THE USE OF PLANT GROWTH REGULATORS IN SUSTAINABLE STRESS-MITIGATING APPROACHES IN VEGETABLE PRODUCTION – A CASE STUDY IN *LACTUCA SATIVA* (LETTUCE)

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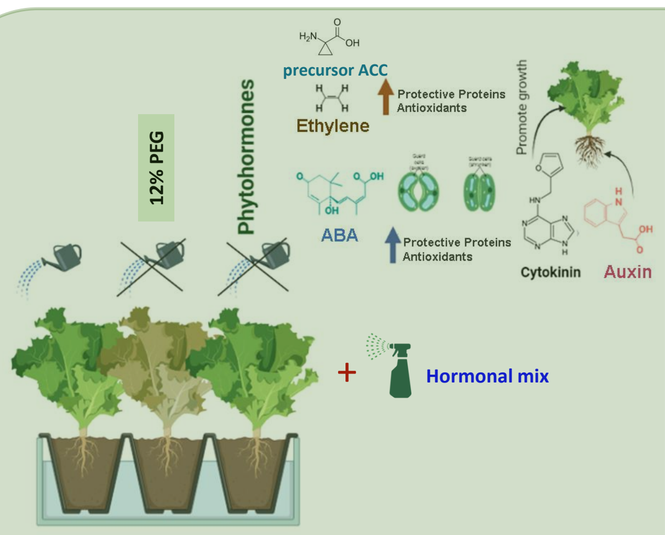
ABSTRACT

The ongoing climate change calls for urgent introduction of efficient and sustainable agricultural practices to improve crop stress tolerance and productivity. Plant growth regulators (PGRs) play role in orchestrating responses to diverse abiotic stresses and facilitate plant adaptation to harsh conditions. Application of PGRs in very low amounts could trigger the natural defence mechanisms without any hazardous consequences. Therefore PGR-based approaches could offer highly efficient and economically relevant protocols for improving crop fitness under adverse environments. We tested the osmotic-stress mitigating potential of PGR combinations on hydroponically-grown lettuce treated with 12% PEG. The PGR mixes comprised ABA, ACC, auxin- and cytokinin analogues in micromolar concentrations. The protective effect of the mixes was evaluated through biometric measurements, biochemical analyses and transcript profiling of genes coding for antioxidative enzymes. The priming with PGRs correlated well with the subsequent better performance of the drought-stressed plants. It was linked to the upregulation of particular antioxidant system components. The good protective properties of PGRs applied in small doses are consistent with sustainable farming practices and might be beneficial for cost-efficient crop management.

BACKGROUND

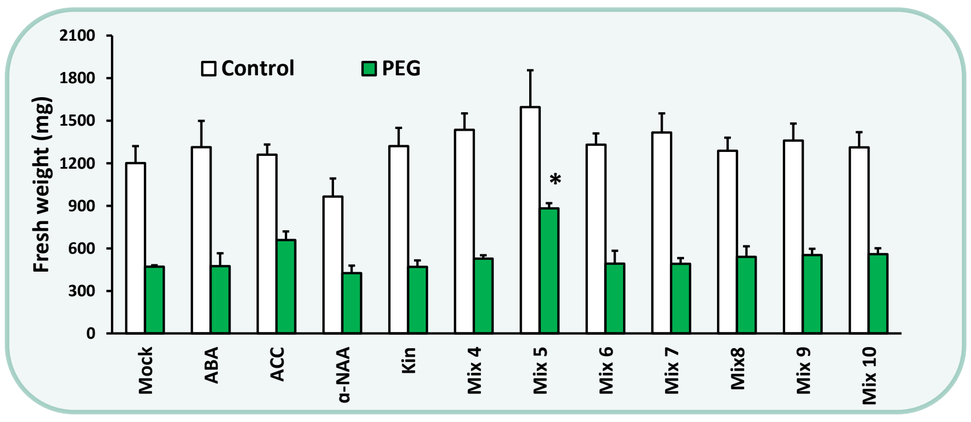
Plant Growth Regulators (PGRs) are natural or synthetic organic compounds capable to modify physiological processes by activation of different signaling pathways. Most commercially available products labeled as PGRs contain analogs of auxins, gibberellins, and cytokinins. HormOnDrought is a collaborative Bulgarian-Lithuanian research project testing drought-stress mitigating the effects of hormonal mixes on lettuce.

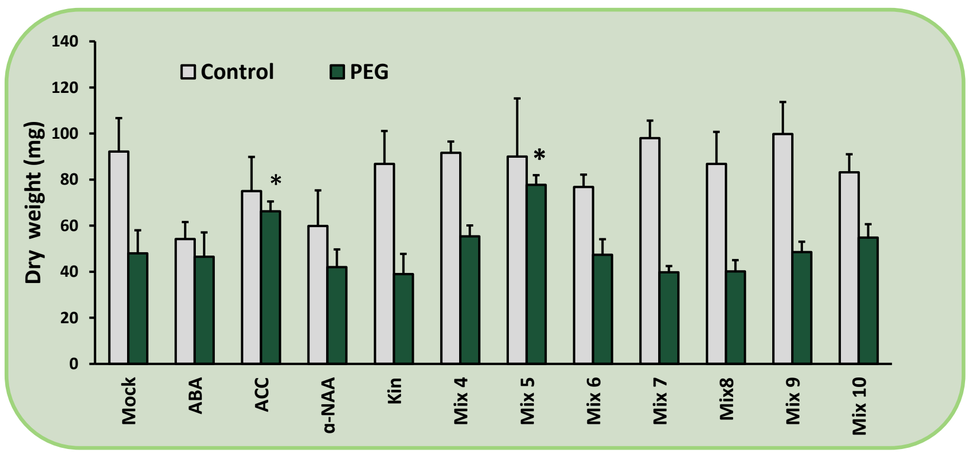
EXPERIMENTAL DESIGN



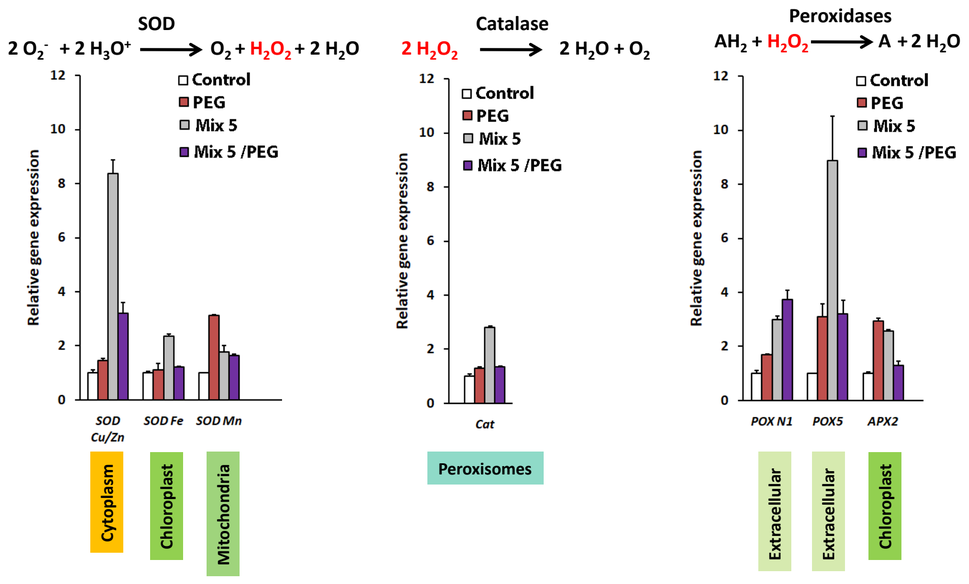
- ❖ Hydroponically grown plants
- ❖PEG for drought stress simulation
- ❖PGR applied as monosolutions or combined in mixes
- ❖Stress hormones: ABA and ACC (ethylene precursor)
- ❖Growth-stimulating hormones: αNAA (auxin) and Kinetin (cytokinin)

Effects of mono-treatments and hormonal mixes on growth parameters



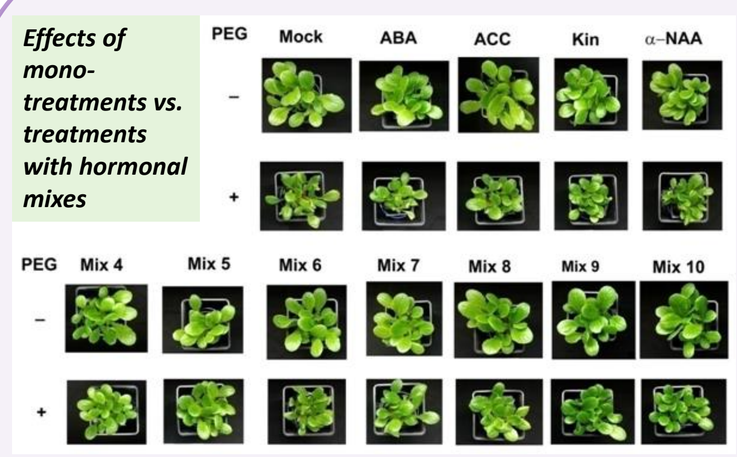


Mix 5 upregulates coding for ROS-scavenging enzymes

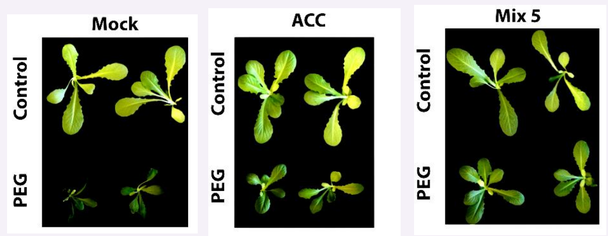


RESULTS

Effects of mono-treatments vs. treatments with hormonal mixes

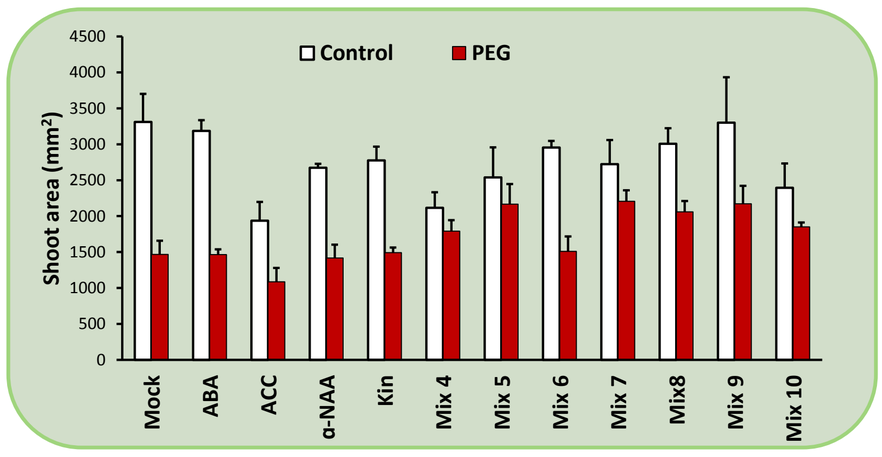


- ❖Different combinations of ABA, ACC, **αNAA, and Kinetin were tested**
- ❖All components were used in micro molar (μM) concentrations

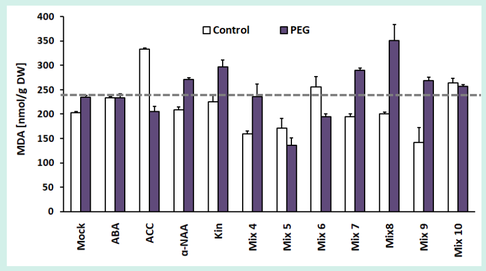


- ❖**ACC** shows the best protective potential among the tested monotreatments
- ❖**Mix 5**, a combination of [ABA]>[ACC]>[αNAA]>[Kinetin], shows the best stress-protective effect

- ✓ACC application has significant growth-inhibiting effect which is evident from the smaller shoot size of the ACC-treated control plants
- ✓The reduction of shoot area was less affected in the plants treated with Mix 5

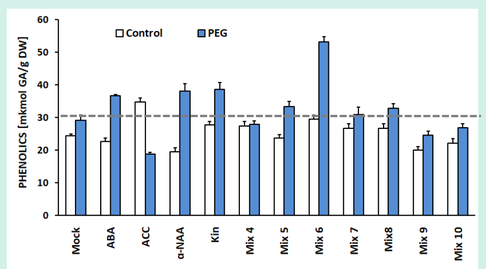


Effects of mono-treatments and hormonal mixes on antioxidants and stress markers



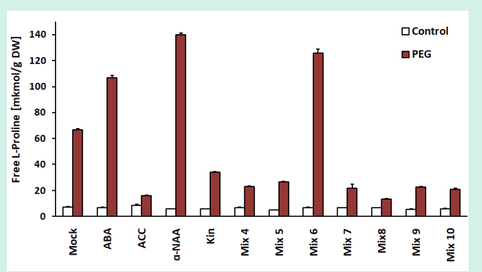
MDA – an oxidative stress marker

✓Malonedealdehyde (MDA) content is a parameter which is linked to the cellular membrane integrity. Mix 5-treated plants demonstrate lower MDA levels under control and stress conditions



Total Phenolics – antioxidants

✓Mix 5/PEG-treated plants accumulate higher amounts of phenolics compared to the ACC/PEG-treated group



L-Proline – an osmoprotectant with ROS scavenging capacity which could be regarded also as an oxidative stress marker

✓ACC and Mix 5 treatments have similar effects on L-Pro content

Conclusions

- ✓ Plant hormones exert protective effects in very low concentration making **PGR mixes a safe and cost-efficient method for stress mitigation**
- ✓ The amount of the **"stress-hormone"** components in the mix should be **carefully fine-tuned to avoid reduction in crop productivity**

Acknowledgements: *The study was supported by the research agreement between Bulgarian Academy of Sciences and Lithuanian Academy of Sciences, Project* ***HormOnDrought (2022-2024).***