EFFECTS OF SELECTIVE HERBICIDE AND SUBSEQUENT DROUGHT OR WATERLOGGING ON TRITICALE

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Introduction

The abiotic stressors drought and waterlogging havoc crop development and yield. Triticale (*xTriticosecale* Wittm.) is supposed to be more tolerant to stress than wheat due to its rye traits. Herbicide Serrate® (Syngenta) is systemic and selective for triticale restraining annual grass and broadleaf weeds. In natural conditions plants are rather subjected to stress combinations. The resultant effect is not possible to be estimated in advance but only experimentally tested (Rivero et al. 2022). Oxidative stress characterized with boost in reactive oxygen species (ROS) is universal reaction to stress but the antioxidant defense (enzymatic and non-enzymatic) might be activated to balance redox status. The research aims to reveal if stress combinations applied in consequent manner cause negative or positive effect to triticale.

Materials and methods

➢ *Model system:* Triticale (cv. Rozen) seeds obtained from the Institute of Plant Genetic Resources (Sadovo, Bulgaria) were grown on soil under controlled conditions (22/17 °C, 16/8 h photoperiod, 60% relative air humidity, each pot consisted of 20 plants). Seventeen-day-old seedlings were treated with herbicide Serrate® according to manufacturer's instructions. After 3 days part of the plants were exposed to drought (by withholding watering for 7 days) or waterlogging (by transferring the pots into an external container with water level 2 cm higher than that of the soil). The stress program lasted for 7 days and the seedlings were transferred to normal irrigation conditions for recovery. The plant material was collected for analysis at the 4th and 7th day of stress and at 4th day of recovery.

➢ *Stress markers:* H_2O_2 (Alexieva et al. 2001), malondialdehyde (MDA, Kramer et al. 1991), proline (Bates et al. 1973).

➢ *Non-enzymatic antioxidants:* thiols (Ellman et al. 1959), phenolics (Swain & Goldstein, 1964).

➢ *Antioxidant enzymes activity:* superoxide dismutase (SOD, Beauchamp & Fridovich, 1971), guaiacol peroxidase (POX, Dias & Costa, 1983), catalase (CAT, Aebi 1984), glutathione reductase (GR, Smith et al. 1988).

➢ *Detoxification enzymes activity:* glutathione *S*-transferase (GST, Gronwald et al. 1987), NADPH:cytochrome P450 reductase (CPR, Tanigaki et al. 1993), NADH:cytochrome *b5* reductase (B5R, Tanigaki et al. 1993).

Results

➢ Serrate® does not cause prominent changes in antioxidant defense and detoxification status.

➢ The water stress and combined treatment enhanced the content of stress markers, non-enzymatic and enzymatic antioxidants, and detoxification enzymes.

➢ The observed effects were more severely expressed after drought.

➢ Serrate® application did not induced additional negative response in triticale subjected to consequent drought stress.

➢ The impact of combined treatment was stronger for the drought-treated plants even during recovery, while the effects for waterlogged triticale decreased with time.

Conclusion

➢ Serrate® application did not induced additional negative response in triticale subjected to consequent water stress.

➢ The impact of combined treatment on stress markers, antioxidant defense and detoxification status was stronger for the drought-treated triticale plantlets.

➢ The observed effects for waterlogged triticale declined with time.

References

Rivero R. M., Mittler R., Blumwald E., Zandalinas S. I. The Plant Journal. 2022, 109, 373–389.
Alexieva V., Sergiev I., Mapelli S., Karanov E. Plant Cell Environ. 2001, 24, 1337–1344.
Kramer G., Norman H., Krizek D., Mirecki R. Phytochemistry 1991, 30, 2101–2108.
Bates L.,Waldren R., Teare I. Plant Soil 1973, 39, 205–207.
Ellman G.L. Arch. Biochem. Biophys. 1959.
Swain T., Goldstein L. Pridham J.B., Ed.; Pergamon Press: Oxford, UK, 1964; pp. 131–146.
Dias I., Costa M.J. Exp. Bot. 1983, 34, 537–543.
Aebi M. Methods Enzymol. 1984, 105, 121–126.
Tanigaki F., Ishihara A., Yoshida K., Hara T., Shinozaki M., Iwamura H. Z. Naturforsch. 1993, 48, 879–885.

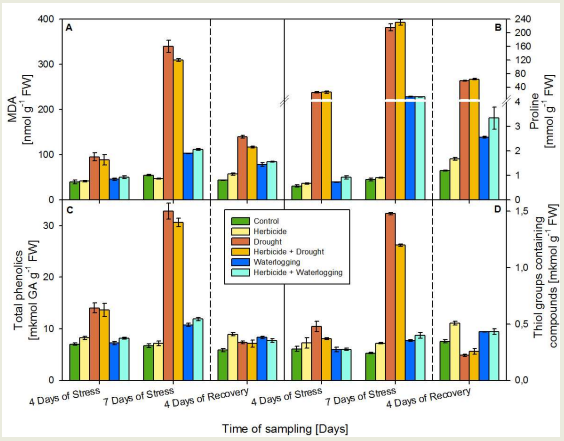

Fig. 1. Content of MDA, Proline, total phenolics and thiols in leaves of triticale plantlets treated with herbicide and subjected to consequent water stress (drought or waterlogging).

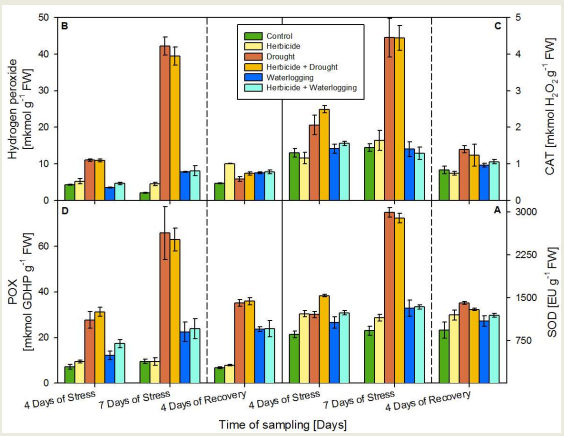

Fig. 2. Content of hydrogen peroxide, and activities of CAT, POX and SOD in leaves of triticale plantlets treated with herbicide and subjected to consequent water stress (drought or waterlogging).

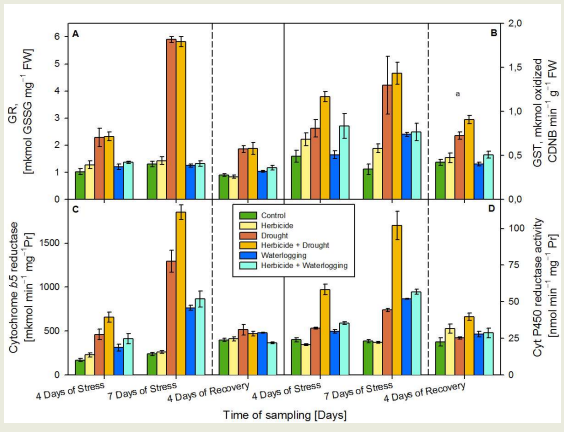

Fig. 3. Activities of GST, CPR and B5R in leaves of triticale plantlets treated with herbicide and subjected to consequent water stress (drought or waterlogging).

Acknowledgments: This study was funded by grant KP-06-N36/3 (30.09.2020) of National Science Fund, Ministry of Education and Science, Republic of Bulgaria.