

Honeydew management to promote biological control

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Abstract

Honeydew is the excretion product of many plant-feeding hemipterans and some lepidopterans. This sweet excretion product is the most abundant and accessible source of carbohydrates for parasitoids and predators in many agroecosystems [1,2]. Being so abundant, honeydew mediates many direct and indirect interactions that affect biological control. Here, we describe these interactions and identify honeydew-management strategies to reduce pest pressure. First, as with flowering plants, the presence of non-damaging honeydew producers in cover crops and hedges increases the abundance and fitness of parasitoids and predators [3]. Second, breaking the mutualism between ants and honeydew-producing pests with alternative sugar sources promotes biological control of these pests [4-6]. Third, we propose to explore honeydew volatiles to attract biological control agents and repel pests, as well as to induce plant defences [7-9]. Finally, we urge reducing the use of systemic pesticides that contaminate honeydew and negatively affect biological control agents that feed on it [10]. Overall, we propose that honeydew management is incorporated in integrated pest management programs to contribute to the development of sustainable agriculture [11].

References

- [1] Wäckers F.L., van Rijn P.C.J., Heimpel G.E. "Honeydew as a food source for natural enemies: Making the best of a bad meal?" *Biol Control*, 45:176–184, (2008).
- [2] Tena A., Wäckers F.L., Heimpel G.E., Urbaneja A., Pekas A. "Parasitoid nutritional ecology in a community context: the importance of honeydew and implications for biological control". *Curr Opin Insect Sci*, 14:100–104, (2016).
- [3] Irvin N.A., Hoddle M.S. "The effects of floral nectar, extrafloral nectar and hemipteran honeydew on the fitness of *Tamarixia radiata* (Hymenoptera: Eulophidae), a parasitoid of *Diaphorina citri*". *Biol Control*, 163:104753, (2021).
- [4] Wäckers F.L., Alberola J.S., Garcia-Marí F., Pekas A. "Attract and distract: Manipulation of a food-mediated protective mutualism enhances natural pest control". *Agric Ecosyst Environ*, 246:168–174, (2017).
- [5] Nagy C., Cross J.V., Markó V. "Sugar feeding of the common black ant, *Lasius niger* (L.), as a possible indirect method for reducing aphid populations on apple by disturbing ant-aphid mutualism". *Biol Control*, 65:24–36, (2013).
- [6] Pérez-Rodríguez J., Pekas A., Tena A., Wäckers F.L. "Sugar provisioning for ants enhances biological control of mealybugs in citrus". *Biol Control*, 157, (2021).
- [7] Peñalver-Cruz A., Satour P., Jaloux B., Lavandero B. "Honeydew Is a Food Source and a Contact Kairomone for *Aphelinus mali*". *Insects*, 14:1–11, (2023).
- [8] Liu J., Xiao D., Liu Y., Zhan Y., Francis F., Liu Y. "Chemical cues from honeydew-associated bacteria to enhance parasitism efficacy: from laboratory to field assay". *J Pest Sci*, (2023).
- [9] Wari D., Kabir M.A., Mujiono K., Hojo Y., Shinya T., Tani A., Nakatani H., Galis I. "Honeydew-associated microbes elicit defense responses against brown planthopper in rice". *J Exp Bot*, 70:1683–1696, (2019).
- [10] Calvo-Agudo M., González-Cabrera J., Picó Y, Calatayud-Vernich P., Urbaneja A., Dicke M., Tena A. Neonicotinoids in excretion product of phloem-feeding insects kill beneficial insects. *Proc Natl Acad Sci U S A*, 116:16817–16822, (2019).
- [11] Fernández de Bobadilla M., Moreno Ramírez N., Calvo-Agudo M., Dicke M., Tena A. "Honeydew management to promote biological control". *Curr Opin Insect Sci*, 61 (2024).