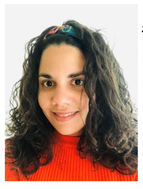
Biocontrol for food security:
Characterization of local maize response to entomopathogenic nematodes.



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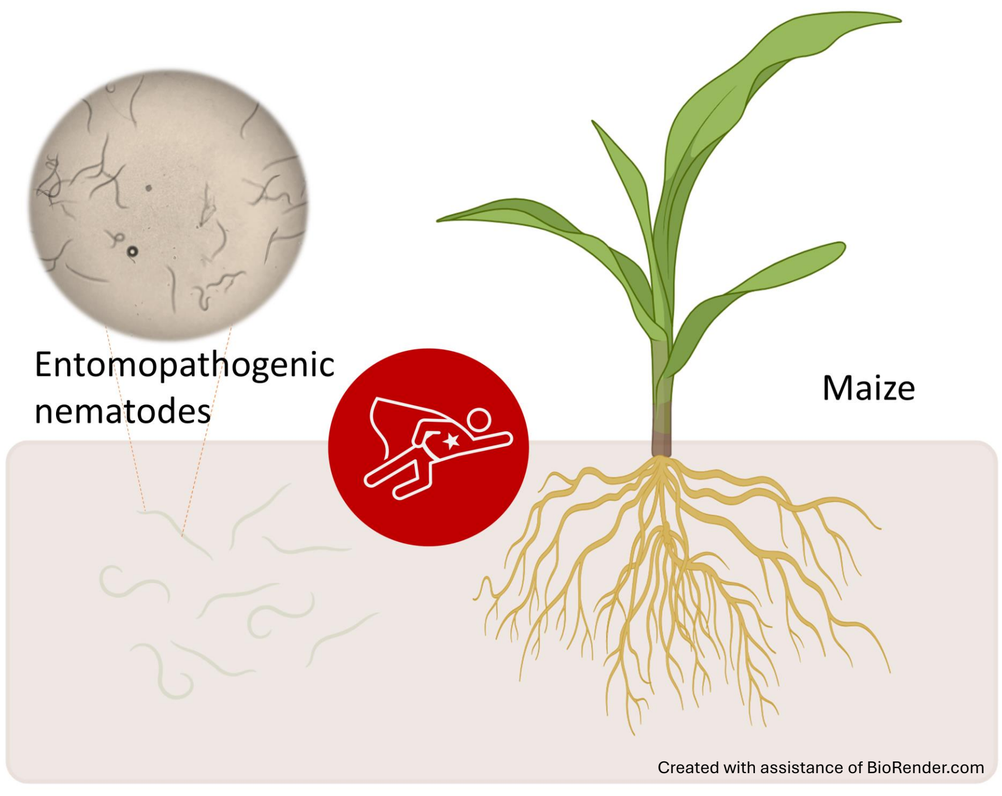
To summarize:

1. Maize plants respond to the presence of entomopathogenic nematodes (EPNs) in the soil.
2. Maize plants change the sugar and amino acid concentrations in their roots upon EPN exposure.



Background

Multitrophic interactions between plants, herbivores, and the enemies of the herbivores are key drivers of ecosystem functioning and biodiversity (van Dam & Heil, 2011). Entomopathogenic nematodes (EPNs) are used as biocontrol of many insect species in valuable food crops (Koppenhöfer, Shapiro-Ilan, & Hiltpold, 2020). Previous studies affirmed that plants respond systemically to the presence of EPNs in the soil (Jagdale et al., 2009). However, how plants respond locally to herbivore enemies remains unclear. By combining metabolomics and transcriptomic analyses, we investigated how maize (*Zea mays*) plants respond locally to the presence of EPNs in soil.

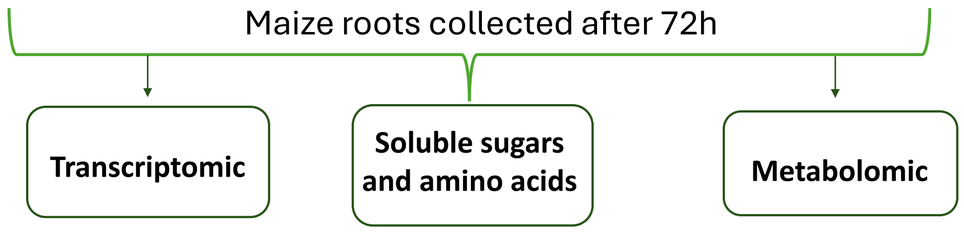
Experimental design

B73 plants grown in greenhouse conditions.

- Treatments:

Control (tap water)

EPNs (2000 individuals per plant)



Results

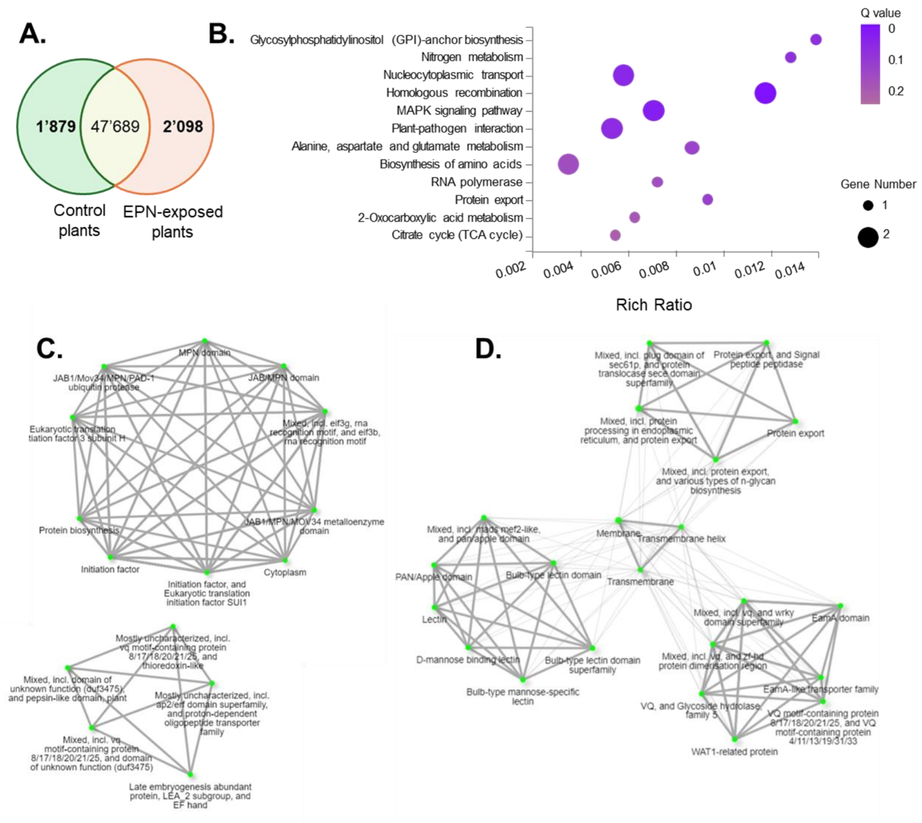
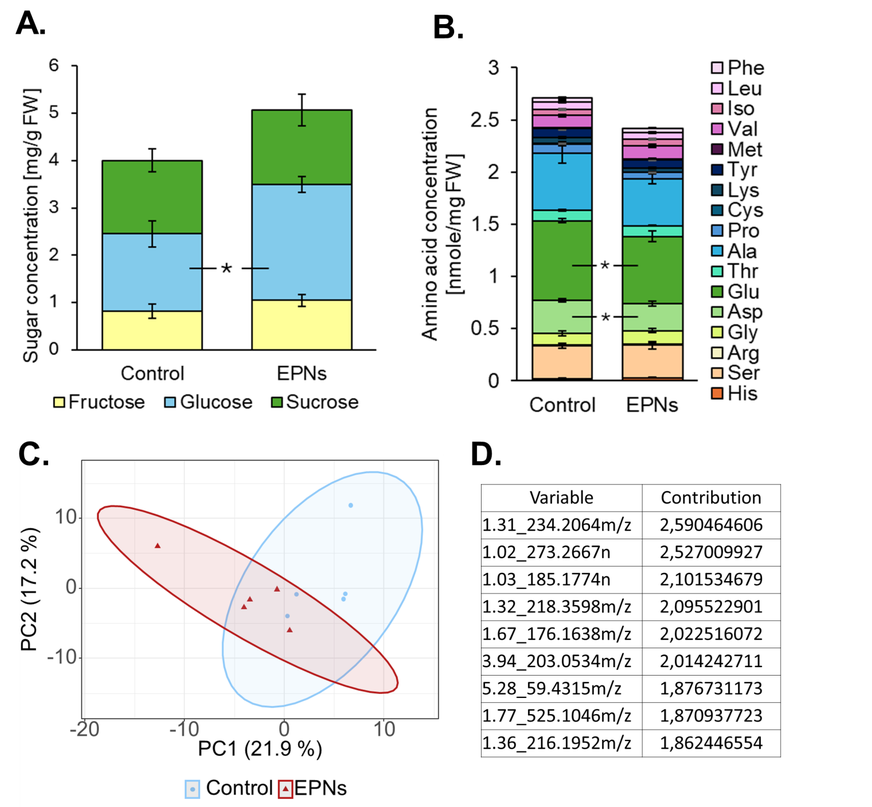


Fig 1. Entomopathogenic nematodes (EPNs) modulate maize primary metabolism. **(A.)** Venn diagram illustrating the number of differentially expressed genes in control and EPN-exposed plants in transcriptomic analyses. **(B.)** KEGG pathway enrichment analysis, where the size and color of the bubbles represent the gene number and Q-value, respectively. **(C.)** Network analyses of down- and **(D.)** upregulated genes, respectively. EPN exposure was achieved by adding 2'000 *Heterorhabditis bacteriophora* nematodes for 72 hours in the soil (n=5 per treatment).



D.

Variable	Contribution
1.31_234.2064m/z	2,590464606
1.02_273.2667n	2,527009927
1.03_185.1774n	2,101534679
1.32_218.3598m/z	2,095522901
1.67_176.1638m/z	2,022516072
3.94_203.0534m/z	2,014242711
5.28_59.4315m/z	1,876731173
1.77_525.1046m/z	1,870937723
1.36_216.1952m/z	1,862446554

Fig 2. Maize plants increase glucose and reduce amino acid concentrations in the roots upon exposure to entomopathogenic nematodes (EPNs). **(A.)** Bar plot representing the concentration of soluble sugars in control and EPN-exposed plants. **(B.)** Bar plot representing the concentration of amino acids in control and EPN-exposed plants. **(C.)** Principal components analysis (PCA) including powered partial least squares – distribution analysis (PPLS-DA) in control and EPN-exposed plants. Dim: Dimension. **(D.)** Table indicating the principal variables that contributed to the PC1. EPN exposure was achieved by adding 2'000 Heterorhabditis bacteriophora nematodes for 72 hours in the soil (n=5 per treatment). Stars indicate significant difference (*:p<0.05).

Discussion and future perspectives

This study reveals the molecular response of maize seedlings to EPNs, specifically *Heterorhabditis bacteriophora*, highlighting sugar signaling as a potential plant response mechanism. The findings are crucial for understanding tritrophic interactions, which are essential for grasping complex ecological systems. Additionally, the study underscores the significant potential of using biocontrol agents in sustainable agriculture, reducing reliance on chemical pesticides and contributing to global food security efforts. This research not only advances our knowledge of plant-nematode interactions but also opens new avenues for future studies.

I am open to collaborate on new biocontrol projects starting in June 2025. Please feel free to contact me to discuss potential opportunities further.

References

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3. van Dam, N. M., & Heil, M. (2011). Multitrophic interactions below and above ground: en route to the next level. *Journal of Ecology*, *99*(1), 77–88. http://www.jstor.org/stable/41058839

Acknowledgments

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