

Cucumber Pollination

Cucumbers are native to Asia but are currently grown around the globe.



Photo: Tom Ford, Penn State

In 2018, this vegetable crop covered 110,900 acres in the United States, yielding over 148.3 cwt/acre, and had an economic value of over \$278 million (USDA NASS 2019 data).

Centuries of selective breeding have created about 100 varieties, many of which are consumed today. Like other cultivated plants in the family Cucurbitaceae, cucumbers (*Cucumis sativus*) are annual vines that flower throughout the summer. Most cucumber varieties are monoecious with unisexual flowers—have separate male and female flowers within the same individual—and thus require animal pollination for reproduction. However, some varieties are mostly or totally gynoecious (produce only female flowers) and can produce fruit through parthenocarpy. Additionally, some varieties have perfect flowers that have both stamens and pistils.

Pollination is required to produce marketable cucumbers in most open-field production systems. Pollination of cucumber plants impacts the yield, size, and weight of fruit in non-parthenocarpic varieties (Figure 1). Records of floral visitors in the native geographic range of cucumbers include the Asian honey bee (*Apis cerana*), the Western honey bee (*Apis mellifera*), several bumble bees (e.g., *Bombus haemorrhoidalis*), ants (*Formica* spp.), sweat bees (*Halictus* spp.), and flies, among other insects (Thakur & Rana, 2008).

In parts of the world where cucumbers have been introduced, honey bees and stingless bees have been recorded as the main groups of pollinators, and in the United States, 28 species of bees were recorded visiting cucumber flowers in Ohio (Smith et al. 2013). Cucumber production in greenhouses uses bumble bees and hand pollination to achieve marketable yields, but the use of stingless bees has also been proven effective for this production type (dos Santos, 2008).



Figure 1. Cucumber fruit shape is impacted by pollination. In field plants, cucumbers grow straight when flowers receive enough pollination (A) and curved when flowers are pollination deficient (B). The opposite is true for parthenogenetic plants that are commonly grown in greenhouses. Photos: Tom Ford, Penn State

In a recent study conducted at the Russell E. Larson Research and Extension Center (Rock Springs) at Penn State, we found that the most abundant pollinator of cucumbers in central Pennsylvania were honey bees (*A. mellifera*) (Figure 2). Indeed, honey bees dominated the community of 'Bristol' cucumber visitors during a season-long census done in a 0.64-acre plot at Rock Springs in 2019. The plot was established using 3-week old transplants at 1 ft in-row spacing into raised beds with black plastic mulch and drip irrigation. Cucumber flowers had an average of 3.8 honey bee individuals for every ten minutes of observations.

However, other pollinating insects were observed in the field, including flies (averaged 0.87 visits/10 minutes), bumble bees (averaged 0.04 visits/10 minutes), and squash bees (averaged 0.02 visits/10 minutes) (Figure 3). The diversity and abundance of pollinating insects decreased later in the season, likely when plants were producing less flowers.

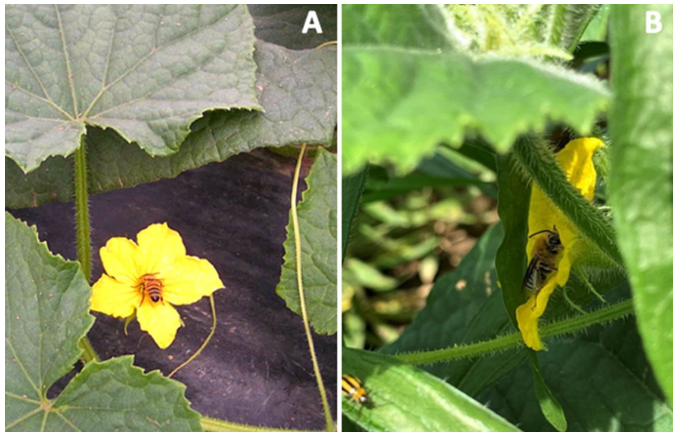


Figure 2. Common floral visitors of cucumbers in central Pennsylvania. (A) Honey bees are the most abundant floral visitor of cucumber flowers. (B) Squash bees are sometimes seen visiting cucumber flowers.

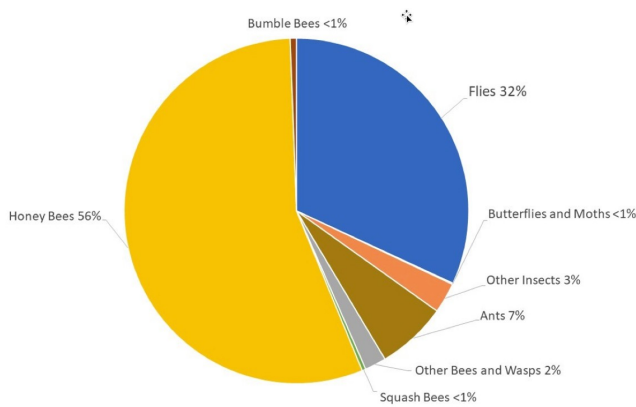


Figure 3. Pie chart showing the proportion of visitors to cucumber flowers during a summer census conducted in central Pennsylvania.

One of the most important management practices to keep healthy cucumber plants is to control striped cucumber beetles. However, insecticide applications may negatively impact the abundance of pollinators and the amount of pollination in cucumber fields. In this study, we also investigated the number of pollinators visiting flowers when treated with a variety of insecticides, using rates and materials that might improve bee safety (Table 1). Treatments were applied to 4-row plots, 20-feet long by 28 feet wide, with 4 replications. The Admire followed by Warrior served as a grower standard. Application timing was based on beetle counts.

Table 1. Insecticide treatments used to compare effects on yield and pollinator visitations. Sivanto applied in amounts that exceeded labeled rates for experimental purposes.

Insecticide Brand Name	Rate per acre	Chemical name, and IRAC category, and IRAC code	Application dates (days post transplanting)
Admire followed by Warrior (Grower std)	7 fl. oz Admire/3.84 fl. oz Warrior	Imidacloprid (neonicotinoid 4A) followed by lambda-cyhalothrin (pyrethroid – 3A)	Admire – 1 / Warrior -10, 17
Beleaf	4.28 oz	Flonicamid (chordotonal organ modulator– 29)	10, 17, 24, 38
Grandevo	3 lbs	Chromobacterium subsugae (bacteria)	10, 17, 24, 38
Sivanto Foliar	14 fl oz	Flupyradifurone (butanolide – 4D)	10, 17, 24, 38
Sivanto Soil followed by Sivanto Foliar	28 fl. oz soil 14 fl oz foliar	Flupyradifurone (butanolide – 4D)	Soil – 10 / Foliar – 17, 24, 38
Control	N/A	N/A	N/A

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We found few differences in the rate of honey bee visitation to cucumber plants that were treated with different insecticides. Specifically, we found that plants treated with Sivanto (both foliar and soil applications, at rates higher than the labeled rates) had lower honey bee visitation than the plants in the grower standard treatment (Figure 4). We found that the control, Beleaf, and the grower standard treatment showed similar levels of bee visitation when compared to the other treatments. Although there were little to no treatment effects on honey bee visitation, there were marked effects on yield (Figure 5) and incidence of bacterial wilt, which is caused by a bacterial plant pathogen (*Erwinia tracheiphila*) that is vectored by the striped cucumber beetle.

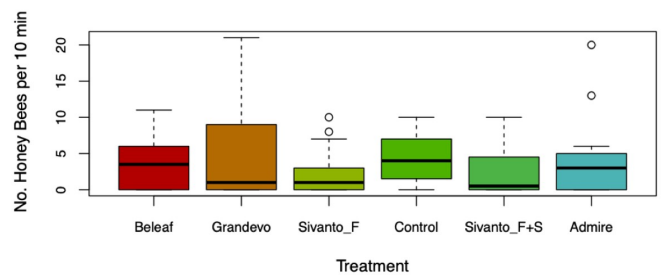


Figure 4. Seasonal average rate of honey bee visitation to 'Bristol' cucumbers at Rock Springs, PA in 2019. The treatment labeled Admire served as a grower standard, and the control had plants with no treatment for striped cucumber beetles.

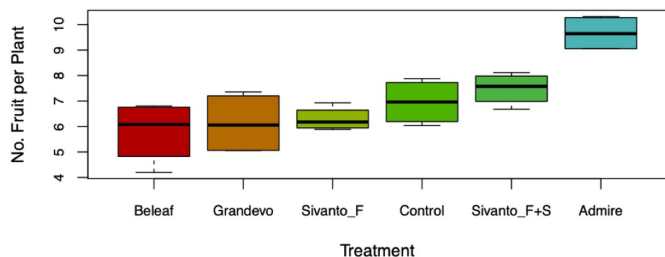


Figure 5. Effects of insecticide treatments on 'Bristol' total cucumber yield. Yield was measured on 3 dates, all showed similar results.

Cucumber flowers need to have a certain amount of pollen grains transferred for marketable fruit to be produced. Negative effects of insufficient pollination include deformed fruit, lower seed count, lighter fruit, and reduced fruit production. Signs of lack of pollination also include fruit abortion by the plant, which happens when the fruit does not mature in the plant. Counting the seeds of the mature fruit is also a way to identify pollination problems. Deformed fruit with low or underdeveloped seeds could be an indication of pollination issues. The weight of the fruit can also be an indication since fruit with lower seed counts tends to be lighter.

More information about cucurbit pollination can be found here: [Integrated Crop Pollination for Squashes, Pumpkins, and Gourds](#)

Upon identifying possible pollination deficiencies, some action can be taken by farmers to increase pollination success:

- Adding honey bee hives can increase the number of floral visitors, and thus could increase pollination. (Note: overstocking honey bees has been linked to reductions in fruit weight in other systems)
- Plant additional floral resources to attract wild bees to the fields, since wild insects also contribute to pollination ([Wild Bees for Pennsylvania Cucurbits](#))
- When using insecticides, farmers can opt for bioinsecticides or use conventional treatments when the flowers are closed.

These are general recommendations that could be helpful but might have some drawbacks (like the time and cost of keeping honey bees on the property). Hence, decisions regarding how to maximize pollination services may be site-specific. As a grower, it is beneficial for you to know what pollinators are visiting your crops and how frequent they are visiting before deciding management practices for improved pollination.

Additional Resources

dos Santos SA, Roselino AC, Bego LR. (2008) Pollination of cucumber, *Cucumis sativus* L. (Cucurbitales: Cucurbitaceae), by the stingless bees *Scaptotrigona* aff. *depilis* Moure and *Nannotrigona testaceicornis* Lepeletier (Hymenoptera: Meliponini) in greenhouses. Neotropical Entomology 37(5):506-12.

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Thakur M, Rana RS. (2008) Studies on the role of insect pollination on cucumber yield. Pest Technology 2(2):130-133.

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Authors

Shelby Fleischer, Ph.D.

Professor of Entomology

sjf4@psu.edu

814-863-7788

Margarita López-Uribe, Ph.D.

Assistant Professor of Entomology

mml64@psu.edu

814-865-8245

extension.psu.edu

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