





Introduction

- Extrafloral nectaries (EFNs) are nectar producing structures that are not located within the flower. Black-eyed peas have two types of EFNs: inflorescence (iEFNs) and stipular (sEFNs).
- Myrmecophile plants produce EFNs that attract ant "bodyguards" to protect valuable parts of plants (as predicted by optimal defense theory; Heil & McKey 2003, Stadler and Dixon 2005).
- Aphids that evolved to be "tended" by ants are likely to choose myrmecophiles as plant hosts (Offenberg 2000). Aphids can parasitize the ant-plant relationship by stealing sugar from the phloem and stealing the "bodyguards" to protect aphids instead.

The main questions behind our research:

- How does presence of ants, aphids or EFN nectar secretion impact growth and reproduction in black eyed pea?
- How does presence of ants, aphids or EFN nectar secretion impact insect visitors (herbivores, predators) on black eyed pea?

We hypothesized that presence of ants will decrease herbivore damage on plants if EFN nectar is available, but plant growth and reproduction will decrease on plants without ants if they maintain active EFN-nectar secretion (energetic loss). We did not anticipate high aphid populations in 2022 that altered these dynamics.

Methods

Species: black-eyed pea (*Vigna unguiculata*) grown for 11 weeks

Treatment	iEFNs	Ants
1	Present	Present
2	Absent	Present
3	Present	Absent
4	Absent	Absent





- Vigna unguiculata 'Fagiolino Dolico di Veneto', Victory Seeds, OR
- Field plot with plants in growbags; placed in 17 randomized blocks
- iEFNs sealed with inert Si (Loctite) as they developed
- Ants excluded with tanglefoot on duct tape at base of growbags
- Weekly insect surveys (am, pm); vouchers to MCZ, Harvard U
- Shoots, roots, fruits dried & weighed (100 days after planting)

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Results















Figure 1: Shoot weight for ant exclusion treatments is significantly higher (p=0.004). Presence of EFN nectar has no effect on shoot weight (p=0.682). The interaction between ants and nectar is borderline significant (p=0.069).

Figure 2: There is a trend for higher fruit weight in ant exclusion treatments (p=0.078). Presence of EFN nectar has no significant effect (p=0.912) and the interaction between ants and nectar is not significant (p=0.480).

Figure 3: Root weight is significantly lower for nectar exclusion treatments (p=0.025). Ant exclusion has no significant effect (p=0.308) and the interaction between ants and nectar is not significant (0.884).

- EFN nectar rewards.

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Discussion

• This is the first study to examine the relationships between the EFN-bearing black eyed pea, ants and aphids. • Aphids colonized plants during the preparation of the field plot, but initial population size was low. After ants (*Camponotus* spp.) established themselves on plants in the field plot, aphid numbers increased very rapidly, and we observed aphid-tending behavior by ants. In addition to herbivores (weevils, sharpshooters, beetles), the abundant aphid population attracted a variety of predatory insects such as ladybird beetle adults and larvae (Harmonia axyridis, Coleomegilla maculata, Propylea quatuordecimpuncta), lacewing adults and larvae, various hoverflies and wasps. • Presence of ants had a negative effect on shoot and fruit weight; means for ant exclusion treatments (3 & 4) were higher than the ant inclusion treatments (1 & 2). • Adverse outcomes for plants with ants likely relate to high costs of ant-tended aphids removing sugar from the plants. • The lowest growth and reproduction was seen in plants with ants and sealed EFNs (Trt 2). Aggressive aphid-tending behavior is likely in this case, since ants have no EFN-nectar. • The interaction between ants and nectar effects on shoot and fruit weight showed a trend for less severe negative effects of

ants when nectar was available. Ants may have reduced their intensity of aphid-tending behavior on plants that supplied

• We were interested to find a significant negative effect of nectar exclusion on root weight. This outcome was not expected since plants with lower energetic costs from EFN nectar might have more energy for root growth. Presence of non-functional EFNs may shift energy allocation away from roots to promote compensatory shoot growth with EFNs. • Because of extreme drought resistance and high protein content, *Vigna unguiculata* is a critical source of global food security in the face of climate change threats. This study may provide ecological insights for ways to employ agroecological approaches to increase yields in the future (Jones et al. 2017).

Literature Cited

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