INTEGRATED PEST MANAGEMENT

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Integrated Pest Management

Northeastern IPM Center

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Inside

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Signature Programs

An Introduction to Beneficial Organisms and Habitat

Scientists are spreading the word about how farmers, gardeners, homeowners, and land managers can cultivate rich habitats for beneficial organisms and suppress pests.

This issue of *IPM Insights* is dedicated to the ways people from all walks of life can promote beneficial organisms and habitat. Margaret Skinner of the University of Vermont has been working for many years in this area, and in particular has done recent work on banker plants in hoop houses—in other words, cultivating the types of plants on which natural enemies of pests will gather and reproduce in the outdoor structures used for growing crops. Likewise, Paula Shrewsbury of the University of Maryland has been working on habitat to increase beneficial organisms. We devote some time to each of these scientists.

Two bees share a flower of *Ratibida pinnata*, yellow coneflower. Source: C. Neal, UNH Cooperative Extension

Pollinators and Beyond

When people think of beneficial organisms and habitat, they might think of recent popular reports in the media about pollinators. Amid this interest, in 2014 the Northeastern IPM Center awarded $17,100 to Amy Papineau of the University of New Hampshire to lead the Northern New England Pollinator Habitat Working Group. This working group is collaborating on methods to protect pollinator habitat in northern New England. They are protecting existing habitat on farms, roadsides, and natural areas, and planting new flowers that are beneficial to pollinators.

Indeed, pollinators are one important aspect of the picture, but there's a much larger world of living organisms and practices to maintain a diverse habitat to promote and increase the numbers of beneficial organisms such as lacewings, ladybugs, and hover flies, all of which can suppress pests on farms and in gardens, as well as around residences and in natural areas. Let's examine the example of high tunnels where commercial crops are grown.

Cultural Practices

Rose Ogutu of Delaware State University writes that cultural practices such as maintaining a diverse variety of disease-resistant plant types is key to managing pests, especially in high tunnels. "Practice crop diversity, crop rotation, including banker plants," she recommends.

Skinner suggests using IPM practices such as using indicator plants. An indicator plant is a type of plant that attracts pests to a site where natural enemies may attack them. In addition to trap plants and banker plants, she suggests using nectar/pollen/habitat plants, which promote various ecosystem functions.

"Now plants are being used to serve several of these functions at once, particularly in greenhouses where plants or plant stages supportive to natural enemies may be rare," Skinner wrote in the introduction to a presentation about IPM and guardian plants in greenhouses.

If the greenhouse is a microcosm of the natural world, then this issue of *IPM Insights* is all about scaling these practices and thinking to the larger world—to entire farms, gardens, homes, and tracts of land. In each of these settings, people from any background can learn IPM techniques to promote beneficial organisms and suppress pests.

Growers: Make Friends with the Good Bugs to Battle Pests

"Aphids are the number one pest of vegetables in Northeast high tunnels," says Margaret Skinner, an entomologist at the University of Vermont. "They stunt plant growth, secrete sticky honey dew, and transmit viral diseases. The bottom line is they cost growers money."

While some growers reach for an insecticide, Skinner and her team are studying plants as a foundation in an IPM approach to manage aphids and other pests cost-effectively.

For example, **indicator** plants are used to scout for the pest; **trap** plants lure pests from the crop so growers can use a targeted spot treatment; **banker** plants provide host insects to support natural enemy populations; and **habitat** plants are groups of flowering plants that combine all the functions into one, luring pests away from the crop, drawing natural enemies from the surroundings, and providing food—nectar and pollen—to support beneficial organisms and pollinators.

In high tunnels, Skinner and her colleagues grow clumps of alyssum, bush green bean, marigold, and lantana, to see how these plants could support commercially available natural enemies, such as *Orius insidiosus*, *Aphidus colemani*, and *Aphidoletes aphidymiza*, and attract naturally-occurring beneficial organisms.

Pest Explosion

Western flower thrips spell bad news for flower growers. Skinner's research has shown that flowering marigolds can lure thrips from bedding plant crops like petunia, calibrachoa, osteospermum, verbena, and impatiens, especially when the marigolds are put in the crop early, before it begins to flower.

For many years, Skinner and her team have worked one-on-one with growers to teach them the IPM approach and several of its techniques, such as use of sticky cards and indicator plants for early pest detection; identification and removal of virus-infected plants; and spot treatments rather than greenhouse-wide sprays to reduce pesticide use. They also show growers how to refine biocontrol strategies and use softer pesticides responsibly. Meanwhile, growers report that pest damage to their crops was reduced because they used an IPM approach. They also felt more confident about pest management and spread the word to their coworkers and customers. Several farm operators have transitioned from a pesticide-based approach to an IPM approach, incorporating biological control as a primary tool for dealing with pests.

Guardian plants support greenhouse IPM by performing indicator, trap, banker, and habitat functions. Source: Carol Glenister, IPM Laboratories, Inc.

D.J. Boyd, a grower in Wilmington, Vermont, reports using tiny, predatory and parasitic wasps to control aphids. He purchases the wasps from a supplier and releases them onto banker plants in his greenhouse—deploying what Skinner describes as an effective and economical control strategy.

"Right now we use sticky traps in the greenhouse to tell us if there are any hotspots where there are insects in the greenhouse," Boyd said in the *Deerfield Valley News*. "We use way less [pesticide] than we used to since we started using the wasps."

Defenders Spread Out

Over time, Skinner says, the parasite population will increase, then disperse from the banker plants into the crop in search of aphids.

All in all, it's an inexpensive way to produce a continual source of allies without needing to order shipments during the season. It eliminates the lag time for receiving goods from a supplier, and doesn't cost the grower much time to produce them locally.

In 2011, Skinner completed a three-year, $59,077 research project for the USDA, coordinated by the Northeastern IPM Center, on the use of an effective habitat plant system to manage western flower thrips. The system used a combination of marigold trap plants and a commercially-available fungus to knock out the thrips.

Ann Hazelrigg, the Vermont state IPM coordinator, mentions that in Skinner's IPM First for Greenhouse Ornamentals Program, one grower in the program works with a local school to produce aphid banker plants, which are then used in production houses during the growing season. Participating growers learn to use plant-mediated IPM systems, and the sites now rely primarily on biological control agents for pest control.

Types of Guardian Plants

indicator plants	used to scout for pests
trap plants	lure pests from crops
banker plants	support natural enemy populations
habitat plants	groups of flowering plants that combine all the above functions

Manipulate Habitats to Increase Beneficial Organisms

Growers often use the IPM technique of increasing the complexity and diversity of vegetation to fight bad bugs (plant damaging insects). While this technique has been around for a long time, scientists continue to test new ways to implement it.

For example, flowering conservation strips and beetle banks, made up of specific types of plants, provide food resources such as pollen and nectar or alternate prey, shelter, and overwintering sites for good bugs.[1] Using native plant species could serve a dual function of fighting the bad bugs by enhancing the beneficial ones, while also promoting other valuable ecosystem services.

Monarda punctata, spotted horsemint, attracts beneficial bugs. Source: Karan A. Rawlins, University of Georgia, Bugwood.org

Attractive Research

For example, Steven Frank, Paula Shrewsbury, and Okemeteri Esiekpe evaluated ten native plant species for their attractiveness to good bugs at the University of Maryland. Plants that showed the most promise were *Monarda punctata* or spotted horsemint (Lamiaceae), *Pycnanthemum tenuifolium* or mountain mint (Lamiaceae), and *Eupatorium hyssopifolium* or hyssopleaf thoroughwort (Asteraceae), all of which generally harbored the greatest number of predators and parasitoids dwelling and foraging among the plant foliage.

This IPM technique is considered by scientists to be a branch of conservation biological control—using nature's tactics to fight pests. Specifically, scientists are studying ways to manipulate habitats—changing the composition of plants and other organisms—to fight attackers. There is evidence going back over twenty years that increasing plant species diversity and vegetation complexity of habitats and therefore the abundance of food resources can increase the longevity and fecundity of natural enemies.

In Europe, beetle banks, composed of bunch grass or *Dactylis glomerata*, provide shelter for ground foraging predators such as carabid beetles, staphylinid beetles, and spiders. Studies in Maryland found similar results.

"Providing overwintering habitat allows good bugs to remain in fields or landscape beds rather than retreating to edges and may lead to more robust populations of natural enemies over time," said Shrewsbury. "We go so far as to say that increasing vegetative complexity in general could benefit ground-dwelling predators."

Common flower species, those that have been proven attracters through research, and that are recommended in habitat manipulation programs, are sweet alyssum, *Lobularia maritima* L. (Brassicaceae), buckwheat, *Fagopyrum esculentum* Moench (Polygonaceae), phacelia, *Phacelia tanacetifolia* Benth. (Hydrophyllaceae), and umbelliferous herbs such as coriander, *Coriandrum sativum* L. (Apiaceae), fennel, *Foeniculum vulgare* Miller (Apiaceae), and dill, *Anethum graveolens* L. (Apiaceae).

One strong performer is mountain mint, *Pycnanthemum tenuifolium* Schrader (Lamiaceae). Another two are the above-mentioned *Monarda punctata* and *Eupatorium hyssopifolium*. Spiders and parasitoids thrived around these species of plants.

Bring It On

Heteropteran predators such as bigeyed bugs, *Geocoris* spp. (Lygaeidae), minute pirate bugs, *Orius* spp. (Anthocoridae) and predatory stink bugs (Pentatomidae) made up a small population, but were important predators of aphids, eggs and larvae of lepidopteran pests, and other

Through this one-on-one outreach program, growers learned about IPM and its diversity of tactics, including use of sticky cards and indicator or trap plants, as well as routine identification and removal of diseased plants. They learned about the use of banker and habitat plants to sustain and grow natural enemies. The key to success has been to develop individualized training programs tailored to meet the needs of each grower. Every year they work with eight to ten grower participants, expanding the base of knowledge among growers within and outside the state.

In one year, Skinner's team in cooperation with specialists from New Hampshire and Maine reached over 150 attendees, and 92 percent indicated that they learned new techniques they intended to use in the coming year.

Skinner and her team are now expanding their work to include assessing the potential of plant-mediated IPM systems for use in high tunnel vegetables and landscape settings.

"The more we uncover about using biological control, the more there is to learn," Skinner said. "Thankfully growers are developing an appreciation for using naturally-occurring beneficial organisms. It saves money and the environment. Sometimes the best things in life *are* free."

For more information

For plant-mediated IPM systems, search the website:
http://www.uvm.edu/~entlab/ipm.html
A fact sheet on aphid banker plants: http://neipmc.org/go/yLxe

small plant feeding arthropods. Coccinellid lady beetles have been shown to reduce aphids and other pests.

Home Defender

The IPM strategy of habitat manipulation could shape up to be a big game-changer for homeowners and gardeners in the match against the brown marmorated stink bug (BMSB), an invasive plant-feeding insect and home invader in the fall and winter months.

In 2015, researchers found that in production nurseries the availability of fruit on trees affected the abundance of that pest.[2] It turned out that although BMSB is a generalist herbivore, the availability of ripe fruit serves as a key resource and attractant for the insect. Removal of fruits from trees suppressed stink bug populations. During their study, *H. Halys* successfully moved about, tracking ripe fruit as it became available throughout the season.

The researchers suggest that for homeowners, gardeners, or ornamental tree growers, removal of fruits from trees could be an effective stink bug population control tactic. Since this tactic is impractical in most cases, another strategy might be to plant non-fruiting varieties of trees as ornamentals, to reduce stink bugs in landscapes, reduce risks to crops, and limit home invasions by the bug. Clearly, fruit growers will have to use other IPM tactics.

No Use for Stink Bugs

In the first outbreak of BMSB in North America in 2010, growers faced multimillion dollar losses in apples and peaches; vegetables such as sweet corn, peppers, and tomatoes; row crops including field corn and soybeans; vineyards; small fruit; and ornamental plants. In the 2011 growing season farmers applied repeated pesticide applications to suppress damage by BMSB while researchers searched for alternative management strategies. BMSB also invaded homes and structures by the thousands in the fall. Pest control companies responded to demand by spraying eaves, windows, and doorways of buildings where BMSB aggregate and enter.

In North Carolina and Virginia natural woodland edges, the greatest numbers of BMSB were found on tree of heaven (*Ailanthus altissima*), catalpa (*Catalpa* spp.), yellowwood (*Cladrastis kentukea*), paulownia (*Paulownia tomentosa*), wild cherry (*Prunus* spp.), walnut (*Juglans* spp.), and redbud (*Cercis* spp.).

Life stages of the brown marmorated stink bug. Source: W. Hershberger

Pycnanthemum tenuifolium, or mountain mint, provides habitat for predators and parasitoids—the good bugs that keep pests in check. Source: Chris Evans, University of Illinois, Bugwood.org

In a study published in 2016, Erik Bergmann and coauthors identified 88 commercially available host plants used by BMSB and 43 plants that did not support BMSB at any life stage.[3] The authors suggest that planting non-hosts, especially gymnosperms—including conifers, cycads, and ginkgo—may help to reduce the intensity of the pest's presence in landscapes providing a further example of habitat manipulation.

IPM to the rescue, again: By avoiding plants that favor BMSB and incorporating non-hosts into landscapes, homeowners could perhaps reduce the need for treating structures and plants with insecticides, and reduce the likelihood of home invasions.

References

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3 Bergmann EJ, Venugopal PD, Martinson HM, Raupp MJ, Shrewsbury PM (2016) Host Plant Use by the Invasive *Halyomorpha halys* (Stål) on Woody Ornamental Trees and Shrubs. PLoS ONE 11(2): e0149975. doi:10.1371/journal.pone.0149975

Chemical Ecology Could Address Pests, Help Pollinators

In a commercial orchard, in a tree, you may have seen a special trap—a sticky card—that uses insect pheromones to trap pests. But have you spent much time thinking about how *plants* use defensive chemicals as well?

Plants use a variety of natural defense mechanisms to counter attacks by pests. Some plants emit chemical "help" signals that call natural enemies—such as beneficial insects—to their aid. Farmers can manage crops to maximize plant defenses.

A solitary bee nest. Source: Jennifer Thaler, Cornell University

In nature, insects not only send chemical signals to each other, but also to other plants. Meanwhile, plants send chemical messages to insects, to other plants, and within parts of a single plant. Nature abounds with chemical signals. Scientists hope to better understand these signals to control pests as well as support bees and other beneficial insects.

The Northeastern IPM Center is part of a five-year, multi-state research and extension project that began in 2015 to harness chemical ecology to address pest and pollinator priorities. These efforts aim to reduce the impacts of insect pests, protect valuable pollinators, support organic agriculture, and develop holistic, ecology-based systems.

The total value of principal crops in the Northeast is greater than $5.3 billion. Northeast vegetable growers harvest crops with a value of over $300 million. Meanwhile, demand for organic fruit and vegetables continues to grow, and producers are demanding holistic, ecology-based systems.

On one level, researchers are studying the chemical structures of the substances that mediate communication between pests, crops, and beneficial organisms. Scientists are also interested in understanding the effects of pesticides on non-target organisms such as pollinators and natural enemies of pests. Another area of interest is the effects of domestication on plant and animal chemical ecology. Do these chemical communication channels become weaker after years of domestication? Are there ways humans can maintain their strength for optimal crops?

This project represents a departure from many typical studies that focus on a particular crop or pest. It essentially is a holistic and interdisciplinary project.

Practical outcomes of the project could be a method to suppress agricultural pests, develop crops that resist or do not attract pests, or finding out how to create chemical volatiles that could repel pests from crops.

This multi-state effort allows for a comprehensive approach to studying chemical ecology in pests and pollinators, as well as share resources such as expensive analytical instruments.

In one area of study, for example, scientists are trying to determine which plant volatile chemicals lure natural enemies to the plant and defend it. Researchers have found evidence that plants attract natural enemies when attacked. However, it's not a simple relationship, as there may be unwanted side effects, such as the attraction of predators and parasites that attack natural enemies as well. Researchers are hoping to understand these relationships better.

The research group working on the project, "Harnessing Chemical Ecology to Address Agricultural Pest and Pollinator Priorities." Source: Jennifer Thaler, Cornell University

Researchers are also trying to understand the effects of pesticides and secondary metabolites in pollen and plant nectar, and how these may influence pollinator infection dynamics. They also want to be able to understand better if pollinators self-medicate, or create their own medicine, when exposed to secondary compounds in flowers.

With this knowledge, farmers could better manage crops, maximize plant defenses, control pests, protect pollinators, support organic agriculture, by using holistic, ecology-based systems.

For further details, see http://neipmc.org/go/AWWp

Ideas for Your Nuisance Deer Conservation Program

In response to our article, "Preventing Deer from Becoming Pests," (July 2017, Volume 14, Issue 3, p.2), we decided to write a follow-up. We begin by asking, are deer pests? We explore the reasons why. Assuming that deer are a regional pest of widespread habitat, we talk about the collaborative and regional efforts that would need to be undertaken to conserve habitat and control populations. Consistent with any integrated pest management strategy, we talk about monitoring for ecological and human health impacts caused by deer as being a key to any conservation program. We discuss management and conservation options.

Read more about deer management online at:
http://neipmc.org/go/TSaL

Are deer pests? Source: Scott Bauer, USDA ARS, Bugwood.org

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Use the link below or scan the image to the right to send us feedback.
http://neipmc.org/go/beYm

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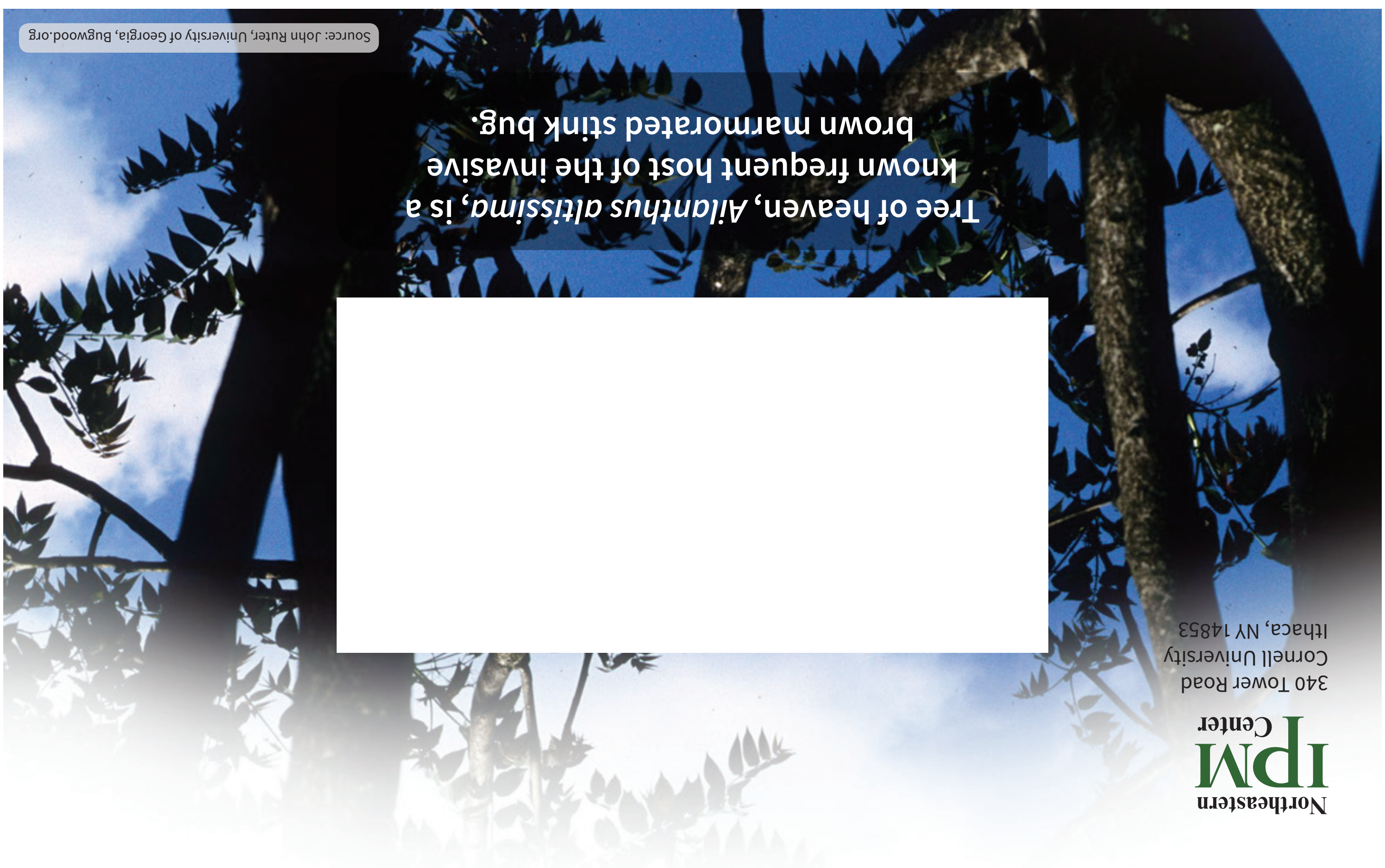

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