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Research Update

The Horticultural Research Institute, in collaboration with AmericanHort, continues to directly fund and leverage research to refine science-based guidance on horticultural practices and protecting bee and pollinator health. As part of the broad-based Horticulture Industry Bee & Pollinator Stewardship Initiative that includes industry and consumer outreach and the establishment of industry best practices, the Horticultural Research Institute has directly funded four important research projects. These projects are a continuation of HRI's longstanding commitment to fostering new information relevant to horticultural practices, techniques, and principles.

The involvement of HRI and the horticultural industry in pollinator research is essential toward fulfilling the industry's role in supporting healthy pollinator populations. Horticulture provides the very thing pollinators need to thrive: abundant sources of forage. HRI is hopeful that these and other ongoing projects result in helpful best practices guidance for growers, retailers, and landscape professionals.

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Variation in development in parts of the *A. incarnata* inflorescence. Two panicles removed for nectar extraction.

PROJECT ONE SYNOPSIS

Residues of and Rapid Assessment of Toxicity for Neonicotinoid Insecticides in Pollen and Nectar in Model Plant Systems. – Awarded \$54,000

Significant data gaps related to the concentration of systemic insecticides in nectar or pollen of ornamental plants hampers efforts to assure the public and retail sellers of these plants that growers' practices result in plants that are safe to bees and other pollinators. Dr. Richard Cowles of the Connecticut Agricultural Experiment Station in Windsor, CT, aims to conduct pesticide residue analysis in pollen and nectar from treated plants. Using plants commonly used in the landscape, he expects to further develop an understanding of systemic insecticide uptake and potential interactions with nectar and pollen. In turn, this knowledge will further the establishment of best management guidelines for growing plants and protecting pollinators.

Update:

We completed the first round of assessments for determining whether minute pirate bugs could be used to quantify neonicotinoid concentrations through dose-response bioassays. Of the various systemic insecticides tested, it appears with these preliminary data that imidacloprid is the only insecticide for which there would be great enough sensitivity in minute pirate bugs for this method to be useful.

Swamp milkweed, *Asclepias incarnata* 'Ice Ballet', was chosen as the model plant to study the movement of neonicotinoids into the nectar of container-grown ornamental plants. The collection of nectar from swamp milkweed previously treated with systemic insecticides was completed several weeks ago. Extracting the nectar required cutting off partial inflorescences as they reached full bloom, inserting them upside down into 50 ml tubes, and centrifuging them for 10 minutes. The samples are frozen and awaiting analyses.

Methods had to be developed for collecting pollen from sunflowers, our model system for studying the transport of neonicotinoids into the pollen of container-grown ornamental plants. We found that brushing the flower disks with a plastic pot label, so that liberated pollen fell into the paper bag covering the flower, was an effective method. Up to one gram of pollen was collected from individual 'Taiyo' sunflowers. The pollen collection process is now complete, but samples are still being cleaned of debris prior to freezing them for analysis. 🐝



(Above): Tiny nectaries on a single nectar-producing panicle.

(Below): Panicles are secured with dental floss within a centrifuge tube.



(Below): Sunflower plants coming into bloom. The bags are in place for when anthesis starts, so that bees will not rob the flowers of the pollen needed for collection.



PROJECT TWO SYNOPSIS

Understanding the Opportunities Present for Bees from Commercial Plant Material. – Awarded \$25,000

This project, led by Dr. Victoria Wojcik from The Pollinator Partnership in San Francisco, CA, and Dr. Christina Grozinger with Pennsylvania State University in University Park, PA, addresses the interactions of bees with landscape plants in order to be better informed on which specific cultivars and varieties bees most frequent. This work will help guide some of the treatment protocols for specific plants and help the industry in marketing particular varieties that are most advantageous for pollinators.

Update:

Pollinator Partnership is undertaking a review of the foraging preferences that honey bees and other wild pollinators have for commonly planted ornamental plants. The goal of this study is to identify the opportunity that the gardening community and the horticultural community have to interface with supporting honey bees and native bees, also focusing on areas where we might see both risks and opportunities relating to the chemical treatment of ornamental plants in pest management scenarios. Funding from the HRI supported the early start of our APHIS funded program.

During the summer of 2015 our partners at Penn State University conducted a grower survey within the region to determine consumer preferences and purchasing habitats for ornamental plants intended to support bees. This data will be used to structure field experiments to be conducted in the 2016 growing year using APHIS funding to understand bee-plant interactions and further sample nectar and pollen of these preferred plants in order to determine if there are potential interactions with pesticides that might impact foraging bees.

The Pollinator Partnership and Penn State University working group has planned a meeting and symposium to bring together key honey bee stakeholders (beekeepers and researchers) with ornamental horticulture industry representatives, to develop a consensus-based research protocol for the 2016 field season. This meeting takes place on November 5, 2015. 🐝

PROJECT THREE SYNOPSIS

Best Management Practices for Growing Bee-Friendly Plants in the Greenhouse.
– Awarded \$20,000

Dr. David Smitley from Michigan State University in East Lansing, MI, will conduct research aimed at developing scientifically-based best management strategies for the production of high quality greenhouse-grown plants that are safe to pollinators after they are purchased and planted.

Update:

Two field experiments designed to test the impact of imidacloprid drenches applied to greenhouse or nursery plants on bumble bees have been completed. Results are shown in graphical form, along with an explanation of the experiments and results.

Experiment One: Impact of an imidacloprid basal drench applied to annual flowers grown in 12" pots on bumble bees. One popular cultivar each of petunia, verben, geranium, marigold, portulaca, salvia and begonia were grown in the greenhouse with standard production practices. At 5 weeks before the finish data, half of all the plants were drenched with imidacloprid at the labeled rate. The remaining plants were drenched with water. One week after the finish date, four plants of each type were put into 16 different screen tents. Half of the tents were filled with imidacloprid-treated plants and half with control plants. One bumble colony was placed in each screen tent. Bumble bee colonies were caged with treated or control plants for 3 weeks. After the exposure period, bumble bee colonies were moved to shelters and allowed to forage freely.

Results: The number of bees per colony declined rapidly in both treatments. Cold weather in early June when they first arrived, and a major thunderstorm with high winds did not help their initial establishment. Also, when compared with the excellent survival of the bumble bees in the second experiment when *Tilia* trees were put into the screen cages, it is likely that the six species of annual flowers did not provide adequate pollen and nectar for the bumble bees. Still, recovery from the screen-tent exposure period was better for colonies in the control treatment compared with the imidacloprid drench treatment (Figure 1).

Experiment Two: Impact of an imidacloprid basal drench applied to base of container-grown *Tilia* trees in early July 2014, on bumble bees caged with the same trees in June 2015. *Tilia americana* and *Tilia cordata*

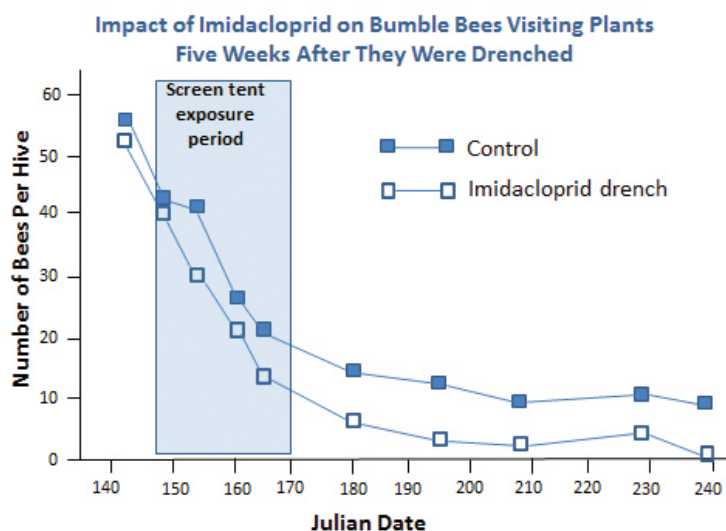


Figure 1. Survival of bumble bee colonies confined in screen tents with annual flowers for three weeks in June, 2015, then moved to shelters and allowed to forage freely. Each screen tent contained 12" pots previously drenched with imidacloprid or with water (Control). Data are means of eight colonies per treatment.

trees were grown in pot-in-pot containers at the Horticulture Farm at Michigan State University. Half of the trees received a basal soil drench of imidacloprid, applied at the labeled rate, in early July, 2014, after the trees had finished blooming and most of the flowers had dropped. The *Tilia* trees were moved into screen tents on June 15, 2015, when they first started blooming. One bumble bee colony was placed into each screen tent at this time, and remained in the tents for 10 days. Bumble bees were counted weekly or biweekly for the rest of the summer, until August 27th.

Results: Imidacloprid drenches made in early July 2014 had no impact on the number of bumble bees per colony throughout the growing season, or on the number of queens produced per colony. Control colonies average 7.8 queens per colony, while colonies in the imidacloprid treatment averaged 5.8 queens per colony (Figure 2).

Conclusions: Poor survival of bumble bees after being caged with annual flowers for three weeks limits the conclusions that can be made from the first experiment, which gave similar results in a 2014 experiment. However, failure of the bumble bee colonies in the imidacloprid drench treatment to recover from the stress created by screen-tent enclosure suggests that drenching flowers which are attractive to bees in the spring of the same year that they are sold could be harmful to bees. Also, poor survival of bumble bees in screen tents with six of the most popular types of annual flowers, while survival was excellent when bees were caged with *Tilia* trees, highlights the importance of understanding the relative attractiveness of flowering plants to bees.

Excellent survival of bumble bees after being confined with *Tilia* trees which had been treated the previous year with an imidacloprid drench suggests that treatments made a year before trees are sold are not harmful to bees. Good queen production in both treatments supports this conclusion.

As research continues on how to produce greenhouse and nursery plants that will be safe for pollinators after they are sold and planted in the yard and garden, it is becoming increasingly clear that growers efforts should focus their efforts on plants that are highly attractive to bees. Many of the most popular annual flowers are not frequently visited by bees, and therefore production practices are not expected to impact bees. However some perennials, and some trees and shrubs are highly attractive to bees. For these plants it is important not to spray them with any insecticide the last three weeks before shipping, and to avoid soil applications of a systemic insecticide in spring of the same year that they are sold. 🐝



Impact of Imidacloprid Basal Drench of Linden Trees Applied after Petal Fall in 2014 to Bumble Bees 12 months later

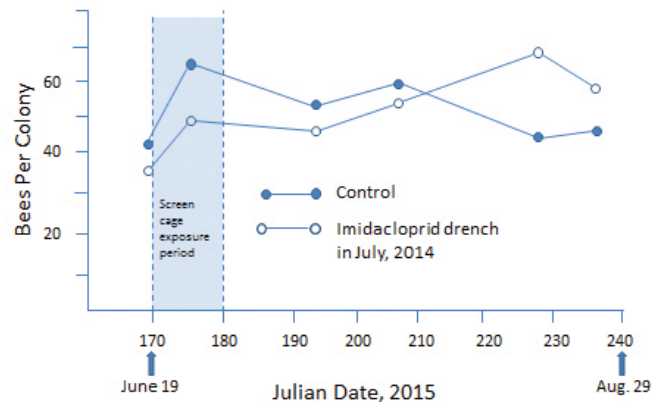


Figure 2. Survival of bumble bees after being caged with *Tilia* trees for 10 days in June, 2015, when the trees were blooming. Trees in the imidacloprid drench treatment were drenched in early July, 2014. Data are means of four colonies per treatment.

PROJECT FOUR SYNOPSIS

Assessing Bee Attractiveness of Woody Landscape Plants and Mitigating Potential Bee Hazard from Neonicotinoid Insecticides. – Awarded \$26,000

In this project, Dr. Daniel Potter of the University of Kentucky in Lexington, KY, aims to inform best management practices by which producers and landscape managers can protect plants from pests while mitigating the risk to bees. Additionally, his research has the potential to further support planting recommendations for landscapes that sustain bees throughout the growing season, identify plants that warrant particular caution when using systemic insecticides, and highlight plants whose floral characteristics reduce the potential for bees to be impacted by systemic insecticides.

Update:

A project led by Dr. Daniel Potter of the University of Kentucky (Lexington, KY) is documenting the bee assemblages (types of bees, bee species richness and diversity) associated with 55 species of native and non-native woody ornamental trees and shrubs, as well as ranking the plants' relative attractiveness to bees. The goal is to support science-based recommendations for bee-friendly landscapes, opportunities for growers, garden centers, and landscapers to profit from demand for bee-friendly plant materials, and impetus to diversify landscapes with horticulturally-desirable, but heretofore under-utilized plant species.

Potter's team, which includes graduate student Bernadette Mach, has already sampled more than 200 sites and 10,000 bees. The large data set is revealing some interesting patterns. Different woody ornamental often attract unique bee assemblages, some quite specialized and other very diverse. For example, nearly all of the bees attracted to mock orange (*Philadelphus*) are of a single species, whereas chaste tree (*Vitex*) attracts a dozen or more bee species. Some plants (e.g., fuzzy deutzia) attract




Students collecting a sample of 50 bees from one of the 200 sites completed so far.

a lot of carpenter bees whereas others (e.g., yellowwood, buttonbush) attract mainly bumble bees and honey bees. Many non-native plants are just as attractive as the most bee-friendly native ones. Flower form matters, too, even within the same plant genus. Prairie rose, for example, is highly attractive whereas most hybrid tea or knockout roses attract few or no bees. Similarly, lacecap or panicle-type hydrangeas with accessible fertile flowers attract far more bees than do mop-head or snowball types covered in sterile flower-like sepals.

Some spring-blooming “bee magnets” include eastern redbud, flowering crabapple, false indigo, serviceberry, cornelian cherry, hawthorn, Foster’s holly, flowering cherry, dwarf fothergilla, American yellowwood, and others. Highly bee attractive summer-blooming plants include bottlebrush buckeye, climbing prairie rose, summersweet, St John’s wort, winterberry holly, golden raintree, *Amur maackia*, Virginia spirea, and linden, and others, and some late-blooming bee favorites include winged sumac, glossy abelia, seven son flower tree, chaste tree, devil’s walkingstick, bee bee tree, buttonbush,

and others. Note that the above list contains a mix of native and non-native plants, and that most of the species are relatively pest free.

Potter’s team is also investigating best management practices by which producers and landscape managers can safeguard bees when it is necessary to use soil-applied systemic insecticides to protect plants from pests. Their study involves three model plant species (Winter king hawthorn, Fosters holly, summersweet clethra), two systemic insecticides (imidacloprid, dinotefuran), and three treatment timings (November, pre-bloom, or post-bloom). The investigators are tracking residues in nectar, pollen, and foliage for two growing seasons to determine the best combinations of product and treatment timing for particular situations. For example, some pests (e.g., azalea lace bug) can be controlled post-bloom, and others (e.g., boxwood psyllid and leaf miner) with autumn application combined with spring pruning to allow residues to dissipate to levels that are non-toxic to bees. Residue analysis of more than 300 samples collected in spring/summer 2015 will be completed this winter. 



Crabapple



Deutzia

Different woody plant species attract very different assemblages of bees.



Mock Orange



Vitex