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EC1266

Integrated Pest Management for Landscapes

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Chances are good that gardeners will have to deal with some type of pest during the year, whether that pest is a flea beetle chewing holes in a potato leaf, rabbits nipping lilies, dandelions invading the lawn, or early blight on tomatoes. Integrated Pest Management (IPM) is a strategy that uses a combination of methods to manage pests to avoid unacceptable damage while also protecting the health of humans, pets, and other nontargets, and the environment. An IPM program consists of the following series of steps to manage the target pests effectively.

Step 1. Get to know the landscape plants. Identify plants in the landscape and learn which are likely to have problems year after year and which plants or groups of plants significantly contribute to the value of the landscape *(Figures 1* and *2)*. Some plants, such as roses, are highly susceptible to pests while others are weakened and more susceptible to pests due to site issues, such as poor grading and soil compaction; environmental conditions that are less than ideal, including water and temperature extremes; and plant damage caused by human activity such as using equipment *(Figure 3)*. After identifying plants that are prone to having problems, determine the pests most likely to affect those plants. Then learn how to identify the pests, their biology and threshold levels, and best control methods for each. Research has shown that only 10 insect species or related groups account for 83 percent of the arthropod

Figure 1. Woody landscape plants, such as trees and shrubs, often have high value in landscapes due to the environmental, functional, and aesthetic benefits they provide. They are long-lived, respond slowly to change, and rarely can be rescued when in decline. As a result, they often are the focus of monitoring and control efforts in landscapes that contain a mixture of woody and herbaceous plants.

Figure 2. In areas where trees don't grow easily, such as central and western Nebraska, soil cover is highly valued. IPM programs must concentrate on keeping ground covers healthy and actively growing to prevent soil erosion.

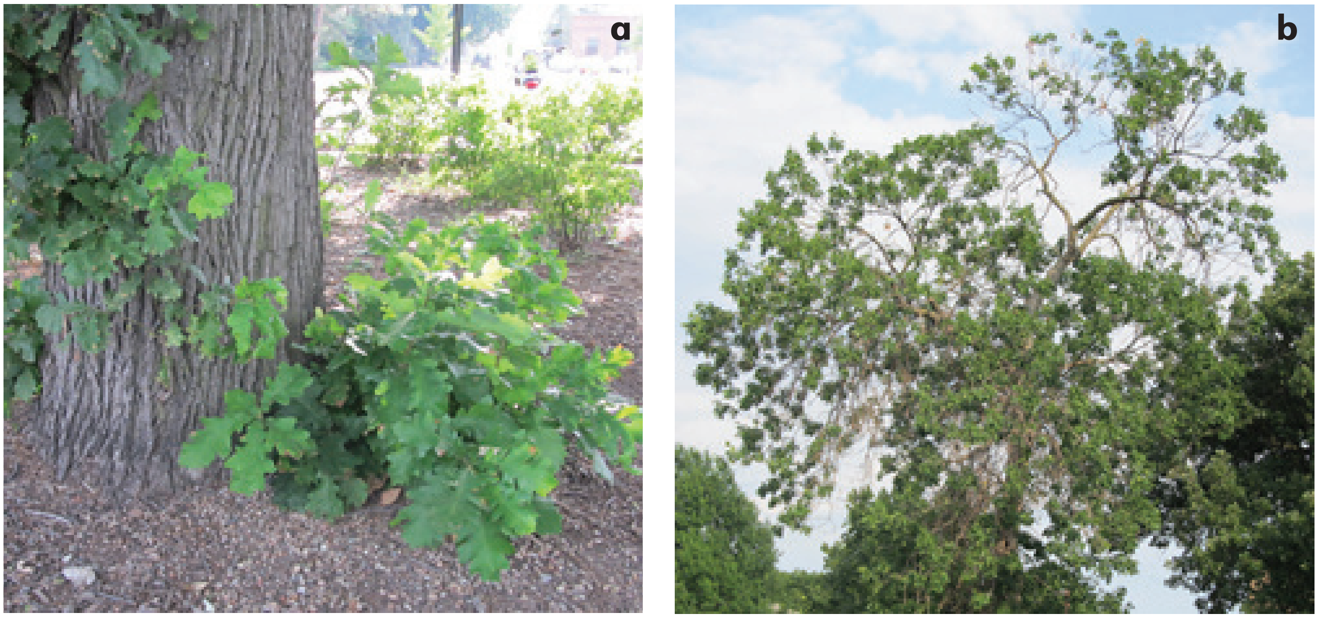

Figure 3. Stresses caused by human activity can make plants more susceptible to pests. Indicators of plant stress include early foliage color change, reduced shoot density and shoot elongation, suckering on plants that don't normally sucker (a), and tip or leaf dieback (b). These indicators are not always obvious.

pests encountered annually in home landscapes. These pests include lace bugs, mites, scales, borers, leaf miners, Japanese beetles, aphids, bagworms, galls, and weevils.

Step 2. Monitor pests and damage and record information.

A homeowner who wants to practice IPM must spend time observing plants throughout the growing season. Monitoring typically begins when plants leaf out in the spring and continues through leaf drop in the fall. Watch for unusual spots on foliage, insects massing on the undersides of leaves, or insect droppings on the plants that were identified in Step 1. Regular monitoring will help indicate if, where, and when a treatment is needed. Monitoring throughout the winter may be necessary for landscapes that are routinely affected by wildlife.

Monitoring is accomplished through various methods. Visual inspection is the most common method used in home landscapes. Other methods include shaking plants, soil sampling, drenching, and trapping to

Figure 4. Yellow sticky cards or tapes often are used in greenhouses and landscapes as a method of monitoring for pests. They trap flying insects, which allows for early detection of potential pest problems and proper timing of control methods.

Figure 5. Flowering time of common forsythia often was used as an indicator for application of a preemergence herbicide for summer annual weeds. With various bloom times of new forsythia cultivars (a), this is no longer a reliable indicator. Conversely, bud break or just before or after bud break is the appropriate timing for oils applied for insects on many coniferous trees or diseases on several fruit trees, such as apple (b).

Figure 6. Garden journals provide a valuable history of the landscape and serve as a reminder of pest arrival and treatment times. They can be handwritten, electronic, or a combination of written and electronic notes, diagrams, and pictures.

detect the presence of insects *(Figure 4)*. Tracking weather conditions is important for monitoring plant diseases. Diseases may be difficult to see, but some can be predicted based on the presence of susceptible hosts and favorable environmental conditions. Observing plant life cycle events, such as flowering and bud break, can provide an estimated time for pesticide applications *(Figure 5)*.

An important component of monitoring is quantifying and recording the pest problem. How many leafhoppers or aphids are present per leaf or per plant? What percentage of the leaf area has been chewed or is covered with a lesion? By keeping track of pest populations and planning a control program, a gardener can react quickly if control is needed. Notes on weather conditions, site-specific plant information, such as exposure and drainage conditions, and recent management practices should be included in the records in addition to pest activity. This information may be helpful in creating management plans for future years *(Figure 6)*.

Step 3. Identify pests and understand pest biology. Identify the pests that were found during monitoring to determine whether they **are** indeed pests *(Figure 7)*. If insects, diseases, or weeds are found that were not already researched in Step 1, learn about their biology, thresholds, and control methods. Some organisms are more vulnerable at specific stages of their lives. Young weeds are easier to kill than mature weeds. Waiting to control a weed problem after seeds have set invites more weed problems the following year. Grasshoppers go through incomplete metamorphosis *(Figure 8)*. Therefore, younger, smaller nymphs cannot fly and are much easier to control than larger, fully winged adult grasshoppers. In addition, understanding the life cycle of beneficial organisms is important so their populations aren't wiped out while managing pests.

Figure 7. Mantids are beneficial predators; they eat pests. Image courtesy of UNL Entomology.

Step 4. Determine threshold levels. Instead of taking action at the first sign of a potential pest problem, understanding thresholds and determining whether any action needs to be taken at that time is a key component of IPM *(Figure 9)*. Thresholds are based on the pest population (i.e., one leafhopper nymph per leaf, number of grubs per square foot), the stage of the pest (a young grasshopper will eat less than an older grasshopper), and the life stage of the plant. Thresholds are different for every plant.

Injury threshold represents the pest level population that causes unacceptable injury. The **treatment threshold** is less than the injury threshold and indicates the number of pests or level of damage that would initiate treatment to prevent the pest population from reaching the injury threshold. In businesses, the treatment threshold is based mainly on economics and quality of the produce so that it can be sold. For a homeowner, the

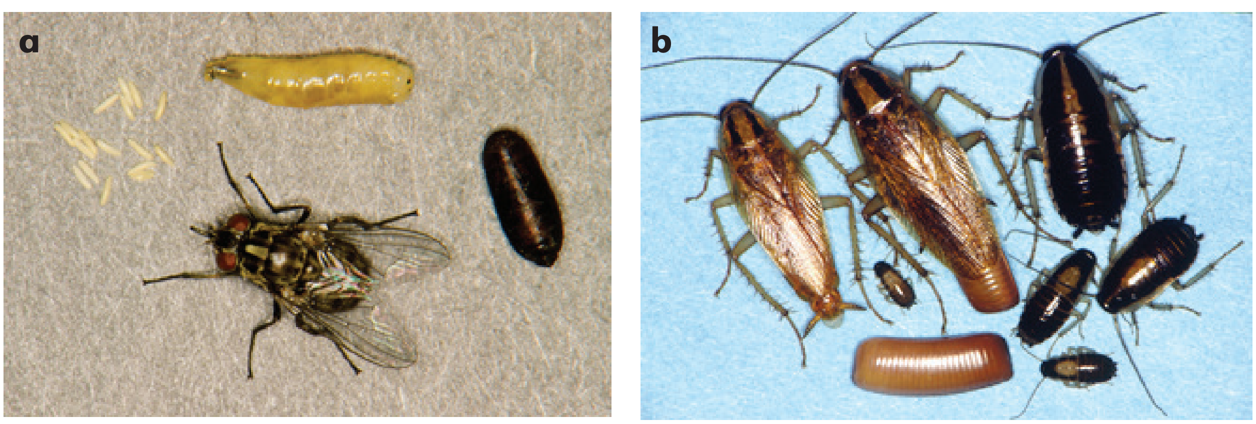

Figure 8. The stable fly undergoes complete metamorphosis, going through various stages of development that don't resemble each other — egg, larva, pupa, and adult (a). The German cockroach goes through incomplete metamorphosis, sometimes called gradual or simple metamorphosis. After birth, the young cockroaches go through various stages as nymphs, rather than larvae. A nymph looks like the adult insect, just smaller in size (b). Images courtesy of UNL Entomology.

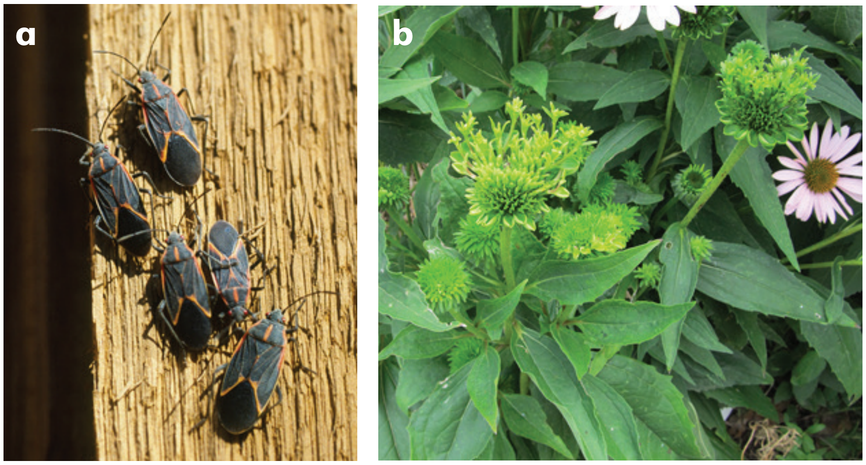

Figure 9. Presence of an insect or a single hole in a leaf usually doesn't require action; healthy landscapes will have a variety of insects present and some imperfect leaves. For example, presence of boxelder bugs (a) can be tolerated at fairly large populations without causing a problem. Conversely, simply the presence of a pest, such as aster yellows (b), can mandate treatment, or in this case, removal of the plant. When possible, the least toxic method, including cultural and mechanical controls, should be used first to control pests. Image "a" courtesy of UNL Entomology.

Figure 10. Diseases commonly affect plants in the same family, such as tomato, pepper, eggplant, and potato, so they should be rotated to different areas of the garden and not placed in the same location again for a minimum of three years. Crop rotation can be difficult in a traditional garden plot that is rototilled and the soil is mixed. Raised beds or containers can offer an alternative for separate areas to rotate crops.

treatment threshold may be based on aesthetics. By reviewing notes taken in previous years about pest levels and their associated damage, appropriate treatment thresholds can be set for the most important plants in a landscape.

Step 5. Consider a variety of control methods. Organisms do not exist independently; there are many connections between them. This should be kept in mind when considering various options for pest control. Some options may have more of an impact on nontarget organisms (e.g., lady beetles, pollinators such as bees and butterflies, birds, pets, or plants a gardener didn't intend to affect) than others. Once the decision has been made that it is time to manage the pest, there are several IPM control methods from which to choose, including cultural, mechanical, biological, and chemical. Selection of the most appropriate control method is based on several factors, including the environment, aesthetics, economics, and pest populations.

Cultural controls are practices that gardeners use to manage their landscapes throughout the growing season. Homeowners can adopt a number of management practices starting prior to planting through the end of the growing season to reduce pest populations. Some of the easiest and most popular practices include:

- Rotate crops by crop family when planning a garden. Plants of the same family often have similar pests and planting them in the same area each year allows pest populations to build up *(Figure 10)*.
- Select disease- and insect-resistant varieties.
- Check bedding plants for signs of insects, diseases, or weeds before buying them. Avoid unintentionally introducing pests into a landscape.

- Dig, till, or cultivate to reduce weed or insect populations. Insect pupae or grubs may be exposed to predators such as birds, and small annual weeds will be uprooted by cultivation.

- Compost plant waste. If done correctly, the compost pile will be hot enough to kill weed seeds and pathogens. Heavily diseased plants should be placed in the garbage, burned, or buried. The specific disease determines the best disposal method.

- Thin seedling stands to the proper plant spacing, usually found on seed packets, so that plants have plenty of sunlight and good air movement.

- Water in the early morning hours to reduce the amount of time that plant leaves stay wet.

- Apply fertilizer at recommended rates and times to avoid plant stress.

- Alter planting or harvesting dates to avoid some insect or disease problems. Use plant varieties with differing days to maturity to help with the timing.

- Remove diseased material, such as discarded dried up vegetables or fruit mummies, from the ground to reduce the spread of diseases. Plant debris may provide overwintering sites for insects and diseases.

- Use mulch to help reduce infection by disease organisms in the soil. A mulch cover reduces soil splash onto the lowest leaves, which is usually the first infection site.

- Control weeds. They may serve as alternative hosts for pests by providing food and cover or as an alternate site for viruses.

- Use cover crops to prevent weeds from infesting an area that won't be planted immediately. They provide organic matter when incorporated into the soil prior to planting. Legumes, such as clovers and hairy vetch, can provide nitrogen to the soil.

- Use companion plants to lure pests away from desirable plants. Typically planted at the edges of a garden, companion plants usually are removed from the garden early and not harvested for produce. They are sometimes referred to as trap crops. For example, Hubbard squash can be used as a trap crop to protect other cucurbits from squash vine borer.

Mechanical or physical controls use methods to exclude or remove pests from an area. These methods can be time-consuming and may work best on pests when populations are still low.

- Use traps to kill or capture pests. An example of trapping is placing a wet burlap sack or shallow pans filled with beer near hosta plants to attract and trap leaf-eating slugs.

- Place barriers to prevent pests from reaching the plants. Cans or folded newspapers can act as collars around seedlings, preventing attack by cutworms. A fence can protect a specimen plant or a garden from deer or rabbits. Netting on strawberries serves as a barrier to protect the fruit from birds. Row covers can protect crops from insects, but timing of coverage is important if the plants depend upon insect pollination.

- Remove pests by hand. Some insects, including Colorado potato beetles and tomato hornworms, are slow enough and large enough to pick by hand. Remove them from the garden area or drown them in soapy water. Many weeds are easy to pull and remove from the landscape.

- Wash or rinse pests off the plants. A forceful spray of water can dislodge pests such as aphids or spider mites from plant stems or foliage. Plants must be sturdy enough to withstand the blast of water. Spraying with water may have to be repeated if the pests return.

- Use extreme temperatures. Cover an area with clear plastic to increase soil temperatures enough to kill weeds and weed seeds. Pour boiling water on weeds to kill them.

- Vacuum small insects. Small pests such as thrips, white flies, crawling insects, and insect eggs can easily be vacuumed from plants, although this method is used more often to remove pests from inside structures. Some vacuums are battery operated, with disposable sticky cartridges that contain trapped insects.

Biological Control is the use of natural enemies to manage pests. Organisms used in biological control are available through mail-order and online catalogs. Unfortunately, the release of these organisms doesn't guarantee pest control, especially when using predatory insects. Predatory insects may fly, walk, or crawl away without significantly reducing the pest problem. In addition, beneficial insects, such as praying mantids, may eat each other. Rather than purchasing predators, improve habitat for existing native predators and beneficial organisms. In reality, predators are slow reproducers, while pests often multiply quickly. The considerable lag time in control when using biological methods may make the purchase of predators an inefficient use of time and money.

- **Pathogens,** sometimes called microbials, are bacteria, protozoa, viruses, fungi, and nematodes that cause disease in pests. Most are very specific to the pest that they

Figure 11. The catalpa sphinx caterpillar is a destructive, defoliating pest of ornamentals. Female parasitoid wasps lay their eggs on the larvae of the catalpa sphinx, which later hatch and feed on the caterpillar. Wasps pupate in small white cocoons outside the caterpillar, from which they soon emerge as adults. The infected catalpa sphinx caterpillar will not survive to adulthood.

Figure 12. Lady beetles are one of several predators that feed on aphids. The various sizes of aphids represent various stages of incomplete metamorphosis.

infect and are virtually harmless to nontarget species. For example, a bacterium called *Bacillus thuringiensis* (Bt) is commonly used to control caterpillars, and more recently, larvae of mosquitos and Japanese beetles. When eaten, Bt produces toxic protein crystals that cause the gut walls of susceptible insects to burst, or may cause paralysis of the gut.

- **Parasites** are organisms that live and feed off of hosts. They may harm the health of a host pest but typically won't kill it. A **parasitoid** is a type of parasite that kills the host pest, usually an insect. One example is the braconid wasp that lays eggs on tomato hornworm caterpillars. The eggs hatch, and the larvae feed on the caterpillar from the inside out. They later pupate through the exoskeleton of the caterpillar and then emerge as adults *(Figure 11)*.

- **Predators** pursue and kill prey. Lady beetles, green lacewings, and praying mantids are examples of predators that eat insects such as aphids *(Figure 12)*. Predators aren't necessarily insects; spiders, birds, bats, and toads are beneficial predators as they eat many insect pests.

Organisms that provide biological control may be present in the yard. When controlling pests, no matter which methods are used — cultural, biological, mechanical, or chemical — consider their effects on beneficial organisms and try to protect those organisms. Gardeners can use a number of methods to encourage beneficial organisms, including pollinators and biological control agents.

- Reduce or eliminate pesticide use.

- Adjust the timing of pesticide applications to promote beneficial organisms.

- Learn to distinguish beneficial organisms from pests.

- Use plants near the garden that attract natural enemies, such as flowering plants to provide pollen and nectar, or grasses and trees for shelter or shade.

- Leave small populations of pest species so that beneficial organisms feeding on them can survive.

Chemical control is the use of any pesticide to control pest populations. Over time, new types of synthetic chemical controls have been developed that only kill specific types of pests and are less harmful or even harmless to people and other nontarget organisms. Some of the newer pesticides also break down rapidly and do not persist in the environment or contaminate fish and other animals. Common pesticides used in home landscapes include:

- **Fungicides** prevent or control fungal diseases.

- **Rodenticides** control rats, mice, and other rodents.

- **Insecticides** prevent or control insects.

- **Herbicides** prevent or control weeds.

- **Acaricides** control spiders and mites.

- **Molluscicides** control slugs and snails.

- **Piscicides** control unwanted fish.

Besides being categorized by the target pest, chemical controls can be categorized by their active ingredients — the chemicals in the pesticides that kill, control, or repel the pest. Some of these categories overlap.

- **Inorganic chemicals** are derived from naturally occurring minerals or molecules and do not contain carbon in their chemical structure. The earliest insecticides and fungicides were mineral-based and included inorganic chemicals, such as arsenic and mercury, which are no longer used because of their high toxicity to nontarget organisms. Copper and sulfur are still commonly used for insect and disease control on many plants.

- **Synthetic chemicals** are manufactured. Scientists call these organic chemicals because they contain both carbon and hydrogen in their chemical structures. Organic gardeners, however, usually do not use these products because they are manufactured and don't occur naturally. Most common turf, landscape, and garden pesticides are synthetic, including Roundup® (glyphosate), Sevin® (carbaryl), and Banner® (propiconazole). Synthetic chemicals vary greatly in their toxicity to target and nontarget pests, as well as how long they remain active.

Botanicals are naturally occurring nonmanufactured materials derived from plants that provide pesticidal activity. They typically cost more than synthetic pesticides. They also degrade more quickly, so they require increased applications for pest control. The most common botanicals are neem and pyrethrins. While many people consider botanicals to be safe, they have a wide range of toxicity and hazards.

- **Insecticidal oils** are made from plants (so could be considered botanicals) or from petroleum products. They work by blocking insect breathing pores (spiracles) and cause insects to suffocate, or by penetrating the membrane of insect eggs, causing a water imbalance. Insecticidal oils, such as capsaicin oil from peppers and garlic oil, also are used to repel some insect pests and wildlife. Neem oil, extracted from neem seeds, acts as an insect growth regulator that kills insects by inhibiting molting or shedding of the exoskeleton. Various petroleum and mineral oils are used to control sooty mold, aphids, mites, thrips, and scale. Some may damage plants if applied during periods of high temperature. Always test insecticidal oils on a few plant leaves before applying them on many plants as some oils are toxic to plants.

- **Insecticidal soaps** break down soft cuticle tissues and destroy cell membranes of soft-bodied insects. Some people use solutions of water and dish soap to control insects. These also should be tested before use as some soaps contain perfumes and other additives that could be toxic to plants.

Many people categorize inorganics, botanicals, insecticidal oils, and insecticidal soaps as organic or natural chemical controls. Often, an organic pesticide is considered to be "found in nature" or "not synthetic," and organic produce is assumed to be free of manufactured pesticides. In December of 2000, the U.S. Department of Agriculture issued the National Standards on Organic Agricultural Production and Handling, which include a list of "allowed synthetic and prohibited nonsynthetic substances." It is very difficult to define organic pesticides or natural pesticides. Inorganic or botanical pesticides should not automatically be considered the safest to use, nor should synthetic pesticides be considered the most dangerous. All chemical controls should be used carefully according to label directions.

Those who follow the principles of IPM use chemical controls only when other methods have failed, and choose the least hazardous yet most effective chemical control. The extension publication *Pesticide Safety for Gardeners* tells how to determine the hazards of pesticides, and how to use them with the least risk of harming people, pets and other nontarget organisms, and the environment.

Step 6. Evaluate the IPM program. A number of questions need to be answered to evaluate each year's IPM program. The answers to these questions will help prepare for next year's pests. Was the insect, disease, or weed problem a significant one? Were the control actions taken necessary or would the problem have gotten better without any intervention? Did the control actions solve the insect, disease, or weed problem? Could the insect, disease, or weed problem be managed better next time? Is more knowledge needed to make a better treatment decision in the future?

Summary

IPM is an effective and environmentally sensitive approach to pest management and control that takes advantage of all appropriate options, including cultural, mechanical, biological, and chemical control.

To be most successful:

- get to know the plants in the landscape;
- monitor and record information on pests and damage;
- identify pests and understand their biology;
- determine thresholds;
- use a variety of control methods; and
- evaluate the results.

Keep in mind the impact that any control option will have on nontarget organisms and sites, including people, pets, wildlife, and the environment.

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