Biological Pest Controls for the Home Landscape

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Many gardeners are concerned about environmental and health effects of using chemical pesticides in the landscape. Yet pests commonly reach destructive levels, requiring control. Biological control is a safe, effective and environmentally friendly form of pest management that can easily be applied to the home landscape. It is most effective when practiced as part of a multifaceted Integrated Pest Management (IPM) program. This Fact Sheet outlines the goals of biological control and how to apply this strategy in the home landscape.

Biological control is defined as the suppression or prevention of a pest outbreak through the purposeful manipulation of natural enemies. All organisms have natural enemies that limit their population size through predation, parasitism or disease. In a biological control program, gardeners work to maximize the impact of predators, parasites (parasitoids) and disease agents to manage pests. Biological control can be used to manage insect, disease and weed pests in the landscape.

Biological control can be described as three sets of three principles. These are:

1. **Goals:** prevention, reduction or delay of a pest population
2. **Natural enemies:** predators, parasitoids and pathogens
3. **Strategies:** conservation, augmentation and importation of natural enemies

Biological Control Goals

It is important to have realistic objectives and expectations when managing pests in the landscape. The goal of biological control is pest suppression, not elimination. Biological control works to keep pest populations below the level where significant damage occurs. Damage may be measured in terms of crop yields or it may be aesthetic appearance for ornamental plants. Every gardener has a different level of tolerance for plant damage. Likewise, damage tolerance varies considerably from one plant to another, as do pest management goals.

Pest Prevention

One goal of biological control is to manage pests to prevent populations from reaching pest status. This is commonly applied to ornamental plants, with which there is a very low tolerance for visual damage. Successful pest prevention entails intervention when pest numbers are very low. This requires early detection through monitoring practices. Biological control agents are used to provide mortality early in the pest cycle to prevent outbreaks. Prevention requires thorough understanding of the pest life cycle and is most successful against regular, predictable pests.

Pest Reduction

Similar to chemical pesticides, which are often applied to quickly reduce a pest outbreak, biological control can be used to provide a remedial, knock-down effect. In this situation, the treatment is made after the pest has reached a damaging level. The objective is to quickly reduce the population to non-damaging levels and maintain low pest density.

Pest Delay

In some situations, the goal of biological control is to simply delay a pest until after a critical phase of plant development, such as bud burst or flowering. This method is not applicable in all situations, but can be useful for crops with critical periods of development. Delaying a pest requires early intervention – when pest numbers are still low. Ultimately, the pest may reach high levels, but not until after the critical window has passed.

Natural Enemies

In a biological control program, our natural enemies include the three P's: predators, parasitoids and pathogens. Proper pest identification is the first step to understanding which natural enemies will provide effective pest management. Understanding pest biology will help in identifying an appropriate biological control agent.

Predators

Predators are insects and their relatives that consume several prey during 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 lacewing larvae, damsel bugs, syrphid fly larvae, bigeyed bugs, aphid predators, mealybug destroyers, predatory mites and praying mantids. Spiders are highly beneficial; they feed on insects and other small arthropods.

Extension Fact Sheet EPP-7307, "Beneficial Insects," contains photographs and descriptions of the beneficial insects common in Oklahoma. Extension Circular E-1023: "Conserving Beneficial Arthropods in Residential Landscapes" provides detailed information of common natural enemies.

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

A toad 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 shrubs and small trees by covering them with protective netting when the fruit is beginning to ripen.

Parasitoids

A 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.

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

Pathogens

Pathogens are microscopic, disease-causing organisms such as bacteria, fungi, viruses, protozoa and nematodes. Hosts infected by a pathogen experience reduced growth and development, may fail to reproduce and/or succumb to death. Pathogens are very common and occur naturally in the landscape. The host-specificity of disease agents varies considerably, with some affecting only a single host or a handful of closely related hosts, and others having a very broad host range.

Pathogens can be used in a number of ways to manage pests. Some are introduced to the landscape as a living agent and others are available as a microbial insecticide, applied in much the same manner as chemical pesticides. Pathogens are used in biological control programs to manage insects, weeds, plant-parasitic nematodes and plant-infecting pathogens.

Microbial pesticides are derived from natural materials such as animals, plants, bacteria and certain minerals. They may contain the actual living organism or toxins produced by these organisms. Microbial pesticides are applied as sprays, dusts or granules, and are used against a wide range of pests including insects, bacteria, fungi and weeds (Table 1). The microbes are essentially nontoxic to humans, wildlife and other organisms not closely related to the target host. Their residues present no hazards to humans or other animals, so can be applied even when a crop is almost ready to harvest. In some cases, they can become established in a host population or in the host's habitat and provide control during subsequent seasons.

Bacteria are used in microbial insecticides, fungicides, bactericides and herbicides. The most common use of bacteria is in microbial insecticides. For this application, the 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 to control, then apply the spray to the feeding area of the target insect.

Entomogenous (Entomopathogenic) **Nematodes** are multicellular roundworms serving as successful biological control agents to control certain insect pests. 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 and highly host specific. Extension Fact Sheet EEP-7670 "Detection, Conservation, and Augmentation of Naturally Occurring Beneficial Nematodes for Natural Pest Suppression" describes nematodes in depth and details ways to conserve these beneficial organisms.

Fungi are another kind of pathogen used for insect control, and to a lesser extent, weed management. 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.

Protozoa are one-celled organisms. Some species of protozoa infect insect hosts, sometimes causing mortality. More often, these organisms weaken the hosts, causing them to produce fewer offspring. Use of protozoan pathogens as insecticides is currently very limited.

Viruses are another group of biological agents being developed for use as insecticides. Insect viruses must be produced in live host insects, which is expensive and time-consuming. Viruses are highly specific diseases that usually act against only a single insect genus or species. As such, development as insecticides has been very limited.

Biological Control Strategies

There are three approaches to using biological control for pest management. Two of these, conservation and augmentation, are practices available to homeowners. The third, classical or importation biological control, is restricted to scientific practitioners. In the home landscape, conservation is generally the primary method practiced, with augmentation used only as needed.

Conservation Biological Control

The most important practice a homeowner can follow in applying biological control is to encourage and enhance natural enemies already present in the landscape. This is called conservation biological control and is accomplished by attracting natural enemies to the landscape and protecting them through changes in landscape management practices. The goal of this practice is to prevent or avoid pest problems from developing.

Like all animals, natural enemies require food, water and shelter. In addition to feeding on prey, many predators and

Table 1. Microbial pesticides available to homeowners in Oklahoma.

Active Ingredient	*Type of Agent*	*Trade Name(s)*	*Target Pest(s)*	*Crop(s)*
Bacillus licheniformis	Bacterium	EcoGuard	dollar spot	turfgrass
Bacillus thuringiensis subsp. *Israelensis*	Bacterium	numerous products available	mosquitos, black flies, drain flies, fungus gnats	water gardens, rain barrels, fountains, bird baths, flower pots
Bacillus thuringiensis subsp. *Kurstaki*	Bacterium	numerous products available	lepidopteran larvae (caterpillars)	vegetables, ornamental trees and shrubs
Bacillus pumilus	Bacterium	Yield Shield, Pro-Mix	*Fusarium, Rhizoctonia, Alternaria, Aspergillus, Pythium*	vegetable crops
Bacillus sphaericus	Bacterium	Vectolex	mosquitos	water gardens, rain barrels, fountains, bird baths, flower pots
Bacillus subtilis	Bacterium	Integral, Kodiak, Serenade, Taegro	*Rhizoctonia, Pythium, Fusarium, Aspergillus*, Botrytis *Phytophthora*, powdery mildew	vegetable crops, ornamental plants
Beauveria bassiana	Fungus	BotaniGard, Naturalis, Mycotrol	beetle larvae, lepidopteran larvae (caterpillars), aphids, ants, fungus gnats, grasshoppers, leafhoppers, mealybugs, mites, whiteflies	fruit and vegetable crops, ornamentals plants
Isaria fumosorosea	Fungus	Preferal	aphids, leafminers, mites, lepidoptera larvae (caterpillars), plant bugs, mealybugs, whiteflies, beetle larvae	vegetables, fruits, ornamentals
Metarhizium anisopliae	Fungus	Met 52 Bioinsecticide, Tick-EX	ticks, whiteflies, thrips, mites, weevil, aphid, grubs	berry crops, vegetables, turfgrass, ornamental plants
Myrothecium verrucaria (killed)	Fungus	DiTera	plant-parasitic nematodes	vegetable crops, fruits, ornamentals, turgrass, trees
Nosema locustae	Protozoan	Nolo Bait, Semaspore bait	Grasshoppers, Mormon cricket	turfgrass, landscape, rangeland
Spinosad	Bacterial product	numerous products available	caterpillars, leafminers, beetle larvae, thrips, borers, spider mites, fruit flies, fleas	
Streptomyces griseoviridis	Bacterium	Mycostop	*Fusarium, Alternaria brassicola, Phomopsis, Botrytis, Pythium, Phytophthora*	field, ornamental, and vegetable crops
Streptomyces lydicus	Bacterium	Actinovate, Actino-Iron pathogens	numerous soil-borne fungal and bacterial	vegetable crops, herbs, ornamentals, turf
Trichoderma asperellum and T. *gamsii*	Fungus	Tenet	*Fusarium, Phytophthera*, Pythium, *Rhizoctonia, Sclerotinia, Verticillium*	vegetable crops, ornamental plants
Trichoderma hamatum	Fungus	Incept	Soil born diseases	ornamental and vegetable crop soils
Trichoderma harzianum	Fungus	RootShield, T-22	Pythium, *Rhizoctonia, Fusarium, Sclerotinia*	trees, shrubs, transplants, ornamentals, vegetables

parasitoids feed on nectar and pollen. We can attract natural enemies to the landscape and encourage their activity by providing an abundance of flowering plants throughout the year. We can also create natural enemy habitat to shelter these beneficial organisms year-round.

In home landscapes, the activity of natural enemies is often disrupted through use of pesticides, changes in land management practices, and limited availability of habitat used by natural enemies. The primary strategy homeowners can employ to conserve natural enemies in the landscape is to reduce pesticide use by trying alternative control strategies, using selective chemistries, and limiting applications to only infested plants. Fact Sheet HLA-6447 outlines conservation biological control practices that can be applied in the home landscape to encourage and protect natural enemies.

Augmentation

Augmentation biological control involves the purchase and release of natural enemies into the landscape. This is done as a means of increasing the numbers and kinds of natural enemies present and adding an additional source of mortality to manage a pest. The objective of augmentation is not to permanently establish the control agent. Existing natural enemies may be present naturally, but not in sufficient numbers to manage the pest. Augmentation biological control supplements the activity of existing natural enemies to suppress pest populations. Augmentation can be used to reduce a pest outbreak by overwhelming the pest population through mass releases of natural enemies. It can also be used as a preventive technique by releasing small numbers of natural enemies early in the pest life cycle. Application of microbial pesticides is also a form of augmentation biological control. Fact Sheet HLA-6446 “Augmentation Biological Control Practices for the Home Landscape” outlines in detail the goals and approaches to augmentation biological control.

Importation or Classical Biological Control

Many of our worst pests are exotic species introduced from other countries. One reason they become problematic is because they are introduced without their natural enemies. In importation biological control, natural enemies from the exotic pest’s country of origin are introduced to re-establish predator-prey relationships. Importation biological control is a rigorous science and is highly regulated. It requires extensive research conducted under quarantine to avoid introduction of unwanted organisms that may have been collected with the control agent. Likewise, extensive testing of the host-range of the biological control species is done to ensure it will not have undesirable impacts on native species. Importation biological control has produced hundreds of successes against many different types of pests.

Biological Control and Integrated Pest Management

Biological control is most effective when used in conjunction with additional preventive control measures. It can be an effective tool as part of a comprehensive IPM program. Biological control is compatible with many other IPM practices including cultural, physical and mechanical controls. There are also some pesticides compatible with a biological control program (Table 2). When using chemicals in conjunction with biological control, select host-specific chemistries and time applications to have minimal impact on beneficial insects and limit treatment to only infested plants.

Biological control is not an off-the-shelf technology. It requires knowledge of pests and their natural enemies. Biological control involves taking a closer look at the landscape and understanding the many interactions taking place among multiple species. Simple changes in landscape practices can go a long way toward enhancing beneficial insects and other predators. These efforts help restore a balance of nature in the garden, where predators, parasitoids and pathogens can limit pest populations.

Table 2. Pesticides compatible with biological control.

Pesticide name	*Target Pest(s)*
Horticultural oil	Soft-bodied insects
Horticultural soap	Soft-bodied insects
Neem oil	Soft-bodied insects
Azadirachtin	numerous
Microbial pesticides	see Table 1
Spinosad	thrips, caterpillars

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