INTEGRATED PEST MANAGEMENT

Unit 2 Section 1
Background: Biological Pest Control
An Introduction

What Is Biological Pest Control?

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Biological control is, generally, man’s use of a specially chosen living organism to control a particular pest. This chosen organism might be a predator, parasite, or disease that will attack the harmful insect. It is a form of manipulating nature to increase a desired effect. A complete Biological Control program may range from choosing a pesticide which will be least harmful to beneficial insects, to raising and releasing one insect to have it attack another, almost like a living insecticide.

Some Advantages of Biological Pest Control

Biological control methods can be used as part of an overall integrated pest management (IPM) program to reduce the legal, environmental, and public safety hazards of chemicals. In addition, it may be a more economical alternative to some insecticides. Some biological control measures can actually prevent economic damage to agricultural crops. Unlike most insecticides, biological controls are often very specific for a particular pest. Other helpful insects, animals, or people can go completely unaffected or undisturbed by their use. There is less danger of impact on the environment and water quality.

Some Disadvantages of Biological Pest Control

Biological control takes more intensive management and planning. It can take more time, require more record keeping, more patience, and sometimes more education or training. Successful use of biological control requires a greater understanding of the biology of both the pest and its enemies. Many natural enemies are very susceptible to pesticides, and using them successfully in an IPM program takes great care. In some cases, biological control may be more costly than pesticides. Often, the results of using biological control are not as dramatic or quick as the results of pesticide use. Most natural enemies attack only specific types of insects - unlike broad-spectrum insecticides, which may kill a wide range of insects. Though often an advantage, this can also be a disadvantage.
The Three Main Approaches to Biological Control

Biological control uses naturally occurring predators, parasites and diseases to control pests. There are three main ways to use these natural enemies against unwanted insect pest populations.

**Classical Biological Control** (importation) involves traveling to the country or area from which a newly introduced pest originated and returning with some of the natural enemies that attacked it and kept it from being a pest there. New pests are constantly arriving accidentally or intentionally. Sometimes they survive. When they come, their enemies are left behind. If they become a pest, introducing some of their natural enemies can be an important way to reduce the amount of harm they can do.

**Augmentation** is a method of increasing the population of a natural enemy that attacks a pest. This can be done by mass producing a pest in a laboratory and releasing it into the field at the proper time. Another method of augmentation is breeding a better natural enemy that can attack or find its prey more effectively. Mass rearings can be released at special times when the pest is most susceptible and natural enemies are not yet present, or they can be released in such large numbers that few pests go untouched by their enemies. The augmentation method relies upon continual human management and does not provide a permanent solution, unlike the importation or conservation approaches.

**Conservation** of natural enemies is an important part in any biological control effort. This involves identifying any factors that limit the effectiveness of a particular natural enemy and changing them to help the beneficial species. Conservation of natural enemies involves either reducing factors that interfere with the natural enemies or providing needed resources that help natural enemies.
IPM Tactic: Biological Control

Now that we have some background on the biology and identity of pest organisms, we can spend more time intelligently (?!?) discussing which tactics might work to suppress which organisms under what conditions. Please review the IPM Steps and Tactics. (See curriculum Introduction)

Many of the tactics listed for IPM are common-sense and fairly well understood. For example, it is not news to most of you that one can hoe or hand-pull weeds, both physical tactics. Choosing pest-resistant plant varieties and keeping them well-fertilized and watered are cultural tactics that are fairly well understood. However, two categories of tactics require special background preparation before use; these are the use of biological control and chemical tactics, i.e. the use of pesticides. An overview of the dynamics of biological control is discussed below.

Biological Controls: General Points

“Balance of Nature”

In nature, very few species populations explode into vast numbers. Most are suppressed by an active group of predators, parasites or diseases. In the case of plants, herbivore (plant eater) species keep them in check. From a human perspective, we consider these organisms beneficial organisms or natural enemies if they are harming something that is a pest to us. However, pests are not completely eliminated or eradicated using biological controls. Think about it. If the natural enemy destroyed all the prey, there would be no food left for their next generation and they would die out. Thus, the balance between predator-prey; parasite-host; disease-host; or herbivore-plant allows some of the host species to survive so that the natural enemy can reproduce and continue, from our point of view, suppressing the pests.

The goal of using biological controls, therefore, is to suppress pest populations below damaging or intolerable levels.

There are three ways people use these organisms in their gardens, greenhouses or farms to help suppress pests; they import, augment or conserve and/or encourage them.
Three Ways to Use Biological Controls

1. Importation

This method is also called classical biological control. The idea is that many organisms we know as pests on this continent actually originated elsewhere and were introduced by humans either on purpose or accidentally. Unfortunately, these introduced species usually come without their natural enemies back home, so no predators, parasites, diseases or herbivores keep them in check. If well-suited to their new environment, introduced species can explode and even become invasive, taking over habitats formerly occupied by native species. In importation or classical biological control, governments sponsor expeditions to the locations of origin of the pest to search out and bring back their natural enemies. Researchers look for organisms that are highly specific to attacking only the target pest to avoid causing unforeseen disruptions in the ecosystem in question.

To learn more about importation and use of natural enemies, teachers and their classes can partner with local agencies to help release natural enemies and study the effects of biological control on the pest species over time. A good recent example in the Northeast U.S. is the release of 3 beetle species in the last decade to control the invasive wetland plant, purple loosestrife. In this way, students will learn about current on-going issues and outcomes in pest management.

2. Augmentation

When you buy and release commercially available biocontrol organisms, you are augmenting, or adding to, the naturally occurring population of beneficials. You can use this technique when you know the exact identity of the pest species and which biocontrol agents will attack that pest. This technique can be used most easily by classes that have access to a greenhouse. Greenhouse plants can be used to set up a controlled experiment to test the efficacy of different biocontrol agents. Alternately, a biocontrol program can be designed by students to manage the pests that will most likely come to live in your greenhouse anyway. For example, the greenhouse whitefly can be successfully suppressed by using the tiny wasp parasitoid, Encarsia formosa which is commercially available from a number of sources. Other pests, such as aphids, can be suppressed by other parasitoids and a number of predators.
Three Ways to Use Biological Controls

3. Conservation or Encouragement

Natural enemies are already in great abundance outdoors and are suppressing most of the potential pest populations. Thus, a garden or farm manager would do well to try to conserve them or encourage them.

What sorts of actions can be taken to conserve and encourage natural enemies? Consider the following list and think of how class activities could be built around them.

a) Learn to recognize natural enemies (Friend or Foe?)

b) Learn to scout for natural enemy populations as well as scouting pests. Pest managers count the number of pests at regular intervals to take data on whether the pest population is present and if so, is it increasing or decreasing. Sometimes, if you are looking for them and notice that the natural enemy population is increasing also, you can mathematically predict that soon they will suppress the pest all by themselves - meaning you do not have to spray a pesticide if you just wait a bit longer.

c) If using chemicals, choose those that are soft on natural enemies. Chemical pesticides are all different; some are harsher than others, so try to pick those that will not kill the natural enemies. Remember, if you destroy them, you inherit their jobs of controlling pest species!

d) Provide habitat useful to the natural enemies. Biological control organisms are living, breathing organisms with needs of their own. To encourage their presence, provide for shelter, food or other needs. For example, the tiny wasps that parasitize caterpillars need to feed themselves on nectar from shallow flowers to keep up their energy. There are specific plants you can plant in your garden to help the good guys out!
Practical Uses of Biocontrol

In private, commercial settings, the most common use of biocontrol is the augmentation method, where natural enemies are purchased and released. Greenhouses are the most common place where this method is used. However, because the natural enemies and pests are ALIVE and form dynamic populations, success of biological control in suppressing pests requires attention to certain important factors.

* Get the right enemy for the pest species.

* Release them at the right time in the pest population cycle. (Start when pest populations are LOW so enemies have a chance!)

* Environmental conditions must be favorable (weather / temperature / moisture).

* Food sources must be present for the natural enemy (adults or larvae in some cases).

Advantages and Limitations of Augmentative Biological Control

Advantages include:

* Reduced reliance on chemical pesticides.
* On-going suppression of pests over time (vs. repeated spraying).
* They reproduce themselves and keep working.
* Can you think of others?

Limitations include:

* More knowledge is required to use successfully.
* More attention to detail is required.
* Results are not immediate - it takes awhile before pest populations decline.
* Cost is usually higher than use of chemical pesticides.
* Can you think of others?
Anti-Insect Items

The anti-insect items on the sheet fall into these three general categories:

1. Physical and Mechanical Controls are some of the safest ways to control insect pests because they aren't poisonous.

Physical and mechanical controls include:

* putting up window screens

* installing metal termite flashing and termite barriers, which help prevent termites from getting into the wood underneath and on the sides of houses

* using flyswatters

* planting marigolds and other pest-repellent plants throughout your garden

* picking pests off your garden plants by hand

* removing old tires and other items that often fill with water and become mosquito breeding grounds

* using sticky, non-poisonous tape

* putting up mosquito netting

Many entomologists think that bug zappers are not effective insect pest controls because they indiscriminately kill any insects that are attracted to lights, including predatory insects that eat insect pests.
Anti-Insect Items (continued)

2. **Chemical Controls** are considered the most risky form of pest control. Even though pesticides and other poisons are often the most effective controls in the short run, many insects quickly become resistant to them. And most insect poisons are deadly to many types of living things - not just insect pests. They also can contaminate the soil for many years, and they're difficult to dispose of safely.

Most entomologists agree that you should try other pest control methods first and use pesticides only as a last resort. And if you do use poisons, you should follow these safety procedures:

* use the least toxic pesticide that is available
* buy only as much as you'll need
* read the directions for proper use and disposal
* never apply when children and pets are nearby
* store out of reach of children and pets

**Chemical controls** include mothballs, aerosols, powdered and liquid insecticides, roach traps, insecticide-soaked pest strips, and other pest poisons.
Anti-Insect Items (continued)

3. **Biological Controls** include insect parasites, predators, or pathogens. Biological controls are safer than poisons because they don’t harm other living things.

Here are some examples of ways to use biological controls:

* encourage natural predators, such as bluebirds and purple martins, to nest in your yard

* release ladybird beetles, lacewing larvae and other natural insect predators in your yard to help control aphids and other pests

* release parasites that will parasitize the pest you are trying to control

* use species-specific, natural pathogens to kill various pest species

For more information about Integrated Pest Management, contact your local Cooperative Extension agent (usually in the phone book under local government) or visit the University of Connecticut Integrated Pest Management website at www.hort.uconn.edu/ipm/

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Beneficial Creatures

Nature’s Pest Control

By Patti Schenck, Penn State Master Gardener

**Ladybird beetle** commonly known as the ladybug overwinters as an adult in leaf litter, mulch, woodpiles or in garden debris. In the spring she will feed on nectar, pollen and honeydew and lay clusters of elongated, yellow eggs. The larva is dark with orange or yellow marks and raised black spots resembling an alligator in shape. The larva feeds on aphids, scale, mites, mealy bugs, whiteflies, thrips and the eggs of other insects. To attract the ladybug grow tansy, angelica, scented geraniums and spring flowering shrubs; and don't be too hasty to get rid of all the aphids.

**Mealybug destroyers** resemble ladybugs but are a third of their size and are black with orange-red heads. Adult mealybug destroyers prey mainly on mealybugs but will also eat certain stages of scale and aphids. The larva resembles the mealybug because it produces white cotton to protect itself against ants.

The **ground beetle** family contains hundreds of species. Most of these insects are dark and shiny. Their larvae are segmented with strong legs and visible pinchers for grasping prey. Most hide during the day and feed at night. Do not handle them because they may pinch and some give off a disagreeable odor. The adults and larvae prey on caterpillars, cutworms, root maggots, spiders, mites, other beetles and many other insects. The best way to encourage the ground beetle is to provide places for them to hide: ground covers, perennial beds and hedgerows.

The wheel bug or **assassin bug, soldier beetle** and the **big-eyed bug** are of the Hemiptera family and all have piercing, sucking mouthparts. The assassin bug preys on flies, bees, leafhoppers, Japanese beetles, tomato hornworms and other large caterpillars. Although small, the big-eyed bug consumes dozens of spider mites a day. The soldier beetle preys on caterpillars, sawfly larvae, Mexican bean beetles and Colorado potato beetles.

**Rove beetles** are usually black or brown in color. They have short antennae and pinching jaws used to grab their prey. They scurry about with the tip of their abdomen in the air. Rove beetles prey on mites, aphids, springtails, nematodes, fly eggs and maggots. These interesting insects are attracted to dark, damp places and would be happy in a compost pile, under leaves, stones and boards.

The **lacewing** is a delicate looking creature with long, lacy wings and copper-colored eyes. The adults lay eggs attached to the end of filaments on leaves near aphids. The grayish brown larvae emerge ready to eat anything in their reach with their prominent sharp curved jaws. They can consume 100 or more insects a day. To attract the lacewing grow yarrow, angelica, sunflowers, scented geraniums, Queen Anne's lace or corn.
Tachinid flies resemble a large housefly but are bristle-covered and gray or brown with pale markings. They are often seen on or around flowers where they feed on the nectar. The female lays her eggs on a pest insect or on the leaves, which are then eaten by the host insect. The eggs hatch and the maggots develop within the host insect, eventually killing it. The maggot leaves its dead host and drops to the ground where it pupates. Tachinid flies prey on caterpillars, beetles, sawflies, borers and stinkbugs. Wildflowers and herbs such as tansy, spearmint, dill and Queen Anne's lace will attract them.

Hover flies resemble wasps but have only one set of wings and do not sting; they are also called syrphid or flower flies. The adult is not predacious but is very beneficial as a pollinator. By closely observing the fly you can distinguish it from a bee or wasp by its movements. The hover fly will dart quickly in and around a flower while a wasp or bee will land and remain for awhile. The pale, greenish brown, sluglike maggot will consume 400 aphids before changing into an adult. They also eat leafhoppers, scale, mealybugs, thrips, corn borers and corn earworms. Eggs are laid singly among aphid colonies. Cosmos, coreopsis, marigolds, feverfew, parsley and spearmint are some of the herbs and flowers that will provide the pollen and nectar that they need.

All wasps have a physical feature that makes them different from other insects in that they have a narrow waist. Adult wasps have chewing mouthparts and tongue-like structures they use for drinking nectar. Females of most species have stingers. Most wasps are beneficial as pollinators, predators, and/or parasitoids. Oxeye daisies, strawflowers, black-eyed Susans, yarrow and even goldenrod will draw wasps to the garden.

Spiders have eight legs and two body parts and belong to a group called arachnids. Most spiders spin webs to entangle their prey but some use their environment like crab spiders who camouflage to match the flowers they hide in. Wolf spiders are named for their coloring and method of hunting. They live mainly on the ground and burrow for shelter. To encourage spiders provide mulch, especially straw and a diversity of flowers.

Some nematodes are very destructive but others are extremely beneficial. These microscopic roundworms attack many soil-dwelling and pupating insects. The species Steinernema carpocapsae or Sc is used for caterpillars, cutworms, webworms and billbugs. Heterorhabditis bacteriophora or Hb is used to control Japanese beetle grubs. Research is also being done to see if they would be effective to control termites.
Resources

Works Cited


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The use of natural enemies to suppress or prevent insect pest outbreaks is termed "biological control." Natural enemies are called "beneficials" because they are helpful in controlling insect pests. Proper identification and understanding of natural enemies, as well as the insect pests attacked by these beneficials, is the first step in implementing biological control. Natural enemies can be classified into three major groups.

**Predators** attack, kill, and eat multiple numbers of prey. Predators may feed on a wide variety of pests, or they may be more specific, feeding on one or a few pest species.

**Parasites** lay an egg in or on a host, which then hatches and develops at the expense of the host. Most often the host is eventually killed as the developing parasite consumes the host's organs or body-fluids.

**Pathogens** are free-living microscopic organisms (bacteria, fungi, viruses, etc.) that invade the host's body and cause disease. The diseased host is greatly weakened and often killed.

Biological control can be used in combination with other control measures, such as mechanical (e.g. removing insect pests) or cultural (e.g. crop rotation) control, resistant crop varieties, and the judicious use of insecticides.

The three groups of natural enemies are further explained and illustrated on the following pages.
Insect predators fall into one of two groups depending on their mouthparts. Most species have “chewing mouthparts.” These predators typically eat most of their prey. Other predators have “piercing-sucking” mouthparts, to suck the prey’s body-fluids.

A praying mantid finds this captured larva makes a detestable feast.

This spined soldier bug pierces its prey with “straw-like” mouthparts.

Insects at all life-stages can be attacked by one or more predatory species.

This insidious flower bug “sucks the life” out of a pest’s egg.

A major group of non-insect predators are the spiders (8-legged arthropods). Spiders are predacious throughout their lives. Spider hunting techniques vary widely, from web spinning species to active hunters. Most spiders are “shy.” Because some species can inflict a painful bite, they are best left alone to do their “job.”

Garden spiders can catch quite large prey with the webs they form between plants.

The aphid lion is the immature larva of the fruit-looking lacewing. It grasps prey with sickle-like mandibles.

Crab spiders wait motionless on plants to capture unsuspecting prey like this fly.
PARASITES

There are two common types of insect parasites: stingless wasps and certain flies. The wasps are small (most less than 1/4-inch), usually black or red insects, that do not sting people (indeed they can not because they have no stinger). Parasitic flies often resemble the common house fly. Like the parasitic wasps, these flies are harmless to people, because they attack only their host. While you may notice the occasional adult parasite, you may more frequently encounter the parasitized hosts, as they are often misshapen and may have undergone noticeable color changes. Sometimes, you will find hosts with “eggs” attached to them, which may indeed be eggs or the pupal cases of the emerging parasites.

PATHOGENS

Pathogens gain entry into the insect’s body through two main routes: directly through the insect’s “skin” or orally when the insect eats contaminated plant parts. Fungi invade through the “skin” from a spore that lands on the host’s body. Eventually, the host becomes filled with a growing mass of “hyphae” that turn the host “fuzzy” and rigid.

Bacteria and viruses enter through the host’s digestive system after the host has eaten contaminated plant material. Once inside the host body, these pathogens rapidly multiply, and eventually liquify the host’s internal organs. Due to their microscopic size, pathogens are most often noted for the disease they cause, and the changes in the insect’s body after infection.

Insects at all life-stages can be attacked by one or more parasite species.
All the species described in this publication occur naturally in the field. Thus, one of the general approaches to biological control is to conserve these beneficials by adopting practices that are friendly to natural enemies.

1. Learn to distinguish between pests and beneficials. Monitor for insect pests and natural enemies to determine their presence, pest related plant damage, and effectiveness of the beneficials. Implement control measures only when it is economically and environmentally justified (e.g., some plants can withstand considerable injury from pests before yield is affected).

2. Avoid or minimize the use of broad-spectrum pesticides that are harmful to non-target organisms. If insecticides are necessary, the use of microbial insecticides (e.g., Bacillus thuringiensis, "B.t."), insecticidal soaps, and horticultural oils will be less harmful to beneficials.

3. Provide diverse sources of nourishment to natural enemies by planting mixed annual flowers which can provide nectar and pollen. Maintain a permanent bed of perennials in the garden to provide shelter for beneficials. Maintain ground covers, standing crops, and crop residues to supply overwintering sites for natural enemies.

4. Understanding the pest and natural enemy is necessary before purchasing beneficials to add to the naturally occurring population (e.g., praying mantids do little to control caterpillars on cabbage). Several organic gardening magazines provide information on the availability of commercially available beneficials.

Selected references:


Numerous fact sheets concerning various crops, pest identification and their damage, management guidelines, and control recommendations are available from the Cooperative Extension Service.

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Reducing insecticide use in the home garden

Every home garden attracts insects. Gardeners encounter bugs on their broccoli and beetles on their beans every summer. But before you reach for that can of insect spray, consider Integrated Pest Management. You may never need insecticides again.

Home gardeners have many options for managing insects that attack their vegetables, while reducing insecticide use. Incorporating these practices based upon pest and beneficial insect life cycles and behavior is a key component of Integrated Pest Management. For example, Integrated Pest Management options include pre-plant cultural methods, such as selecting insect-resistant varieties and rotating crops. After the garden has been planted, harmful insects can be reduced by applications of soaps and oils, which are relatively safe compounds for humans and the environment.

If the garden is relatively small and the number of pests few, hand-picking insects remains one of the most effective means of eliminating them. There are also many traps or barriers that can suppress selected insect pest species. Several commercial biological control agents are available, that can be effective against specific harmful insects. When all other measures have failed, consider selective and well-timed spot treatments of individual plant parts with a low-impact insecticide, such as soap and oil sprays (page 5).

Most gardeners learn a great deal about their plants' growth needs, but they may know little about the insects in their gardens. The majority of insects found in a garden are not harmful. The vast majority of insect species in North America are either beneficial or harmless to humans and garden plants. One of the best things a gardener can do is learn to recognize the difference between beneficial and pest insects. Learning to appreciate the activities of insects is one of the benefits from reduced insecticide use in the garden.
What exactly is an insect pest?

“Pest” is a human label for an insect species that reduces the value or quality of a particular resource. In a home garden, insects are rarely economic pests unless the garden produce is providing a source of income. Regular, frequent inspections to discover pests before they develop into problems is the basis for reducing insecticides in a garden. Gardeners need to know what to look for, where, and when to look.

Certain insect species will feed on garden vegetables and may cause some visible insect feeding damage. However, tolerating a modest level of insect damage is another aspect of Integrated Pest Management that can greatly reduce pesticide use. Each gardener must determine how much damage is too much.

Benefits of using fewer insecticides

Limiting the use of insecticides offers many advantages to gardeners and the environment. Among the benefits are:

1. Reduced human exposure to pesticides.
   Many gardens are found in highly populated areas where the chances of human contact with sprayed insecticides may be greater than in rural areas. Also, the greatest risk of pesticide exposure is to the applicator—you, the gardener.

2. Reduced potential for pesticide residues on garden products; thus, safer produce.

3. Fewer potential risks to wildlife, pets, and the environment.

4. Increased activity of naturally occurring beneficial insects.

Minimizing the use of insecticides will have a dramatic effect on the diversity of insects in a garden. The enhancement of naturally occurring beneficial predators and stingless wasps is an asset for a gardener. The beneficial insects attack damaging insects and keep their numbers low. The activities of these beneficial species may also be encouraged by planting a variety of plants, including flowers, that provide alternative food sources (pollen and nectar). These practices should increase the numbers of beneficial predatory species, such as lady beetles, damsel bugs, spiders, and stingless wasps.

Management options for the garden

There are many alternatives available for gardeners who want to effectively manage their insect pests. The recognition of insects causing plant damage is a key element. Beyond knowledge of beneficial and pest insects, a well-designed garden also can have a very positive effect on insect management. The rotation of plants to different areas and the design of plantings within a garden are viable options. Your local library may have books on garden designs that reduce the need for insecticides. Planting a diversity of well-adapted vegetable and fruit varieties and ensuring their vigorous growth can bolster plant defenses to insect pests.

Several insect barriers are available for the home garden. Various screening products can be used to keep insect pests from plants that are prone to attack. Cheese cloth and fabric crop covers are two such barriers.

Also, insects traps that use color or odors to attract a particular insect species to sticky cards may be helpful. For example, yellow sticky
traps can be used for the spotted cucumber beetle. Yellow plastic dish pans filled with soapy water may be used to attract aphids. The color yellow attracts many insects. (figure 4)

Some traps use chemical bait to attract insect species. These chemicals lure insect pests to a sticky trap either because the pests mistake the smell for food or a potential mate (pheromone-baited trap). Due to the relatively small size of most gardens, traps can be used to determine if a specific insect species is present or can possibly be used for control. These traps are specific for one insect species, so if a particular pest is causing a problem, they can be highly effective. For example, a pheromone-baited trap available for the cabbage looper will trap insect adults flying in a garden in search of cabbage and broccoli.

**Using insect pests' natural enemies**

A second option for a home gardener is commercially available beneficial organisms, or microbial insecticides. The most widely used microbial insecticide is a bacterium, *Bacillus thuringiensis*, or Bt, for short. New developments with this bacterium have expanded the range of insects Bt infects and extended its activity. Several Bt products are available under various trade names that are formulated as liquid concentrates, wettable powders, and ready-to-use dusts. Repeated applications may be necessary, because Bt does not persist and multiply in the home garden environment. Bt products are effective against a number of caterpillar pests of vegetables including several species attacking broccoli and tomatoes. Another type of Bt acts against leaf-feeding beetles, including an occasional pest of potatoes, the Colorado potato beetle, and the bean leaf beetle, which attacks beans.

Several commercially available beneficial nematodes—tiny insect-attacking worms—attack several insects, including many garden pests. These nematodes should not be confused with plant-parasitic nematodes, which can be harmful to certain garden vegetables. The infective stages of these beneficial nematodes enter an insect and release a symbiotic bacterium inside the insect. The bacterium multiplies and kills the insect host within one to two days. The nematode then feeds and reproduces within the dead insect.

These nematodes will attack a wide range of soil-inhabiting insect pests. For example, nematodes are excellent options for suppressing larval cutworms in the garden. They can provide a safe alternative to soil insecticides for many insects that live on the soil surface or in
places that are difficult to spot. Other insect pests suppressed using nematodes are squash vine borers, armyworms, cabbage root maggots, wireworms, and white grubs. These nematodes are easy to handle and apply and they present no risk to humans or other beneficial species in the garden, like earthworms. Timing of releases is important, because nematodes move through films of water. Releases at night following rains or watering are recommended.

An excellent option for aphid suppression is the use of green lacewings. Naturally occurring populations of green lacewings can be encouraged with reduced insecticide use in a garden. These predators also may be purchased as eggs or young larvae and easily released in a garden. They feed primarily on aphids, but will also eat eggs and other soft-bodied insect pests. Lacewing adults, beautiful insects with delicate wings, add to a home garden’s insect diversity. The use and encouragement of these aphid predators, in combination with yellow-pan trapping and spot treatments of insecticidal soap, provide an excellent management program for aphid pests. (figures 5 and 6)

Tiny, stingless wasps called *Trichogramma* are mass-produced by several commercial firms for home garden insect suppression. These wasps are not harmful to humans, but attack eggs of many butterfly and moth insect pests. In a garden, *Trichogramma* wasps may be released when eggs of the cabbage worm and looper, or tomato hornworm are found. Timing their release is critical, since these parasitic wasps only attack the eggs of insect pests. These wasps also should be released in the early evening, when temperatures and winds are moderate. Eggs of insect pests attacked by *Trichogramma* will turn black and produce a new generation of these beneficial wasps.

Purchasing other insect predators, such as lady beetles and praying mantids, for release in the home garden is not recommended. The species of lady beetles sold for use in gardens is collected at overwintering sites and stored in a refrigerator until shipped. When released, these adults will fly away from a garden, because even though they have been physically removed from their overwintering site, they still will attempt long-distance flights. Praying mantids are cannibals and the insect species most commonly found in a home garden will not provide adequate food for mail-order mantids. As a result,
they too will often leave the garden, if they survive attacks from other praying mantids! A home gardener should encourage the activity of naturally occurring species, and only purchase insects that are truly helpful.

Using insecticidal oils and soaps
The practice of Integrated Pest Management includes the careful use of selective insecticides as spot treatments when other options are unavailable or when they have failed to provide adequate control. Gardeners have two environmentally friendly spray options for many insect pests—insecticidal soap products and oil sprays. Soaps act selectively on many damaging insect pests, including aphids, squash bug nymphs, leafhoppers, and thrips. These soaps break down quickly and do not cause any long-term environmental contamination. Due to the selective action of these products, most beneficial insects are not harmed by soap sprays.

Oil sprays suffocate insects, and also have the advantage of rapid breakdown. These compounds are not toxic to humans and will not cause environmental contamination. However, they are not selective in their action, so overuse may have detrimental effects on beneficial insect species.

Conclusion
Using Integrated Pest Management techniques in the garden should significantly reduce the use of pesticides and maybe eliminate them altogether. By learning more about the natural balance between beneficial insects and insect pests, and encouraging the beneficial ones, gardeners will gain more appreciation for nature and the ecosystem.

For additional information


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File: Entomology 2

...and justice for all
Iowa State University Extension programs and policies are consistent with pertinent federal and state laws and regulations on nondiscrimination regarding race, color, national origin, religion, sex, age, and handicap.

## Table 1. Common insect garden pests and alternative forms of suppression.

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Common insect pests</th>
<th>Traps/Barriers</th>
<th>Beneficials</th>
<th>Soaps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broccoli &amp; Cabbage</td>
<td>Aphids</td>
<td>Yellow pans</td>
<td>Lacewings</td>
<td>Insecticidal soap</td>
</tr>
<tr>
<td></td>
<td>Cabbage looper*</td>
<td>Pheromone</td>
<td></td>
<td>Trichogramma</td>
</tr>
<tr>
<td></td>
<td>Imported cabbageworm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tomatoes</td>
<td>Hornworms*</td>
<td>Pheromone</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fruitworm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peppers</td>
<td>Aphids</td>
<td>Yellow pans</td>
<td>Lacewings</td>
<td>Insecticidal soap</td>
</tr>
<tr>
<td>Potatoes &amp; Egg Plant</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beans</td>
<td>Bean leaf beetle</td>
<td>Yellow sticky</td>
<td>Bt</td>
<td></td>
</tr>
<tr>
<td>Peas</td>
<td>Aphids</td>
<td>Yellow pans</td>
<td>Lacewings</td>
<td>Insecticidal soap</td>
</tr>
<tr>
<td>Squash</td>
<td>Squash vine borer</td>
<td></td>
<td>Nematodes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Squash bug*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweet Corn</td>
<td>Earworm</td>
<td>Pheromone</td>
<td>Trichogramma</td>
<td>Bt</td>
</tr>
<tr>
<td></td>
<td>European corn borer</td>
<td></td>
<td></td>
<td>Nematodes</td>
</tr>
<tr>
<td></td>
<td>Cutworm</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Hand-picking is an option due to the insect's size and location on the plant.

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**Lady beetle life cycle**

Beneficial insects appear in the garden in many life stages, each with a different form. Here are the developmental stages of a lady beetle, starting at right and going clockwise.
"What is Biological Pest Control?"
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