Earth-Kind Gardening Series

Biological Pest Controls

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Earth Kind Gardening practices work with nature to keep insect problems at bay. A healthy garden contains beneficial (or helpful) insects and pathogens, which help battle the destructive pests. Often, these "beneficials" can keep pests under control. However, when the balance of nature is upset and crops begin to suffer more damage than can be tolerated, the gardener must consider control methods. One such method is the use of biological controls—predators, parasites, and pathogens—to hold pest populations at low levels.

Some Helpful Definitions

Earth-Kind Gardening—a program that encourages non-chemical practices such as cultural, mechanical, botanical, and biological controls for garden pests.

Organic Gardening—a system of growing healthy plants by encouraging healthy soil, beneficial insects, birds, and natural or organic fertilizers and pesticides. The term organic gardening has different meanings among different individuals, so a synthetically manufactured fertilizer or pesticide may be objectionable to one organic gardener but acceptable to another.

Integrated Pest Management—using a combination of techniques to reduce the need for pesticides in the garden.

Biological Controls—Biologicals are predators, parasites, and pathogens that act as natural enemies of the pest a gardener wants to control. The parasites and predators are often referred to as “beneficial insects” and the pathogens as “biological insecticides.”

Predators

Predators are insects and their relatives that consume several prey over the course of their development. They are usually as large or larger than their prey. They may feed on a wide variety of prey (including other species of beneficial insects), or feed on only one or a few related species. Common predators include lady beetles (ladybugs), green lacewir larvae, damsel bugs, syrphi fly larvae, bigeyed bugs, aphic predators, mealybug destroyers, predatory mites, and praying mantids. Spiders are highly beneficial; they feed on insects and other small arthropods.

OSU Extension Fact Sheet EPP-7307, “Beneficial Insects,” contains photographs and descriptions of the beneficials common in Oklahoma. For a copy or for more information, contact your county Extension educator.

Parasites

Parasites are generally much smaller than their hosts and during development usually weaken but rarely kill the host. **Parasitoid** is a type of parasite that kills its host, and is used as biological pest control. The majority of parasitoids are tiny wasps, but a few species of flies and beetles are included in this group. Parasitoids lay their eggs on or in the eggs, larvae, pupae, and adults of other insects. When they hatch into larvae, they then become predators of their hosts. They usually attack only one or a few closely-related species. Examples are tachinid flies, trichogramma wasps, braconid wasps, ichneumonid wasps, scale parasites, and whitefly parasites.

OSU Extension Fact Sheet HLA-6713, “Using Biocontrol Agents in the Commercial Greenhouse,” is a good source of photographs and information on these beneficial parasitoids.

Birds, Bats, and Toads

Insects are not the only group of beneficials. Gardeners should also befriend birds, bats, and toads, which help keep insects in control if provided with things they need such as water and shelter.

A toad reportedly can eat up to 15,000 insects in a growing season—16 percent of which are destructive cutworms. To encourage toads to stay in the garden, give them water and cool, shady places protected from cats, dogs, and lawn mowers.

Proper shelters and night lights that attract moths will help bring bats to your yard or garden area. Bats are mammals that feed at night. They can eat up to half their body weight in insects each evening. They eat mosquitoes, gnats, moths, beetles, and other night-flying insects.

Insect-eating birds are also valuable allies to the gardener, although birds that eat or damage fruit from bushes and trees may be categorized as pests. Gardeners can protect their fruiting bushes and small trees by covering them with protective netting when the fruit is beginning to ripen.

Pathogens

Pathogens, also known as microbials or biologicals, are microscopic disease-causing organisms such as bacteria, fungi, viruses, and nematodes. These organisms either infect insects directly or are ingested by the insects. The insects then

become diseased and stop feeding, fail to reproduce, and/or die.

Microbial insecticides are applied as sprays, dusts, or granules. The microbes are essentially nontoxic to humans, wildlife, and other organisms not closely related to the target insect. Their residues present no hazards to humans or other animals, so they can be applied even when a crop is almost ready to harvest. In some cases, they can become established in an insect population or in the insect's habitat and provide control during subsequent seasons.

Bacteria must be eaten to be effective as an insecticide; they cannot simply be sprayed on an insect as a contact poison. Gardeners planning to use these insecticides must know the feeding habits of the insect they are trying to control and then apply the spray to an area that will be fed upon.

The bacterium used most often in the United States for insect control is a preparation of *Bacillus thuringiensis*, abbreviated as *Bt*. An insect that eats plant material sprayed with *Bt* will soon stop feeding. It may not die for several days but will no longer damage the plant. *Bt* does not reproduce quickly in the garden environment, so repeated applications may be necessary.

There are many *Bt* varieties, each of which will control only a few species of a specific group. Make sure the product you purchase contains the correct strain to control your particular insect problem.

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The *Bacillus thuringiensis* variety kurstaki, simply known as *Bt*, is toxic only to larvae of butterflies and moths. Brand names of products containing *Bt* kurstaki include Dipel, Javelin, Thuricide, and Worm Killer. Available as liquid concentrates, wettable powders, and ready-to-use dusts and granules, these products deactivate rapidly in sunlight and should be applied in the evening or on overcast days. Direct some spray to lower surfaces of leaves. This *Bt* is only effective against small (< 1/2") caterpillars, so time sprays carefully.

The *Bacillus thuringiensis* variety israelensis, *Bti*, kills larvae of mosquitoes, black flies, and fungus gnats. It does not control the larval stages of "higher" flies such as house, stable, or blow flies. Product brand names include Gnatrol, Bactimos, and Vectobac. For mosquito and black fly control, Bti is most effective when used on a community-wide basis in abatement districts. For most homeowners or farmers, it is more effective to eliminate sites that serve as sources of standing water, such as tires and empty containers, and to control weeds around ponds. *Bti* is applied as a drench to control fungus gnat larvae in greenhouses.

The *Bacillus thuringiensis* variety tenebrionis is toxic to Colorado potato beetle larvae and elm leaf beetles.

Two other bacterial insecticides, *Bacillus popilliae* and *Bacillus lentimorbus* (generic name Milky Spore Disease), are toxic to the larvae (grubs) of Japanese beetles, which are turf pests. These two bacteria offer only limited usefulness in Oklahoma in those locations where Japanese beetles are **not** found. Annual white grubs are not susceptible, or only slightly susceptible, to these bacterial insecticides.

Another bacterium that is toxic to larvae of some mosquito species is *Bacillus sphaericus*.

Entomogenous nematodes are multicellular roundworms. It is not the nematodes themselves, but bacteria associated with them, that actually kill insects. Entomogenous nematodes and their associated bacteria are considered nontoxic to plants and mammals.

Steinernema feltiae, used against larvae of a wide variety of soil-dwelling and boring insects, is the main nematode species available at retail in the United States. Because of moisture requirements, it is effective primarily against insects in moist soils or inside plant tissues. Prolonged storage or exposure to extreme temperatures before use may kill or injure the nematodes. Most effective in cool temperatures, they will persist for only two to four weeks following application.

Beneficials: Attracting vs. Releasing

Beneficial insects and pathogens are probably already present in your garden, although there may not be enough of them to control a severe pest outbreak. Gardeners can help attract and keep beneficials by making the garden more attractive to them. How?

- Grow pollen and nectar plants. Beneficial predators may be able to use them as an alternative food source when pest numbers are low.
- Diversify the garden habitat. Grow some wildflowers among the crops, or perhaps plant trees and shrubs nearby, but do not plant them so close that they compete with your garden crops for light, water or nutrients. A variety of plants may make it harder for pests to find garden crops, and may provide a source of food and living space for the beneficial predators.
- Use insecticides wisely. They can kill the beneficials as easily or easier than they kill the pests.

Mail order businesses and some garden centers sell beneficial insects that can be released into a yard or garden, but once released they may not stay around and provide the control needed. For instance, if you buy lady beetles that were collected in the wild during their winter resting phase, they will likely follow their instincts to migrate as soon as you release them in your garden. Often, lady beetles are only a good buy if they are to be released in a greenhouse where they can't escape, or if they were collected during the spring after they had already migrated and are ready to start feeding.

If you do purchase insects, there are some ways to encourage them to stay in your garden.

- Make sure you have the right predator or pathogen for your pest problem. Some biological controls prey on only one or a few related species.
- The timing of the release is important. If released too early, there may not be enough food and they may leave or die. If released too late, there may be too many pests for them to control effectively.
- Release the helpful insects on infested plants, making sure food is available to them.
- Mist the plants with water.
- Release in the evening or morning when temperatures are cooler.

Common Insects and What to Do about Them

	aphid predator	parasit-oids (eg., Tachinids & Tricho-gramma wasps)	predatory mites	green lacewing	lady beetle	mealybug destroyer	scale parasites	Bacillus thuringiensis	whitefly parasite (Encarsia formosa)	parasitic nematodes	minute pirate bugs
aphids	•	•		•	•	•				•	•
armyworms		•						•			
cabbage root maggots										•	
cabbage worm, butterflies		•						•			
codling moths		•									
Colorado potato beetles								•			
corn earworms		•		•				•			•
cucumber beetles		•								•	
cutworms		•						•		•	
elm leaf beetles								•			
flea beetles										•	
geranium budworms								•			
grubs, white										•	
leaf-hoppers				•							
leaf rollers		•						•			
looper caterpillars		•						•			
mealybugs				•	•						
oak moths								•			
scales				•		•	•				
spider mites			•	•	•						•
thrips			•	•							•
tomato hornworms		•						•			
whiteflies (green-house)				•					•		
whiteflies (sweet potato)				•							
wireworms										•	

This is a generalized list of biological treatments recommended for common garden insect pests. However, these treatments are sold under many different brand and trade names. Always read the label of a product to see if it is formulated for use against the particular insect you want to control. The chart does not list every insect pest you may find in your garden, but does include many of the most common ones.

Disadvantages of Microbial Insecticides

- They are toxic to only a certain species, so each application may control only a portion of the insects present in the garden.
- They are very sensitive to heat and ultraviolet radiation.
- Some require special formulations and storage procedures.
- Microbial insecticides tend to be relatively expensive and sometimes not easily found.

Fungi are another kind of pathogen sometimes used for insect control. Most fungi are spread by asexual spores called conidia. To germinate, the conidia usually require free water or very high humidity. Like bacteria, the fungi also can be killed by desiccation (drying out) and by ultraviolet radiation. But unlike bacteria, fungi do not have to be eaten by a pest to be effective. They can germinate on the insect's cuticle and develop special structures that penetrate into the insect's body. Few fungi pathogens are commercially available in the United States. However, one or more fungi are used in Great Britain, China, the Soviet Union, Eastern Europe, and South America.

A beneficial fungus that can be incorporated in growing media to suppress the pathogens that cause damping-off diseases of greenhouse crops is Gliocladium virens (GL-21).

Another product that is new on the market is Beauveria bassiana JW1. It controls insects such as aphids, thrips, mites, whiteflies, and leaf-feeding caterpillars on a variety of indoor and outdoor ornamental plants, trees, and shrubs. It is not labeled for food crops. This fungus is sold under the brand name Naturalis-L.

Protozoa are pathogens that sometimes kill their insect hosts, but more often weaken them, causing them to produce fewer offspring. Few protozoan pathogens seem to be suited for development as insecticides.

Viruses are very specific diseases that usually act against only a single insect genus or species. Viruses, like bacteria, must be eaten by the insect to be effective. This is another category of biologicals under development, and uses as an insecticide have been limited. Insect viruses must be produced in live host insects, which is expensive and time-consuming. Since viruses are host-specific, each viral insecticide has a limited market. Many viruses have also proven to be less effective than available synthetic insecticides.

Choosing a Pest Control Method

Earth-Kind gardeners learn to live with some pests in their gardens but must also determine when to treat with insecticides and which insecticides to use. They must become familiar with insect friends and foes to know which ones to fight and which to encourage.

Correct identification of an insect or other pest is the first step in selecting a control method. This means **frequent inspections** and **monitoring** of garden crops. Complete elimination of pests is nearly impossible. The goal of pest control is to lower the number of pests to a manageable level.

If you cannot diagnose the problem yourself, you can get help from your county Extension educator, who has publications with pictures of the pests and the damage they cause. If necessary, the educator can also provide information on how to select, prepare and send specimens to OSU entomologists or pathologists for identification of insects or diseases.

Once you have identified the pest, use all available cultural and mechanical pest control measures first, which may include hand-picking and destroying insects.

Avoid using any insecticide when only minor damage is evident and an action threshold has not been reached. An action threshold is the point when it is less expensive to use an insect control method than to endure damage to your plants—a smattering of grasshopper nibbles in a tomato planting or discovery of a few white grubs in the soil beneath your lawn normally are not serious enough problems to justify the use of insecticides.

If insecticide application is required, choose the material proven by research to be the safest and most effective. Consider spot treating areas rather than giving blanket treatments. Avoid improper use of pesticides—make sure you are not trying to use an insecticide on a problem caused by a fungus or bacterium.

For more information on Earth Kind Gardening, watch the Oklahoma Gardening television show broadcast 11:00 a.m. Saturdays and 3:30 p.m. Sundays on Oklahoma Educational Television Authority channels.

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