Pests and partners: the effects of cucumber beetles on pollinators, mycorrhizal fungi and yield in cucumbers

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Cucumber beetles (*Acalymma vittatum*) are important pests of cucurbit crops that are well-known for both inflicting direct damage on plants and fruits and spreading bacterial wilt. However, beetles may also have indirect impacts on cucurbits by affecting interactions between the plants and other organisms. The damaging effects of cucumber beetles are most evident aboveground, but their larvae develop underground and feed on roots. Thus plants may suffer negative effects from herbivores above and below the soil surface. However cucurbits also interact with beneficial organisms above- and belowground. Pollinator visitation is essential for fruit production, and associations between roots and beneficial mycorrhizal fungi help plants take up water and nutrients from the soil.

We studied how leaf damage by adult cucumber beetles directly affected cucumber plants and indirectly affected other interacting organisms (larvae, pollinators, and fungi). We enclosed the first four leaves of cucumber seedlings in mesh bags with beetles to impose different levels of damage in June and followed plants through the growing season. Given recent concerns of declines in both wild and domestic pollinators, we also applied an enhanced pollination treatment to half of the plants to determine if plants are receiving sufficient natural pollination.

Plants with higher leaf damage in June remained smaller throughout the season and produced fewer male and female flowers. Damage also reduced the size of petals on male flowers, which may reduce their attractiveness to pollinators. Beetle larvae tended to be more abundant on plants with low levels of leaf damage, but this pattern was not statistically significant. Beetle damage had strong effects on yield: low-damage plants produced more cucumbers than high-damage plants, and these fruits tended to be heavier.

Analyses of fungal colonization and pollinator visitation data are ongoing, but enhanced pollination did affect yield. Plants on which each female flower was hand-pollinated produced more cucumbers than plants that relied on natural visitation by pollinators. But this was not due to differences in pollination success – the proportion of female flowers that successfully developed into cucumbers was not different for the two groups. Rather, plants that received supplementary pollen actually produced more female flowers, leading to more fruits.

These results underscore that the negative effects of cucumber beetles may extend beyond their role as vectors of bacterial wilt. Early-season damage to only the first four leaves reduced plant yield all season long. By reducing the size of male flowers, beetle damage may reduce their attractiveness and lower the number of visitations by pollinators such as bees. Given our result that increased pollination led to greater flower production, reducing the number of visits by pollinators may result in lower cucumber production even if pollinators successfully transfer pollen to the flower they do visit.

In addition to examining fungal colonization and pollinator visitation data, in future years we will test the effects of root damage by experimentally altering the number of beetle larvae feeding on roots and the impacts of different fungal strains. By surveying fungal diversity in local fields, we hope to develop management recommendations that encourage the establishment of the most beneficial fungi to help growers maximize yield.