Aphid infestation changes metabolic activity and composition of bacterial communities in the wheat rhizosphere

ROTHAMSTED RESEARCH

Sandra Lucía Cortés-Patiño, Adriana Torres-Ballesteros, Vanessa Nessner-Kavamura, Amanda Rasmussen, John Caulfield

Background

Aphids, phloem sap-feeding insects, are among the most damaging pests. Current control relies on insecticides, but aphid populations quickly become resistant. Furthermore, their use has a negative impact in the environment[1,2].

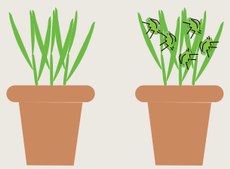
Microbial communities in the rhizosphere can influence plant growth and protection. Beneficial microbes have been shown to "prime" plants to increase their defences to several biotic and abiotic stressors[3].

Research question

Do wheat rhizosphere microbial communities change in response to aphid herbivory?

Methods

Two weeks of aphid infestation



Control vs. Aphid-infested

Aboveground
Released plant volatiles

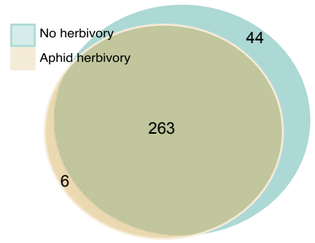
Belowground
16S rRNA amplicon sequencing
Carbon source use

Plant volatiles were collected using air entrainments for GC and GCMS analysis.

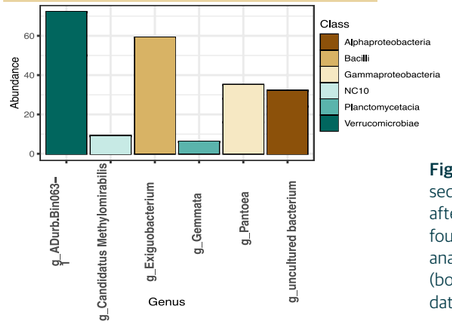
Rhizosphere soil was taken for community-level physiological profiling and DNA extraction for further analyses.

Bacterial communities in the rhizosphere changed under herbivory

a) Bacteria genera after two weeks of herbivory



b) Unique genera under aphid herbivory



c) Differential abundance of bacteria under herbivory (top: aphid herbivory, bottom: no herbivory)

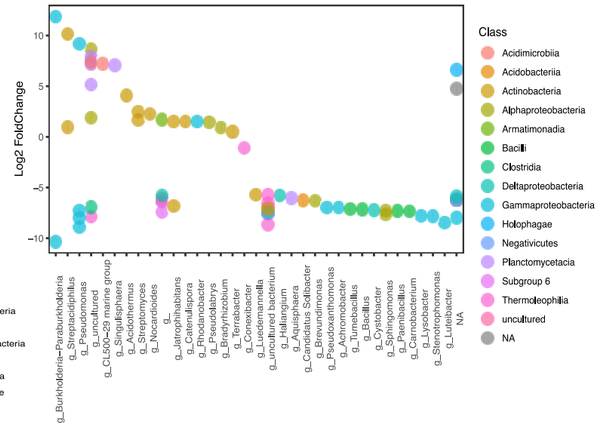


Figure 1. Analysis of rhizosphere bacterial communities (16S amplicon sequencing) of aphid-infested and control wheat plants. Samples were taken after two weeks. a) Venn diagram showing shared genera, b) Unique genera found in the rizhosphere of plants under herbivory, c) Differential abundance analysis of genera found in plants under herbivory (top) and control plants (bottom) ($p < 0.05$). Taxonomy was assigned to ASVs using the SILVA132 database.

Metabolic activity of rhizosphere bacterial communities

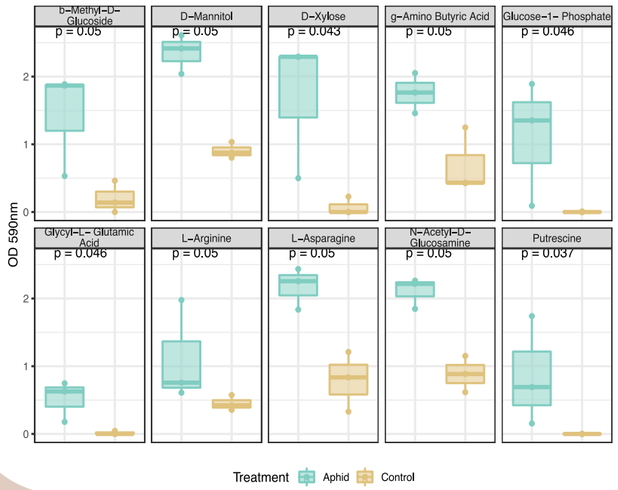


Figure 2. Community level physiological profiling of rhizosphere microbial communities from aphid-infested and control plants. Soil suspensions were incubated in 31 carbon sources (Biolog, Ecoplate). Boxplots show carbon sources where microbial activity in aphid-infested plants was significantly different ($p < 0.05$) from control plants.

Wheat plants released volatiles associated with stress response

Released volatiles were significantly different after 2 weeks of aphid infestation ($p = 0.032$). GCMS analysis tentatively identified compounds related to plant defence against herbivory.

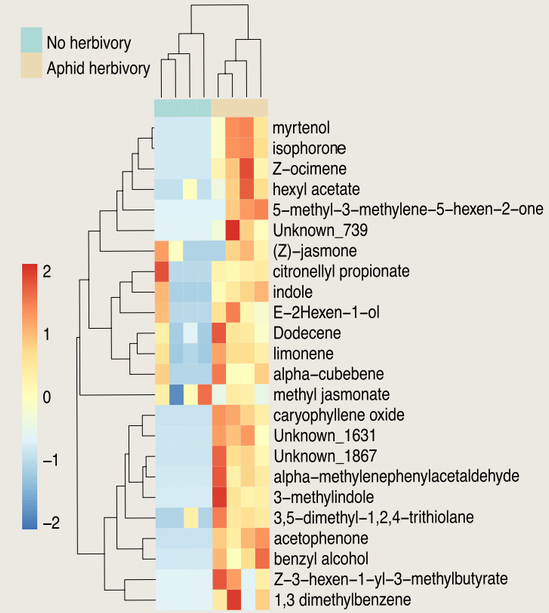


Figure 3. Volatile compounds released by plants two weeks after infestation. Tentative identification of compounds was made using GCMS and retention index. Data analysis was made using the GCAlignR package in RStudio.

Conclusion

Bacterial taxa like *Pantoea, Burkholderia* and *Streptacidiphilus* were impacted by aboveground aphid herbivory.

Further work will investigate the role of the bacterial taxa increased under herbivory and their interaction with root exudates.

References

1. Jaouannet, M., Rodriguez, P. A., Thorpe, P., Lenoir, C. J., MacLeod, R., Escudero-Martinez, C., & Bos, J. I. (2014). Plant immunity in plant–aphid interactions. Frontiers in plant science, 5, 663.
2. Simon, A. L., Caulfield, J. C., Hammond-Kosack, K. E., Field, L. M., & Aradottir, G. I. (2021). Identifying aphid resistance in the ancestral wheat Triticum monococcum under field conditions. Scientific reports, 11(1), 1-12.
3. Kumar, A., & Verma, J. P. (2018). Does plant—microbe interaction confer stress tolerance in plants: a review?. Microbiological research, 207, 41-52.

Envision
Developing next generation leaders in environmental science
University of Nottingham
UK | CHINA | MALAYSIA
UKRI Biotechnology and Biological Sciences Research Council