of four wheat cultivars under optimal watering, drought stress and after recovery

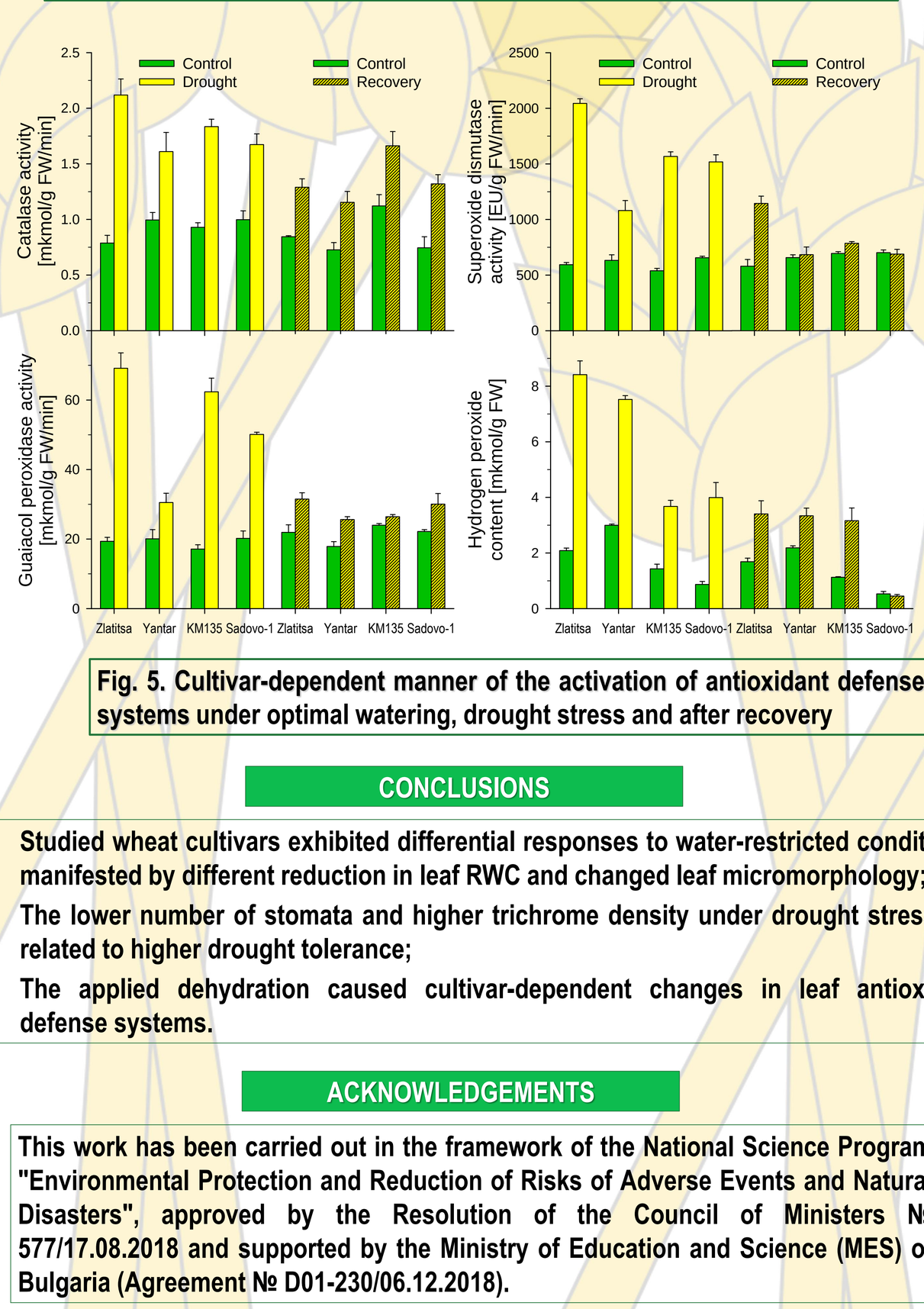

Fig. 5. Cultivar-dependent manner of the activation of antioxidant defense systems under optimal watering, drought stress and after recovery

CONCLUSIONS

- Studied wheat cultivars exhibited differential responses to water-restricted conditions, manifested by different reduction in leaf RWC and changed leaf micromorphology;
- The lower number of stomata and higher trichrome density under drought stress are related to higher drought tolerance;
- The applied dehydration caused cultivar-dependent changes in leaf antioxidant defense systems.

ACKNOWLEDGEMENTS

This work has been carried out in the framework of the National Science Program "Environmental Protection and Reduction of Risks of Adverse Events and Natural Disasters", approved by the Resolution of the Council of Ministers № 577/17.08.2018 and supported by the Ministry of Education and Science (MES) of Bulgaria (Agreement № D01-230/06.12.2018).