

Biological Pest Control

Integrated pest management (IPM) involves the use of a combination of strategies to reduce pest populations safely and economically. This guide describes various agents of biological pest control. These strategies include judicious use of pesticides and cultural practices, such as crop rotation, tillage, timing of planting or harvesting, planting trap crops, sanitation, and use of natural enemies.

Natural vs. biological control

Natural pest control results from living and nonliving factors and has no human involvement. For example, weather and wind are nonliving factors that can contribute to natural control of an insect pest. Living factors could include a fungus or pathogen that naturally controls a pest.

Biological pest control does involve human action and is often achieved through the use of beneficial insects that are natural enemies of the pest. Biological control *is not* the natural control of pests by their natural enemies; host plant resistance; or the judicious use of pesticides.

The three P's of biological control

Biological control agents consist of the three P's:

- Predators
- Parasites
- Pathogens

Each of these control agents is a natural enemy that can be used to reduce, delay or prevent pest infestations.

Natural enemies can be introduced after the pest is established. For example, the Vedalia beetle was introduced to the United States as a natural predator of cottony cushion scale. When eradication of a pest is impossible or not economically feasible, such as with the gypsy moth, predators or pathogens can be used to delay or slow the spread of the pest. Prevention of a predictable pest through the release of natural enemies early in the season is rarely attempted because of the time it takes for populations of the beneficial insects to increase sufficiently.

To effectively use biological control, you need to know what pest you are trying to control and what its natural enemies are. Some resources that can help you identify pests and their natural enemies are listed in the *For more information* and *Also from MU Extension Publications* sections.

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Steps for conserving beneficial insects

- Recognize beneficial insects.
 - Minimize insecticide applications.
 - Use selective (microbial) insecticides, or treat selectively.
 - Maintain ground covers and crop residues.
 - Provide pollen and nectar sources or artificial foods.
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Predators and parasites

Predator insects actively hunt and feed on other insects, often preying on numerous species. Parasitic insects lay their eggs on or in the body of certain other insects, and the young feed on and often destroy their hosts. Not all predacious or parasitic insects are beneficial; some kill the natural enemies of pests instead of the pests themselves, so be sure to properly identify an insect as beneficial before you work to increase its population.

Populations of beneficial insects can be increased by conservation, augmentation or importation.

Conservation of a pest's natural enemies often requires a change in production practices or pesticide applications so as not to harm the beneficial species.

Augmentation involves adding natural enemies to the area, usually by buying or rearing them. This strategy works only if the practice adds to overall death of the target pest instead of replacing existing causes of death.

Importation is the classical biological control strategy. Many pests are exotics — that is, they have been brought into a region that they are not native to, usually accidentally. The natural enemies of these pests can be imported so as to “reunite” the pests with their natural control agents. Importation must involve extensive natural hosting studies and a quarantine stage to ensure that bringing these natural enemies into the area won't cause further problems.

Pathogens

Certain bacteria, viruses, fungi, protozoa and nematodes are beneficial pathogens. Many of these pathogens are a form of natural control in that they can drastically reduce a pest's population in nature; for example:

- Viruses in tobacco budworm, corn earworm, alfalfa looper, tent caterpillars and forest sawflies
- Fungi in alfalfa weevil, potato leafhopper and green cloverworm

- Microsporidia in grasshoppers, corn borer and many others

Although some pathogens have been mass-produced and packaged, for the most part these have not been readily formulated as effective microbial insecticides.

Viruses

Viruses commonly cause disease outbreaks and population crashes in caterpillars. A few virus-based biopesticides are available commercially, but they are not used widely in the U.S. These products include viruses that infect codling moths, gypsy moths, corn earworms, tussock moths and others.

Bacteria

Bacillus thuringiensis (Bt) toxins work by developing crystal proteins in the gut of insects that cease their feeding and quickly cause death. Species are available that kill pest larvae:

- *B. israelensis* and *B. sphaericus* for larvae of several mosquitoes, black flies and fungus gnats
- *B. popilliae* and *B. lentimorbus* for Japanese beetle larvae

Insect-pathogenic fungi

Insect-pathogenic fungi often cause disease outbreaks in insect populations, but few have been commercialized as biopesticides. One reason for the lack of commercialization is that production of virulent strains that maintain viability “on the shelf” is difficult. Another is that the effectiveness of products applied in the field is affected by the weather and the field’s microhabitat.

The following fungi are examples of those that kill insects:

- *Metarhizium anisopliae* infects a broad range of hosts, including corn rootworms, white grubs and root weevils. A commercial cockroach bait station uses *M. anisopliae* to kill cockroaches.
 - *Beauveria bassiana* (white muscardine fungus) kills the European corn borer and Colorado potato beetle.
 - *Entomophthora muscae* (and *E. grylli* and others) kills flies, seed and root maggot adults, and other insects.
- The fungus sporulates from dead or swollen adult flies.

Microsporidia

A microsporidian is a parasitic fungus. An important Midwestern example is *Nosema pyrausta*, a pathogen of the European corn borer. Although microsporidia can kill their hosts outright, infections often do not cause death rapidly. Infected individuals develop more slowly and are smaller, and infected females lay fewer eggs, many of which will become infected and die. *N. pyrausta* causes periodic collapses in European corn borer populations in Missouri and neighboring states. The only microsporidian that has

Importation successes

The classic example of successful control of a pest through importation of its natural enemy is the Vedalia beetle for control of cottony cushion scale in citrus. Between 1868 and 1870, cottony cushion scale was introduced from Australia and became a serious pest of citrus and ornamentals. In 1887, C.V. Riley convinced the California Fruit Growers’ Convention to pressure the U.S. Congress to provide \$2,000 for the covert collection of natural enemies in Australia. Albert Koebele sailed for Australia in August 1888, presumably to represent the California citrus growers at the world agricultural exposition. Koebele brought back several thousand parasites (*Cryptochaetum iceryae*) and a few hundred Vedalia beetles (*Rodolia cardinalis*). The Vedalia beetles were held on trees under mesh tents to increase their numbers; then they were transferred from orchard to orchard on branches by growers. To date, the beetle is the best control measure for cottony cushion scale.

Other successful examples include parasites of the alfalfa weevil, beetles for gypsy moth suppression, larval parasites of cereal leaf beetle, and the mealy bug destroyer beetle.

been commercialized as a biopesticide is *Nosema locustae*, a species that attacks grasshoppers.

Insect-parasitic nematodes

The nematodes that have been cultured for sale as biopesticides include species in the genera *Steinernema* and *Heterorhabditis*. They enter an insect’s body through the mouth, anus or spiracles and move into the body cavity, where they release symbiotic bacteria (*Xenorhabdus* or *Photorhabdus* species) that multiply within the host insect. Infection by these bacteria is what kills the insect host. The nematodes feed on the bacteria, complete their development, and reproduce, yielding thousands of progeny that then seek another host.

Nematodes can be effective against soil insects, particularly in settings where irrigation can be used to maintain soil moisture. Targets have included root weevil larvae, seed and root maggots, fungus gnat larvae and several other pests. Nematodes have not proven to be effective against wireworms, corn rootworms, grape phylloxera or several other key pests.

For more information

Biological Control: A Guide to Natural Enemies in North America, Cornell University: <http://www.biocontrol.entomology.cornell.edu>

Integrated pest management publications, University of Missouri Extension: <http://extension.missouri.edu/ipm>