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FIELD NOTES FOR FARMERS NO. 2

Special Topic: Using Planted Habitat on Farms To Increase Insect Biological Control

This special topic has three components:

- *Part 1. Using Beneficial Insect Habitat on the Farm: An Introduction*
- *Part 2. Evaluating the Quality of Commercial Beneficial Insect Habitat*
- *Part 3. Beneficial Insects Attracted to Planted Habitat: Do They Contribute to Pest Insect Control?*

CEFS Field Note 2 provides Part 1. Subsequent field notes will address the other topics.

Part 1. Using Beneficial Insect Habitat on the Farm: An Introduction

For centuries, farmers have relied on beneficial insects to help control crop pests. These beneficials still play a role in pest management, and they are particularly important in organic agriculture. Organic growers are very interested in practices that conserve and enhance populations of beneficial insects on their farms. One way to accomplish this is to plant or provide habitat that provides resources needed by beneficial insects, such as food and shelter. The purpose is to increase beneficial insect populations and decrease pest insect numbers.

This increased interest in beneficial insect habitat has led to retail outlets offering premixed seeds of plants that provide habitat for insect predators and parasitoids. At least eight companies currently sell seed mixtures for beneficial insect habitat, and another company sells transplants for the same purpose. In our survey of the scientific literature, we found very little research evaluating the value of these mixes.

Academic research on beneficial insect habitats has focused on increasing beneficial organisms by manipulating vegetation both within and around crop fields. This type of research has proven to be very complex, and it has been directed primarily at understanding the underlying ecological mechanisms that support beneficial insects. The gap between research and implementation means that few approaches to manipulating habitat to enhance beneficial insect populations are research based. Much basic research needs to be completed before researchers will be able to make specific recommendations on how to build and maintain these habitats. Farmers, however, need some guidance now. In this publication, we have distilled the scientific literature to provide a guide for farmers who want to incorporate beneficial insect habitat in their farming operations.

While the idea of beneficial insect habitat seems straightforward, farmers must consider a number of complicating factors when trying to make a habitat work as a pest-insect management tool.

Habitat Requirements For Biological Insect Control

As a general rule, to be useful for pest management, any area maintained for beneficial insect habitat must result in a net gain in beneficial insects and a net reduction in pest insects. More specifically, the habitat has to display these characteristics (Figure 1):

1. It must attract beneficial insect populations.
2. It must improve the health or reproduction of beneficials so they can be more effective.
3. It must allow beneficials to move from the habitat to the crop(s) of interest.
4. The beneficials must eat or parasitize an increasing number of pest insects once they have moved into the crop.
5. The activity of the beneficials must lead to an economic reduction in pest populations. Preferably, their activity would prevent economic damage to the crop—the bottom line for habitat and any other pest management tactic.

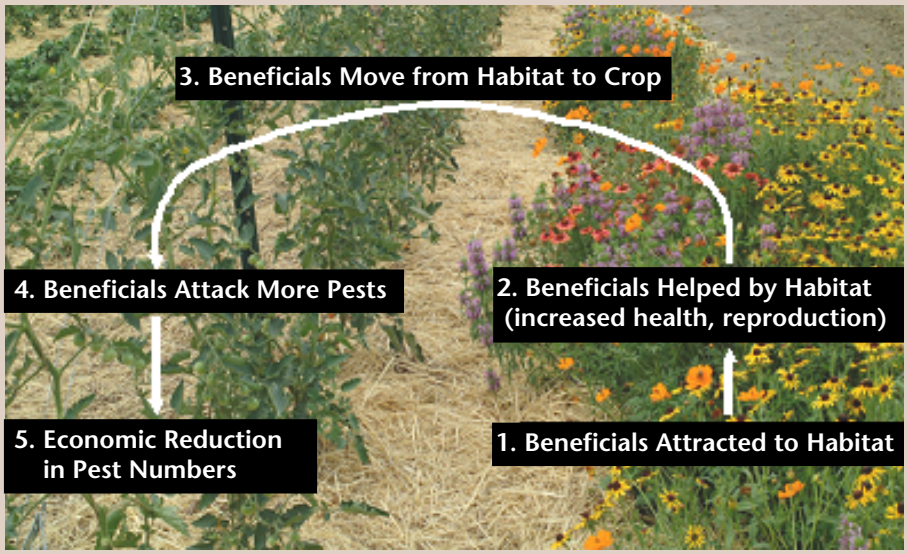

Figure 1. Five requirements for a beneficial insect habitat to be a useful pest management tool

Complicating Factors

Each of the five habitat requirements presents some complicating factors that farmers must consider.

1. The habitat must attract beneficial insects. First, we need to define what a beneficial insect is. For example, many people consider butterflies to be beneficial. This is often an aesthetic judgment, however, rather than one based on an ecological assessment. A number of butterflies can also be pests. For example, a common beneficial habitat plant is fennel. A common butterfly, the Eastern black swallowtail *(Papilio polyxenes)*, feeds as an adult on flowers of various plants that are often included in habitat plantings. The swallowtail larvae, however, can do extensive damage to fennel, and as such might be considered a pest.

Another consideration is this: Flowers that may attract butterflies in the daytime might also attract pest moths at night. Many important agricultural pests are caterpillars that hatch from moth eggs. Therefore, it is important to make sure a habitat is not feeding pest insects and helping their populations increase. Figure 2 shows how three commercial habitats, two cut flowers, and an herb differ in their attractiveness to feeding pest moths.

Most people look upon honeybees and other pollinators as being beneficial, and rightly so. Flowers that are attractive to honeybees, however, do not necessarily provide the resources needed by parasitic and predatory insects. Parasite and predator insects are the ones we are particularly interested in attracting for their help in managing pest insect populations. Often their mouthparts are small, and they cannot access nectar from the same flowers that attract bees and wasps. Also, bees and wasps may be so efficient at collecting nectar and pollen that none may be left for the much smaller parasitoids.

How do we determine if a habitat is attracting insects that are truly beneficial for crop pest management? It is important to begin looking more closely at the kinds of insects that your habitat plants attract. Typically, you will mostly see bees, predator wasps, and butterflies (Figure 3). Many of these insects are visiting these plants to get nectar and pollen, and they may be very beneficial

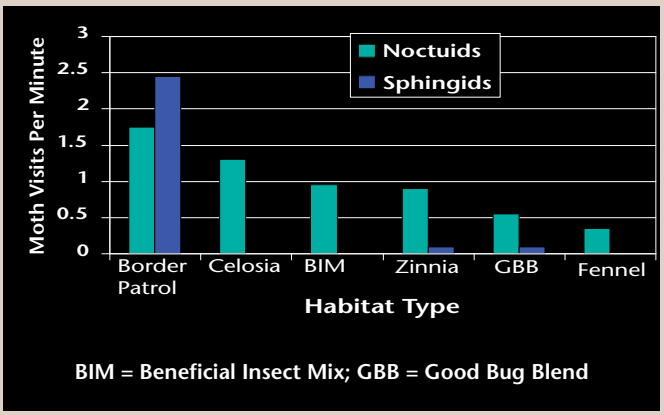

Figure 2. Feeding by two important pest moths on three commercial beneficial insect habitats, two cut flowers, and one herb. Based on research completed at CEFS in Goldsboro, N.C., 2004, noctuids produce caterpillars such as the tomato fruitworm, and sphingids produce caterpillars such as the tobacco hornworm.

by providing pollination services. However, they have nothing to do with regulating populations of pest insects in nearby crops. The predatory insects, and particularly the parasitic insects that feed specifically on crop pests, will not be so obvious.

Parasitic insects are extremely valuable for the natural control of pest insects they provide. Their small size and often secretive habits, however, make them difficult to observe and identify under field conditions. For example, consider egg parasitoids that make their living exclusively from other insect eggs: They are often only ½-millimeter in length, and almost impossible to see without the aid of a magnifier or microscope (Figure 3H). Others may be mistakenly

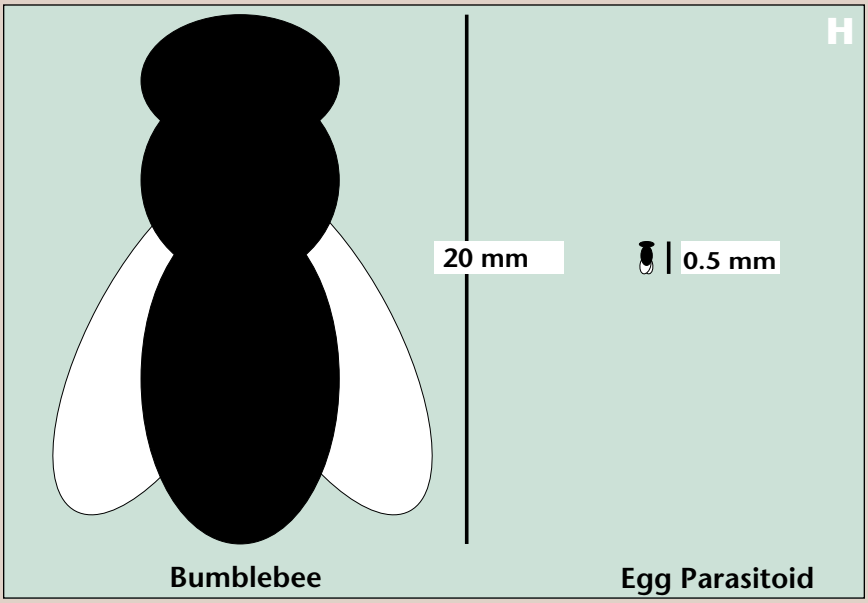

Figure 3. Examples of some of the insects commonly seen on beneficial insect habitat.

A. Bees are great pollinators, but they do not contribute to pest management.

B. Paper wasps are effective predators of caterpillars.

C. Butterflies are beautiful insects that may pollinate crops. But on some plants their larvae can be pests.

D. Tachinid flies, like this stink bug parasitoid, benefit from feeding on nectar.

E. Spider wasps are effective predators but feed primarily on spiders.

F. Cuckoo bees are attractive but parasitic on pollinating bees.

G. This parasitoid of caterpillars is large for a parasitoid, but it is still relatively small and inconspicuous.

H. Comparative size of bumblebee and trichogramma egg parasitoid

overlooked, such as the tachinid flies that attack caterpillars and stink bugs.

Apart from the examples listed above, other insects, both beneficials and pests, may be attracted to habitat plants. When assessing habitat plants, it is important to keep this in mind. But also remember that at low numbers, plant-feeding insects in habitat can actually act as an extra food source, in some cases, for predators and parasitoids. It is also important to consider crop diseases and avoid plants that harbor them.

2. The habitat must help the beneficial insect in some aspect of its life history. This help can be some kind of food resource or a favorable microclimate (for example, shade, cooler temperatures, or higher humidity).

Food resources. When we consider potential plants for beneficial insect habitat, we often think of flowers that provide nectar or pollen, which can increase the lifespan of a beneficial insects. Nectar, pollen, or both can indeed help some beneficials. But not all beneficials use these resources or benefit from them.

Parasitic insects, for example, may not be limited by nectar or sugar in their environment. Even if there are no nectar sources from flowers, there may be sugar sources available in the crop itself. Some crop plants (such as cotton) produce nectar from *extrafloral nectaries*—structures not associated with flowers that produce sometimes copious amounts of nectar or sugar. Aphids or other sap-sucking insects on the crop leave behind honeydew, a sugary excrement, that some parasitic insects will readily eat. Still other parasitoids may feed on the host insect they attack by inserting their egg-laying tube (*ovipositor*) into their insect host. Then, either before or after laying an egg, they drink some of the blood that comes from the host's wound.

Some predators may benefit from the availability of nectar or pollen. Pollen, in particular, provides protein. For some predators, the protein may be important in egg development, especially when prey insects are scarce. Some of the beaked predators may use the beak normally used to impale an insect to feed on plant juices. Beneficial insect habitats have been shown to harbor a variety of plant-feeding insects other than crop pests that predators and parasitoids might readily feed on. Alternate prey can help beneficials build up or maintain populations in an area before pest insect populations begin to build in nearby crops.

Figure 4. A 14-spotted ladybeetle feeding on pollen.

Favorable microclimates. Climatic conditions in crop fields can sometimes present a very hostile habitat for insect parasitoids and predators. Some habitats may offer more shade, more moisture, and lower temperatures than could be found in a crop field. These conditions may provide a comfortable place for beneficials to rest and recharge before seeking pest insects again. In other cases, habitats may provide ideal conditions for beneficials to overwinter. Allowing larger numbers of beneficials to survive the winter means their populations can get a jump-start on pests the following season.

3. A habitat will not contribute to pest management unless beneficial insects move from habitat to nearby crops. In some cases, beneficials may be so attracted and benefited by the habitat that they either do not leave, or have no need to move into the crop for resources. When this happens, the habitat may actually reduce the number of beneficial insects available in nearby crops. Ideally, habitat should act as a source for beneficial insects. In other words, it should enhance or increase both the populations of beneficials in the surrounding area *and* their effectiveness in reducing crop pest populations.

4. The beneficials attracted to the crop must eat or parasitize an increasing number of pest insects. Relatively few research studies demonstrate an increase in parasitism or predation in a crop resulting from the presence of beneficial insect habitat. Many of these studies were performed in areas with very little diversity or natural vegetation, such as highly developed agricultural areas in Europe, or in turf or other residential settings.

5. The activity of the beneficials must lead to an economic reduction in pest populations. At this writing in December 2008, we cannot find any studies in the scientific literature that prove beneficial insect habitat can reduce pest numbers below economic thresholds. Although a number of scientific studies have documented beneficial insects being attracted to some habitats and being benefited by components of that habitat, relatively few have documented the movement of beneficials from habitat to surrounding crops. Because of the small size and mobility of beneficials, this can be a daunting task that requires very careful sampling. Very few studies have shown an increase in parasitism or predation

in a crop as a result of having habitat for beneficials nearby. No studies to date have demonstrated all five of the steps outlined in this publication, leading to an economically tolerable reduction in pest populations from beneficial insect habitat.

Summary

Despite products and articles that suggest otherwise, there is no "magic bullet" approach to using beneficial insect habitat. When considering the integration of habitat into your system, remember that the best beneficial insect habitat may already be on your farm. We know that vegetation diversity enhances predator and parasitoid populations and the biological control services they provide. Natural vegetation on or surrounding the farm such as forest, tree-lines, hedgerows, old fields, as well as a diversity of crop types on the farm all contribute to improved natural control of insect pests. These elements probably contribute far more than small planted strips of flowers or other habitat plants could.

Additional Resources on Beneficial Insects

- *Radcliffe's IPM World Textbook.*
  http://ipmworld.umn.edu/ipmchap.htm

- *Biological Control: A Guide to Natural Enemies in North America.*
  http://www.nysaes.cornell.edu/ent/biocontrol/

- Biological Control Information Center.
  http://cipm.ncsu.edu/ent/biocontrol/

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December 2008

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AG-676-02W **12/2008/bs**
EO7-45844

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