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ATTRAnews

Newsletter of the National Sustainable Agriculture Information Service: A project of the National Center for Appropriate Technology (NCAT)

Ecological Pest Management

Growers can often manage pests by expanding the diversity of plants and animals in farm fields. This issue of ATTRAnews describes ways to protect crops through biodiversity and other practical strategies.

Why On-Farm Biodiversity Makes $ense

By Rex Dufour, NCAT Agriculture Specialist

Pest management is an ecological matter. The size of a pest population and the damage it inflicts will depend on the design and management of an agricultural ecosystem. If the system design is faulty—making it easy for pests to develop or making it difficult for their natural enemies—then farmers will have to expend unnecessary resources (think: energy costs) for pest management.

Ecological pest management can reduce expensive chemical inputs by creating more habitat for the "good guys"—more biodiversity.

We've come to accept routine use of biological poisons and fertilizers made from fossil fuel. But continuous application of these chemicals represents significant energy inputs into the agricultural system, and carries both obvious and hidden costs to the farmer and society. Substituting chemical inputs for ecological design is an increasingly expensive, never-ending cycle, and an exercise in futility and inefficiency.

Photo by R.B. Dufour Photo by K.R. Dufour

Ecological pest management uses common-sense principles to deal with pests and their parasites and predators. The idea is to increase the environmental pressure against pests, and provide

(see "Biodiversity" pg. 4)

Save Money and Energy with Ecological Pest Management

Ecological pest management is based on preventing pest problems before they happen. With this approach, farmers can avoid the costs of pesticides as well as the fuel, equipment and labor used to apply them. In the July 2005 issue of *BioScience*, Cornell University researcher Dave Pimentel reviewed a 22-year trial comparing conventional and organic corn / soybean systems: "Organic farming approaches for these crops not only use an average of 30 percent less fossil energy," he reported, "but also conserve more water in the soil, induce less erosion, maintain soil quality, and conserve more biological resources than conventional farming does."

Unsung Heroes — Bats and Spiders

Bats and spiders are generally not "top of the list" animals when producers think about creating a healthy farm. But every farm should provide habitat for them because of the pest control benefits they provide.

Bats: Most bats are insect-eaters. Found in every state of the U.S., bats prey at night on adult forms of critters that farmers don't like—armyworms, cutworms, codling moths, cucumber beetles, stinkbugs, June bugs, and mosquitoes.

Bats can be invited onto a farm by **putting up a bat box, or by making simple modifications to a farm building** (see photo on pg. 3)**.** For more information about bat habitat and which bats live in your region, contact your state Fish and Game Department or Bat Conservation International, *www.batcon.org/home/default.asp*

Spiders: Like bats, spiders are generalist predators, devouring many kinds of insects. For centuries the Chinese have augmented spider populations in field crops as a pest management strategy. Spiders are able to rapidly colonize an area by parachuting on a silk thread—a practice known as ballooning. Spiders are often the earliest predaceous colonizers of agricultural fields.

Unlike insects, spiders have a soft external skeleton, making them more vulnerable to extremes of temperature or humidity, **so mulching or no-till cropping techniques help promote spider populations.** A study in Germany found that mulch increased spider densities in wheat fields, and thereby reduced cereal aphid populations by 25%. Researchers have

(see "Heroes" on page 3)

Inside

Great Illustrated Resources!

ATTRA's Organic Integrated Pest Management (IPM) Field Guide

This pictorial series highlights:

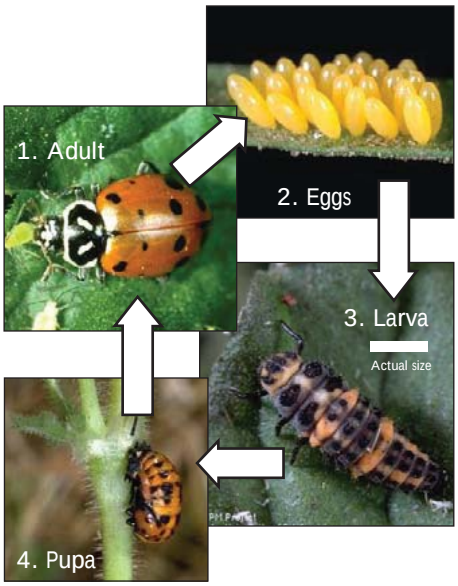
- Beneficials, Beneficial Habitat, and Insect Pests
- Plant Disease Management
- Weed Management
- Vertebrate Pest Management

Filled with color photos that show the details you need, these guides feature beneficial organisms as well as harmful pests. The focus is on how to prevent insect and vertebrate pests, diseases, and weeds from becoming a problem in the first place. Brief text provides useful take-home messages for farmers about what the critter eats and how to manage it. Available in English (IP257) and Spanish (SP257), both online and in CD format.

Excerpt from *Organic IPM Field Guide to Beneficials, Beneficial Habitat, and Insect Pests:*

Life Cycle of Ladybugs

- *What do they eat?* Larvae & adults eat: Aphids, mealy bugs, mites, soft scale, eggs of insect pests.
- *Where do they live?* In plants of the carrot family: fennel, dill, Queen Anne's lace. Also yarrow and sunflowers. Deer grass and other clumping grasses are excellent habitat for over-wintering ladybugs.



Ladybug photos courtesy of www.ipm.ucdavis.edu

Perimeter Trap Cropping to Attract and Remove Insect Pests

Farmers can grow an insect pest's favorite host plant around the edge of fields to attract and "hold" the pest away from the main crop. The trick is to completely surround the field and then to manage the pests in the trap crop.

For Cucumber Beetles in Squash & Cucumbers: Plant one or more rows of Hubbard squash (the trap crop) around the perimeter of fields of summer squash, butternut, and cucumbers. Begin scouting the outer trap crop rows for cucumber beetles as soon as the plants emerge or within days of completing transplant operations.

Spray to kill cucumber beetles when they begin feeding on the trap crop. Scout for beetles twice weekly. Prevent the beetle population from killing and overrunning the perimeter plants. For the barrier to function, it is crucial to maintain the health and attractiveness of the trap crop plants. To learn more: T. Jude Boucher, University of Connecticut Co-op Extension, 860-875-3331, *www.hort.uconn.edu/ipm*

For Pepper Maggot Fly in Bell Peppers: Using hot cherry peppers as a perimeter trap crop, growers have reduced insecticide use by up to 89%. They report the system simplifies pest control and saves money. Economic analysis confirms an improvement in crop profitability of between $13 and $378 / hectare. To learn more: T. Jude Boucher (see above): *www.hort.uconn.edu/IPM/veg/htms/trpcrops.htm*

For Diamondback Moth in Cole Crops: Plant 2 rows of collard greens as a trap crop around fields of cabbage family crops. To learn more: Everett Mitchell, USDA-ARS; 352-374-5710; *www.hort.uconn.edu/IPM/veg/htms/ptrpcrop.htm*

ATTRA Publications about Ecological Pest Management

These publications—and many more on specific techniques, crops, pests, and diseases—can be downloaded for free from the ATTRA website's pest management section, http:/ / attra.org / pest.html. *Or call 800-346-9140 for a printed copy.*

- Applying the Principles of Sustainable Farming (IP107)
- Biointensive Integrated Pest Management (IP049)
- Cucumber Beetles: Organic and Biorational IPM (IP212)
- Deer Control Options (CT131)
- Downy Mildew Control in Cucurbits (CT111)
- Farmscaping to Enhance Biological Control (CT065)
- Flame Weeding for Vegetable Crops (CT165)
- Flea Beetle: Organic Control Options (CT114)
- Grasshopper Management (IP145)
- Integrated Pest Management for Greenhouse Crops (IP144)
- Nematodes: Alternative Controls (CT069)
- Notes on Compost Teas (IP118)
- Squash Bug: Organic Control Options (CT126)

Healthy Soil: The Foundation of Ecological Pest Management

By Rex Dufour, NCAT Agriculture Specialist

"We are what we eat." This folk wisdom relates to plant health as well as to human health. Any organism that consumes a poor diet will be stressed and susceptible to a variety of ills.

The soil is the primary source of nutrition for plants. If the soil is unhealthy, with low levels of organic matter, poor biological activity, and unbalanced nutrients, plants are likely to be more susceptible to attacks by various pests and diseases, and less able to recover from these attacks. The grower, in turn, will have to spend resources—management time, money, machinery, chemicals—to address pest infestations that may only be symptoms of poor soil health.

Fair Trades in the Root Zone

Plants and soil organisms evolved together for hundreds of millions of years in non-agricultural systems. They developed symbiotic partnerships that give plants the water and nutrients they need to successfully grow and reproduce.

The area immediately surrounding the plant root—known as the rhizosphere—is densely populated with bacteria and fungi. This is not surprising, since roots exude carbon compounds (sugars, etc.) that are used by fungi and bacteria. These root secretions bring minerals to the roots through a range of very complex interactions that depend on the plant, soil type, and soil health.

In undisturbed soils, mycorrhizal fungi respond to the root secretions by forming a layer dense enough to protect the root surface from disease organisms. Mycorrhizal fungi also enter the root itself and provide the plant with water and various soil nutrients in exchange for the carbon compounds that roots secrete. The mycorrhizae are able to "mine" a volume of soil much greater than the plant roots could reach. It seems a fair trade.

Mycorrhizae have another positive effect on plants. They can cause the plant to produce compounds that protect it against pathogens and insects. Some of these protective compounds are antioxidants, which have recently been shown to provide health benefits to humans. They have been found in higher concentrations in some organically grown produce than in conventionally grown produce.

What happens in unhealthy soils?

In poorly managed soil, the plant roots exude greater carbon in an apparent effort to mobilize the minerals that are deficient in the soil. This extra effort weakens the plant, making it more attractive to insect pests and reducing crop production.

In frequently tilled soils, many of the beneficial organisms disappear because organic matter is destroyed and pesticides and fertilizers are applied. Without the beneficial organisms, there is a much greater likelihood that harmful species of bacteria, fungi, and nematodes will grow and develop on the plant roots.

So the bottom line is that healthy soils translate into healthy, pest-resistant plants and ultimately into healthy, disease-resistant animals and people.

When Soil is Tilled

Dr. Elaine Ingham, soil microbiologist and founder of Soil Foodweb, Inc., describes an undisturbed grassland—where a wide diversity of plants grow, their roots mingling with a wide diversity of soil organisms—and how it changes when it becomes a field of row crops.

A typical teaspoon of native grassland soil contains between 600 million and 800 million individual bacteria that are members of perhaps 10,000 species. Several miles of fungi are in that teaspoon of soil, as well as 10,000 individual protozoa. There are 20 to 30 beneficial nematodes from as many as 100 species. Root-feeding nematodes are quite scarce in truly healthy soils. They are present, but in numbers so low that it is rare to find them.

After only one plowing, a few species of bacteria and fungi disappear because the food they need is no longer put back in the system. But for the most part, all the suppressive organisms, all the nutrient cyclers, all the decomposers, all the soil organisms that rebuild good soil structure are still present and trying to do their jobs.

Why doesn't the reduced food supply have a greater effect? A good savings account of organic matter has been built up in native grassland and native forest soil. The soil organisms use the organic matter they "put away" all those years when disturbance did not occur.

But agricultural tillage continues to deplete soil organic matter and kill fungi. The larger predators are crushed, their homes destroyed. The bacteria go through a bloom and blow off huge amounts of that savings-account organic matter. With continued tillage, the "policemen" (organisms) that compete with and inhibit disease are lost. The "architects" that build soil aggregates are lost. So are the "engineers"—the larger organisms that design and form the larger pores in soil. The predators that keep bacteria, fungi, and root-feeding organisms in check are lost. Disease suppression declines, soil structure erodes, and water infiltration decreases because mineral crusts form. (From *"Replacing Methyl Bromide with Compost."* BioCycle, December 1998)

Heroes... continued from page 1

also noticed an interesting fact about spiders: their presence causes some insect pests to abandon their host plant, decreasing damage to crops. This has been observed for cucumber beetles, Japanese beetles, cutworms, greenbugs, leafhoppers, planthoppers, and for moth larvae in apple orchards.

Spiders often kill more insects than they can consume, but each species of spider has its own food and habitat preferences. To attract a wide range of spiders that will prey on many different kinds of pests, farmers can plant hedgerows in or adjacent to fields. It's a good idea to include perennial and annual plants of different heights, as well as groundcovers and mulches. For more information: *rexd@ncat.org*

Simple bat habitat: A sheet of 1/4" plywood on board-and-batten barn siding.

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Solarization: Using the Sun's Energy to Fight Pests

By Martin Guerena, NCAT Agriculture Specialist

Imagine harnessing the sun's energy to destroy your enemies. Like Archimedes—the ancient Greek whose "solar death ray" used mirrors to burn a Roman fleet—farmers can destroy or disable insects, diseases, nematodes, and weeds in the field. The technique known as solarization consists of laying a **clear plastic tarp on moist soil** and letting the sun's rays heat the soil.

Heat is trapped under the plastic, raising the soil temperature to kill or debilitate pests. Most of the research worldwide has concentrated on hot and arid areas, but anyplace with hot summers has the potential to use this system.

Usually this soil pasteurization process takes 4-6 weeks, but the amount of time depends on many factors such as rain, wind, day length, soil texture, and the quality of the polyethylene tarp. Ultraviolet-protected plastic is recommended so the tarp can be removed and re-used.

Certain types of organic matter can be added to the soil for "bio-fumigation." Residues from brassica crops such as broccoli and mustards, for example, have shown this bio-fumigant effect. When heated in the solarization process, they release volatile compounds that are toxic to many pests.

Before solarization takes place, the land where the crop is to be seeded or transplanted must be prepared for planting. Beds must be shaped, drip tape installed, and fields leveled. This is to avoid stirring up the soil after solarization, which would bring fresh pest organisms to the soil surface.

Special Caution: Drip tape must be buried at least an inch deep to avoid damage from the sun's rays. In experiments where the tape was placed on the surface of the bed and then covered with the clear plastic, the drip tape was damaged by the magnifying effect of the sun on the water droplets that condensed on the plastic.

Depending on the outside temperature, sunlight density, and the type of pests, soil solarization can provide good pest control 8 to 10 inches deep, although best control is generally obtained down to 6 inches.

Soil Solarization websites

Soil Solarization Home: *http://agri3.huji.ac.il/~katan*
International Workgroup on Soil Solarization and Integrated Management of Soil borne Pests: *www.uckac.edu/iwgss*
Soil Solarization: A Nonchemical Method for Controlling Diseases and Pests: *http://ucce.ucdavis.edu/files/filelibrary/40/942.pdf*

— New and Updated ATTRA Publications —

- Edamame: Vegetable Soy (IP 286)
- Ethanol Opportunities and Questions (IP 292)
- Grapes: Organic Production (IP031)
- Parasite Management for Natural and Organic Poultry: Coccidiosis (IP 245)

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habitat for beneficial organisms. You want to creatively manipulate your cropping systems to your advantage.

Many seemingly small interactions in an agricultural ecosystem can combine to create effective pest management and overall health of the farm system. Don't be shy—Biodiversify!

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