Exogenous Ferulic Acid Differentially Modulates Phenolic Composition of Broccoli Microgreens under Regular Watering and Flooding Conditions

University of Zagreb Faculty of Science,
Department of Biology, Horvatovac 102a,
10000 Zagreb, Croatia
*marta.frlin@biol.pmf.unizg.hr

Marta Frlin*, Ivana Šola

Egzogena ferulična kiselina diferencijalno modulira fenolni sastav mikropovrća brokule u uvjetima redovitog zalijevanja i poplave

Introduction

Flooding, as a type of abiotic stress, poses a serious threat to plant growth and yield. Although flooding is a natural occurrence, anthropogenic effects and climate change are expected to increase flood risk. To cope with stress, plants activate defense mechanisms, where **phenolic compounds** such as **ferulic acid (FA)** play a key protective role. Our previous study showed that flooding significantly elevated endogenous FA levels in broccoli microgreens, indicating its involvement in stress tolerance. Therefore, the aim of this study was to **evaluate the potential of exogenous FA** application to modulate defense responses and **enhance flood tolerance in broccoli microgreens.**

Methodology

Broccoli (*Brassica oleracea* var. *cymosa*) microgreens were grown under regularly watered (RW) and flooded (F) conditions and treated with exogenous ferulic acid (1, 10 and 100 mg/L). The effect of exogenous FA on phenolic compounds was assessed spectrophotometrically.

Results

- **phenolics**: exogenous FA had no effect under RW, but all concentrations significantly increased total phenolics under F
- **phenolic acids**: elevated by 1 and 100 mg/L FA under RW, with no significant FA effect under F
- **proanthocyanidins**: markedly elevated by 100 mg/L FA under RW, while all FA concentrations increased levels under F
- hydroxycinnamic acids, flavonols, and tannins were not significantly affected by FA treatment under either RW or F
- **flooding stress** increased total phenolics (10 mg/L FA), phenolic acids (100 mg/L FA), hydroxycinnamic acids (1 and 10 mg/L FA), flavonols (control, 1 and 10 mg/L FA) and proanthocyanidins (control, 10 and 100 mg/L FA)

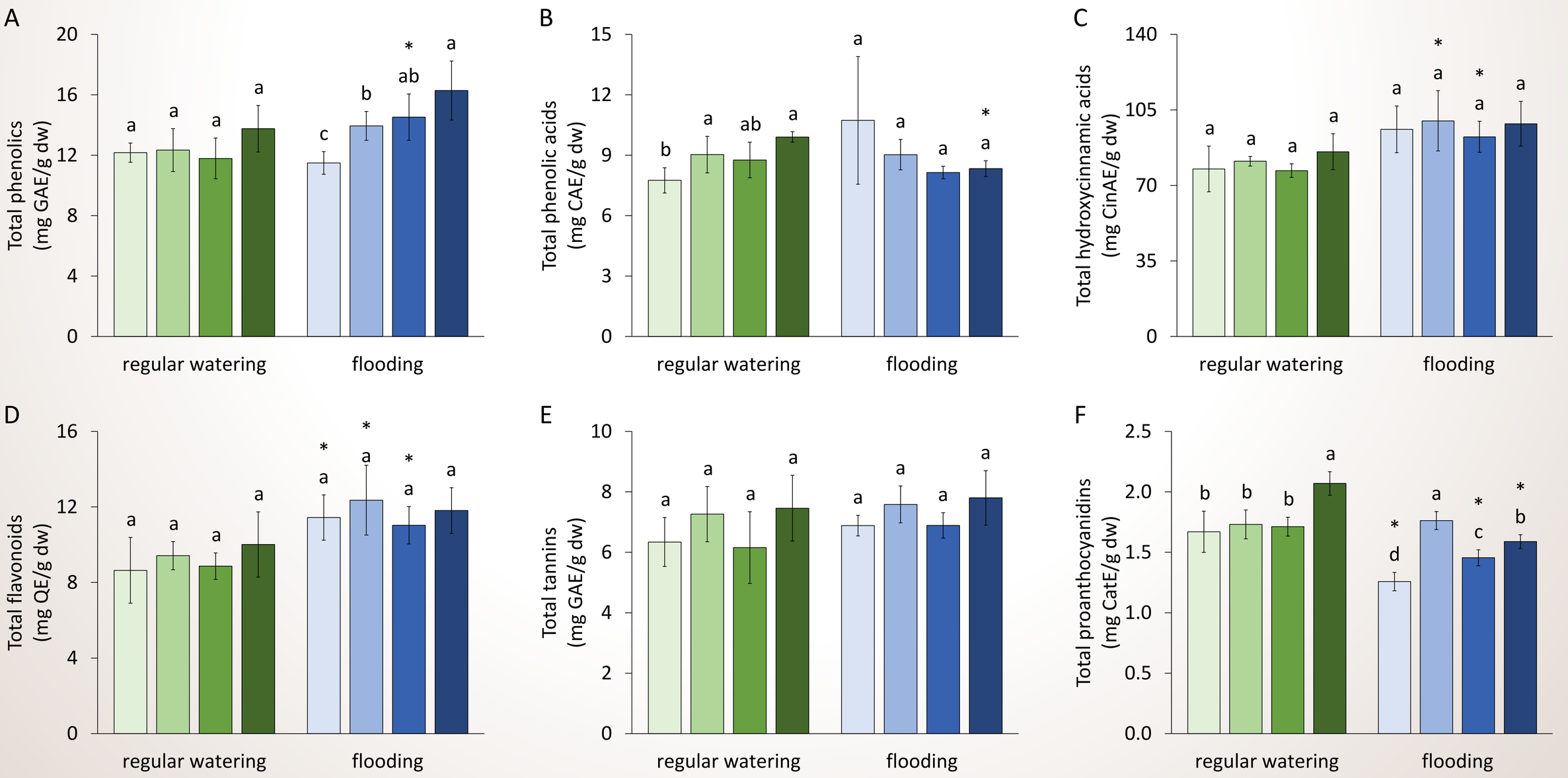


Figure 1. Effect of exogenous ferulic acid on different groups of phenolic compounds in broccoli microgreens grown under regular watering and flooding. A) total phenolics, B) total phenolic acids, C) total hyroxycinnamic acids, D) total flavonoids, E) total tannins, F) total proanthocyanidins. Values represent average ± standard deviation of four biological replicates. Different letters indicate a significant difference among plants grown under the same watering regime (one-way ANOVA, Duncan's test, $p \leq 0.05$). An asterisk (*) indicates a significant difference between the same treatment group grown under regular watering regime and flooding (Student's *t*-test, $p \leq 0.05$).

Conclusions

- both exogenous FA and flooding stress modulated the phenolic profile of broccoli microgreens
- the effect of exogenous FA was dependent on soil water status

Overall, these findings indicate a role for **exogenous FA** in **modulating stress-related phenolic compound metabolism**, suggesting its potential application in **mitigating flooding stress** in microgreens.

Reference

Frlin, M., & Šola, I. (2026). Exogenous Ferulic Acid Mitigates Flooding Stress in Broccoli via GSH-Mediated Redox Homeostasis. *Plants*, *15*(9), 1323.

Acknowledgements

This study was supported by the Croatian Science Foundation project IP-2020-02-7585 and DOK-NPOO-2023-10-2396.