



A Cornell Cooperative Extension Publication



PART I

PEST MANAGEMENT

Around the Home



Cultural Methods

Miscellaneous Bulletin S74



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Every effort has been made to provide correct, complete, and up-to-date pest management information for New York State. Changes in pesticide regulations occur constantly, and human errors are still possible. These guidelines are not a substitute for pesticide labeling. Read the label before applying any pesticide.

Trade names used herein are for convenience only. No endorsement of products is intended, nor is criticism of unnamed products implied.

Table 1. Helpful weights and measures

American Fluid Measure

80 drops = 1 teaspoon (tsp.)

3 teaspoons = 1 tablespoon (Tbsp.)

2 tablespoons = 1 fluid ounce (fl. oz.)

8 fluid ounces = 1 cup (c.)

2 cups = 1 pint (pt.)

2 pints = 1 quart (qt.)

4 quarts = 1 gallon (gal.)

American Dry Measure

3 teaspoons = 1 tablespoon (Tbsp.)

16 tablespoons = 1 cup (c.)

2 cups = 1 pint (pt.)

2 pints = 1 quart (qt.)

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INTRODUCTION

WHAT IS IPM?

Integrated pest management (IPM) is a systematic approach to managing pests that focuses on long-term prevention or suppression with minimal impact on human health, the environment, and nontarget organisms. IPM incorporates all reasonable measures to prevent pest problems by properly identifying pests; monitoring population dynamics; and using cultural, physical, biological, or chemical pest population control methods to reduce pests to acceptable levels.

Although the home environment can contain a huge array of organisms, only a very small percentage of these would be classified as pests. Pollinators, decomposers, natural enemies of pests, and many others whose function is unknown live in harmony. The goal is to manage a pest population without upsetting the natural balance of organisms or harming ourselves or the environment.

The first step in an integrated pest management program is to understand which organisms are pests and what damage they are likely to cause. Once the pest has been identified and the potential damage assessed, a creative, effective, and commonsense management approach can be undertaken. IPM focuses on the prevention of pests and the use of control measures that are most effective and present the least risk to people and the environment when pest problems arise.

This bulletin promotes the use of an integrated approach to managing the pests that infest our food, homes, and surroundings. Whether you do the pest management work yourself or contract to have the service done, it is wise to know the management procedures. An integrated program uses all pest management resources available. It does not necessarily eliminate all pests but attempts to limit the damage to acceptable levels. Practicing pest management does not eliminate the use of all pesticides but promotes their judicious use when

and where needed. Using pesticides as a last resort and choosing those that are least toxic makes sense.

When plants are diseased or injured by insects or when pests are found in the house, *avoid panic*. Assess the severity of the problem and identify its cause (a few ants in the kitchen does not constitute an infestation). If you do not know what the pest is, try to have it identified. Once the pest has been identified, attempt to learn more about it. Many sources of information about plant problems, including insects, diseases, and other pests, are available. Your local Cooperative Extension office may have fact sheets about common pests. Local libraries often have a good selection of books about gardening topics, including insects, plant diseases, and other pests. Many gardening and housekeeping books and articles in newspapers, newsletters, and magazines address pest problems.

Important things to learn about the pest problem include the time pest activity occurs, the number of generations occurring each year, and the first symptoms and signs of activity. You should also know how pest populations can be *monitored* and whether certain pest population levels can be tolerated before a damage *threshold* is reached. Doing nothing is one option. Allowing the damage to occur and letting nature take its course may lead to decisions about what plant material you want to grow in the future. Natural enemies may also come in and reduce pest pressure.

A good pest management program includes a record-keeping system. Monitoring or scouting for pest presence and damage is a fundamental practice in IPM. Visual monitoring as well as the use of various types of traps or detection devices are used. The data collected will help you decide what to do. Such a system might be organized according to plants in the yard, the pests appearing on them, or the places that pests occur. Include information on what

you did or did not do to manage the pest and what the outcome was. It may prove helpful to draw a map of the yard showing trees, shrubs, garden, and lawn areas. Include other important features and label the plants. Record significant events such as construction, lightning strikes, chemical spills, and occurrences of pests and natural enemies. Such a record, kept over the years, will provide an accurate picture of events that occur in your yard, garden, or house. This information should be valuable in the future if the pest problems recur.

A good pest management program also considers ways to prevent future outbreaks:

Appropriate plant selections.

Selection of plants that resist or tolerate pests should be a first choice. Consider whether natural enemies can be conserved or if you can make augmentative releases to keep the pest in check. Cultural sanitation practices such as removing garden debris during and at the end of the growing season may remove harborage for many pests.

Assuring plant health. Keeping plants growing vigorously may enable them to withstand some pest attacks and resist weed problems.

Mechanical methods. Tightening window screens and filling holes into the house with caulk may help prevent a future household pest problem. For example, a troublesome disease on an annual plant could be prevented the following year by planting a resistant variety, or you might consider changing to low-maintenance landscaping. If we change our attitudes and work with our yards rather than fighting them, pest management may become easier.

Benefits of home IPM:

- Reduces the need for pesticides by using several pest management methods
- Balances proper and minimal use of chemical pesticides with the need to manage pests

- Helps protect the environment from excessive and unnecessary pesticide applications
- Fosters sound structures and healthy plants. Well-maintained homes and lawns better withstand damage from insects, weeds, and other pests.

Although we have listed several pest management techniques in Part I, new ones become available regularly. Continue to read about the latest pest management devices.

Part II, Pesticide Guidelines, complements Part I. It offers specific, detailed information on pesticide pest management methods.

1 DIAGNOSIS AND IDENTIFICATION OF PLANT DISORDERS

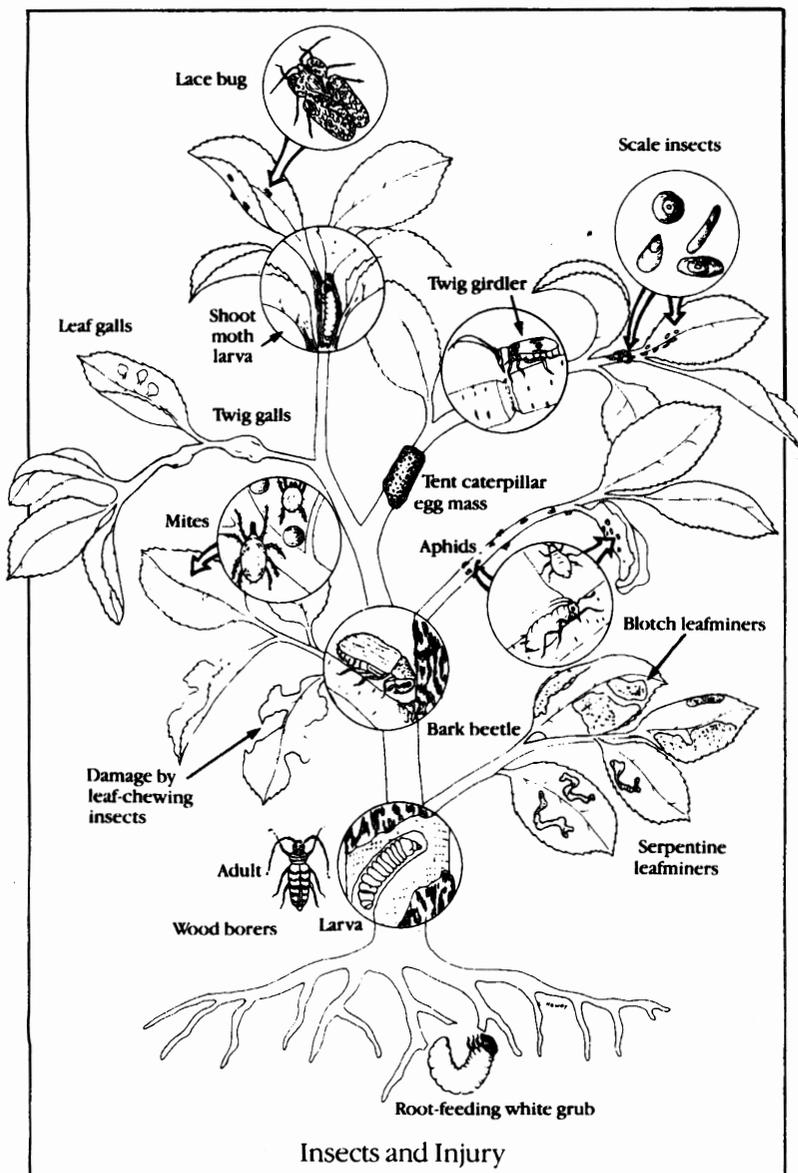
Diagnosis is the process of recognizing a disorder from its symptoms and signs whether the disorder is caused by something in the physical environment, an infectious organism (pathogen), or an insect. The diagnostic process should include looking at

the entire plant as well as its separate parts, carefully analyzing the observations, and attempting to understand or explain why a disorder has occurred.

Symptoms on plants include leaf spots, blights, wilt, yellows, galls, leaf mines, and skeletonized leaves. The same symptoms may be caused by different organisms or abnormalities in the physical environment and thus may require different management practices. A sign of a pathogen might be the white powdery fungus growth that occurs on leaves infected with powdery mildew. A sign of an insect infestation might be the presence of scale insects on twigs or leaves (see

illustration on this page).

Diagnosis is an often complicated process that involves broad horticultural knowledge as well as patience and sleuthing. It is usually difficult to explain why one plant in a hedge declines or dies while the others appear healthy. The history of a plant and its treatment, intentional or otherwise, may reveal the answer to a diagnostic problem. Diagnosis may also be simple, especially if the cause produces indisputable symptoms or has recognizable signs. Finding an insect (the sign) chewing on a leaf in a characteristic pattern (the symptom) can result in a positive diagnosis.



Ways Insects Injure Plants

Chewing. Devouring, notching, or mining leaves; eating wood, bark, roots, stems, fruit, seeds. *Symptoms:* ragged leaves, holes in wood and bark or fruit and seed, serpentine mines or blotches, wilted or dead plants, presence of "worms."

Sucking. Removing sap and cell contents and injecting toxins into plant. *Symptoms:* usually off-color, misshapen foliage and fruit.

Vectors of diseases. Carrying diseases from plant to plant, e.g., elm bark beetles are vectors of Dutch elm disease, various aphids are vectors of certain viral diseases. *Symptoms:* wilt; dwarf, off-color foliage.

Excretions. Honeydew deposits lead to the growth of sooty mold, and the leaves cannot manufacture food. A weakened plant is the result. *Symptoms:* sooty black leaves, twigs, branches, and fruit.

Gall formation. Forming galls on leaves, twigs, buds, and roots. Galls disfigure plants, and twig galls often cause serious injury.

Oviposition scars. Forming scars on stems, twigs, bark, or fruit. *Symptoms:* scarring, splitting, breaking of stems and twigs, misshapen and sometimes infested fruit.

Injection of toxic substances. *Symptoms:* scorch, hopper burn.

Examples of insect injury to plants are shown at left.

Identifying pests can be as easy as recognizing a dandelion from a picture. Generally speaking, however, the smaller the offending organism, the more difficult it is to identify. This is the case for many plant diseases. Occasionally the cause of a disorder is synonymous with the symptom. For example, mined leaves of a birch mean birch leafminer; scab lesions on apple mean apple scab. If an animal is chewing on a leaf, a degree of identification is necessary before any management practice can be suggested. To know that it is a caterpillar may be adequate for making a pest management decision, but determining the kind of caterpillar is a job for a specialist. Likewise, many infectious microorganisms can be confirmed only by laboratory tests.

What can the home gardener do when confronted with diagnosis and identification problems? An experi-

enced neighborhood gardener may be a source of reliable information. Local expertise can be valuable. Nursery operators and garden supply dealers may be able to provide significant help. If an arboretum or botanical garden is within reasonable distance, the specialist there may be of help. Many Cooperative Extension offices employ experienced horticulturists and have additional diagnostic resources available through New York State's land-grant university system.

If precise identification or accurate confirmation of a disorder is required, a suitable example or specimen must be taken or sent to a diagnostic laboratory or a consultant. For plant identification or disease diagnosis, collect specimens that are dry. Place fresh leaves between layers of dry paper towels, sandwich this between stiff cardboard, then enclose it all in an envelope. If the leaves are diseased, send ones that represent a range of symptoms. Freshly cut branches arrive in best shape when the cut end is wrapped in a moist paper towel and enclosed in a plastic bag fastened above the paper towel. Be sure to

punch a few holes in the plastic bag.

If insects are to be mailed, be sure they are dead. Collect adult insects in a small container and place them in a freezer for a few days to kill them. Add some paper toweling to help dry the insects, and package them in a crushproof container for shipping. Enclose at least five specimens and indicate the kind of plant they are feeding on and where they are found, especially if they are household pests. Preserve immature or soft-bodied insects by dropping them in boiling water for a few seconds and then placing them in rubbing alcohol. Whether submitting a plant or insect, always include detailed information about the infestation, the history of the plant, and the disorder.

Remember, a plant can fail for many reasons—insects and diseases are only two possibilities. Other causes include unsuitable moisture conditions, air and water pollution, unfavorable soil pH, winter freezing or drying injury, poor cultural techniques, and incorrect plant choice for the location. Be sure of the cause before you decide on a pest management strategy.

Ways Infectious Diseases Injure Plants

Destroying or injuring leaves. Examples: brown patch disease of turf, early blight, anthracnose. *Symptoms:* black, brown, red, or yellow spots on leaves; dead leaves; leaves that drop off earlier than normal.

Interfering with or blocking water conduction inside stems. Examples: Dutch elm disease, Verticillium wilt. *Symptoms:* yellow, wilted, or brown leaves; dark brown streaks inside the stem.

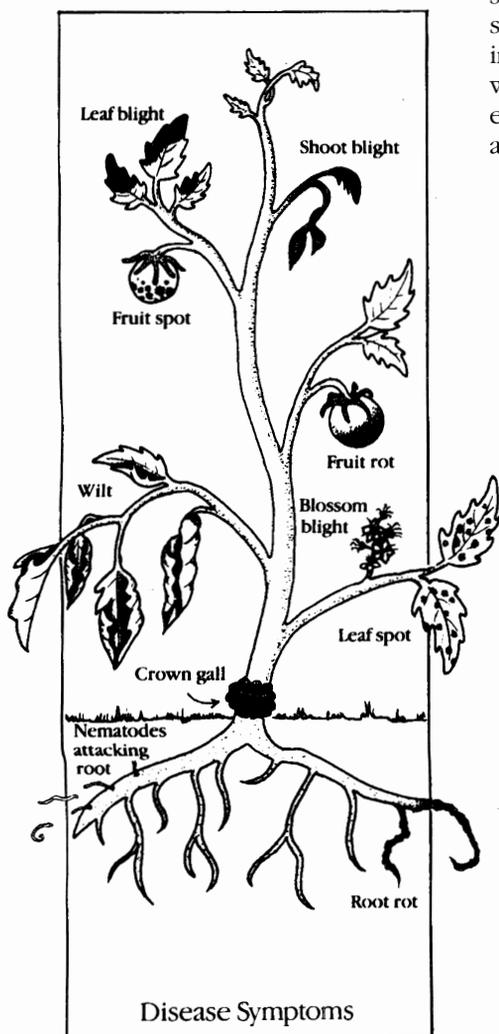
Destroying or injuring roots. Examples: Pythium root rot, club root, root knot nematode. *Symptoms:* black or brown roots, galls on roots, stunting of the plant, yellow or brown leaves.

Destroying or injuring flowers, fruit, or food products. Examples: fire blight, apple scab, potato scab. *Symptoms:* dead flowers, black or brown spots on flowers or produce.

Destroying or injuring stems or shoots. Examples: Diplodia tip blight, Botrytis blight, Nectria canker. *Symptoms:* dead shoots or stems; cankered areas on branches, brown, shriveled, clinging leaves; brown inner bark.

Disrupting normal cellular organization (gall-forming diseases). Examples: crown gall, root knot nematode. *Symptoms:* unusual growths on flowers, leaves, twigs, or roots.

Symptoms of injury to plants from infectious diseases are shown at left.



2 PEST MANAGEMENT OPTIONS FOR HOME AND GARDEN

Always make sure that the pest in question has been correctly identified as described in Chapter 1. In addition, determine whether the pest problem is severe enough to warrant treatment. Then examine the many alternatives for pest management.

CULTURAL CONTROLS

Pests can often be managed using sanitation, crop rotation, weed control, prevention of injury, appropriate variety selection, resistant varieties, site preparation, and soil sterilization.

Sanitation

Cleanliness in and around the home is an excellent way to manage pests. Many infestations can be avoided by keeping cupboards clean; the house free of lint, hair, and food particles; and the yard and garden area free of litter and plant debris. Well-pruned, recommended varieties of plants are less likely to develop problems. Diseased or infested plants can be trimmed or removed. Weeds can be pulled or hoed and discarded.

Crop Rotation

Planting the same crop (or related crops) in the same place year after year enables some insects and pathogens to build up and can result in depletion of nutrients. Rotating crops—changing their location on a regular basis—helps fight pest buildup and depletion of soil nutrients.

Weed Control

Keep weeds under control by roguing out young ones by hand. Weeds compete with plants for water and nutrients and can also harbor diseases and insects.

Prevention of Injury

Wounding plants with lawn mowers, string trimmers, or dull pruning tools

invites secondary invaders. Many pathogens infect plants through wounded tissue.

Variety Selection

Purchase only healthy, disease- and insect-free transplants, plants, and nursery stock from a reputable supplier. Shop early in the season for the best selection. Choose recommended varieties for your area and, if possible, ones that are resistant to local pests.

Resistant Varieties

Resistant plants are those that repel pests or do not sustain them. Some varieties are tolerant of pests and will yield a good harvest in spite of pest infestation. Although few home and garden plants are bred for insect resistance, many are bred for resistance to certain diseases. Disease-resistant varieties are listed in this bulletin (see commonly used codes in box, page 6), in seed catalogs, and on seed package labels. Your Cooperative Extension office or a reliable nursery can recommend species and cultivars of trees and shrubs resistant to specific diseases.

Site Preparation

Plant at the recommended time and follow recommended procedures for soil preparation (including proper pH and organic matter content), size of hole for transplanting, and proper spacing and light requirements for plants being considered. Unfavorable environmental conditions may stress plants and make them more susceptible to pest attack. Delayed planting may enable some plants to avoid attack by certain pests. Do not plant in a monoculture (large groups of the same plants together) but mix up the plantings in a garden or yard to lessen the chance of total destruction of a particular crop or plant. Thin stands or seedlings to proper spacing, allowing for more vigorous growth.

Soil Sterilization

Sterilized soil or soilless mixes are recommended for potted and container plants in and around homes and for germination of seedlings. Sterilized

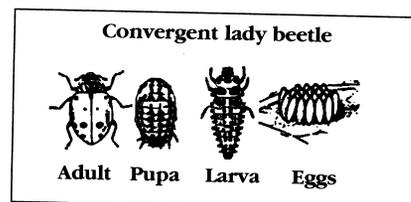
soil is free of weed seeds, plant-parasitic nematodes, insects, mites, and disease-causing organisms. Most important is the absence of organisms that can cause damping-off of seedlings and root rot and vascular wilt of potted plants. All of these diseases can ultimately kill infected plants. Sterilized soil can be purchased from greenhouses, nurseries, and garden stores. Soilless or peat-lite mixes, formulated with peat moss and vermiculite or perlite, are generally considered sterile.

Although it is not highly recommended, garden soil can also be used. Mix the soil with equal parts of sand, vermiculite, or perlite. Then sterilize this mixture by placing it in a shallow pan and baking it in a preheated oven for one hour at 200° F. The soil must remain at 160° F for at least 30 minutes. The sterilizing operation may give off a strong odor, which may linger in the oven.

NATURAL ENEMIES—BIOLOGICAL CONTROL

Most insect and mite populations are held in check by a complex of natural enemies, including predators, parasites, and diseases. A primary concern in choosing a particular pest management program is to conserve *natural enemies* that are already present or to attract those that are nearby. To attract and maintain beneficial species some of their prey must be present. Otherwise the beneficial species will leave or their numbers will dwindle from a lack of food. Herbs with abundant nectar and long flowering periods are attractive to beneficial insects that visit them for nectar, a food source. Limited and careful use of recommended pesticides, applied only when needed and with precision, will help conserve beneficial insects.

Many horticultural merchandisers now advertise predators, such as lady-



DISEASE RESISTANCE OR TOLERANCE CODES

A	anthracnose resistant or tolerant
AFR	anthracnose and Fusarium wilt resistant
AL	angular leaf spot resistant or tolerant
ALSR	angular leaf spot resistant
AR	anthracnose resistant
AT	anthracnose tolerant
BR	black rot tolerant
BWMS	bacterial wilt moderately susceptible
BWR	bacterial wilt resistant
BV-1	bean common mosaic virus (type strain) resistant or tolerant
BV-2	bean yellow mosaic virus resistant or tolerant
DM	downy mildew resistant or tolerant
DMR	downy mildew resistant
EV	enation virus resistant or tolerant
F	Fusarium wilt resistant or tolerant
FR	Fusarium wilt resistant
FT	Fusarium wilt tolerant
LBR	leaf blight resistant
MDMR	maize dwarf mosaic virus resistant
MMR	mildew and mosaic resistant
MR	mosaic resistant
MT	partial mosaic resistance or mosaic tolerant
N	root knot nematode resistant or tolerant
NY-15	bean common virus (NY-15 strain) resistant or tolerant
PM	powdery mildew resistant or tolerant
PMR	powdery mildew resistant
R	rust resistant or tolerant
RR	rust resistant
RSR	red stele resistant
SmR	smut resistant
SMR	scab and mosaic resistant
SR	scab resistant
SWI	Stewart's wilt intermediate resistant
SWR	Stewart's wilt resistant
TBR	tipburn resistant
V	Verticillium wilt resistant or tolerant
VF	Verticillium and Fusarium wilt resistant
VFN	Verticillium, Fusarium, and nematode resistant
VR	Verticillium wilt resistant
YR	yellows resistant or tolerant



Praying mantis

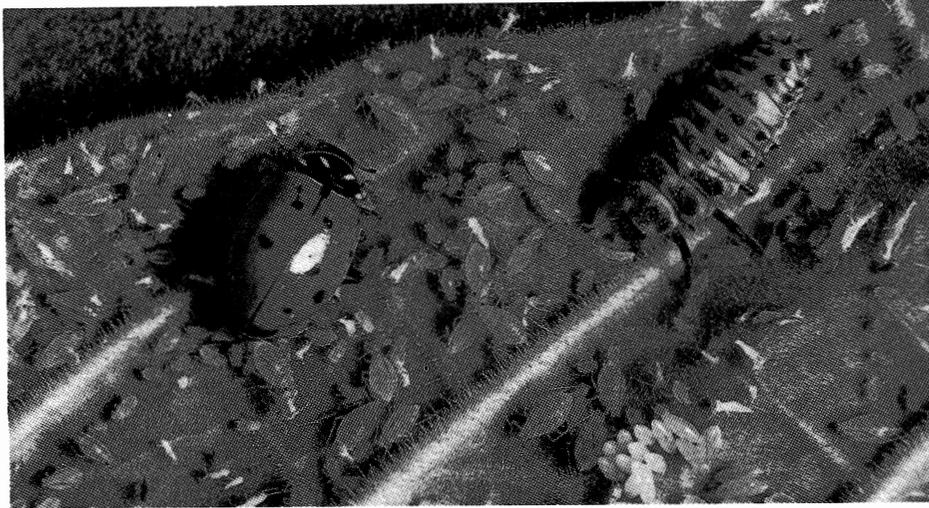
bugs, praying mantids, and green lacewings, for augmentative releases as nature's way of controlling pest species. Several parasitoids are also available. Some of the predators need careful handling and will eat only certain kinds of insects.

The common green lacewing is an often-used natural enemy of many different aphids, mites, caterpillars, and moth and butterfly eggs that occur in both farm and garden. Natural populations may be sufficient to provide good control, but if you decide to augment natural populations with purchased insects, you should know that the predator larvae feed for only about three weeks before becoming adults. You may need to make additional releases during the growing season if pest populations have not been sufficiently reduced by the first release.



The purchase of praying mantids alone for use as biological control agents around the house and garden may not give adequate results. Although they do feed on other insects, they do not discriminate between pests and beneficial insects. Ladybugs obtained in the spring usually have been collected during their winter hibernation and, unless given special treatment, will soon fly away from the release site.

Insect parasitoids differ from predators in that they grow and develop within their insect host. Parasitoids may be almost the same size as their hosts and their development kills the host. Some are readily available to home gardeners. Care and understanding of the biological systems determines their success or failure. A tiny parasitic wasp, *Encarsia formosa*,



Ladybug and larva feeding on aphids

is available for control of whiteflies in greenhouses. Success depends on temperature. In the case of *Encarsia*, temperatures of 70° F or above are needed for parasitoids to survive and reproduce. For commercial growers multiple releases (usually three at two-week intervals) are recommended. Tiny wasps, usually *Trichogramma* sp. (insect egg parasitoids), are available, but multiple releases are usually necessary.



Minute trichogramma wasp on insect egg



Small braconid wasp stinging an aphid

Mite predators (often other species of mites) are also available for use in homes or greenhouses and for use in fruit orchards. Use for pests of ornamentals is being investigated. Choose the one that best meets the temperature and humidity conditions in your growing area.

Achieving success with natural enemies takes time, and you should have realistic expectations. Using parasitoids and predators is a good alternative to pesticides in some situations. Commercial fruit growers are now successfully using predatory mites to control European red mite in apple orchards. Naturally occurring benefi-

cial insects should be encouraged and conserved. If you use pesticides, choose those that are selective and least damaging to natural enemies.

PESTICIDES

Pesticides may be the choice in certain instances using an IPM approach to pest management. The Environmental Protection Agency defines a pesticide as “**any substance or mixture of substances intended to prevent, destroy, or mitigate any insects, rodents, nematodes, fungi, or weeds, or other forms of life declared to be pests and any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant.**”

This definition includes biorational and chemical pesticides. Biorational pesticides include biochemical products (pheromones, hormones, and enzymes) and microbial products (viruses, bacteria, protozoa, nematodes, and fungi). In turn, the microbials consist of two groups: products whose active ingredients occur in nature and those whose active ingredients are genetically engineered. Chemical pesticides are chemicals, of either natural or synthetic origin, that kill or protect against pests—insects, weeds, plant pathogens, rodents, and other kinds of animal and plant life.

Pesticides differ in their effectiveness on the pest species and may also differ in their effects on natural ene-

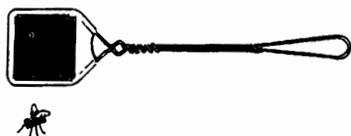
mies. The “softer pesticides” have less effect on natural enemy populations.

Additional information on pesticides and pesticide guidelines is found in Part II of this publication.

FURTHER READING

- Integrated Pest Management Around the House and Garden*. November 1999. BCERF Fact Sheet 31. Cornell University, Ithaca, N.Y.
- Reducing Pesticide Exposure in the Home and Garden*. October 1999. BCERF Fact Sheet 4 (revised). Cornell University, Ithaca, N.Y.
- Resources for Information on the Health Effects of Pesticides and Responding to Pesticide Poisonings*. September 1999. BCERF Fact Sheet 32. Cornell University, Ithaca, N.Y.

3 TOOLS FOR CULTURAL PEST MANAGEMENT



INDOOR TOOLS

Sanitation is one of the key ways to manage pests indoors without the use of pesticides. Make cleanup a habit. A routine time set aside for cleanup every day can make the job easier. Preventing unnecessary clutter, especially around entryways, can do much to prevent certain pests from gaining entry into the home. Many insects and household pests like to stay in dark places and lay eggs in warm, dark, undisturbed areas. Vacuuming or sweeping regularly, including under furniture, around baseboards, in furnace air ducts, closets, food storage areas, and pet resting areas, will discourage pest populations from building up. Regularly cleaning areas where wall and ceiling meet, especially in corners, will also help remove spiders and discourage web building. If you vacuum up insects or spiders, empty the vacuum bag so that pests do not climb out while in the storage closet. Storing food in tightly closed insect- and rodent-proof containers is a good way to help prevent pests.

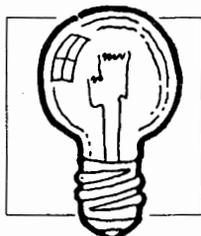
Food spills should be cleaned up quickly. They are easy to remove with detergent and water if not allowed to harden. Wet mops and sponges are useful for cleaning up many spills. Avoid letting mildew grow on shower curtains, wall surfaces, and around windows. Washing surfaces with warm, soapy water; wiping with a disinfectant; and reducing humidity by using fans or dehumidifiers can help. Insects such as booklice feed on microscopic molds and mildew, and if the proper climatic conditions exist, populations will increase very rapidly. Removing food

and perspiration stains from fabric can also make it less palatable to insects such as clothes moths and carpet beetles.

A flyswatter is a wonderful device for taking care of occasional pests in the home. Sticky tapes are also available to collect insects that land on them and, although they may not be a pleasant addition to the dining room, they may be useful in a porch or pantry or even an entryway. Be sure to place them high enough so people will not come in contact with the sticky paper. They should be replaced when they become filled with insects.

Window screening keeps out many insects. Be sure screens fit snugly and are in good condition. Close doors when entering or leaving. Many insects are able to sneak into a house in the few minutes a door is left ajar.

Outdoor lighting can attract many insects to the vicinity of the house.



Switching to a yellow "bug light" bulb will sometimes reduce the numbers attracted. These bulbs may be especially useful if you live near a body of water

where large numbers of aquatic insects emerge at certain times during the summer.

See Part II, Pesticide Guidelines, for information on pesticide application equipment.

OUTDOOR MECHANICAL AND PHYSICAL TOOLS

Handpicking and destroying is a method of pest management in which you become the "tool." Removing infested plant parts and insects can be effective for certain pests. Removing weeds and crop refuse eliminates sources of plant pathogens.

Spades, hoes, tillers, and so forth are useful tools. Spading or cultivating the soil uproots weeds, buries disease organisms, and exposes insects to birds, other predators, and adverse weather condi-



tions. Fruit trees grown without weed competition show marked increases in growth and vigor.

Many pruning tools are available. Be sure to choose the proper size tool for the job. Pole pruners are useful for tree branches that are too high to reach otherwise. Hand clippers are useful for smaller trees and shrubs. Be sure to follow all safety precau-

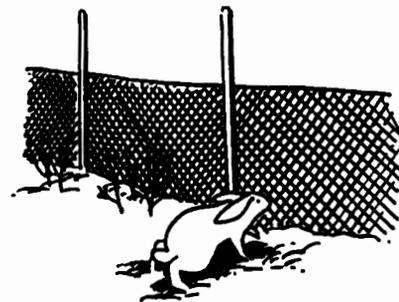


pruning tools

tions when using any tool. Prune properly so tree wounds heal quickly.

For plant pathogens, disinfect pruning tools between cuts.

Various fencing designs are useful for keeping animals out of gardens or off plantings. Plant guards may keep rodents from girdling trees, and some may also prevent insects such as borers from laying eggs on tree trunks. Row covers of many types are available (see Chapter 12, "Vegetable Pest Management") and many block pests from the crop or planting. Netting is especially useful for keeping birds out



Adequate fencing

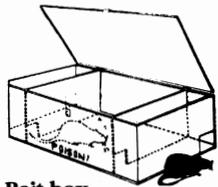
of fruit plantings and also prevents deer damage to ornamental shrubs.

Sticky barriers are sometimes used on tree trunks to prevent crawling insects from reaching the foliage, and mechanical devices (such as burlap bands) can provide places for insects to hide so they can be collected and destroyed easily. Spraying water from a hose can dislodge aphids and spider mites from some plants.

Numerous mulching materials are available (see Chapter 14, "Weed Management"). Weed competition is a major determinant of whether young plants will survive and grow vigorously. Light-reflective mulches such as aluminum foil can keep aphids at bay.

Traps

Various traps continue to be useful in pest management. Sticky traps (e.g., flypaper and roach traps) may be useful indoors to catch pests and monitor pest activity. Mechanical traps for rodents, including snapback mouse and rat traps and live traps, provide a quick way to remove pests without



Bait box

poison baits. Live traps are also available for wildlife. In New York State, however, it is illegal to possess or transport captive wild animals without a special

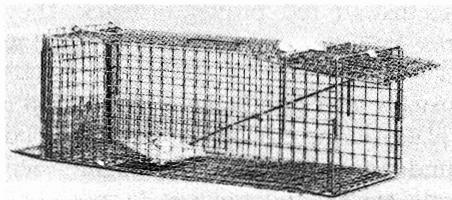
license. One option is to hire a licensed animal control specialist to capture and remove nuisance wildlife.

Sticky traps. Sticky traps are an option for home gardens. They may be purchased commercially or may be handmade. Traps for whiteflies, when properly placed, may reduce the population enough that no other control measures are necessary. It is important to put traps in the right place and to renew the sticky surface or discard them when full.

Lure traps. Home gardeners growing apples may be able to control apple maggot with the use of yellow sticky cards and red sphere traps. Lures may be used to enhance the attractiveness of traps to adult maggot flies. The traps are also excellent monitoring tools that are used to determine when apple maggots first appear and to help assess population



Pheromone trap



Live animal trap



Snap-back trap

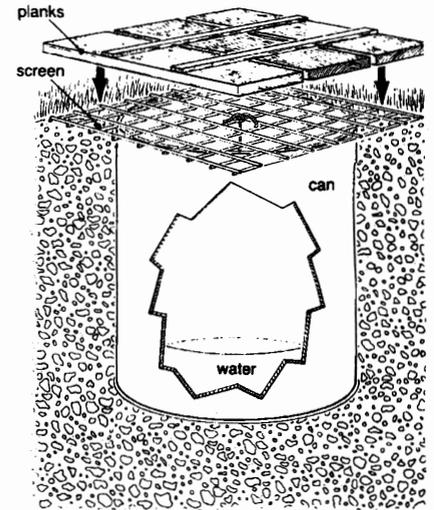
levels, thus aiding managerial decisions. Similar traps are available for other fruit pests. White rectangular traps are useful in controlling tarnished plant bug in fruit trees before the flower petals open. They are also more effective than yellow traps for flea beetle control.

Lures include pheromones. Pheromone traps are basically sticky traps with a sex attractant for the pest species. These traps are excellent monitoring devices and have shown good results for control of certain species such as the codling moth. Gypsy moth traps, however, do not play a significant role in reducing the population and are best used only as a monitoring tool.

Japanese beetle traps have been available for many years. The traps use scented lures (floral scent and sex pheromone) to attract male and female beetles into a bag or canister.

The traps may attract more beetles than they catch, however, so that, if used, the traps should be placed 25 to 50 feet away from the plants you want to protect.

Pitfall traps. Various pitfall traps can also be useful, especially for crawling pests. The well-known pie tin-beer traps for slugs are a good example. A small pan or tin is placed in the soil with its top flush with the soil surface and half filled with beer. Beer attracts slugs, which fall in and drown. A similar pitfall trap has been used to monitor black vine weevil populations in nurseries and home landscapes. Pest management consultants may use such traps in designing



Pitfall trap

a program for customers.

Other traps include boards placed in gardens to attract slugs and some insects. The undersides of the boards should be checked daily and the slugs removed and destroyed. Rolled-up newspapers make attractive hiding places for earwigs; again, check daily and remove and destroy insects.

Electric light traps. Electric light traps are sometimes useful for night-flying insects. Bluelight or blacklight traps are good monitoring tools but provide little protection for gardens or for people. Electrocuting traps kill many insects—beneficial as well as harmful species—but they also attract insects, not all of which find their way into the trap. These traps have not proven useful for mosquito or house fly control.



Mole trap

4 MANAGEMENT PRACTICES FOR HOUSEHOLD PESTS

Managing pests in homes can be a challenge. The first step is to determine what kind of pest(s) you have and the potential damage they can cause. Next you need to plan a strategy for managing them, choosing the best tactics for your situation. Non-chemical methods of pest management are often very effective. Good sanitation practices and general upkeep of the home can help prevent outbreaks.

Sealing openings that allow access to your home can do much to keep pest problems at bay. It often helps to seal openings around pipes, wires, doors, and windows using caulk or putty or to install tight-fitting screens and weather stripping. Insects often gain access from under the door, so check to see that the door sweep on

the bottom of exterior doors forms a tight seal.

Vacuum frequently to prevent accumulations of food crumbs and lint. If you are vacuuming up pests, empty the vacuum bag promptly. Keep food in sealed containers and do not let fruits and vegetables spoil. Dispose of infested foodstuffs. Keep garbage in closed containers and empty them on a regular basis, daily if possible. Do not let pet food sit out for long periods of time.

Moisture may encourage some household insects. Keep areas under sinks and cabinets, basements, and soil near foundations relatively dry.

Eliminate hiding places by removing clutter, sweeping out corners of garages and storage areas, repairing cracks, and filling in crevices in walls and floors. Dispose of paper bags or other items that might harbor pests.

Remove or trim vegetation close to the house and eliminate contact between wood and soil. Change exterior lighting to minimize attracting insects.

Store firewood and scrap lumber away from the house because they can provide a home for carpenter ants and other pests.

If you are having difficulty managing a household pest problem yourself, another option is to hire a pest management company, pest control operator (PCO), or exterminator. Look for a company that uses least toxic pest management practices. You will need to describe the pest problem and possibly collect and keep samples of pest insects. Indicate where and when the pests have been seen, what you have done to try to remedy the situation, and what the results have been. To be successful in managing the pest, it is important to follow all recommendations made by the pest management company, especially making repairs and maintaining the structure.

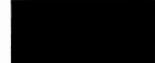
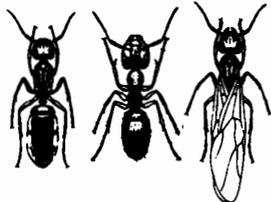
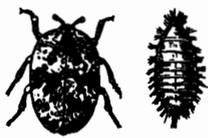
Specific nonchemical management practices for household pests are listed in Table 2. Pesticide guidelines are listed in Part II, Table 5.

Table 2. Annoying pests inside the home

<i>Insect</i>	<i>Biological notes and recommended cultural management</i>
<p>Ants</p>  <p>ACTUAL SIZE</p>	<p>Frequently attracted from outdoor colonies by greasy or sweet food. Keep food covered or refrigerated. Thoroughly clean areas where ants occur or gather. Search for routes of entry and seal with caulking compound. Ant traps containing baits of boric acid or other poisons attract pest to poison without need for applying poison throughout environment. Keep traps out of reach of children and pets. Newer baits offer ants a choice of protein food or sweet food. When using these baits and traps do not clean near area where baits are placed because chemical foraging trails can be erased, making traps and baits useless. Although useful for some species, traps do not work for all ants. Ants sometimes nest in wall voids. If problem persists, you may want to consult a PCO.* See also Carpenter ants.</p>
<p>Bark beetles</p>	<p>Small cylindrical beetles that are red, brown, or black. They enter homes in firewood. Keep firewood outdoors; bring in only what will be used within a few days.</p>
<p>Bedbugs</p>  <p>ACTUAL SIZE</p>	<p>Wingless insects that usually attack and take a blood meal at night. These pests remain hidden near sleeping place during daylight hours. Take beds apart and vacuum mattresses, especially around seams and tufts. Thoroughly vacuum bedstead and floor, concentrating on baseboards, cracks, and crevices. Dispose of vacuum bag contents before storing machines. Clean infested bedding before reuse. Do not treat bedding with any chemical; wash in hot water with detergent and place in hot dryer for 20 minutes to kill bedbugs. Repeat cleanup procedure periodically if bedbugs persist. Bedbugs may be introduced with used beds, bedding, and furniture. Check carefully before bringing into</p>

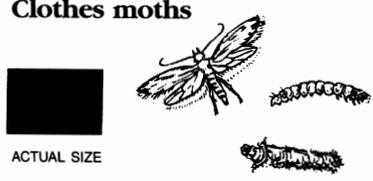
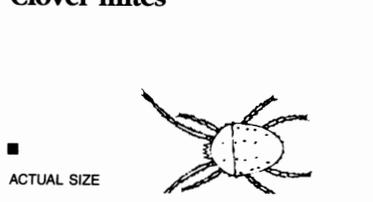
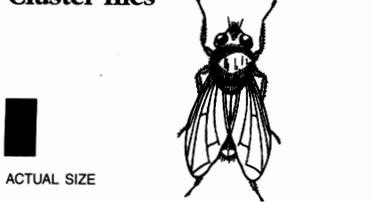
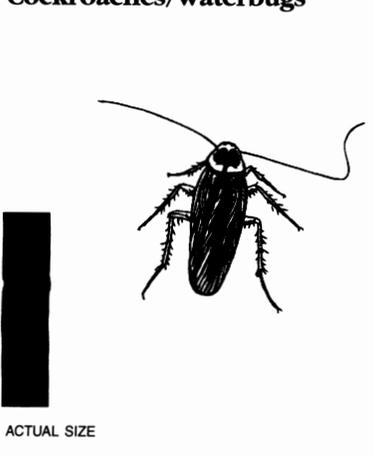
*PCO = pest control operator

Table 2. Annoying pests inside the home (continued)

Insect	Biological notes and recommended cultural management
Bedbugs (continued)	home. Bedbugs can sometimes be carried by bats. Eliminate bats from structure (see Table 7, Wildlife damage management methods).
Bird mites	Tiny, eight-legged critters that may bite people. They enter home from bird nests in attics, on windowsills, and in eaves by creeping or being blown through ventilators, windows, or other openings. Screen birds from common nesting areas on buildings. Wear rubber gloves to remove nests and clean up area. Avoid breathing "fecal dust." Remove nests. Clean infested surfaces with warm, soapy water to remove mites. Wash bedding in hot water with detergent or dry in hot clothes dryer for 20 minutes to kill mites.
Booklice/paperlice	Small, transparent insects about 1 mm in size that feed on sizing of paper stored at high humidities and warm temperatures. If possible, do not store books, paper, or cardboard in damp areas. Ventilate and dry infested areas using a fan to increase air circulation or possibly a dehumidifier.
  ACTUAL SIZE	
Boxelder bugs	Outdoor pests of boxelder that overwinter indoors. Damage occurs when smashed bugs stain fabric or paint. Locate and close or seal openings through which bugs enter. Vacuum or sweep up and destroy bugs.
  ACTUAL SIZE	
Carpenter ants	Structurally damaging pests that excavate galleries for nesting in wood. New infestations are nearly always associated with wet or moist wood, but infestation may continue after wood is dried. Moisture problems often occur around windows, chimneys, plumbing, and porches. Coarse sawdust is sometimes seen near nest site. For control, locate and eliminate ants in nest; a vacuum cleaner can be used. Eliminate causes of wet wood. Fix leaks in roof and pipes; clean out clogged rain gutters; remove stumps, logs, and wood-piles from areas adjacent to buildings. If moisture problems continue, ants will return. Insecticides (see Part II) can provide temporary relief. Baits may eliminate a colony, but if conditions are conducive, more may move in at a later time.
  ACTUAL SIZE	
Carpenter bees	Bees bore holes for nesting in face boards of porches, windows, and door frames. See Chapter 6, "Management of Annoying Pests Outside the Home."
  ACTUAL SIZE	
Carpet beetles	Black or variegated beetles that are often first observed on windowsills in spring. Larvae are covered with golden brown hair and are found infesting wool, hair, feathers, leather, mounted "trophy" animals, and dead insects. They may be associated with mice if there is a mouse problem. Moths are tan to gold-colored and small (3–4 mm long). Vacuum wool lint and pet hair from between floorboards; remove accumulations of dead insects from attic areas. Store only clean woolens. Dry-cleaning kills carpet beetles. Protect uninfested goods by storing in tight containers. When heavy infestation occurs, you may need to consult a PCO.*
  ACTUAL SIZE	

*PCO = pest control operator

Table 2. Annoying pests inside the home (continued)

Insect	Biological notes and recommended cultural management
<p>Clothes moths</p> 	<p>Larvae feed on fabric containing wool or other animal fibers. Silken feeding tubes or hard protective cases are often found on fabrics. Brush infested articles and air them outdoors in a sunny location and/or dry-clean them. Vacuum wool lint from between floorboards. Protect uninfested goods by storing in tight containers. Cedar-lined chests and closets are effective in repelling moths but should be lightly sanded to release oils after a year or two of use. For a severe infestation, you may need to consult a PCO.*</p>
<p>Clover mites</p> 	<p>Eight-legged, reddish or brownish creatures, smaller than a pinhead. In late fall, mites seek protected overwintering sites either under shingles or siding; thousands may enter homes from nearby vegetation. Some may enter when activity begins in spring. They are a nuisance pest and, if crushed, leave a red stain that is especially noticeable on white surfaces. Caulk or weather-strip openings where mites enter; keep windows closed tightly during fall migration. Clean areas where mites accumulate with warm soapy water or use a vacuum cleaner, remembering to empty bag after use.</p>
<p>Cluster flies</p> 	<p>Large (6 mm long), awkward, noisy flies that blunder about lights and windows, colliding with many objects, often dropping to floor to lie on their backs and spin noisily until exhausted. Vacuuming up flies is helpful. When done vacuuming, place vacuum bag into plastic bag and into freezer or outdoors if cold enough. Do not store vacuum in closet without disposing of flies or blocking their exit. Flyswatters are useful especially if only a few flies are present. Close entry routes when possible. Dispose of dead flies to avoid infestations of carpet beetles and other insects that feed on dead insects.</p>
<p>Cockroaches/waterbugs</p> 	<p>Broad, flat insects with six long legs; adults range from 1/2 to 2 inches in length, depending on species. They hide during the day in warm, moist, dark places and come out to forage at night. They prefer starchy or sugary foods but will feed on milk, soda, beer, cheese, meat, pastry, grain products, bookbindings, and dead insects. When disturbed, cockroaches run rapidly for hiding places. Because they are often attracted by food residue and garbage, wash dishes promptly, seal food containers tightly, clean residue on jars and surfaces, and mop up spills. Repair water leaks and sweating pipes. Remove clutter, which provides hiding places. In apartments it may be helpful to place window screening over heating ducts, grating, and other places where roaches can enter. Caulk to repair holes and cracks in walls. Use sticky traps to aid in control. Place them in corners and in areas where roaches have been observed. Baits and insect growth regulators (IGRs) are also available in some traps. To find hiding places, enter a dark room quietly, turn on the lights, and watch where roaches run. They typically hide beneath kitchen sinks and under and behind appliances. Shed skin and feces from cockroaches may cause asthma and/or allergic reaction in children.</p>
<p>Crickets</p> 	<p>Usually enter dwellings in late summer when vegetation becomes scarce or after crops have been harvested. A few species are commonly found in basements. Remove accumulations of moist debris from basement and ground-floor entrances and windows. Be sure doors fit well and are kept closed during autumn months. Keep storage areas clean and dry. Sticky roach traps may help catch crickets.</p>
<p>Drain flies</p>	<p>See Moth flies.</p>

*PCO = pest control operator

Table 2. Annoying pests inside the home (continued)

Insect	Biological notes and recommended cultural management
<p>Drosophila (vinegar flies, pomace flies, or fruit flies)</p>  <p>ACTUAL SIZE</p>	<p>Small flies (approx. 2 mm long) with red-orange eyes, seen around kitchen. Larvae feed on spoiled fruits and vegetables. Discard garbage regularly; discard all spoiled fruit. Be patient—flies may be present for a few days after food source is removed. Home remedy**: a trap can be constructed by using a canning jar equipped with a paper funnel. Bits of banana sprinkled with yeast make a good bait that will last about two weeks. Larvae in trap can be killed with hot tap water at least 150° F. Commercial traps using vinegars or other baits may be purchased.</p>
<p>Earwigs</p>  <p>ACTUAL SIZE</p>	<p>Light to dark brown insects (12- to 20-mm long); most distinctive feature is pair of forceps on tip of abdomen. Generally feed as scavengers on dead insects and rotting plant material. Keep entrance areas dry and clear of decaying vegetation; keep storage areas of clear damp newspapers or carpets. Repair damaged window screens and doors. Inspect home-grown vegetables or flowers before bringing into kitchen. Vacuum or sweep up insects and dispose of outdoors. Also see Table 6, Annoying pests outside the home.</p>
<p>Elm leaf beetles</p>  <p>ACTUAL SIZE</p>	<p>Outdoor pests of elm that overwinter indoors, usually in attics, unused chimneys, and barns. Repair and caulk openings near elms. Remove by hand with vacuum or by sweeping up; dispose of beetles outdoors. Open attic windows to allow release in spring.</p>
<p>Fleas</p>  <p>ACTUAL SIZE</p>	<p>Small, brown insects that jump and bite humans as well as animals. Usually noticed when a pet is removed from the home for a period of time. Flea larvae feed on detritus, shed skin, hair from animals, and feces of adult fleas. Check pet bedding often in warm weather; populations are often concentrated where pets sleep. Limit area used as bedding. Thoroughly clean hair, bits of food, and debris from animals' sleeping quarters. Thoroughly clean or discard animal bedding and treat animal. Flea-comb pets regularly. For questions about flea control on pets, check with your veterinarian. Vacuuming daily can help control fleas. See Table 6 for outdoor treatment. For persistent problems you may want to consult a PCO.*</p>
<p>Flour and grain beetles</p>  <p>ACTUAL SIZE</p>	<p>Usually discovered when an infested package is opened or when small brown beetles appear in kitchen near containers of stored grain products, pet food, or birdseed. Discard infested food; clean shelves and cupboards thoroughly. Remove food and dishes; vacuum and scrub storage areas. Store products in tightly sealed containers and inspect stored food regularly or refrigerate or keep in freezer. Keep fresh supplies in tightly closed jars or cans. Keep birdseed and pet foods in tightly closed containers.</p>
<p>Flour and grain moths</p>  <p>ACTUAL SIZE</p>	<p>Indian meal moth is most commonly encountered species. Larvae feed in flour and grain products, dried fruits, nuts, and dried pet and fish food. When mature, they can crawl up walls to ceiling to pupate. Destroy infested food. Clean shelves and cupboards thoroughly; remove food and dishes, remembering to clean upper corners as well. If larvae have climbed walls, also carefully clean area where walls and ceiling meet. Keep fresh supplies in tightly closed jars or cans or keep birdseed and pet foods in closed containers. Be alert for flying moths. Use flyswatter as needed. Pheromone traps can be helpful in catching remaining stray male moths.</p>
<p>Fruit flies</p>	<p>See Drosophila.</p>

*PCO = pest control operator

**Home remedies are *not* endorsements by Cornell University of any product or procedure, and they are not recommendations for use, either express or implied. Neither Cornell University nor its employees or agents is responsible for any injury or damage to person or property arising from the use of this information.

continued

Table 2. Annoying pests inside the home (continued)

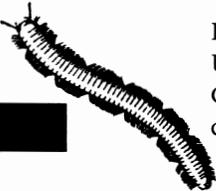
Insect	Biological notes and recommended cultural management
Fungus gnats  ACTUAL SIZE	 Small, dark-colored flies often seen in home around flowerpots. Larvae feed on decaying organic matter. When houseplants are source, remove and discard growing media; repot in sterile media (see Table 3, Common insects on houseplants). Clean up spills of organic matter indoors.
Grain mites/cheese mites/mold mites	Pale grayish-white, microscopic ($1/50$ in., 0.5 mm) arthropods with numerous long hairs on legs and back. Occasionally increase so rapidly that grain, grain products, dried fruits, and dried vegetable matter seem alive with them. Feed primarily on microscopic mold or fungi that may grow on stored food. Clean up accumulated food debris, vacuum cabinet shelves, cracks, and crevices; avoid prolonged storage of susceptible material; and do not store in warm, humid areas.
Ground beetles	Medium-sized beetle that may accidentally get into houses. Size and color may vary with species. Beneficial outdoors where they feed on other insects. Remove with broom and dustpan or vacuum. Discard outdoors.
Head lice  ACTUAL SIZE	 Infestations are transmitted by children in school or by other people in close contact. Do not share combs, brushes, hats, or scarves. To kill eggs, dry-clean clothing or wash in hot water and detergent at 125° F for 10 minutes. Treatment of person must be recommended by a physician.
House dust mites/Dust mites	Microscopic, insect-like critters found in houses and other buildings that people frequent. Often found on mattresses, carpets, and upholstered furniture; they thrive in warm, moist conditions. Feed on shed scales from human skin and other similar debris. Waste particles from mites may cause reactions in allergic people. Consult your allergist or medical doctor. Avoid overhumidification and keep dust to a minimum. Dust-proof covers may be recommended in certain situations as may removal of carpeting, curtains, and venetian blinds.
House flies  ACTUAL SIZE	 Gray-bodied fly (5–6 mm long) with checkered abdomen, black stripes on thorax, and slightly hairy appearance. Summertime pests that breed in manure, garbage, and fermenting crop wastes. Dangerous principally because may carry and spread disease germs that may be in material where they breed, feed, or walk. Use screens, keep food covered, and dispose of garbage frequently. Spread piles of grass clippings or other rich decaying organic matter to dry. Clean up pet dung in yard because it can become a breeding site. Avoid using doors for entering or exiting house downwind of food odors where flies have accumulated. A flyswatter is very useful for dealing with flies indoors. Sticky flypaper is useful in some situations. Home electric light traps not very effective.
Indian meal moth	See Flour and grain moths.
Lady beetles, ladybugs	Small to medium-sized, hemispherical beetles; usually reddish-orange with black spots, 8–10 mm long, two-toned wing color—outer portion brick red, inner part gray to yellow-gray. May become nuisance pests when overwintering in homes and buildings. Heat in homes and buildings warms them and they become active crawling on walls and ceilings or moving to sunny windows. Vacuum or sweep up gently and deposit outside. Seal entrances as appropriate with caulk, screening, etc.
Millipedes  ACTUAL SIZE	 Elongate, segmented, wormlike creatures with two pairs of legs per body segment. Usually found in moist areas such as basements, near patio doors, or in garages. Generally feed outdoors on decaying vegetable matter. Sweep up and dispose of outdoors. See Table 6, Annoying pests outside the home.

Table 2. Annoying pests inside the home (continued)

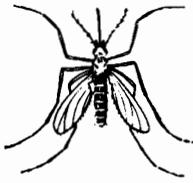
Insect

Biological notes and recommended cultural management

Mosquitoes



ACTUAL SIZE



Biting insects that suck blood from people and animals. Larvae are aquatic. Keep doors and windows tightly screened and closed to prevent entry into home. Drain tin cans, old tires, and other water containers to reduce breeding sites. Keep house gutters free of moist leaves and debris. Community control may be necessary. If problem persists even in winter, check for indoor water sources that were not drained. Home electric light traps not very effective.

Moth flies (drain flies)



ACTUAL SIZE



Woolly, stout-bodied (up to 2 mm long) flies commonly seen around drains or in sinks; breed in grease and soap scum in drains. To clean up breeding sites scrape pipes with wire brush to remove slime in which moths may lay eggs. Use drain-cleaning product, caustic followed by commercial bleach to rinse one day later. *Note: never combine chlorine and ammonia because deadly fumes are produced.* Use flyswatter to kill adults.

Old house borer

Often damages new buildings. Prefers sapwood of pine and spruce. Larvae may be heard rasping or "ticking" while feeding in wood. Professional control often necessary.

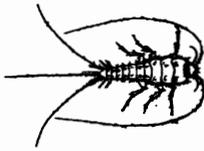
Powderpost beetles

Powder or very fine sawdust on or beneath wood and small round or oval shot holes in wood surfaces indicate infestation. Well-finished, painted, or other finished dry wood is seldom attacked. Keep wood dry; keep moisture and humidity levels low wherever possible. Reinfestation rarely occurs in dry, seasoned wood. Repaint or refinish surfaces as necessary.

Silverfish and firebrats



ACTUAL SIZE



Shiny, silver grey, or mottled gray insects with three long, tail-like structures on hind end. Silverfish prefer moisture; firebrats prefer warm, dry areas such as furnace room in apartments. Active at night and hide during the day. Eat foods and other materials high in protein or starch (e.g., glue or paste, bookbindings, starch in clothing, and rayon fabrics.) Remove residues of high-protein foods. Store valued books, papers, or clothing in dry areas or in sealed heavy plastic bags. Seal cracks and crevices. Special caulking is available for sealing around pipes.

Sowbugs and pillbugs



ACTUAL SIZE

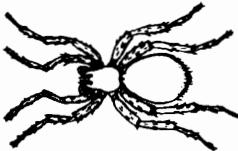


Fat, dark gray, hard-shelled crustaceans, usually found in moist areas around the home but occasionally enter basements and garages. Roll into a ball when disturbed. Sowbugs are lighter in color, softer shelled, and do not roll into complete ball like pillbugs do. Repair cracks in foundation; caulk around basement windows and other entryways. Keep ground-level entrance areas free of rotting leaves and debris; trim shrubs or other planting to promote air circulation and drying. Control same as for millipedes.

Spiders



ACTUAL SIZE



Keep spiders out with proper screening and weather stripping. Remove indoor webs and spiders with broom; discard outdoors. This may take some time, but eventually spiders will be controlled. Control insects on which spiders feed.

Springtails



ACTUAL SIZE



Minute insects, abundant in most soils, with forked appendage on abdomen that enables them to jump. Feed on algae, fungi, and decayed vegetable matter. Occasionally found in damp places such as kitchen, basements, bathrooms, around drains, and in soil of potted plants. Keep areas dry where possible; correct moisture problems. Repot houseplants in sterile soil (see Soil Sterilization in Chapter 2).

Strawberry root weevil and black vine weevil



ACTUAL SIZE



Plant-feeding insects that occasionally invade buildings, becoming nuisances. They do not cause damage indoors. Block entry routes with caulking material.

continued

Table 2. Annoying pests inside the home (continued)

<i>Insect</i>	<i>Biological notes and recommended cultural management</i>
<p>Subterranean termites</p>  <p>ACTUAL SIZE</p>	<p>Social insects that live almost entirely inside wood on which they feed. If wood is not in contact with ground, termites can build mud tunnels over obstacles to reach it. Use termite-resistant construction methods. Refer to USDA Bulletin 64, <i>Subterranean Termites</i>. When infestation is discovered, professional help is usually needed. Effective insecticides are restricted for application by certified applicators only.</p>
<p>Ticks</p>  <p>ACTUAL SIZE</p>	<p>Usually enter home on dog or other pet. After feeding, they drop off host and hide in cracks and crevices, under rugs, and behind baseboards. Can transmit serious diseases to both humans and animals. Control treatment should begin with pet; check with your local veterinarian.</p>
<p>Wasps and hornets</p>  <p>ACTUAL SIZE</p>	<p>Stinging insects that often build nests near occupied dwellings and may become nuisance or danger to those allergic to their sting. Social insects—many individuals live in same nest. Check periodically around outside of house during early summer to spot and treat small nests. By August and September, wasp populations are at their highest and individuals sometimes enter houses accidentally. Use screens in buildings and screen ventilators to attics. If one or two enter, use a flyswatter. Use caution—insects indoors may be irritated and can sting. Also see Chapter 6, "Management of Annoying Pests Outside the Home."</p>
<p>Western conifer seed bug</p>	<p>Leaf-footed bug that overwinters in homes and buildings and becomes active when warmed up. Screen attic and wall vents to prevent entry. Caulk gaps and holes in siding; tighten loose-fitting screens, windows, and doors to prevent entry. Remove by hand (wear gloves) or with vacuum cleaner.</p>

FURTHER READING

Common Sense Pest Control Quarterly. Bio-Integral Resource Center newsletter. P.O. Box 7414, Berkeley, Calif. 94707.

Controlling Household Pests. USDA Home and Garden Bulletin 96, Washington, D.C. 31 pp.

Hansen, M. 1993. *Pest Control for Home and Garden*. Consumer Reports Books, Yonkers, N.Y. 372 pp.

IPM Practitioner Bio-Integral Resource Center newsletter. P.O. Box 7414, Berkeley, Calif. 94707.

Mallis, A. 1982. *Handbook of Pest Control*. 6th ed. Franzak & Foster Co., Cleveland, Ohio. 1101 pp.

Managing the Cluster Fly. Insect and Plant Disease Diagnostic Laboratory fact sheet. Insect and Plant Disease Diagnostic Laboratory, Dept. of Entomology, Comstock Hall, Cornell University, Ithaca, N.Y. 2 pp.

Olkowski, W., S. Daar, and H. Olkowski. 1991. *Common Sense Pest Control: Least Toxic Solutions for Your Home, Garden, Pets, and Community*. Taunton Press, Newtown, Conn. 715 pp.

Subterranean Termites. USDA Home and Garden Bulletin 64, Washington, D.C. 30 pp.

Fact sheets on specific pests may be available. Check with your local Cooperative Extension office.

5 HOUSEPLANT PEST MANAGEMENT

Various methods are available for managing pests of houseplants. The pest, number of plants infested, size of the planting, and inclination of the owner will determine what methods are best. Table 5 lists appropriate cultural pest management practices for houseplants.

When new plants are brought home, isolate them from other houseplants. It is also a good idea to inspect plants carefully and isolate those that are brought inside after vacationing outdoors for the summer. This quarantine period should last about one month. Monitor the newcomer for signs of insect populations or diseases that are not initially apparent. This avoids the spread of pests to healthy, established plants. Established plants that develop pest problems in the home should be isolated from others during treatment and until they regain health.

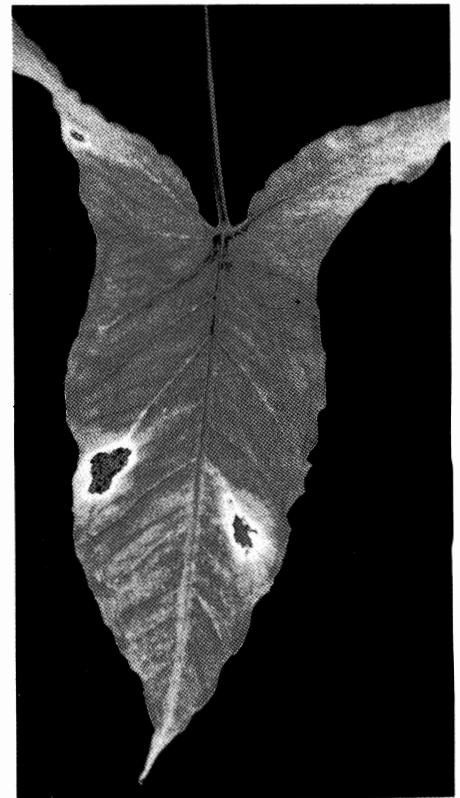
Always use sterilized soil potting mix to grow houseplants. Do not reuse potting media. Soil pests such as springtails, millipedes, nematodes,

and disease organisms can be present in garden soil. See Soil Sterilization in Chapter 2.

Houseplants are resistant to most fungal diseases of foliage as long as the leaves are kept dry. Powdery mildew is the notable exception; it can prosper in the home environment even if leaves are not splashed with water.

It is wise to throw out any plants with root and crown rots or other soil pests. It may be more economical to replace an infested plant or to make a cutting as soon as you spot the problem, rather than investing time and energy in fighting the pest. Soil fungi and insects are very difficult to manage. They spread from plant to plant by handling and in drainage water. Fungus gnats can vector diseases as they feed on roots and fungi, moving pathogens to healthy plants.

A general description of some common insects and diseases on houseplants and information on management follows. Although biological control agents may not be practical for one or two houseplants, they offer a practical alternative to those with home greenhouses. Remember that some pests will have to be maintained to keep a good biological control system working. Much exciting research is being done in biological control, and researchers and green-



Bacterial leaf spot of syngonium. Symptoms are similar on philodendron, pothos, and dieffenbachia

house managers are developing strategies for handling beneficial insects.

See Part II, Table 6, for pesticide guidelines.

Table 3. Common insects on houseplants

Insect	Description/Biology
Aphids 	Small, often pear-shaped, soft-bodied insects that use their long, slender mouthparts to pierce stem, leaves, and other tender plant parts to suck out plant fluids. Sticky appearance caused by honeydew, a sweet, sticky liquid that aphids and other sucking insects excrete. Sooty mold, a black fungus, may grow on honeydew. Available aphid predators include ladybugs and lacewings as well as the cecidomyid fly <i>Aphidoletes aphidimyza</i> .
Cyclamen mite	Very tiny, not readily visible to human eye. Feed on new growth, causing curling and distortion. Particularly difficult to control. Discarding infested plants is often best choice.
Fungus gnats 	Recently have become more of a pest problem with increasing use of soilless potting mixes. Adult flies are attracted to damp locations where fungi are likely to flourish. Larvae feed primarily on fungi but occasionally attack roots of growing plants and are especially destructive to young plants. Adult flies may also become a nuisance. Removing and discarding growing media and repotting in sterile media can help reduce pest numbers. Avoid keeping mixes too wet and prevent accumulations of stagnant water in pot saucers or other containers. To check for presence of fungus gnat larvae in potting mix, cut a small potato in half, place cut side down, and lightly press into mix.

continued

Table 3. Common insects on houseplants (continued)

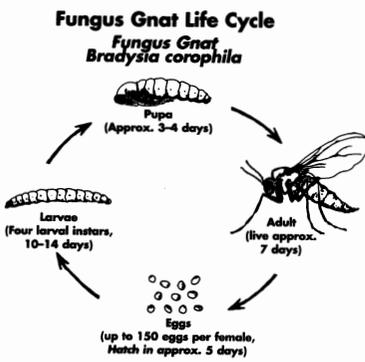
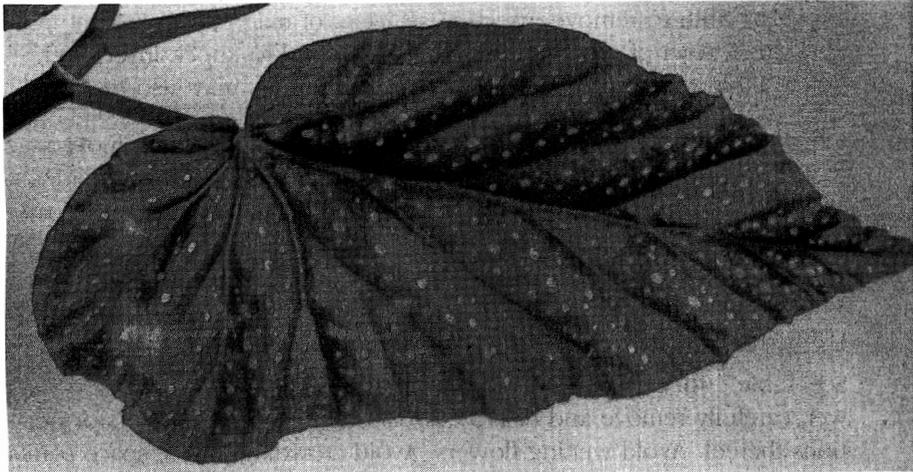
Insect	Description/Biology
<p>Fungus gnats (continued)</p>  <p>Fungus Gnat Life Cycle <i>Fungus Gnat</i> <i>Bradysia corophila</i></p>	<p>Leave for three to four days, then lift up and look for shiny white larvae with black heads. Larvae are attracted to moist potato. For adult monitoring and capture, yellow sticky cards can be used. Place card on rim of pot. Biological control of larvae can be achieved with a soil drench of the microbial pesticide <i>Bacillus thuringiensis</i> var. <i>israelensis</i> (Gnatrol) but since this product is only sold in gallon containers, you may find this costly. Commercial growers may also use predatory nematodes (<i>Steinernema</i> spp.) or the predatory mite <i>Hypoaspis miles</i>.</p>
<p>Mealybugs</p> 	<p>White, waxy, slow-moving, sucking insects often found on undersides of leaves or where branching occurs on plant. Mealybugs suck sap from plant parts and may exude honeydew. The predator ladybeetle, known as the mealybug destroyer (a tropical species), is available for biological control. It feeds on mealybugs and soft scales in greenhouses. Predator larvae mimic mealybugs so they are also covered with white, waxy filaments. Because the destroyer is a tropical species, it does not thrive at low temperatures.</p>
<p>Scales</p> 	<p>Scale insects are so unlike insects that many people do not recognize them as such. Insects are hidden under waxy or hard scale cover. Brown soft scale is common in greenhouses and on houseplants. Long, piercing mouthparts allow scales to suck juices from leaves, stems, twigs, branches, and trunks. Plant may decline and die. Honeydew (see Aphids) may be abundant. Crawlers are young insects that emerge from eggs and "crawl" to a feeding site; they are more sensitive to insecticidal treatment than other stages. Once crawler finds an acceptable site it settles down and begins to feed. Thereafter it molts to next stage and begins to secrete waxy or hard scalelike covering.</p>
<p>Spider mites</p> 	<p>Tiny eight-legged arthropods that are not insects but related to them. Visible with a hand lens on undersurface of leaves. Feed by inserting mouthparts into plant and sucking liquid contents, causing yellowish stippling at feeding sites and general plant decline. Webbing often seen when held up to sunlight. Mites may appear as tiny moving dots on webbing. Several predacious mites feed on spider mites. At least three are available commercially. It may be important to know what species of spider mite you have so as to choose the proper predator.</p>
<p>Thrips</p> 	<p>Tiny (less than 1/20 in.), often yellowish insects. Adults have long fringe of hair around wings. Cause damage by rasping leaf surface and drinking fluid that collects in injured areas. Leaves appear silvered or dried out. Brown or black scars (fecal matter and feeding scars) often seen on plant tissue. Two species of mites prey on thrips and are available commercially.</p>
<p>Whiteflies</p> 	<p>Adults are small, yellowish insects with dull, white wings. Immature whiteflies are oval and flattened, yellowish scalelike insects. Heavily infested plants send up a cloud of adults when disturbed. Some whiteflies transmit viruses that are devastating to some crop plants. Eggs are very tiny, laid on undersides of leaves. Crawlers hatch from eggs, move to feeding site, then become more sedentary. Honeydew may be present. The small wasp parasite, <i>Encarsia formosa</i>, is available for biological control. The combined use of sticky traps and <i>Encarsia</i> looks very promising.</p>

Table 4. Common diseases of houseplants

<i>Disease</i>	<i>Description</i>
Anthraxnose	Fungi that cause this disease produce necrotic spots with raised borders on stems, foliage, and fruit. Disease affects many different plants and can be caused by many different fungi. Dieback often occurs.
Botrytis blight (Gray mold)	Buds, flowers, fruit, twigs, leaves, and other plant parts may be affected. A gray felt envelops plant parts. Most common under wet, humid conditions. Stunting, dieback, and distortion may result.
Powdery mildew	Symptoms include a delicate web of white felt (mycelium) and colorless spores, which give a powdery effect. Mildew is usually present on upper sides of leaves but may also be seen on undersides. Dwarfing and stunting often occur.



Powdery mildew on angel wing begonia

Table 5. Houseplant pest management*

<i>Plant</i>	<i>Pest/Disease†</i>	<i>Cultural pest management practices</i>
African violet	Botrytis blight (Gray mold)	Use sterile potting mix. Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. Avoid wetting flowers. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings.
	Crown rot	Use sterile potting mix. Avoid overwatering or planting too deeply. Avoid wetting foliage if possible; water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Rogue plants: remove and destroy or discard entire infected plant and potting soil. Propagate by starting a cutting taken above affected area.
	Powdery mildew	See Table 4 for description. Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings.
	Ring spot	Do not splash cold water on leaves.
	Cyclamen mites	Discard infested plants.
	Mealybug	See Table 3 for description. Remove by hand. Wash plants with soapy water and soft brush or cloth to remove insects. Use 2 tsp. of mild dish

***Note:** The use of alcohol and washing with soapy water are home remedies. **Home remedies** are *not* endorsements by Cornell University of any product or procedure, and they are not recommendations for use, either express or implied. Neither Cornell University nor its employees or agents is responsible for any injury or damage to person or property arising from the use of this information.

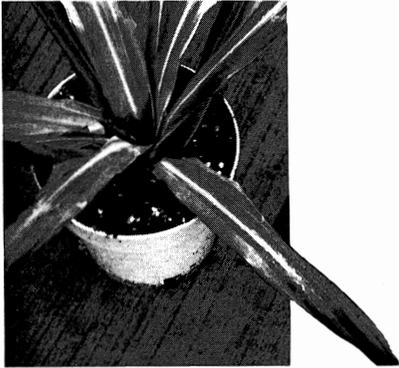
†See Tables 3 and 4 for a description of common pests and diseases.

continued

Table 5. Houseplant pest management (continued)

<i>Plant</i>	<i>Pest/Disease†</i>	<i>Cultural pest management practices</i>
African violet (continued)  Mealybug	Mealybug (continued)	detergent in 1 gal. water. Thoroughly wash undersides of leaves where pests may also reside. Remove mealybugs with tweezers or toothpick. Rubbing alcohol on a swab can also be used to remove insects. Make a swab by attaching a tuft of cotton to tip of a thin stick. Dip cotton end in rubbing alcohol, then touch insect and gently remove it. Do not spread alcohol on plant tissue because injury can occur.
	Root mealybug	No cultural controls available. Discard plant to avoid spreading.
Asparagus fern	Aphids  Aphid or plant louse	See Table 3 for description. Wash plants with soapy water and soft brush or cloth to remove insects. Use 2 tsp. of mild dish detergent in 1 gal. water. A jet of clean water can also be used to knock insects off. Thoroughly wash undersides of leaves where pests may also reside.
Begonia	Bacterial leaf spot (<i>Xanthomonas</i> sp.)	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Rogue severely infested plants: remove and destroy or discard entire infected plant and potting soil.
	Botrytis blight (Gray mold)	See Table 4 for description. Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. Avoid wetting flowers. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings.
	Powdery mildew	See African violet.
	Aphids	See Asparagus fern.
	Mealybug	See African violet.
 Whitefly	Whitefly	See Table 3 for description. Wash plants with soapy water and soft brush or cloth to remove insects. Use 2 tsp. of mild dish detergent in 1 gal. water. A jet of clean water can also be used to knock insects off. Thoroughly wash undersides of leaves where pests may also reside.
Christmas cactus	Fusarium crown rot	Avoid wetting foliage if possible. Water early in the day so the aboveground plant parts will dry as quickly as possible. Avoid overwatering. Propagate by starting a cutting taken above affected area. Use sterile potting mix.
Citrus	Scales	See Table 3 for description. Remove by hand. Wash plants with soapy water and soft brush or cloth to remove insects. Use 2 tsp. of mild dish detergent in 1 gal water. A jet of clean water can also be used to knock insects off. Thoroughly wash undersides of leaves where pests may also reside. Rubbing alcohol on a swab can be used to remove insects. Make swab by attaching a tuft of cotton to tip of a thin stick. Dip cotton end in rubbing alcohol, then touch insect and gently remove it. Do not spread alcohol on plant tissue because injury can occur.
 Spider mite	Spider mites	See Table 3 for description. Wash plants with soapy water and soft brush or cloth to remove mites. Use 2 tsp. of mild dish detergent in 1 gal. water. A jet of clean water can also be used to knock insects off. Thoroughly wash undersides of leaves where pests may also reside.
	Whitefly	Wash plant.

Table 5. Houseplant pest management (continued)

<i>Plant</i>	<i>Pest/Disease†</i>	<i>Cultural pest management practices</i>
Coleus	Mealybug	See African violet.
	Whitefly	See Begonia.
Croton	Mealybug	See African violet.
Cyclamen	Bacterial soft rot of corm	Use sterile potting mix. Plant corm shallowly. Rogue plants: remove and destroy or discard entire infected plant and potting soil.
	Wilt	Rogue plants: remove and destroy or discard entire infected plant and potting soil.
	Cyclamen mites	Discard infested plants.
Dieffenbachia	Bacterial leaf and stem rot (<i>Erwinia</i> sp.)	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Propagate by starting a cutting taken above affected area. Rogue plants: remove and destroy or discard entire infested plant and potting soil.
	Spider mites	See Citrus.
Dracaena	Leaf spots, whorl rot	Keep soil pH at 6–6.5; avoid fluoride (in fluoridated water, superphosphate, or perlite). Avoid wetting foliage and crowding plants. Never put water into whorl of plant.
	Mealybug	See African violet.
	Spider mites	See Citrus.
		
		<p>Dracaena whorl rot caused by the fungus <i>Fusarium</i></p>
False aralia	Scales	See Citrus.
	Spider mites	See Citrus.
		
	Spider mite	
Ferns	Anthraco-nose	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings.
	Scales	See Citrus.

continued

Table 5. Houseplant pest management (*continued*)

<i>Plant</i>	<i>Pest/Disease†</i>	<i>Cultural pest management practices</i>
Fuchsia	Botrytis blight	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings.
	Thielaviopsis root rot	Use growing medium with pH between 4.5 and 5.5.
	Mealybug	See African violet.
	Whitefly	Rogue plant: remove and destroy or discard entire infected plant and potting soil. Or wash plants with soapy water and soft brush or cloth to remove insects. Use 2 tsp. of mild dish detergent in 1 gal. water. A jet of clean water can also be used to knock insects off. Thoroughly wash undersides of leaves where pests may also reside.
Gardenia	Fungal leaf spot	Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Practice plant sanitation; when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof.
	Bud drop	Prevent water stress. Avoid high night temperature.
	Mealybug	See African violet.
	Scales	See Citrus.
	Spider mites	See Citrus.
	Whitefly	See Citrus.
Geranium	Bacterial blight (<i>Xanthomonas</i>)	Rogue.
	Bacterial leaf spot (<i>Acidovorax</i> or <i>Pseudomonas</i> spp.)	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Rogue severely infected plants: remove and destroy or discard entire infested plant and potting soil.
	Black leg (<i>Pythium</i> spp.)	Use well-drained, sterile potting mix; avoid overwatering. Do not fertilize.
	Botrytis blight (Gray mold)	Use sterile potting mix. Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. Avoid wetting flowers. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings.



Black leg, a root and stem rot disease of geranium

Table 5. Houseplant pest management (*continued*)

<i>Plant</i>	<i>Pest/Disease†</i>	<i>Cultural pest management practices</i>
Geranium (<i>continued</i>)	Oedema	Avoid overwatering.
 Caterpillar	Caterpillars	Remove caterpillars by hand and dispose of them; some are night feeders, so use a flashlight to locate pests at night.
	Spider mites	See Citrus.
	Whitefly	See Begonia.
Gloxinia	Leaf and stem rot	Use well-drained, sterile potting mix; avoid overwatering.
 Aphid	Aphids	Wash plants with soapy water and soft brush or cloth to remove insects. Use 2 tsp. of mild dish detergent in 1 gal. water. A jet of clean water can also be used to knock insects off. Thoroughly wash undersides of leaves where pests may also reside. Remove by hand. Remove aphids with tweezers or toothpick, or use rubbing alcohol on a swab to remove insects. Make a swab by attaching a tuft of cotton to tip of a thin stick. Dip cotton end in rubbing alcohol, then touch insect and gently remove it. Do not spread alcohol on plant tissue because injury can occur.
	Cyclamen mite	Discard infested plants.
	Mealybug	See African violet.
Grape ivy (<i>Cissus</i>)	Powdery mildew	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants in plantings.
Ivy (English)	Fungal leaf spot	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Verify diagnosis.
	Spider mites	See Citrus.
Jade plant	Powdery mildew	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings.
	Root rot	Use well-drained, sterile potting mix; avoid overwatering; increase lighting. Propagate by starting a cutting taken above affected area.
	Mealybug	Remove by hand. Wash plants with soapy water and soft brush or cloth to remove insects. Use 2 tsp. of mild dish detergent in 1 gal. water. A jet of clean water can be used to knock insects off. Thoroughly wash undersides of leaves where pests may also reside. Remove mealybugs with tweezers or toothpick. Rubbing alcohol on a swab can also be used to remove insects. Make a swab by attaching a tuft of cotton to tip of a thin stick. Dip cotton end in rubbing alcohol, then touch insect and gently remove it. Do not spread alcohol on plant tissue because injury can occur.

continued

Table 5. Houseplant pest management (*continued*)

<i>Plant</i>	<i>Pest/Disease†</i>	<i>Cultural pest management practices</i>
Palms  Mealybug	Leafspot or tipburn	May indicate low relative humidity, overfertilization, or other root injury. Check roots. Verify diagnosis. Accurate diagnosis is required before more specific treatment.
	Mealybug	See Jade plant.
	Scales	See Citrus.
	Spider mites	See Citrus.
Philodendron	Bacterial leaf spot (<i>Erwinia</i> sp.)	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Rogue severely infested plants: remove and destroy or discard entire infested plant and potting soil.
	Scale	Remove by hand. Wash plants with soapy water and soft brush or cloth to remove insects and spider mites. Use 2 tsp. of mild dish detergent in 1 gal. water. A jet of clean water can also be used to knock insects off. Thoroughly wash undersides of leaves where pests may also reside. Rubbing alcohol on a swab can also be used to remove insects. Make swab by attaching a tuft of cotton to tip of a thin stick. Dip cotton end in rubbing alcohol, then touch insect and gently remove it. Do not spread alcohol on plant tissue because injury can occur. Treat crawler stage (young insect that emerges from egg and “crawls” to a feeding site). Crawlers are more sensitive to insecticidal treatment than other stages are. Once crawler finds an acceptable site it settles down and begins to feed. Thereafter it molts to next stage and begins to secrete a waxy or hard scalelike covering.
Pittosporum	Spider mites	See Citrus.
Podocarpus	Spider mites	See Citrus.
Poinsettia  Whitefly	Root rot	Avoid overwatering or overfertilization. Use sterile potting mix. Rogue plants: remove and destroy or discard entire infested plant and potting soil.
	Whitefly	Wash plants with soapy water and soft brush or cloth to remove insects and spider mites. Use 2 tsp. of mild dish detergent in 1 gal. water. A jet of clean water can also be used to knock insects off. Thoroughly wash undersides of leaves where pests may also reside. Or rogue plant: remove and destroy or discard entire infested plant and potting soil to avoid spread to other houseplants.
Pothos	Bacterial leaf spot	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. Avoid wetting foliage if possible. Water early in the day so the aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Rogue severely infested plants: remove and destroy or discard entire infested plant and potting soil.

Table 5. Houseplant pest management (*continued*)

<i>Plant</i>	<i>Pest/Disease</i> [†]	<i>Cultural pest management practices</i>
Roses (miniature)	Botrytis blight (Gray mold)	Use sterile potting mix. Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. Avoid wetting flowers. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings.
	Powdery mildew	Often terminal for a mini-rose. Discard plant.
	Spider mites	See Citrus.
Rubber plant	Anthracnose	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid wounding leaves.
	Oedema	Avoid overwatering.
	Mealybug	See Jade plant.
	Scales	See Citrus.
Schefflera	Anthracnose	See Rubber plant.
	Scales	See Philodendron.
	Spider mites	See Citrus.
Weeping fig	Phomopsis canker and dieback	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. Avoid wounding. Increase lighting.
	Scales	See Citrus.

FURTHER READING

Chase, A. R. 1987. *Compendium of Ornamental Foliage Plant Diseases*. American Phytopathological Society, St. Paul, Minn. 114 pp.

Cole, C. L. 1994. *Insect and Mite Pests of African Violets*. African Violet Society of America (800-770-2872).

Common Sense Pest Control Quarterly. Bio-Integral Resource Center newsletter. P.O. Box 7414, Berkeley, Calif. 94707.

Fischer, C. C. 1978. *Growing African Violets*. Cornell Cooperative Extension Information Bulletin 135, Ithaca, N.Y. 17 pp.

Fischer, C. C., and R. T. Fox. 1984. *The Selection, Care and Use of Plants in the Home*. Cornell Cooperative Extension Information Bulletin 117, Ithaca, N.Y. 26 pp.

Fischer, C. C., and E. F. Schaufler. 1981. *Artificial Lighting for Decorative Plants*. Cooperative Extension Home-Grounds-Garden fact sheet 500.00, Ithaca, N.Y. 2 pp.

Horst, R. K., and P. E. Nelson. 1985. *Diseases of Geraniums*. Cornell Cooperative Extension Information Bulletin 201, Ithaca, N.Y. 33 pp.

IPM Practitioner. Bio-Integral Resource Center newsletter. P.O. Box 7414, Berkeley, Calif. 94707.

Powell, C. C., and R. Rossetti. 1992. *The Healthy Indoor Plant*. Rosewell Publishing, Box 2920, Columbus, Ohio 43216. 297 pp.

6 MANAGEMENT OF ANNOYING PESTS OUTSIDE THE HOME

Before deciding that control is needed, try to identify the critters occurring outdoors and learn what their habits are. Are the things you see really pests? We may need to change our perspective about seeing insects and other arthropods outdoors. Many are harmless or even beneficial in the outdoor environment. Spiders, for instance, feed on a large number of insects, and in some countries they are even brought into cropland to control insects. Outdoor lighting that attracts insects may also attract spiders that prey on them. Changing to yellow lights when insects are most active or turning off outside lights may help reduce the numbers found. Lights directly above a door attract insects; those placed away from the

door may still provide adequate lighting but will lessen the chance that insects will be carried in accidentally by people or pets whenever the door is opened.

Some of the insects encountered outdoors may occasionally invade the home. Weather can influence their population numbers and behavior. Very dry years may cause insects or other arthropods to move near foundations or garages because the foundation itself holds some moisture. Very moist years may drive them to higher ground to avoid drowning in water-soaked soils. In large numbers they can be an extreme nuisance, especially when they start to move up foundation walls and into garages.

Some small outdoor insects may fit through standard window screening. If insects are getting in, possibly attracted to light at night, it may be advisable to shut windows, use another light source, change to finer-mesh screening, or use lightproof window coverings.

Maintenance can help keep numbers of insects and arthropods low outside the home and may prevent them from getting indoors. Do not allow birds to build nests on the sides of buildings or adjacent to them. Mites that feed on the birds often get into houses from these nests when the young have fledged. Once inside they look for a warmblooded animal to feed on.

Tightening and repairing screening as needed can keep many pests out of homes. Altering the habitat near the house and foundation can do much to discourage insects and other arthropods from being there in the first place.

Harborage outdoors near the house foundation, doors, patios, or porches should be avoided wherever possible. To prevent future pest problems, clean up brush, accumulated dead leaves, and other debris; trim shrubbery or trees that touch the building; and carefully select plants and mulching materials.

Pesticide guidelines are found in

Table 6. Annoying pests outside the home

<i>Insect</i>	<i>Description and cultural management recommendations</i>
<p>Ants</p> 	<p>Beneficial because they help clean up the environment, feeding on a variety of substances, including dead insects and other animal matter, sweets, starches, and fats. Will enter houses in search of food but will leave if none is present. Caulking and other home repairs will help keep ants out. Locate and eliminate nesting sites. If needed, spot treat foraging trails and nests. Home remedy:* Boiling water poured on shallow nests may be effective.</p>
<p>Black flies</p> 	<p>Biting flies that are active during the daytime. When numerous, their irritation and annoyance can be unbearable. They breed in fast-moving streams and rivers. If possible, avoid being outdoors during black fly season. Wear protective clothing that the insects cannot bite through.</p>
<p>Boxelder bug</p> 	<p>A tree-feeding red and black bug that can be a nuisance pest around the home, usually in fall when seeking sheltered sites for overwintering. If openings are not available, bugs will not be able to enter homes to overwinter.</p>

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Table 6. Annoying pests outside the home (continued)

Insect

Description and cultural management recommendations

Carpenter bees



ACTUAL SIZE

Structural pests that bore holes for nesting in face boards of porches, windows, and door frames. Like other bees, carpenter bees are pollinators and are considered beneficial. Once nesting sites are established, the bees tend to return to the site year after year, preferring rough-cut untreated wood surfaces over painted or well-finished surfaces. Screen bees from nesting sites, especially in spring and early summer. Fill holes with putty and repaint as needed. Hanging trap boards may cause bees to use these instead of the wood of the house. Boards may gradually be moved away from house.

Chiggers



ACTUAL SIZE

Minute red to orange-yellow larval mites that bite people, causing intense itching. When entering known chigger-infested areas, wear long pants with bottoms tucked into socks or boots.

Clover mites



ACTUAL SIZE

See Table 2, Annoying pests inside the home. Establish a vegetation border 18–24 in. wide around foundation of house or building. Trim shrubs so they do not touch house.

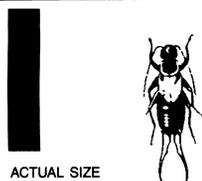
Crickets



ACTUAL SIZE

Feed on most vegetation and will also eat pet foods left outside or in basement. Often enter homes in late fall when outdoor food is scarce. Remove accumulations of moist debris from basement and ground-floor entrances and windows. Some crickets are attracted to light at night—switch to yellow bulbs. Be sure windows and doors are tightly sealed to prevent entry into buildings.

Earwigs



ACTUAL SIZE

Nuisance pests that are easily recognized by the “forceps” on hind end of body. Keep areas around entrances dry and clear of compost, debris, and decaying leaves; keep storage areas clear of damp newspapers or watersoaked carpets. Rolled newspaper can be used as a trap; remove and dispose of earwigs daily. In wet areas their feeding may damage some plants.

Fleas



ACTUAL SIZE

See Table 2, Annoying pests inside the home. Spot treat pet resting/sleeping areas. Remove and wash pet bedding regularly. Flea-comb pets regularly. Outdoor flea control is important to making indoor control successful. Cat fleas are carried by raccoons, possums, and other dogs or cats. Keeping these animals out of your yard (e.g., tight garbage can lids) will help you keep fleas off your pet.

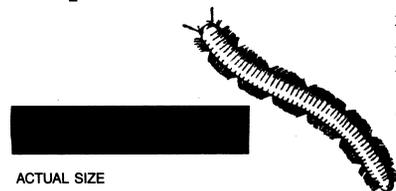
Flies



ACTUAL SIZE

Eliminate breeding areas: manure, garbage, piles of grass clippings, and other rich and decaying organic matter. Spread to dry. Sticky flypaper is useful in entryways if flies congregate there.

Millipedes

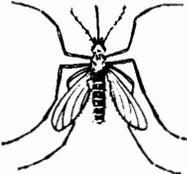


ACTUAL SIZE

See Table 2, Annoying pests inside the home. Keep ground-level entrance areas free of rotting leaves and debris; trim or remove shrubs to promote air circulation and drying near foundation. Sweep up and destroy millipedes daily. In very moist years large numbers of millipedes may move near foundations to escape excessive soil moisture, and control may be difficult.

continued

Table 6. Annoying pests outside the home (continued)

Insect	Description and cultural management recommendations
<p>Mosquitoes</p>  <p>ACTUAL SIZE</p>	<p>Empty or dispose of all receptacles that can hold stagnant water (including old tires) in which mosquitoes breed. Several useful repellent and repellent formulations are available. Check with your department of environmental conversation on legality before you apply anything to water.</p>
<p>Moss (on roofs)</p>	<p>A simple plant growth that thrives in damp, shaded locations. Usually found on north slopes of roofs and roots shaded by overhanging trees. Remove overhanging branches; scrape away as much moss as possible.</p>
<p>Slugs and snails</p>  <p>Garden snail</p>	<p>Keep area near foundations dry and free of refuse or piles of organic matter (such as decaying leaves) that may attract slugs and snails. Home remedy:* As a bait, use beer $\frac{3}{4}$ in. deep in steep-sided dish or tray. Various moisture-holding devices such as an upside down flower pot or empty grapefruit skin can be used to trap slugs and snails during the day. They need to be removed (wearing gloves) and disposed of daily before dark.</p>
<p>Sowbugs and pillbugs</p>  <p>ACTUAL SIZE</p>	<p>Gray-colored, small crustaceans that roll up into a ball when handled. Feed primarily on decaying wood. Remove food sources from around the home. Same as for millipedes.</p>
<p>Ticks</p>  <p>ACTUAL SIZE</p>	<p>Avoid tick-infested areas if possible. Stay in center of trails and paths. Wear light-colored, long-sleeved shirts and long pants with bottoms tucked into socks or boots. It is easier to spot ticks on light-colored clothing. Check yourself, pets, and children frequently while outside. Check again at home (at least once in a 24-hour period). Ticks must feed for many hours before diseases are transmitted to people or pets. Repellents are available commercially.</p>
<p>Wasps and hornets</p>  <p>ACTUAL SIZE</p>	<p>Stinging insects that often build nests near occupied dwellings and may become a nuisance or danger to those allergic to their sting. Social insects; many individuals live in the same nest. Species in New York State are annual nesters. Most are paper wasps that use wood pulp to build their nests. Attracted to unfinished wood decks, lawn furniture, or awnings; and usually build nests there. Painting or oiling these surfaces reduces their attractiveness to paper wasps. Check periodically outside the house during early summer to find and remove small nests. By August and September, wasp populations will be highest. Use screens in buildings and screen ventilators to attics. If possible, wait until frost kills insects, then remove and dispose of nests.</p>

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FURTHER READING

Common Sense Pest Control Quarterly. Bio-Integral Resource Center newsletter. P.O. Box 7414, Berkeley, Calif. 94707.

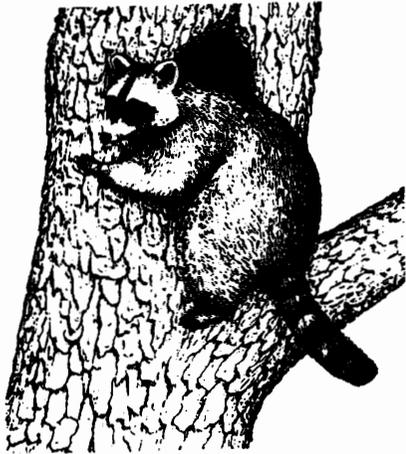
Hansen, M. 1993. *Pest Control for Home and Garden*. Consumer Reports Books, Yonkers, N.Y. 372 pp.

IPM Practitioner. Bio-Integral Resource Center newsletter. P.O. Box 7414, Berkeley, Calif. 94707.

Olkowski, W., S. Daar, and H. Olkowski. 1991. *Common Sense Pest Control: Least Toxic Solutions for Your Home, Garden, Pets, and Community*. Taunton Press, Newtown, Conn. 715 pp.

Ware, G. W. 1988. *A Complete Guide to Pest Control: With and Without Chemicals*. Thomson Publications, Fresno, Calif. 304 pp.

7 MANAGEMENT OF WILDLIFE PROBLEMS



Conflicts between humans and wildlife can be managed using a variety of alternatives. These techniques for managing wildlife damage fall into several broad categories: exclusion, habitat modification, wildlife population reductions, biological control, visual or auditory repellents, repellents, and chemical toxicants. Although exclusion and habitat modification may appear to be more expensive than other methods, they often are the most efficient and provide longer-term relief from damage problems.

Vertebrates, commonly referred to as wildlife, frequently enter structures where humans live. The results range from simple nuisance situations to significant damage and health risks. Woodwork, plastic, or other materials may be damaged; electric wires may be chewed, which could result in system failures and fires; insulation may be soiled and destroyed; and fecal droppings from birds may damage building exteriors. Wildlife can also potentially transmit a variety of diseases and parasites to humans.

A thorough inspection should be the first step. A good flashlight and extendible mirror can help in viewing less accessible locations. Safety equipment, including respirators with HEPA filter, goggles, and knee pads, should be used if entering crawl spaces or

attics. Look for entry holes, fecal droppings, runways (such as in insulation), tracks, rub marks, urine stains, gnaw marks, food caches, nests, odors, noise, and evidence of past control efforts. Also look for burrows, access routes, carcasses, and live animal sightings. Ask, what do you know about the problem?

IPM procedures and options include animal removal, exclusion/repair, prevention of future damage, and monitoring. Unless you are experienced, removal might best be referred to professionals. Many homeowners, however, will want to try excluding pests themselves.

Certain factors should be considered when doing exclusion work. First, before closing animal entry sites, be certain that the animals will not be trapped inside or find their way back in. If you are uncertain, monitor for two days by placing newspaper in the hole, stapling cardboard over the hole, or placing duct tape over the hole. Animals will need to be removed first. Second, the time of year is important. During the winter many vertebrates (chipmunks, raccoons, woodchucks) are inactive for long periods. Snow and ice can make outdoor work difficult. In spring and summer young may be present. Third, exclusion materials should meet building codes, fire codes, or other ordinances. For example, homemade chimney covers often do not meet legal safety requirements.

A variety of materials can be used to close structural openings used by vertebrates. *Galvanized metal* is very durable and when attached with screws is resistant to removal by raccoons and other animals. *Hardware cloth* comes in $1/4$ or $1/2$ -inch mesh sizes. Smaller mesh is appropriate for smaller vertebrates. When hardware cloth is used to fence animals out from under portions of structures that lack foundations, the cloth should be buried about 1 foot deep on one side and attached to the bottom of the structure on the other. *Aluminum flashing* may be used for bird exclusion, but raccoons and rodents can chew or claw through it. *Caulk*, *copper gauze*, or *foam insulation* may be used to close small holes or cracks.

Vents are often sites of entry and should be constructed of metal or

heavy-duty plastic. End caps or ridge vents often come loose; replacement caps can be used to secure them.

Insect screening on the back of vents in attics needs to be intact to keep bats and insects out. Small vertebrates may enter clothes dryer vents.

Caution needs to be used if screening these vents because lint can build up quickly and damage the dryer. Screens need to be cleaned frequently or vents should be replaced with models designed for animal exclusion without lint clogging. Commercially produced chimney covers should be used to prevent raccoons, squirrels, chipmunks, bats, starlings, and house sparrows from entering.

If exclusion is done correctly, it will prevent pests from reentering the structure. Even so, one should monitor the site for a period of time just to be certain. And remember, animals often try to find another way in if the site was a favored one for nesting.

In New York State it is illegal to possess or transport captive wild animals without a special license. The New York State Department of Environmental Conservation (NYSDEC) Special Licenses Unit in Albany (518-457-0689) maintains a list of licensed wildlife nuisance control persons who can trap and transport vertebrate pests. It is sometimes legal for a landowner to use lethal techniques (shooting or trapping) to reduce numbers of certain wildlife species causing property damage, but check with your regional NYSDEC office before implementing these methods. Observe all local laws and exercise all precautions.

Table 7 lists cultural methods for reducing damage caused by wildlife species. Chemical repellents and toxicants are listed in Part II, Table 8.

Table 7. Wildlife damage management methods

<i>Animal</i>	<i>Damage management methods</i>
Bats	Seal openings in eaves and attic with 0.25-in. hardware wire, screen, or caulking. Do not seal openings from May through mid-August when flightless bat pups may become trapped inside. Lighting and ventilating attics may discourage bats from roosting. Offer a “bat house” away from areas of human activities. Avoid direct contact.
Birds	Cover fruit trees, berry plants, and grape rows with protective netting. Netting will last 3 to 10 years depending on its quality. Visual or auditory scare devices can provide temporary relief.
Chipmunks	Exclusion or habitat modification will discourage animals from entering buildings. Live-animal or snap-back traps baited with corn, sunflower seeds, whole peanuts, or peanut butter can be used to reduce chipmunk numbers.
Deer	Commercial chemical repellents will reduce damage if browsing pressure is low to moderate. Electric or woven-wire fencing can exclude deer from crops or ornamental plantings. Individual plants can be protected with woven-wire cages or fencing. Carefully selecting landscape plants can reduce deer damage to ornamentals (see Further Reading).
Mice	Seal openings and mow close to home foundations. Snap-back traps baited with peanut butter can reduce numbers. Use tamper-resistant poison bait stations for commercial rodenticides in homes and other occupied structures. Voles can be excluded with circular 0.25-in. wire guards surrounding bases of trees (allow room for five years’ growth of tree). Mulches may attract orchard mice to ornamental plants and increase girdling damage. Using herbicides or closely mowing around fruit trees can also reduce damage.
Moles	Commercial mole traps are most effective control technique.
Pigeons	Screen roosting ledges with hardware wire or plastic netting. Commercial live traps, porcupine wire, post-end-wire systems, and commercial electric shock systems are available. Professional assistance may be necessary.
Rabbits	Use 30-in.-high, 1-in. poultry wire to exclude rabbits from gardens. Circular 0.25-in. hardware wire guards can protect trees or shrubs. Commercial repellents are available. See Part II, Table 8. Baiting a box or cage with apples or shooting rabbits can reduce numbers. Mowing and removing brush piles will make an area less attractive to rabbits.
Raccoons	Use tight-sealing garbage can lids and feed pets indoors. Electric fencing can exclude raccoons from gardens. Animals can be cage trapped using marshmallows as bait.
Rats	Seal openings and mow close to home foundations. Remove brush piles or nesting materials and sources of food. Baited snap-back rat-size traps can reduce numbers.
Skunks	Seal openings to building or foundations at night after skunks leave (except during mid-May and June when young may be in den). Elevate beehives at least 3 ft. above ground. Skunks can be live-trapped with canned fish or eggs (won’t attract cats) as bait. Cover all but opening of live traps with dark plastic to avoid being sprayed during transport. Skunks trapped in pits or cellar windows can be removed by carefully lowering a board with cleats nailed 6 in. apart. Animals will climb out if left undisturbed. Professional assistance may be necessary.
Snakes	Seal openings and mow close to home foundations. Remove brush piles or other suitable cover, and reduce rodent populations in dwellings.

Table 7. Wildlife damage management methods (continued)

<i>Animal</i>	<i>Damage management methods</i>
Squirrels	Use metal flashing or hardware wire to seal openings to homes. To prevent squirrels from foraging in nut trees or bird feeders, attach 2-ft.-wide metal bands to trunk or pole. Cone-shaped metal guards are also effective if mounted 5 ft. or more above ground. Squirrels can be baited with walnut meats, sunflower seeds, or peanut butter and live-trapped. Shooting is effective where legal.
Woodchucks	Shooting and trapping can reduce woodchuck numbers. Vacant burrows are often quickly occupied by animals from surrounding areas. Heavy welded-wire fencing (buried at least 1 ft. deep) may provide longer-term protection for gardens. Mowing and removing brush piles can make areas less attractive to woodchucks.

FURTHER READING

Consult the Cornell University *2000 Management Guidelines for Control of Wildlife* for a more detailed discussion of management options.

Bird, D. M. 1986. *City Critters: How to Live with Urban Wildlife*. Eden Press, Montreal, Quebec. 115 pp.

Braband, L. 2000. *Beasts Begone! A Practitioner's Guide to IPM in Buildings*. NYS IPM Program, Cornell University, Ithaca, N.Y. 50 pp.

Curtis, P. D., and M. E. Richmond. 1994. *Reducing Deer Damage to Home Gardens and Landscape Plantings*. Dept. of Natural Resources, Cornell University, Ithaca, N.Y. 22 pp.

Curtis, P. D., M. J. Fargione, and M. E. Richmond. 1994. *Wildlife Damage Management in Fruit Orchards*. Cornell Cooperative Extension Information Bulletin 236, Ithaca, N.Y. 28 pp.

Fargione, M. J., P. D. Curtis, and M. E. Richmond. 1991. *Resistance of Woody Ornamental Plants to Deer Damage*. Cornell Cooperative Extension Home-Grounds-Garden fact sheet 800.00, Ithaca, N.Y. 3 pp.

8 ANNUAL AND PERENNIAL PLANT PEST MANAGEMENT

Common diseases of annual and perennial plants include damping-off, root and stem rots, leaf spots and blights, rusts, powdery mildew, downy mildew, vascular wilts, and

virus and nematode diseases. Insect pests include aphids, plant bugs, leafhoppers, spittlebugs, mealybugs, scales, thrips, whiteflies, mites, caterpillars, beetles, wasps, leafminers, and borers. Where aphids and other sucking insects are a problem, avoid using excess nitrogen fertilizer.

To keep annual and perennial plants healthy and attractive, you should be able to diagnose common insect and disease problems and formulate an appropriate treatment plan.

This plan should include cultural control measures such as proper site preparation; diversified plantings; sanitation during and after the growing season; disease-free transplants and seed; crop rotation; and scouting. See Chapter 2 for more details. Table 9 contains cultural control guidelines for managing common insect and disease problems. Pesticide guidelines are included in Part II, Table 9.

Table 8. General descriptions of insect pests that feed on several different annual and perennial plants

<i>Insect pest</i>	<i>Description/Biology</i>
Aphids 	Small, often pear-shaped, soft-bodied insects that use their long, slender mouthparts to pierce stems, leaves, and other tender plant parts to suck out plant fluids. Sticky appearance is caused by honeydew, a sweet, sticky liquid excreted by aphids and other sucking insects. Sooty mold, a black fungus, may grow on honeydew.
Lacebugs	True bugs with lacy, whitish wing covers. Feed by sucking sap from leaves and are often found on undersides of leaves. Yellow to white spots appear on upper leaf surface, gradually coalesce, and when severe, leaves may turn brown and drop early.
Scales 	Scale insects are so unlike insects that many people do not recognize them as such. Insects are hidden under waxy or hard scale cover. Those under waxy covers are referred to as soft scales; those under hard covers are called armored scales. Long, piercing mouthparts allow them to suck juices from leaves, stems, twigs, branches, and trunks. Entire plant may decline and die. Honeydew may be abundant and sooty mold may grow on it.
Spider mites 	Related to insects but are tiny arthropods with eight legs. Feed by inserting mouthparts into plant and sucking liquid contents, causing yellowish stippling at feeding sites and general plant decline. Webbing is often seen when held up to sunlight. Mites may appear as tiny moving dots on webbing. Several predaceous mites feed on spider mites.
Thrips 	Tiny (less than 1/20 in.), often yellowish insects. Adults have long fringe of hair around wings. Cause damage by rasping leaf surface and drinking fluid that collects in injured areas. Leaves appear silvered or dried out. Brown or black spots (fecal matter and feeding scars) are often seen on plant tissue.
Whiteflies 	Adults are small, yellowish insects with dull white wings. Immature whiteflies are oval and flattened, yellowish scalelike insects. Heavily infested plants send up a cloud of adults when disturbed. Some whiteflies transmit plant diseases that are devastating to some crop plants. Eggs are very small, laid on undersides of leaves. Crawlers hatch from eggs, move to a feeding site, then become more sedentary. Honeydew may be present.

Table 9. Annual and perennial pest management

<i>Plant</i>	<i>Pest/Disease*</i>	<i>Pest management practices</i>
Ageratum	Root rot	Rogue plants: remove and destroy or discard entire infected plant and immediately surrounding soil or soil clinging to roots. Improve soil drainage. Practice crop rotation: locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil.
Whitefly	Spider mites	Wash off with water occasionally as needed early in the day. A hard stream of water can be used to remove mites from plants. Rogue infested plants.
	Whitefly	Do not purchase infested plants. Rogue heavily infested plants.
Chrysanthemum	Bacterial leaf spot	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Verify diagnosis.
	Brown rust	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Identify alternate host and remove if possible.
	Fungal leaf spot	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Verify diagnosis.
	Powdery mildew	Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible.
	Viral diseases	Rogue plants: remove and destroy or discard entire infected plant and immediately surrounding soil or soil clinging to roots. Manage insect vectors.
	White rust	This disease is under federal quarantine. Contact the NYS Dept. of Ag. and Markets to report; verify diagnosis.
	Aphids	Wash off with water occasionally as needed early in the day. A hard stream of water can be used to remove many aphids from plants.
	Beetles	Remove by hand.
	Borers	Cut and bury large-stemmed weeds nearby. Prune off and destroy affected pests.
	Caterpillars	Remove by hand.



Powdery mildew on a chrysanthemum leaf

*For descriptions of arthropods, see Table 8.

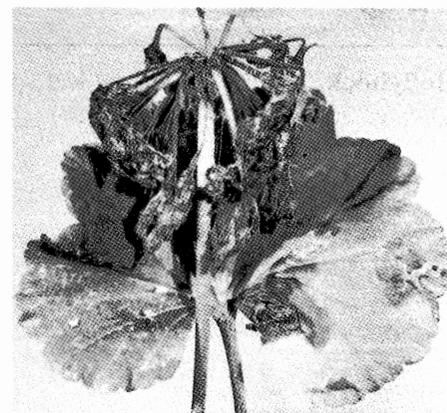
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Table 9. Annual and perennial pest management (*continued*)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Pest management practices</i>
Cockscomb <i>(Celosia sp.)</i>  Spider mite	Fungal leaf spot	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Verify diagnosis.
	Spider mites	See Ageratum.
Columbine  Aphid	Crown and root rot	Improve soil drainage. Rogue plants: remove and destroy and discard entire infested plant and immediately surrounding soil or soil clinging to roots. Practice crop rotation: locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil.
	Fungal leaf spot	See Cockscomb.
	Aphids	See Chrysanthemum.
	Leafminer	These insects create serpentine tunnels or mines in leaves, gradually taking over entire leaf. Practice plant sanitation. Remove or discard affected leaves.
	Sawfly	Remove by hand. Wash off and dispose of young larvae that collect on screening.
Dahlia	Botrytis blight (Gray mold)	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings.
	Powdery mildew	Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible.
	Stem rot and wilt	Improve soil drainage. Rogue plants: remove and destroy or discard entire infested plant and immediately surrounding soil or soil clinging to roots. Practice crop rotation: locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil.
	Viral diseases	See Chrysanthemum.
	Aphids	See Chrysanthemum.
	Beetles	Handpick and destroy.
	Leafhoppers	These insects cause stunting of plants, curling and browning of leaf margins. Grow plants under screening to prevent access by leafhoppers.
	Spider mites	See Ageratum.
	Tarnished plant bug	These bugs cause blackening of buds and new growth. Screen plants to prevent insect access.
	Thrips	These insects cause silvery foliage and flower streaks. No cultural control is available.

Table 9. Annual and perennial pest management (*continued*)

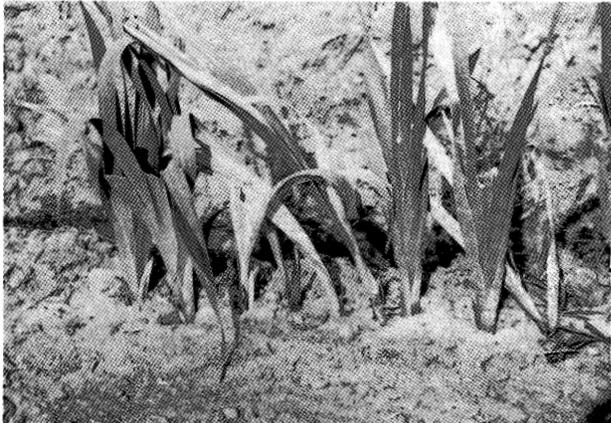
<i>Plant</i>	<i>Pest/Disease</i>	<i>Pest management practices</i>
Daylily (<i>Hemerocallis</i> sp.)	Fungal leaf spot	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings.
	Thrips	These insects cause silvery foliage and flower streaks. No cultural control is available.
Delphinium	See Larkspur.	
Forget-me-not	Wilt (<i>Sclerotinia sclerotiorum</i>)	Rogue plants: remove and destroy or discard entire infested plant and immediately surrounding soil or soil clinging to roots. Practice crop rotation: locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil.
	Aphids	See Chrysanthemum.
	Flea beetles	These small black beetles cause minute shot holes in foliage. No cultural control is available.
Geranium	Bacterial blight	Rogue plants: remove and destroy or discard entire infested plant and immediately surrounding soil or soil clinging to roots. Practice crop rotation: locate new plants in a part of the garden different from the previous year's location. If that is not possible, remove infested soil and replace with fresh soil.
	Botrytis blight (Gray mold)	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings.
	Aphids	See Chrysanthemum.
	Caterpillars	Handpick and destroy.
	Whitefly	This insect causes yellowing and early drop of leaves. Do not purchase infested plants.



Botrytis blight on a geranium flower cluster and leaf

continued

Table 9. Annual and perennial pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Pest management practices</i>
Gladiolus	Fusarium yellows	<p>Rogue plants: remove and destroy or discard entire infested plant and immediately surrounding soil or soil clinging to roots. Practice crop rotation: locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil. Use resistant varieties. Dry corms thoroughly before storing in a cool place. Hot water treatment of corms is possible, but specific recommendations vary.</p>  <p>Fusarium yellows-infected gladiolus among healthy ones</p>
	Thrips	<p>Most serious pest of gladiolus. Feeding causes streaking of leaves and distortion of flowers or even failure of flowers to open. Two very important measures for controlling thrips are breaking tops from corms and discarding them immediately after digging; and storing corms at 35–40° F, which is too low for thrips to survive winter, or 40–50° F, which is too cool for population to build.</p>
Hollyhock (<i>Althaea</i> sp.)	Fungal leaf spots	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible.
	Rust	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation.
	Beetles	Handpick.
	Leafhoppers	No cultural control is available.
	Spider mites	Spider mites cause leaves to yellow and have fine webbing. See Ageratum.
Hosta	Crown rot (<i>Sclerotium rolfsii</i>)	Rogue infected plants.
	Foliar nematode	The foliar nematode enters leaves through stomata. It feeds on internal plant cells, causing death as it moves through leaf. Angular lesions are often observed on infested plants. Remove infested plants.



Thrips

Thrips

Table 9. Annual and perennial pest management (*continued*)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Pest management practices</i>
Hosta (<i>continued</i>)	Slugs	Damage is worse in years with wet spring weather. Slugs feed at night, eating out large, irregular areas in fruit and foliage, hiding during the day in damp refuse or soil. They leave a glistening slime trail that can be seen early in the day. Homemade traps can help; handpick and destroy slugs.
Hydrangea	Bacterial wilt (<i>Pseudomonas solanacearum</i>)	Rogue; remove soil and replace. See Nasturtium.
	Fungal leaf spot	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Verify diagnosis.
	Powdery mildew	Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible.
	Aphids	See Chrysanthemum.
	Leaf-tier (caterpillar)	Handpick caterpillars and destroy.
 Aphid	Spider mites	See Ageratum.
Impatiens	Rhizoctonia web blight	Eliminate overhead watering; water early in the day.
	Seedling damping-off	Use sterile potting mix. Avoid overwatering. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Verify diagnosis.
	Verticillium wilt	Rogue plants: remove and destroy or discard entire infested plant and immediately surrounding soil or soil clinging to roots. Practice crop rotation: locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil. Verify diagnosis.
	Aphids	See Chrysanthemum.
	Spider mites	See Ageratum.

continued

Table 9. Annual and perennial pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Pest management practices</i>
Iris 	Bacterial leaf spot (<i>Xanthomonas tardicrescens</i>)	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings.
	Heterosporium (=Didymellina) leaf spot	Same as preceding entry.
	Aphids	Wash off as needed.
	Borer	Thoroughly clean up plant in fall and spring of each year. Control is based on destroying overwintering eggs. All debris (especially old leaves near plant base) in and around iris planting must be removed and destroyed by late winter. Prune off or squeeze damaged leaves as soon as feeding is noticed. During division, every few years, discard all damaged rhizomes. Beneficial nematodes may be used for control of larvae once they are in rhizomes in soil.
	Heterosporium (=Didymellina) leaf spot on iris	
Larkspur (Delphinium)	Bacterial leaf spot (<i>Pseudomonas syringae</i>)	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings.
	Bacterial soft rot (<i>Erwinia carotovora</i>)	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Cut rotted areas from rhizomes. Dry in direct sunlight for one day.
	Crown rot (<i>Sclerotium rolfsii</i>)	Rogue plants: remove and destroy or discard entire infested plant and immediately surrounding soil or soil clinging to roots. Practice crop rotation: locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil.
	Powdery mildew	Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible.
	Aphids	See Chrysanthemum.
Borers	Collect and bury large-stemmed weeds and all larkspur and delphinium debris after frost in autumn.	

Table 9. Annual and perennial pest management (*continued*)

<i>Plant</i>	<i>Pest/Disease*</i>	<i>Pest management practices</i>
Larkspur (Delphinium) (<i>continued</i>)	Cyclamen mite	Plant becomes deformed. Destroy infested plants.
	Spider mites	See Ageratum.
Lilies (Lilium sp.)	Bacterial soft rot (<i>Erwinia carotovora</i>)	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Rogue plants: remove and destroy or discard entire infested plant and immediately surrounding soil or soil clinging to roots.
	Botrytis blight (Gray mold)	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings.
	Wilt (<i>Sclerotium rolfsii</i>)	Rogue plants; remove and destroy or discard entire infested plant and immediately surrounding soil or soil clinging to roots. Practice crop rotation: locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil.
	Aphids	May transmit virus. See Chrysanthemum.
Lupine (Lupinus sp.)	Crown rot	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Rogue plants: remove and destroy or discard entire infested plant and immediately surrounding soil or soil clinging to roots. Improve soil drainage or relocate plants to a better-drained area.
	Powdery mildew	Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible.
	Aphids	Green with white wax, sometimes numerous. See Chrysanthemum.
	Whitefly	See Ageratum.
Marigold (Tagetes sp.)	Alternaria leaf spot	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Verify diagnosis.
	Botrytis blight	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings.

continued

Table 9. Annual and perennial pest management (continued)

<i>Plant</i>	<i>Pest/Disease*</i>	<i>Pest management practices</i>
Marigold (<i>Tagetes</i> sp.) (continued)	Root rot	Improve soil drainage. Practice crop rotation: locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil. Rogue plants: remove and destroy or discard entire infected plant and immediately surrounding soil or soil clinging to roots.
	Sclerotinia stem rot	Same as for root rot.
	Wilt	Same as for root rot.
	Slugs and snails	Slugs look like snails without shells. Look for both slugs and snails at night or in rain or look for slime trails and feeding damage early in the day. Feeding often starts on lower leaves and moves upward. Traps that produce a cool, shady hideout during the day work well; with certain traps you must collect slugs and dispose of them daily. If you handpick, you may want to wear gloves. Avoid too much organic mulch near planting; mulch keeps environment moist, which slugs like.
	Spider mites	See Ageratum.
Nasturtium	Bacterial leaf spot (<i>Pseudomonas syringae</i>)	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings.
	Bacterial wilt (<i>Pseudomonas solanacearum</i>)	Rogue plants: remove and destroy or discard entire infested plant and immediately surrounding soil or soil clinging to roots. Practice crop rotation: locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil.
	Fungal leaf spot	See Hydrangea.
	Aphids	Bean aphid is black and easily seen. See Chrysanthemum.
	Spider mites	See Ageratum.
	Tarnished plant bug	Keep weeds down in vicinity of garden.
Pansy (<i>Viola</i> sp.)	Anthracnose	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings.
	Downy mildew	Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings.
	Fungal leaf spot	See Anthracnose.
	Scab (<i>Sphaeceloma violae</i>)	See Anthracnose.
	Aphids	See Chrysanthemum.
 Long-tailed mealybug	Mealybug	Discard badly infested plants.

Table 9. Annual and perennial pest management (*continued*)

<i>Plant</i>	<i>Pest/Disease*</i>	<i>Pest management practices</i>
Pansy (<i>Viola</i> sp.) (<i>continued</i>)	Spider mites	See Ageratum.
Peony (<i>Paeonia</i> sp.)  Japanese beetle	Botrytis blight (Gray mold)	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, cut back to ground, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings.
	Redspot (<i>Cladosporium paeoniae</i>)	See Botrytis blight.
	Root rot	Improve soil drainage; avoid overwatering.
	Japanese beetle and rose chafer	Handpick beetles when first seen and repeat as necessary.
	Thrips	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof.
Petunia	Botrytis blight (Gray mold)	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Water early. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space them apart to allow air circulation; prune to thin plants or plantings. Remove spent flowers.
	Sclerotinia stem rot	See Marigold.
	Viral diseases	Rogue plants: remove and destroy or discard entire infested plant and immediately surrounding soil or soil clinging to roots. Do not save seed from infested plants. Manage insect vectors.
Phlox	Fungal leaf spot	See Cockscomb.
	Powdery mildew	Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Place in a sunny location. Plant species or varieties that are resistant or less susceptible.
	Plant bugs	Bugs cause white to brown spots on leaves, deformed buds. No cultural control is available.
	Spider mites	Destroy severely infested plants or portions thereof. Wash plants with a forceful spray of water every other day at least three times to knock off mites.

continued

Table 9. Annual and perennial pest management (continued)

<i>Plant</i>	<i>Pest/Disease*</i>	<i>Pest management practices</i>
Poppy (<i>Papaver</i> sp.)	Bacterial blight (<i>Xanthomonas papavericola</i>)	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Practice crop rotation: locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil. Use treated, disease-free seed.
	Aphids	See Chrysanthemum.
	Leafhoppers	No cultural controls are available.
Roses		See Table 11, Tree and shrub pest management.
Shasta dairy  Aphid or plant louse	Fungal leaf spot	See Cockscomb.
	Aphids	See Chrysanthemum.
	Beetles	Handpick and destroy.
Snapdragon (<i>Chrysanthemum maximum</i>)	Anthracnose	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Use disease-free seed.
	Powdery mildew	Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible.
	Rhizoctonia root and stem rot	Rogue plants: remove and destroy or discard entire infested plant and immediately surrounding soil or soil clinging to roots. Practice crop rotation: locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil. Improve soil drainage.
	Rust	See Chrysanthemum.
	Aphids	See Chrysanthemum.
	Beetles	Handpick and destroy.
	Spider mites	See Ageratum.
	Stock (<i>Matthiola</i> sp.)	Fungal leaf spot
	Wilt	Rogue plants: remove and destroy or discard entire infested plant and immediately surrounding soil or soil clinging to roots. Practice crop rotation: locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil.

Table 9. Annual and perennial pest management (continued)

<i>Plant</i>	<i>Pest/Disease*</i>	<i>Pest management practices</i>
Sweet alyssum <i>(Lobularia maritima)</i>  leafhopper	Downy mildew	Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Use treated, disease-free seed.
	Rhizoctonia root and stem rot	See Snapdragon.
	Leafhoppers	No cultural controls are available.
	Whitefly	See Ageratum.
Sweet pea <i>(Lathyrus odoratus)</i>	Anthracnose	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings. Use disease-free seed.
	Fungal leaf spot	See Cockscomb.
	Root rot	Rogue plants: remove and destroy or discard entire infested plant and immediately surrounding soil or soil clinging to roots. Improve soil drainage. Practice crop rotation: locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil.
	Aphids	See Chrysanthemum.
	Leafminer	Attracted by high organic matter. Remove and bury infested leaves.
	Seedcorn maggot	Use successive plantings 7 to 10 days apart. Some plants will escape damage. Use row cover over seed bed during germination.
Tulip <i>(Tulipa sp.)</i>	Botrytis blight (Tulip fire)	Trim leaves off just after they turn yellow. Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Rogue plants: remove and destroy or discard entire infested plant and immediately surrounding soil or soil clinging to roots.
Verbena  Leafminer injury	Bacterial wilt (<i>Pseudomonas solanacearum</i>)	Rogue plants: remove and destroy or discard entire infested plant and immediately surrounding soil or soil clinging to roots. Practice crop rotation: locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil.
	Powdery mildew	Avoid crowding plants; space apart to allow air circulation. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible.
	Aphids	See Chrysanthemum.
	Leafminer	Handpick infested leaves.
	Plant bugs	No cultural control is available.
Spider mites	See Ageratum.	

continued

Table 9. Annual and perennial pest management (continued)

<i>Plant</i>	<i>Pest/Disease*</i>	<i>Pest management practices</i>
Zinnia	Alternaria leaf spot	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space plants apart to allow air circulation; prune to thin plants or plantings.
	Bacterial leaf spot (<i>Xanthomonas</i>)	Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts or portions thereof. In autumn, rake and remove all garden debris. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Improve air circulation.
	Powdery mildew	Avoid crowding plants; space apart to allow air circulation; prune to thin plants or plantings. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible.
	Sclerotinia stem rot	See Marigold.
	Viral diseases	Rogue plants: remove and destroy or discard entire infested plant and immediately surrounding soil or soil clinging to roots. Manage insect vectors.
	Japanese beetle	Handpick and destroy beetles.
	Spider mites	See Ageratum.

FURTHER READING

Chase, A. R., M. Daughtrey, and G. W. Simone. 1995. *Diseases of Annuals and Perennials*. Ball Publishing, Batavia, Ill. 202 pp.

Daughtrey, M. L., and M. Semel. 1987. *Herbaceous Perennials: Diseases*

and Insect Pests. Cornell Cooperative Extension Information Bulletin 207, Ithaca, N.Y. 25 pp.

Horst, R. K. 1990. *Westcott's Plant Disease Handbook*. 5th Ed. Van Nostrand Reinhold, New York. 953 pp.

Horst, R. K., and P. E. Nelson. 1985. *Diseases of Geraniums*. Cornell Cooperative Extension Information Bulletin 201, Ithaca, N.Y. 33 pp.

Pirone, P. P. *Diseases and Pests of Ornamental Plants*. 1978. John Wiley and Sons, New York. 566 pp.

9 TREE AND SHRUB PEST MANAGEMENT

Trees and shrubs enhance a property and add to its value. Choosing the right plant for the right place is important in the home landscape, as is providing the proper care for each plant. Know what's normal for the plants. For example, evergreens lose their leaves. One- to six-year-old inner leaves or needles turn yellow then brown but new growth remains green. On pines old needles drop off in the fall of the year, but hollies drop old leaves in the spring. Pest infestations and pruning, watering, and fertilization practices may affect the health of plants around the home.

When a pest problem arises, you need to decide what can be done about it. Use an integrated approach to managing pest problems. In some cases pruning out infested portions of plants may be all that is needed. If a pesticide is required, choose the least toxic one available that will still give good control of the pest. You may be able to monitor pests to help you time control measures accurately. For example, in the case of foliar-feeding scale insects, to monitor when activity of crawlers begins, place a piece of double-sided sticky tape around twigs and branches a few weeks before crawlers are expected; using a magnifying glass, check the tape for crawlers every three to four days. Control measures for scale crawlers, in general, should be applied five to seven days after activity begins.

GROWING DEGREE-DAYS

As we learn more about the biology of insect pests, we will be able to make timely management decisions. More accurate timing will allow us to reduce the number of pesticide applications needed. A system using Growing Degree-Days (GDD), which are more accurate than calendar dates, is used to determine when to apply pesticides to ornamental trees and shrubs. The climatological calendar begins on March 1, and the base

temperature is 50° F. The GDDs are additive, giving a cumulative total for each day of the growing season. Insect development can be tied directly to GDD accumulations, especially in the spring, when most activity begins. Apply the pesticide when your GDDs have reached the levels listed in the tables.

The following formula, in degrees Fahrenheit, is used to determine GDD for each day:

$$\frac{\text{Maximum} + \text{minimum}}{\text{daily temperature}} = \text{Mean temperature}$$
$$2$$
$$\text{Mean temperature} - 50 = \text{GDD}$$

Consult your county Cooperative Extension agent for local GDD data for pest management. Known GDD information is included in Part II, Table 11.

PLANT PHENOLOGICAL INDICATORS (PPI)

Phenology is the study of recurring biological phenomena (events) and their relationship to weather. Periodic events such as flowering are recurring biological phenomena that occur only after a definite amount of heat energy accumulates within any given plant, as determined by its genetic inheritance. Every year that event occurs at the same "time," but not as calculated by the calendar. The same forces likewise affect the arthropod pests of any given plant. The insect and its food plant overwintering together are synchronized so well that the insect will appear at a rather precise time (i.e., egg will hatch, larva will break diapause) and be ready to feed when the host plant has what the insect needs.

To provide a readily visible plant phenological event (flowering fruit color, seed drop), one needs only to observe another plant species in flower that coincides with the insect pest of concern. For example, the honeylocust plant bug will be present and vulnerable on honeylocust trees when Japanese quince begins to flower. Many other plants are in flower at the same time and they, too, may be used as phenological markers. In Part II, we have combined the

basics for three timing systems—Growing Degree-Days (GDD), PPI, and calendar. GDD and PPI work independently. A finely tuned GDD system and PPI complement one another. Fine-tuning is a continuous process. These predictor systems are indispensable to IPM scouting and the application of management techniques.

KEY PLANTS AND KEY PESTS

Knowing which pests are most common and cause the most damage can also be helpful. Arborists and landscape contractors who manage pest problems are faced with more than 140 insect pests and 110 different diseases, but not all of these occur every year in damaging numbers. One goal in an integrated pest management approach is to monitor the major pests of the most common and significant plants in each landscape. Table 10 lists key plants and key pests and may help in planning your annual inspection schedule. The pests are grouped according to the first months in which they should be managed or controlled. Certain pests, such as aphids and mites, may continue to be pests for many months.

SAMPLE IPM PROGRAM

The gypsy moth, a forest and shade tree pest that can cause widespread defoliation, is an introduced insect that has few natural enemies in our country. Management options for homeowners include planting resistant species; improving plant health by watering and fertilizing properly; removing and destroying egg masses anytime from September through mid-April; assessing the population and potential damage when young larvae are present in late May or early June and treating if needed; using bands around trees to trap larger larvae or to prevent larvae from entering the canopy; and destroying pupae as found.

Gypsy moth traps are available, but we do not recommend them as a control measure. They are very useful in monitoring the spread of gypsy moth into new areas, but they trap only male moths, which does not significantly reduce the population.

We are continuing to learn about natural biological controls that play a part in the gypsy moth picture. Natural biological controls, including parasites and predators, play a role in suppressing gypsy moth populations over large geographic regions but are unlikely to protect individual trees or properties adequately during outbreaks. Recently the fungus *Entomophaga maimaiga* was found causing the collapse of large numbers of gypsy moth larvae. Scientists do

not know whether the fungus will continue to give control, however, because weather conditions and pest populations influence the survival of the fungus. We hope that this and other natural enemies will continue to play a part in suppressing this pest. Many parasites have been introduced, but none has yet provided satisfactory control of this major pest.

Table 11 lists common plants and pests along with biological notes and nonpesticidal means of managing them.

When treatments are listed as dormant, it indicates the period just before budbreak. At that time, insect activity is beginning to accelerate, there is no foliage canopy, and complete coverage is obtained.

Pesticide guidelines are found in Part II.

Table 10. Key tree and shrub pests

<i>Month (ideal time to manage)</i>	<i>Pests</i>	<i>Principal Hosts</i>
March (dormant)	spider mite elongated hemlock scale maple gall mite pine bark adelgid eastern spruce gall adelgid tuliptree scale euonymous scale black knot	evergreens, crabapple hemlock maple white pine white and Norway spruces tuliptree pachysandra, euonymus plum, flowering cherry
Early April	white pine weevil	white pine (main shoot), spruce
Mid- to late April	tent caterpillar European pine sawfly anthracnose hawthorn leaf spot honeylocust plant bug scab juniper twig blight Diplodia blight	cherry, crabapple Mugo, scots, other pines maple, ash, oak, linden, dogwood hawthorn honeylocust apple, crabapple, hawthorn juniper, cedar pines (especially Austrian)
Early May	birch leafminer aphid dogwood borer euonymous scale Cooley spruce gall adelgid white pine aphid cankermite pachysandra blight viburnum leaf beetle	birch deciduous plants flowering dogwood euonymus, pachysandra blue spruce white pine oak, linden, beech, elm pachysandra viburnum
Mid- to late May	gypsy moth spruce spider mite rhododendron borer lacebug woolly beech aphid black vine weevil Verticillium wilt black spot, mildew	oaks, maple, many trees spruce, juniper, arborvitae rhododendron sycamore, walnut beech rhododendron, azalea, yew maple rose

Table 10. Key tree and shrub pests (continued)

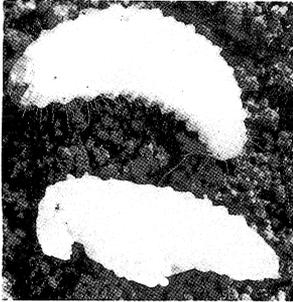
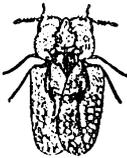
<i>Month (ideal time to manage)</i>	<i>Pests</i>	<i>Principal Hosts</i>
Early June	lacebugs bronze birch borer elongate hemlock scale rose chafer spruce canker (<i>Cytospora</i>) Phytophthora wilt	andromeda birch hemlock rose spruce, fir rhododendron and azalea
Mid- to late June	bagworm leafhopper juniper scale white prunicola scale	arborvitae, juniper maples, deciduous plants juniper flowering cherry and plum
July	Japanese beetle fall webworm spider mite	many deciduous plants many deciduous plants evergreen and deciduous plants

Table 11. Tree and shrub pest management

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Andromeda (<i>Pieris</i> sp.)  Lace bug	Fungal leaf spot	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts.
	Lace bug (<i>Stephanitis</i> spp.)	Stippled, yellowish to silvery leaves and brownish-black "varnish" spots; bugs may be seen on undersides of leaves. Natural enemies rarely abundant enough to control damaging populations. Blast insects off undersides of leaves with a jet of water. Avoid growing plants in full sun or warm, exposed sites. Water to prevent drought stress. Some cultivars are moderately resistant, especially <i>Pieris floribunda</i> and hybrids such as Browsers Beauty.
	Spider mites	Stippled foliage. Predators may greatly reduce populations.
Arborvitae (<i>Thuja</i> sp.)	Arborvitae leafminers	Tips of shoots and foliage turn brown. Remove and destroy infested leaves from fall to early spring. Parasites usually not abundant in specimen trees.
	Arborvitae weevil	Chewed foliage and dieback; roots damaged by larvae. Nursery plants die rapidly. No cultural control is recommended.
	Bagworm	Sparse foliage, spindle-shaped bags attached to twigs or foliage. Handpick bags from trees and destroy. Bags easier to see in fall and winter.
	Scales	Unthrifty plant; dead twigs, honeydew, and sooty mold may be present. For a small infestation, it may be possible to prune out affected plant parts. Identify scale species.
	Spider mites	Often feed on old needles. Stippled, off-color foliage may turn reddish-brown. Predaceous mites often keep spruce spider mite under control. Water to prevent drought stress.

continued

Table 11. Tree and shrub pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
<p>Azalea (<i>Rhododendron</i> sp.)</p>  <p>Black vine weevil—larva and pupa</p>  <p>Lace bug</p>	Fungal leaf spot	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Prune to thin plants and plantings. Avoid crowding plants; allow air to circulate around and within plants. Improve growing conditions.
	Leaf gall (<i>Exobasidium vaccinii</i>)	Remove galls by hand and discard or destroy before white, powdery spores appear.
	Azalea bark scale	Scale insects infest stems, causing an unthrifty plant and dead twigs. For small infestations, prune out affected plant parts.
	Azalea crown borer	Prune out infested branches at root crown.
	Black vine weevil	Notched leaves and bark removed from root crown. Handpick in small plantings. Pitfall traps or beating sheets can help monitor adult activity. Pitfall or burlap collar traps catch night-feeding weevils. Entomophagous nematodes may be used for soil-dwelling stage (larvae) when larvae are present.
	Lace bug	See Andromeda. Resistant cultivars are available.
	Spider mites	See Andromeda.
	Whitefly	Sooty mold, discolored foliage, yellowish mottle; whiteflies usually present on undersides of foliage. Plant resistant azalea varieties. Large populations may require use of pesticides.
<p>Birch (<i>Betula</i> sp.)</p>	Aphids	Unthrifty plant, honeydew or sooty mold, distorted, pale green foliage, reduced shoot growth. Aphids have many natural enemies, including lady bird beetles, syrphid fly larvae, and wasp parasites. Natural enemies usually found with high populations. "Blast" with water (high pressure water spray); pinch off heavily infested leaves.
	Birch leafminer	Dark greenish spots on leaves expanding to blotch mines covering half or more of leaf. Exotic parasites have been established. Birch leafminer has two annual generations; control of first generation is most important. Some species are resistant.
	Birch skeletonizer	Brown skeletonized leaves. No cultural controls available.
	Bronze birch borer	Dieback of tree from tip down and dead crown or leader, Keep trees growing vigorously. Resistant birch species are available. Adults begin to emerge in early June.



Birch leafminer injury

Table 11. Tree and shrub pest management (*continued*)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Boxelder (<i>Acer negundo</i>)  Boxelder bug	Boxelder bug	Remove female seed-bearing trees.
Boxwood (<i>Buxus</i> sp.)	Canker (<i>Volutella buxi</i>)	Prune infected branches, remove and discard old leaves. Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Disinfest pruning tool between cuts. Fertilize to maintain vigor.
	Fungal leaf spot	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts.
	Boxwood leafminer	Yellowish mines; most noticeable on undersurfaces of leaves. Remove infested leaves by hand.
	Boxwood mite	Yellow to bronze stipple on infested foliage. Few parasites exist.
	Boxwood psyllid	Upward-cupped leaves, especially new growth; symptom remains for about two years. English box is less severely attacked. Prune tips of plants in winter or early spring before eggs hatch every few years. Remove prunings.
Clematis (<i>Clematis</i> sp.)	Leaf spot and stem rot (<i>Aschochyta clematidina</i>)	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Disinfest pruning tool between cuts.
	Blister beetle	Handpick (wear gloves) and destroy.
	Borer	Bores in roots. Dig out larvae by hand.
Cotoneaster (<i>Cotoneaster</i> sp.)	Fire blight	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Disinfest pruning tools between cuts. Prune to thin plants. Avoid crowding plants; allow air to circulate around and within plants. Avoid heavy nitrogen fertilization. Plant resistant species: <i>C. adpressa</i> , <i>C. microphylla</i> , <i>C. dielsiana</i> var. <i>elegans</i> , <i>C. francheti</i> , <i>C. simonsi</i> .
	Borer	Dig out larvae. Borers can be removed with a knife and a piece of wire with a sharp point or barb. Cut with caution, being sure not to remove more wood than necessary. Carefully cut wounds usually heal without noticeable injury to tree. Keeping plants healthy and vigorous by proper cultivation, fertilization, pest control, and watering will help infested plants overcome effects of borer injury.
	Lace bug	<i>Corythuca</i> spp. Stippled, yellowish to silvery leaves; brownish-black "varnish" spots on undersides of leaves. No cultural controls available. Some species are resistant: <i>Cotoneaster apiculatus</i> , <i>C. adpreosus</i> var. <i>praecox</i> , <i>C. horizontalis</i> var. <i>persipullus</i> .

continued

Table 11. Tree and shrub pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Cotoneaster (<i>Cotoneaster</i> sp.) (continued)	Pearleaf blister mite	Off-color foliage, blisters (undersides of leaves) turn brown at end of season. No cultural controls available.
	Pearslug (sawfly larva)	Larva causes skeletonization of leaves; two or three generations. No cultural controls available.
	Scales	See Arborvitae.
Crabapple (<i>Malus</i> sp.)	Cedar-apple/cedar-hawthorn rust	Remove nearby juniper trees. Plant less susceptible varieties: Ellwangerina, Henry Kohankie, Ormiston Roy, or Red Baron.
	Fire blight	See Cotoneaster. Plant less susceptible varieties: Adams, Albright, Callaway, David Dolgo, Indian Summer, Jewelberry, Liset, Profusion, Red Baron, <i>robusta</i> cv. Persicifolia, Selkirk, or Sentinel.
	Powdery mildew	In autumn, rake and discard or destroy all fallen leaves, fruit, and branches. Prune to thin plants. Disinfest pruning tool between cuts. Avoid crowding plants; allow air to circulate around and within plants. Plant less susceptible varieties: Adams, Arctic Dawn, <i>baccata</i> cv. Jackii, Bob White, Callaway, Donald Wyman, Ellwangerina, <i>floribunda</i> , <i>sieboldii</i> var. <i>zumi</i> cv. Calocarpa.
	Scab	In autumn, rake and discard or destroy all fallen leaves, fruit, and branches. Prune to thin plants. Disinfest pruning tool between cuts. Avoid crowding plants; allow air to circulate around and within plants. Plant less susceptible varieties: Adams, Albright, Baskatong, Christmas Holly, Cotton Candy, Dolgo, Donald Wyman, <i>floribunda</i> , Henningi, Henry Kohankie, Jewelberry, Liset, Ormiston Roy, Prof. Sprenger, <i>robusta</i> cv. Persicifolia, Robinson, <i>rocki</i> , <i>sargentii</i> cv. Tina, Sentinel, <i>sieboldii</i> var. <i>zumi</i> cv. Calocarpa, Snowdrift, Sugartime, or White Angel.
	Aphids	See Birch.
	Eastern tent caterpillar	Devours new foliage as it unfolds in spring; constructs nests of silk in branch crotches. Remove caterpillars by hand. Prune off egg masses encircling twigs by late winter.
	Japanese beetle	Skeletonized foliage, lacy appearance. Handpick beetles. Grub is a turf pest (see turf section). Pheromone and feeding traps are available but may attract more beetles than they catch. Some resistant varieties and cultivars exist.
	Leaf tiers and rollers	Skeletonization and folded or rolled leaves (insects feed by tying or rolling leaves with silk around themselves). Handpick and destroy small infestations.
	Roundheaded appletree borer	Holes in bark near base of tree; tree may appear unthrifty. Remove borers from trees with a knife and a sharply pointed or barbed piece of wire. Clear away litter around base of tree to help locate borers. Younger borers can usually be cut out; older ones can be killed or impaled by forcing a wire into external hole that leads to borers' tunnel. Cut with caution, being sure not to remove more wood than necessary.



Japanese beetle



Roundheaded appletree borer

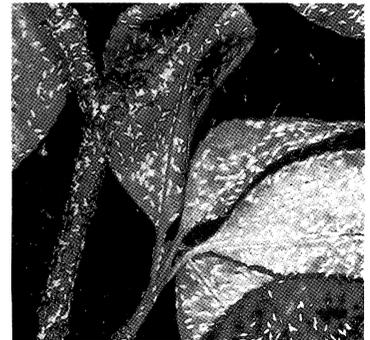
Table 11. Tree and shrub pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Crabapple (<i>Malus</i> sp.) (continued)		Carefully cut wounds usually heal without noticeable injury to tree. Keeping trees healthy and vigorous by proper cultivation, fertilization, pest control, and watering will help infested trees overcome effects of borer injury. If tree is young, put tree wrap around it to prevent egg laying.
	Scales	Dead branches, sooty mold, presence of scale insects. If infestations are small, prune out affected plant parts. Identify scale species if additional measures needed.
Dogwood (<i>Cornus</i> sp.)	Anthracnose	Clean up fallen leaves in autumn and prune diseased twigs as they become apparent throughout the season. Disinfest pruning tool between cuts. Plant resistant species and cultivars: <i>C. florida</i> 'Spring Grove' and 'Sunset,' <i>C. kousa</i> , <i>C. kousa x florida</i> hybrids, 'Constellation,' 'Ruth Ellen,' 'Star Dust,' 'Stellar Pine,' and 'Celestial.'
	Crown canker (<i>Phytophthora cactorum</i>)	Prevent mechanical injuries and borer damage to base of trunk. Remove discolored wood down to heartwood; also remove healthy wood for 1.5 in. around discolored area. Remove trees with cankers encircling more than half of stem. Do not replant with dogwood.
	Fungal leaf spot	In autumn, rake and discard or destroy all fallen leaves, fruit, and branches. Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. If severe, verify diagnosis.
	Cottony maple scale, cottony maple leaf scale	Honeydew and sooty mold accumulate on leaves of branches, twigs die back, foliage drops prematurely. Several effective predators and parasites available. Summer scale form is found attached to undersides of leaves.
	Dogwood borer	Dead branches and adventitious growth. No effective parasites or predators available. Prune or remove and discard or destroy affected plant parts. Keep trees growing vigorously. Drenching bark with beneficial nematodes in late summer has provided some control. Resistant species and cultivars include <i>Cornus kousa</i> and <i>C. kousa x C. florida</i> hybrids: 'Aurora,' 'Constellation,' 'Galaxy,' 'RuthEllen,' 'Stardust,' and 'Stellar Pink.'
	European fruit lecanium scale	Sooty mold and dead twigs. Many effective parasites available. Avoid killing parasites; scout thoroughly.
Douglas fir (<i>Pseudotsuga taxifolia</i>)	Cooley spruce gall adelgid	Yellow spots on needles and crooked needles on host. No effective parasites available. Do not plant Douglas fir with blue spruce. Damage rarely serious.
	Rhabdocline needlecast	Yellow spots on needles in late fall; yellow-brown to red-brown needles in early spring; needle drop begins in early summer. Purchase Douglas fir for planting only in spring. Examine stock for diseased needles and reject trees with suspicious symptoms.

continued

Table 11. Tree and shrub pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Douglas fir (<i>Pseudotsuga taxifolia</i>) (continued)	Swiss needlecast	Yellow to brown needle discoloration during summer months, resulting in needle drop by late August. Black fruiting bodies visible on undersides of needles with a hand lens. Purchase Douglas fir for planting only in spring. Examine stock for diseased needles and reject trees with suspicious symptoms.
Dutchman's pipe (<i>Aristolochia</i> sp.)  Mealybug	Fungal leaf spot	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts.
	Mealybug	White waxy masses and sooty mold. Mealybug destroyer, a biological control, is available.
	Scales	See Arborvitae.
Elm (<i>Ulmus</i> sp.)	Dutch elm disease	Wilting leaves, death of individual branches high up in canopy (flagging), brown streaking pattern on tissue beneath bark (fungus <i>Ophiostoma ulmi</i> or <i>O. novo-ulmi</i> infects vascular system of tree; fungus spread by elm bark beetle). American elms very susceptible. Some crosses with oriental varieties have been made in an attempt to gain some resistance, but keeping upright vase-like shape of American elm has been difficult.
	Elm leaf beetle	Skeletonized leaves. Parasites and predators not abundant enough to provide control. Elm species differ in suitability as food for this beetle.
Euonymus (<i>Euonymus</i> sp.)	Crown gall	Rogue plants: remove and discard or destroy entire infested plant and immediately surrounding soil or soil clinging to roots. Practice crop rotation: set plants in a location different from where they grew previously. If that is not possible, for small shrubs remove infested soil and replace with fresh soil.
	Euonymous scale	Yellow spots on leaves and scurfy material on twigs and leaves. Effective parasites and predators available. A predatory lady beetle, <i>Chilocorus kuwanae</i> , has been introduced. Scout thoroughly. If infestation is small, prune out affected plant parts. Some species and cultivars are resistant, e.g., 'Manhattan' and <i>E. fortunei</i> .
Firethorn (<i>Pyracantha</i> sp.)	Fire blight	See Cotoneaster.
	Scab (<i>Fusicladium pyracanthae</i>)	In autumn, rake and discard or destroy all fallen berries. Plant more resistant Yunan firethorn (<i>Pyracantha fortuneana</i>).
	Lace bug	See Cotoneaster. Some cultivars or species are less preferred: <i>P. angustifolia</i> 'variegata' and <i>P. elatantoides</i> 'Aurea.'
	Scales	See Arborvitae.



Euonymus scale

Table 11. Tree and shrub pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Flowering peach, cherry, and plum (<i>Prunus</i> sp.)	Black knot	Practice plant sanitation in winter: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Disinfest pruning tool between cuts. Improve air circulation. Rogue infected wild cherry trees in surrounding area.
	Cherry leaf spot	In autumn, rake and discard or destroy all fallen leaves, fruit, and branches.
	Cytospora canker	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Fertilize properly. Water during drought.
	Monilinia shoot blight	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Disinfest pruning tool between cuts.
	Peach leaf curl	Remove affected leaves before powdery spores appear.
	Aphids	See Birch.
	Borers (peachtree borer and lesser peachtree borer)	Peachtree borer may girdle at soil line; lesser peachtree borer causes twig or branch dieback and galleries in bark; bark fragments and frass collect on external bark along with gum, and suckers grow below injury site. Pheromone lure traps helpful for monitoring and provide some control. Borers strongly attracted to damaged bark. Do not pile mulch against <i>Prunus</i> stems.
	Eastern tent caterpillar	See Crabapple.
	European fruit lecanium scale	See Dogwood.
	Japanese beetle	See Crabapple.
	Spider mites	See Arborvitae.
	White prunicola scale	Weakened branches, white coated trunk and twigs, dieback. Two generations per year. Predators and parasites abundant but not reliable for control. Scrub infested bark with soft brush dipped in milk soap solution.
	Forsythia (<i>Forsythia</i> sp.)	Crown gall
Hawthorn (<i>Crataegus</i> sp.)	Cedar-apple/cedar hawthorn rust	Plant resistant cockspur (<i>Crataegus crus-galli</i>).
	Diplocarpon leaf spot	In autumn, rake and discard or destroy all fallen leaves, fruit, and branches. Do not plant English hawthorns. Instead, plant resistant hawthorns such as Cockspur.
	Fire blight	See Cotoneaster.
	Borer	See Crabapple—Roundheaded appletree borer.



Japanese beetle

continued

Table 11. Tree and shrub pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Hawthorn (<i>Crataegus</i> sp.) (continued)	Lace bug	See Cotoneaster. Cockspur, <i>Crataegus crus-galli</i> , appears to be resistant. (note: under Diplocarpon it says cockspur IS resistant)
	Leafminer	Blotches on distal half of leaf. Two wasp parasites often provide control. <i>Crataegus mollis</i> rarely mined.
	Scales	See Arborvitae.
	Spider mites	See Arborvitae.
Hemlock (<i>Tsuga</i> sp.)	Elongate hemlock (Fiorinia) scale	Yellow needles and premature needle drop. Several parasites and predators exist but have little effect in reducing populations. Wind blows crawlers to other trees. Avoid nitrogen fertilizer on trees with uncontrolled infestation.
	Hemlock scale	Yellowish foliage and premature needle drop. Parasites usually keep this scale in check. It is easily confused with another hemlock scale, <i>Nuculaspis tsugae</i> .
	Hemlock woolly adelgid	Cottony sacs attached to twigs (may look like light snow covering); premature leaf drop and dieback. No effective parasites available. Do not apply nitrogen fertilizer to infested hemlocks. Western hemlocks appear to be resistant.
	Spider mites	See Arborvitae.
Holly (<i>Ilex</i> sp.)	Cottony maple leaf scale	See Dogwood.
	Holly leafminer	Linear mines in leaves; feeding punctures. Insect reproduces only on <i>Ilex aquifolium</i> . Adults may feed on other holly species. Handpick infested leaves and destroy before May.
	Native holly leafminer	Lineal to small blotch leaf mines (insect lays eggs on underside of leaf; larvae mine predominantly in palisade cells) Handpick and destroy infested leaves before May.
	Scales	See Arborvitae.
	Twobanded Japanese weevil	Notches of various depth in leaves. Natural enemies have not been studied. Females parthenogenetic (no males).
Honeylocust (thornless varieties) (<i>Gleditsia</i> sp.)	Nectria canker	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Disinfest pruning tool between cuts. Fertilize properly. Water during dry periods.
	Honeylocust plant bug	Tiny yellowish to brown spots in leaves; many leaves distorted. No effective predators or parasites available.
	Honeylocust pod gall midge	Deformed, pod-shaped leaves. No effective parasites available. Eggs often laid on newly opening buds.
	Scales	See Arborvitae.
	Spider mites	See Arborvitae.
Honeysuckle (<i>Lonicera</i> sp.)	Herpobasidium leaf blight	In autumn, rake and discard or destroy all fallen leaves, fruit, and branches.

Table 11. Tree and shrub pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Honeysuckle (<i>Lonicera</i> sp.) (continued)	Honeysuckle aphid	Witches'-brooming on new shoots; distorted, folded, and dwarfed leaves. Several predators exist but not effective. Resistant honeysuckle cultivars available.
	Leafroller	See Crabapple.
	Spider mites	See Arborvitae.
	Whitefly	See Azalea.
Horsechestnut and buckeye (<i>Aesculus</i> sp.)	Leaf blotch (<i>Phyllosticta paviae</i>)	In autumn, rake and discard or destroy all fallen leaves, fruit, and branches.
Ivy (Boston) and Virginia creeper (<i>Parthenocissus</i> sp.)	Phyllosticta leaf spot	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Disinfest pruning tool between cuts. In autumn, rake and discard or destroy all fallen leaves, fruit, and branches. Prune to thin plants and plantings. Avoid crowding plants; allow air to circulate around and within plants.
	Powdery mildew	In autumn, rake and discard or destroy fallen leaves, fruit, and branches. Prune to thin plants and plantings. Avoid crowding plants; allow air to circulate around and within plants.
	Japanese beetle	See Crabapple.
	Scales	See Arborvitae.
	Spider mites	Stippled foliage. Wash off with water occasionally as needed. A strong stream of water can be used to remove many spider mites from plants.
Ivy (English) (<i>Hedera helix</i>)	Anthracnose	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Prune to thin plants and plantings. Disinfest pruning tool between cuts. Avoid crowding plants; allow air to circulate around and within plants. In autumn, rake and discard or destroy all fallen leaves.
	Bacterial leaf spot (<i>Xanthomonas bederae</i>)	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Prune to thin plants and plantings. Disinfest pruning tool between cuts. Avoid crowding plants; allow air to circulate around and within plants.
	Scales	See Arborvitae.
	Spider mites	See Ivy, Boston.
Juniper (<i>Juniperus</i> sp.)	Cedar-apple/cedar hawthorn rust	Remove galls in early spring. Apply sulfur, if needed, according to label directions. Plant resistant varieties: <i>Juniperus chinensis</i> : Femina, Keteleeri, or var. <i>sargentii</i> ; <i>J. communis</i> : Aureo-spicata var. <i>depressa</i> , var. <i>saxatilis</i> , or Suecica; <i>J. sabina</i> : all varieties; <i>J. squamata</i> var. <i>fargesii</i> ; or <i>J. virginiana</i> cv. Tripartita.

continued

Table 11. Tree and shrub pest management (continued)

Plant	Pest/Disease	Description/Cultural Management
Juniper <i>(Juniperus sp.) (continued)</i>  Juniper tip blight  Juniper scale	Tip blight	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Prune to thin plants and plantings. Disinfest pruning tool between cuts. Avoid crowding plants; allow air to circulate around and within plants. Overwatering increases tip blight; Water sparingly if at all. Plant resistant varieties: <i>J. chinensis</i> : Femina, Iowa, Keteleeri, Pfitzeriana Aurea, Robusta, var. <i>sargentii</i> , <i>sargentii</i> cv. Glauca, or Shoosmith; <i>J. communis</i> : Ashfordii, Aureo-spica, var. <i>depressa</i> , Hulkjaerhus, Prostrata Aurea, Repanda, or var. <i>saxatilis</i> ; <i>J. sabina</i> : Broadmoor, Knap Hill, or Skandia; <i>J. scopulorum</i> Silver King; <i>J. squamata</i> : Campbelli var. fargesii, <i>Prostrata</i> or <i>Pumila</i> ; <i>J. virginiana</i> cv. Tripartita. Avoid excess fertilizer.
	Arborvitae leafminers	See Arborvitae.
	Juniper scale	Yellowed foliage. Parasites not effective. Prune out infested areas as much as possible.
	Juniper webworm	Webbed twigs; brown foliage Several effective natural enemies available. Plant resistant varieties: <i>J. chinensis</i> Pfitzeriana or <i>J. sabina</i> .
	Spider mites	See Arborvitae.
Laurel (<i>Kalmia</i> sp.)	Fungal leaf spot	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Prune to thin plants and plantings. Avoid crowding plants; allow air to circulate around and within plants. Verify diagnosis.
	Black vine weevil	See Azalea.
	Borer	See Cotoneaster.
	Lace bug	See Andromeda.
	Whitefly	See Azalea.
Lilac (<i>Syringa</i> sp.)	Bacterial blight (<i>Pseudomonas syringae</i>)	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Prune to thin plants and plantings. Avoid crowding plants; allow air to circulate around and within plants. Avoid high nitrogen fertilizer.
	Powdery mildew	In autumn, rake and discard or destroy all fallen leaves, fruit, and branches. Prune to thin plants and plantings. Avoid crowding plants; allow air to circulate around and within plants.
	Lilac borer/Ash borer	Dwarfed or pale foliage and holes; sawdust may collect on bark. Woodpeckers most important predators. Sex pheromone traps useful for monitoring to determine treatment date. Avoid pruning when moths are active. Dig out larvae. Remove borers with knife and piece of wire with sharp point or barb. Cut with caution, being sure not to remove more wood than necessary. Carefully cut wounds usually heal without noticeable injury to tree. Keeping plants

Table 11. Tree and shrub pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Lilac (<i>Syringa</i> sp.) (continued)  Oystershell scale	Lilac leafminer	healthy and vigorous by proper cultivation, fertilization, pest control, and watering will help infested plants overcome effects of borer injury.
	Oystershell scale	Blotch-type mines on both lilac and privet. Little is known about natural enemies. Handpicking and destroying infested leaves on small plants may be effective.
	Twobanded Japanese weevil	Weakened, unthrifty plant with dead twigs. If scale infestations small, prune out affected plant parts. Parasites usually present but do not prevent host damage.
	White prunicola scale	See Holly.
Linden, littleleaf (<i>Tilia</i> sp.)	Japanese beetle	See Crabapple.
London plane (Sycamore) (<i>Platanus</i> sp.)	Anthracnose	In autumn, rake and discard or destroy all fallen leaves, fruit, and branches. London plane trees less severely affected than American sycamore trees.
	Powdery mildew	In autumn, rake and discard or destroy all fallen leaves, fruit, and branches. Prune to thin plants and plantings. Avoid crowding plants; allow air to circulate around and within plants.
	American plum borer	Red frass on loose bark, oozing sap on trunk. Borer has been recorded on several shade and flowering fruit trees. Several effective wasp parasites available. Avoid injured bark, which may increase susceptibility.
	Lace bug	See Cotoneaster.
	Scales	See Arborvitae.
Magnolia (<i>Magnolia</i> sp.)	Magnolia scale	Scale insects are 1/2-inch, round, white dusty to varnish brown. Sooty mold, small leaves, dead twigs. Several effective parasites and predators available. Prune out affected plant parts. Carefully scrape off scales. Remove large female scales by hand in July before crawlers emerge.
	Sassafras weevil (also known as yellow poplar weevil)	Blotch leafmines and irregular holes in leaves. Both larvae and adults injure plants. Several parasites exist, but pupal parasites most important. Knock weevils into soapy water or handpick and destroy when present.
Mahonia	Leaf scorch	Plant where protected from wind.
Maple (<i>Acer</i> sp.)	Anthracnose	In autumn, rake and discard or destroy all fallen leaves, fruit, and branches.
	Decline	Prune dead limbs in dormant season. Water and fertilize properly.
	Girdling roots	Plant carefully, spread out roots. Excavate and prune offending roots on established trees, then water and fertilize.

continued

Table 11. Tree and shrub pest management (continued)

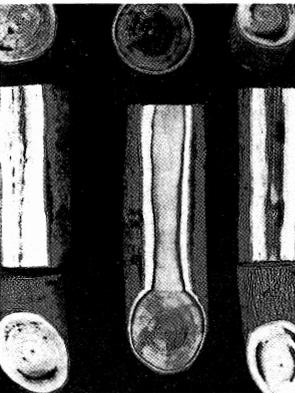
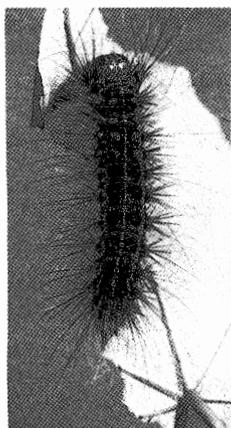
Plant	Pest/Disease	Description/Cultural Management
Maple (<i>Acer</i> sp.) (continued)	Leaf scorch	Avoid use of deicing salt nearby. Water during drought.
	Tar spot	In autumn, rake and discard or destroy all fallen leaves and branches. Verify diagnosis. Disease usually not severe except on Norway maple.
	Verticillium wilt	Fertilize properly. Water during dry periods. Verify diagnosis. Accurate diagnosis required before more specific treatment.
	Aphids	See Birch.
	Borer	See Cotoneaster.
	Cottony maple scale, Cottony maple leaf scale	See Dogwood. If infestation is small, prune out affected plant parts.
	Maple bladdergall mites	Small ($\frac{1}{16}$ to $\frac{1}{8}$ in.), globular, pouch-like galls on foliage, especially that of silver maple. Galls unsightly but usually of little or no consequence to tree. Mites' abundance varies with season. No parasites known; predators unpredictable.
Two declining maple trees		
	Discoloration in wood of maple branches infected with <i>Verticillium</i> wilt	
		Leaf scorch on maple trees
Mountain ash (<i>Sorbus</i> sp.)	Cytospora canker	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Fertilize properly. Water during drought.
	Fire blight	See Cotoneaster.
Mountain ash sawfly	Mountain ash sawfly	Partial defoliation with petiole and main vein remaining; young larvae feed gregariously, devouring leaves one at a time. No information available about effects of natural enemies. Prune off and destroy infested foliage while larvae present but small in size.
	Roundheaded appletree borer	See Crabapple.
	Spider mites	See Arborvitae.

Table 11. Tree and Shrub pest management *(continued)*

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Oak (<i>Quercus</i> sp.)	Anthracnose and other leaf spot diseases	In autumn, rake and discard or destroy all fallen leaves, fruit, and branches.
	Leaf blister	In autumn, rake and discard or destroy all fallen leaves, fruit and branches.
	Gypsy moth	Complete or partial defoliation of tree. Several introduced and native parasites available. Damaging populations of moths often occur in 7- to 10-year cycles. Remove and destroy egg masses anytime from September through mid-April, assessing population and potential damage when young larvae present, and treatment if needed, using bands around trees at proper time to trap larvae, destroying pupae as found, and helping tree by watering and fertilizing properly, especially if severe defoliation occurs. Pheromone traps useful for monitoring in some areas. Some species such as ash and tulip poplar rarely attacked.
	Leaf tiers	See Crabapple.
	Oak blotch leafminers	Blotch mines; severity varies by season. Parasites have not been studied. Mines usually no threat to tree. Rake and discard fallen leaves.
	Oak leaf galls	Galls on leaves; overall tree health usually not affected. Controls work under special circumstances only. On small trees, where practical, handpick and destroy galls before gallmakers emerge.
	Oak skeletonizer	Skeletonized leaves. Natural enemies may affect their numbers in cycles.
	Scales	See Arborvitae.
	Twig galls	Where possible, prune out and destroy galls before gallmakers emerge. For specific galls, seek further information. There may be no practical controls for some galls.



Gypsy moth larva

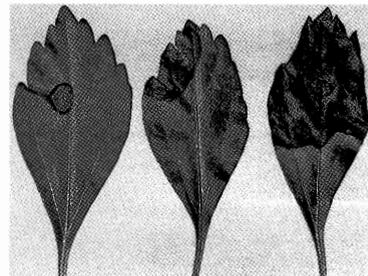


Leaf blister on oak

continued

Table 11. Tree and shrub pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Pachysandra (<i>Pachysandra</i> sp.)	Volutella blight	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Prune to thin plants and plantings. Avoid crowding plants; allow air to circulate around and within plants. Rogue plants: remove and discard and destroy entire infested plant and immediately surrounding soil or soil clinging to roots. Do not plant pachysandra in sites where direct sunlight exceeds two hours per day.
	Euonymous scale	Prune out infested plant parts. See Euonymus.
Periwinkle (<i>Vinca</i> sp.)	Stem canker (<i>Phomopsis livella</i>)	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Prune to thin plants and plantings. Disinfest pruning tool between cuts. Avoid crowding plants; allow air to circulate around and within plants. Rogue plants: remove and discard or destroy entire infested plant and immediately surrounding soil or soil clinging to roots.
	See Andromeda.	
Pines (<i>Pinus</i> sp.)	Diplodia twig blight (<i>Sphaeropsis</i>) (especially Austrian pine)	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Disinfest pruning tool between cuts. Dispose of fallen cones. Water during drought.
	Lophodermium needlecast	Improve air circulation.
	White pine blister rust	Practice plant sanitation: when foliage is not wet, carefully prune and discard or destroy affected plant parts. Disinfest pruning tools between cuts. Rogue severely infested plants: remove and discard or destroy entire infested plant. Plant currants and gooseberries at least 500 feet away.
	Aphids	Unthrifty plants, sooty mold, distorted foliage, and reduced shoot growth. Many natural enemies. Predators usually found with high aphid populations.
	European pine shoot moth	Damaged or dead buds and shoots. Many effective parasites; at times may keep population in check. Pheromone traps useful for monitoring. Prune out dead buds and dying shoots.
	Gypsy moth	See Oak.
	Nantucket pine tip moth	Dead buds, shoots, or both. Many parasites and other natural enemies; none has provided satisfactory control. Prune out dead portions.
	Pine bark adelgid	Small cottony spots on trunk bark, branches, and twigs and occasionally at base of needles on new shoots. Spruce is



Volutella blight on pachysandra leaves



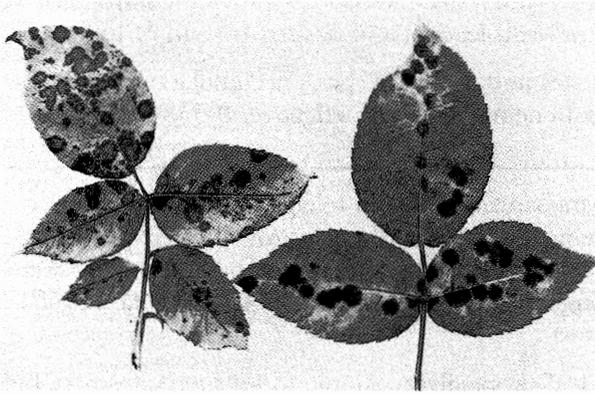
White pine blister rust canker on white pine trunk

Table 11. Tree and shrub pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Pines (<i>Pinus</i> sp.) (continued)		secondary host, but adelgid can repeatedly reproduce itself on pine. Natural enemies have not been studied. Scrub infested bark with soft brush and mild soap solution; or "blast" off with high-pressure water.
	Pine needle scale	From a distance foliage may look white to gray; needles turn yellowish, then brown. Be sure of scale's identification. Several treatments usually required. Parasites rarely effective under landscape or plantation conditions. Pruning out infested branches may be helpful.
	Pine sawflies	Total or partial defoliation. Most conifer sawflies live in colonies. Some sawflies may have two generations per year and may appear anytime during growing season. Remove by hand and destroy when seen on small trees.
	Pine spittlebugs	Spittle masses on shoots (<i>Aphrophora parallella</i>) and yellowed foliage followed by dead twigs (<i>Aphrophora saratogensis</i>). Winter and spring weather conditions have major effect on populations. <i>A. parallella</i> is aesthetically damaging, <i>A. saratogensis</i> adult is economically damaging. Scouting for adults is necessary. Eliminate nearby sweetfern and alternative hosts (blackberry, other weeds) for <i>A. saratogensis</i> .
	Pine tortoise scale	Sooty mold, short needles, dead branches. Parasites usually not found until population is massive. Pruning may be helpful if population is small.
	White pine weevil	Dead leader. Natural enemies do not provide control. Cut out wilted or dead leaders and destroy by end of June.
	Zimmerman pine moth	Dead branches and terminals, pitch accumulation in whorl area. Natural enemies not very effective. Prune out where practical.
 Pine tortoise scale		
	Privet (<i>Ligustrum</i> sp.)	
	Anthracnose	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Disinfest pruning tool between cuts. Fertilize properly. Water during drought. Plant resistant privets: Amur, Ibot, Regal, and California.
	Privet rust mite	Premature leaf drop, silvery stipple to foliage. Mites may be present from May through November. Predaceous mites most effective natural enemy.
	Privet thrips	Chlorotic flecks or dusty grayish appearance of leaves. No dependable parasites or predators.
	Scales	See Arborvitae.
Twobanded Japanese weevil	See Holly.	
White prunicola scale	Prune out severely infested branches. See Flowering peach, cherry, and plum.	

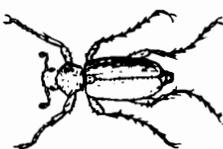
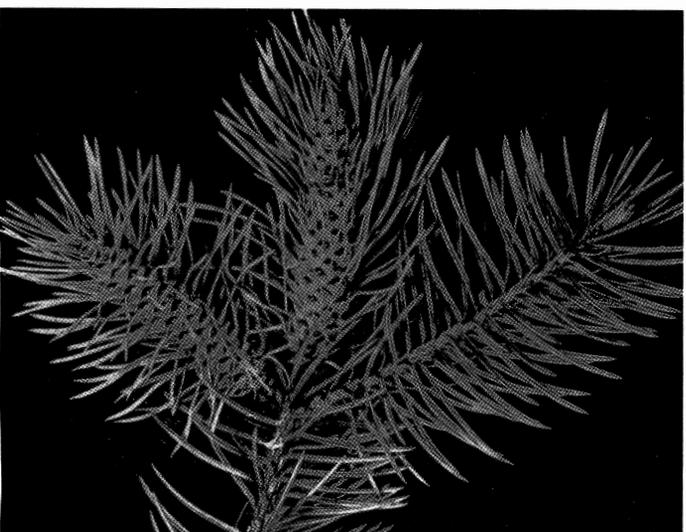
continued

Table 11. Tree and shrub pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Pyracantha	See Firethorn.	
Quince (<i>Cydonia</i> sp.)	Crown gall	Rogue plant: remove and discard or destroy entire infested plant and immediately surrounding soil or soil clinging to roots. Practice crop rotation: set plants in a location different from where they grew previously. If that is not possible, for small shrubs remove infested soil and replace with fresh soil.
	Fireblight	See Cotoneaster.
	Rust	None.
Rhododendron (<i>Rhododendron</i> sp.)	See Azalea.	
	Rhododendron borer	Drought-stressed appearance; holes in bark, often at limb crotches. Sex pheromone traps useful to provide spray timing data. Natural enemies not effective for control. Prune out and destroy infested portions or carefully cut out borers, damaging as little wood as possible.
	Rhododendron gall midge	Distorted or deformed foliage; open-grown plants and those with good air circulation less susceptible to injury. Weekly removal of infested leaves can reduce infestation. Natural enemies have not been studied. Some species and cultivars resistant or not susceptible.
Roses (<i>Rosa</i> sp.)	Black spot	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. In autumn, rake and discard or destroy all fallen leaves, fruit, and branches. Avoid wetting foliage overnight or for long periods of time. Many species and cultivars resistant. Some black spot disease-resistant rose hybrids include: Hybrid teas (Charlotte Armstrong, Duet, First Prize, Mister Lincoln, Peace, Tiffany, and Tropicana); Floribunda/Grandifolia (Angel Face, Carousel, Goldilocks, Love, Montezuma, Queen Elizabeth, Razzle Dazzle, and Sunsprite); Shrub roses (All that Jazz, Carefree Wonder).
		
	Botrytis blight (Gray mold)	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Prune to thin plants and plantings. Avoid crowding plants; allow air to circulate around and within plants.
	Crown gall	Rogue plants: remove and discard or destroy entire infested plant and immediately surrounding soil or soil clinging to roots. Practice plant rotation: set plants in a location different from where they grew previously. If that is not possible, for small shrubs remove infested soil and replace with fresh soil.
	Powdery mildew	In autumn, rake and discard or destroy all fallen leaves, fruit, and branches. Prune to thin plants and plantings; avoid

Black spot of rose

Table 11. Tree and shrub pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>	
Roses (<i>Rosa</i> sp.) (continued)		crowding plants; allow air to circulate around and within plants.	
	Rust	Prune to thin plants and plantings; avoid crowding plants; allow air to circulate around and within plants.	
	Aphids	Reduced shoot growth and distorted or pale green foliage; unthrifty plant with sooty mold present. Many natural enemies; predators usually found with high aphid populations.	
	 Japanese beetle	Japanese beetle	Skeletonized leaves and damaged flowers; partial to roses. Handpick beetles.
	Leafhoppers	Stippled and sometimes distorted or otherwise deformed foliage, swollen shoots, honeydew, sooty mold. Natural enemies rarely effective for control.	
	Mossy rose gall	Mossy growth on stems of plants (caused by gall wasp). Prune out on appearance.	
	 Rose chafer	Rose chafer	Skeletonized leaves and damaged flowers. Handpick beetles and destroy.
	Rose midge	Blackened and dead buds and leaves. Remove and destroy affected buds as soon as you spot them.	
	Roseslugs (sawfly larvae)	Skeletonized upper leaf surface. If infestation small, remove affected leaves. Handpick large sawfly larvae. Wash "slugs" from plants with strong jet of water.	
	Spider mites	See Arborvitae.	
Spruce (<i>Picea</i> sp.)	Cytospora canker	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Prune to thin plants and plantings. Avoid crowding plants; allow air to circulate around and within plants. Disinfest pruning tools between cuts. Fertilize lightly and water during drought. Avoid wounding branches.	
	Cooley spruce gall adelgid	Pineapple-shaped galls on new spring growth (usually affects Colorado blue, Englemann, Sitka, and oriental spruces). Pick galls (prune out) before gallmakers emerge (July) and destroy (bury or burn) to kill gallmakers. No effective parasites available. Some trees resistant to adelgids. Do not fertilize infested trees. Douglas fir is an alternate host. Do not plant blue spruce and Douglas fir together.	
		<p>Cooley spruce gall</p>	

continued

Table 11. Tree and shrub pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Spruce (<i>Picea</i> sp.) (continued)	Eastern spruce gall adelgid	Galls at base of new shoots (primary pest of Norway spruce). On small trees, prune and destroy green galls before insects emerge. No effective parasites or predators. Some trees resistant to adelgids.
	Sawfly	See Pines.
	Spruce bud scale	Sooty mold, dead twigs, and branches. Parasites effective. Manually remove scale if practical.
	Spruce spider mite	To monitor, tap branches over white piece of paper. If more than 10 mites per tap, treatment is recommended. Use lower threshold on Alberta spruce. Cool-season pest. See Arborvitae.
	Twospotted spider mite	See Andromeda, spider mites. Populations favored by hot, dry conditions.
 White pine weevil	White pine weevil	See Pines. Remove and destroy infested leaders as soon as they are noticed.
Sycamore	See London plane.	
 Black vine weevil injury	Taxus (Yew) (<i>Taxus</i> sp.)	
	Black vine (taxus) weevil	See Azalea.
	Fletcher scale	Sooty mold, unthrifty plant. If scale infestations small, prune out affected plant parts.
	Mealybug	Sooty mold, unthrifty plants, thin foliage. Natural enemies have not been studied.
		 Black vine weevil
Viburnum (<i>Viburnum</i> sp.)	Downy mildew	In autumn, rake and discard or destroy all fallen leaves, fruit, and branches. Prune to thin plants and plantings. Disinfect pruning tool between cuts. Avoid crowding plants; allow air to circulate around and within plants.
	Aphids	See Birch.
	Cottony maple leaf scale	See Dogwood.
	Viburnum leaf beetle	Skeletization of leaves May–June by larvae, oblong cutouts in leaves by adults July–September. Prune and destroy twigs with egg masses (rows of black bumps on underside of current year's growth) in late fall or early spring. Some viburnums resistant, including <i>V. carlesii</i> , <i>V. burkweedii</i> , and <i>V. rhytidiophyllum</i> .
Vinca	See Periwinkle.	
Willow (<i>Salix</i> sp.)	Black canker and twig blight	Practice plant sanitation: when foliage is not wet, carefully prune or remove and discard or destroy affected plant parts. Disinfect pruning tools between cuts. <i>Salix babylonica</i> (weeping willow) and <i>S. pentandra</i> (laurel willow) are somewhat resistant.

Table 11. Tree and shrub pest management (continued)

Plant	Pest/Disease	Description/Cultural Management
Willow (<i>Salix</i> sp.) (continued)	Aphids	See Birch.
	Borers	See Crabapple.
	Imported willow leaf beetle	Skeletonized and notched leaves. Several parasites available. Pupal parasite effective in population control.
	Scales	See Arborvitae.
Yew	See Taxus.	

FURTHER READING

- Coyier, D. L., and M. K. Roan. 1986. *Compendium of Rhododendron and Azalea Diseases*. American Phytopathological Society, St. Paul, Minn. 65 pp.
- Daughtrey, M. L., G. W. Hudler, and W. A. Sinclair. 1983. *Crown Gall*. Cornell Cooperative Extension Tree Pest Leaflet A-5, Ithaca, N.Y. 11 pp.
- Horst, R. K. 1983. *Compendium of Rose Diseases*. American Phytopathological Society, St. Paul, Minn. 50 pp.
- Horst, R. K., ed. 1990. *Westcott's Plant Disease Handbook*. 5th ed. Van Nostrand Reinhold, New York. 953 pp.
- Hudler, G. W. 1984. *Diseases of Maples in Eastern North America*. Cornell Cooperative Extension Tree Pest Leaflet A-13, Ithaca, N.Y. 13 pp.
- Hudler, G. W., W. A. Sinclair, and W. T. Johnson. 1985 (rev.) *Anthraco-nose Diseases of Trees and Shrubs*. Cornell Cooperative Extension Tree Pest Leaflet A-2, Ithaca, N.Y. 6 pp.
- Johnson, W. T., and H. H. Lyon. 1988. *Insects That Feed on Trees and Shrubs*. Cornell University Press, Ithaca, N.Y. 556 pp.
- Lambooy, J. S., C. Klass, K. Sirois, and M. Wahling Cole. 1999. *Integrated Pest Management of Roses*. Cornell Ecogardening Fact Sheet 20. Dept. of Fruit and Vegetable Sciences, Cornell University, Ithaca, N.Y. 5 pp.
- Lieberman, A. S., and R. K. Weir III. 1986. *Suggested Practices for Planting and Maintaining Trees and Shrubs*. Cornell Cooperative Extension Information Bulletin 24, Ithaca, N.Y. 13 pp.
- Moorman, G. B. 1992. *Scouting and Controlling Woody Ornamental Diseases in Landscapes and Nurseries*. Pennsylvania State University, University Park, Pa. 90 pp.
- Pirone, P. P. 1978. *Diseases and Pests of Ornamental Plants*. 5th Edition. John Wiley and Sons, New York. 566 pp.
- Rakow, D. A., and R. Weir III. 1989. *Pruning: An Illustrated Guide to Pruning Ornamental Trees and Shrubs*. Cornell Cooperative Extension Information Bulletin 23, Ithaca, N.Y. 28 pp.
- Sinclair, W. A., and G. W. Hudler. 1984 (rev.). *Verticillium Wilt*. Cornell Cooperative Extension Tree Pest Leaflet A-3, Ithaca, N.Y. 8 pp.
- Sinclair, W. A., H. H. Lyon, and W. T. Johnson. 1987. *Diseases of Trees and Shrubs*. Cornell University Press, Ithaca, N.Y. 574 pp.
- Skelly, J. M., and W. Merrill. 1987. *Diagnosing Injury to Eastern Forest Trees*. Pennsylvania State University, University Park, Pa. 122 pp.
- Smith-Fiola, D. C. 1995. *Pest-Resistant Ornamental Plants*. Rutgers Cooperative Extension, Toms River, N.J. 42 pp.
- Stipes, R. J., and R. J. Campana. 1981. *Compendium of Elm Diseases*. American Phytopathological Society, St. Paul, Minn. 96 pp.

10 TREE-FRUIT PEST MANAGEMENT

Some important tree-fruit pests can be monitored by the home gardener. Monitoring is a way of assessing the presence of pests and the size of their population. It is a very useful part of integrated pest management (IPM).

Figure 1 (facing page) shows a calendar of events for apples in the Lake Plains area of New York. This calendar can give you an idea of the relationships between climate and biological phenomena (phenology) of the tree, the diseases, and the insects you may be faced with. Infection periods for diseases (primary and secondary) are included on the chart, as are estimates of activity for various life stages of the insect pests. This information, along with monitoring your specific situation for pests, will help you determine when activity begins and, in some cases, what the population levels are. From this information you can make decisions about what pests you need to manage in your fruit planting and where they can be most effectively controlled.



Do not spray insecticides when fruit trees are in bloom.

Visual traps, one monitoring tool, are available for some of these important tree-fruit pests. For example, both red sphere traps and yellow sticky-board traps are available to monitor the apple maggot fly. Visual traps are used to find out when adult flies are active near the apple tree.

Obviously, one must know what the adult apple maggot looks like to use these traps effectively. Monitoring will help in the development of specific pest management programs. In some cases, red sphere traps may be effective in controlling the apple maggot by trapping most of the females before they land on the real fruit and lay eggs. Synthetic apple volatile lures are now available, which greatly increase the efficiency of the traps. The emergence of black cherry fruit fly, cherry fruit fly, and blueberry maggot fly can also be monitored through the use of these traps. White rectangle traps are used to monitor the tarnished plant bug and European apple sawfly.

In addition to visual traps, pheromone traps are available. Pheromones are chemicals produced by insects and released into the environment to influence the behavior of other insects. Sex pheromones attract male insects, and the trap captures them. These traps are useful in determining the first emergence of males and the peak flight times.

The placement of traps for any of these monitoring tools is critical. Complete directions should be supplied by the manufacturer.

Effective pest management in home orchards depends on recognizing the pest problem, selecting appropriate pesticides, timing applications properly, and thoroughly covering the fruit and foliage with the spray.

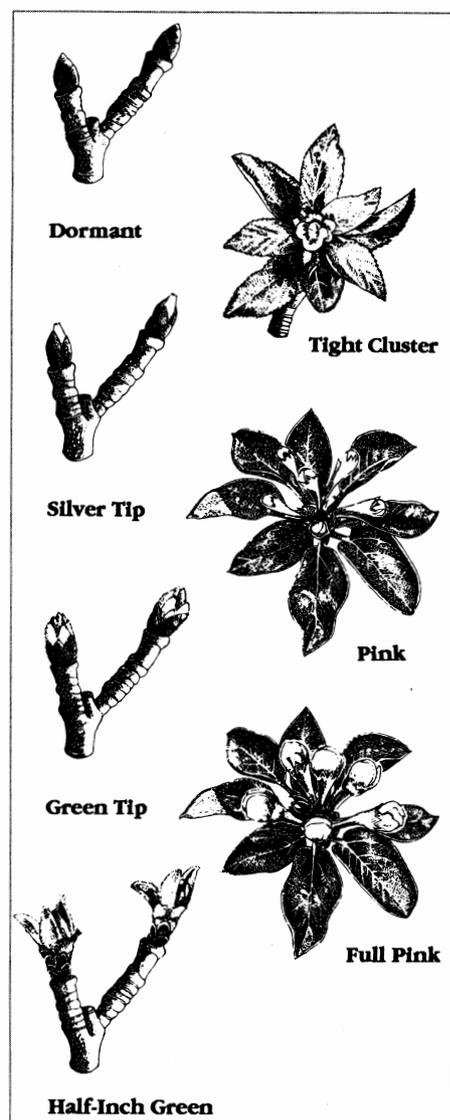


Figure 2. Key apple bud stages

If you are planting fruit trees, consider disease-resistant dwarf trees to minimize the need for fungicides.

Cultural pest management guidelines for tree-fruit follow. Pesticide guidelines are found in Part II, Tables 13 and 14.

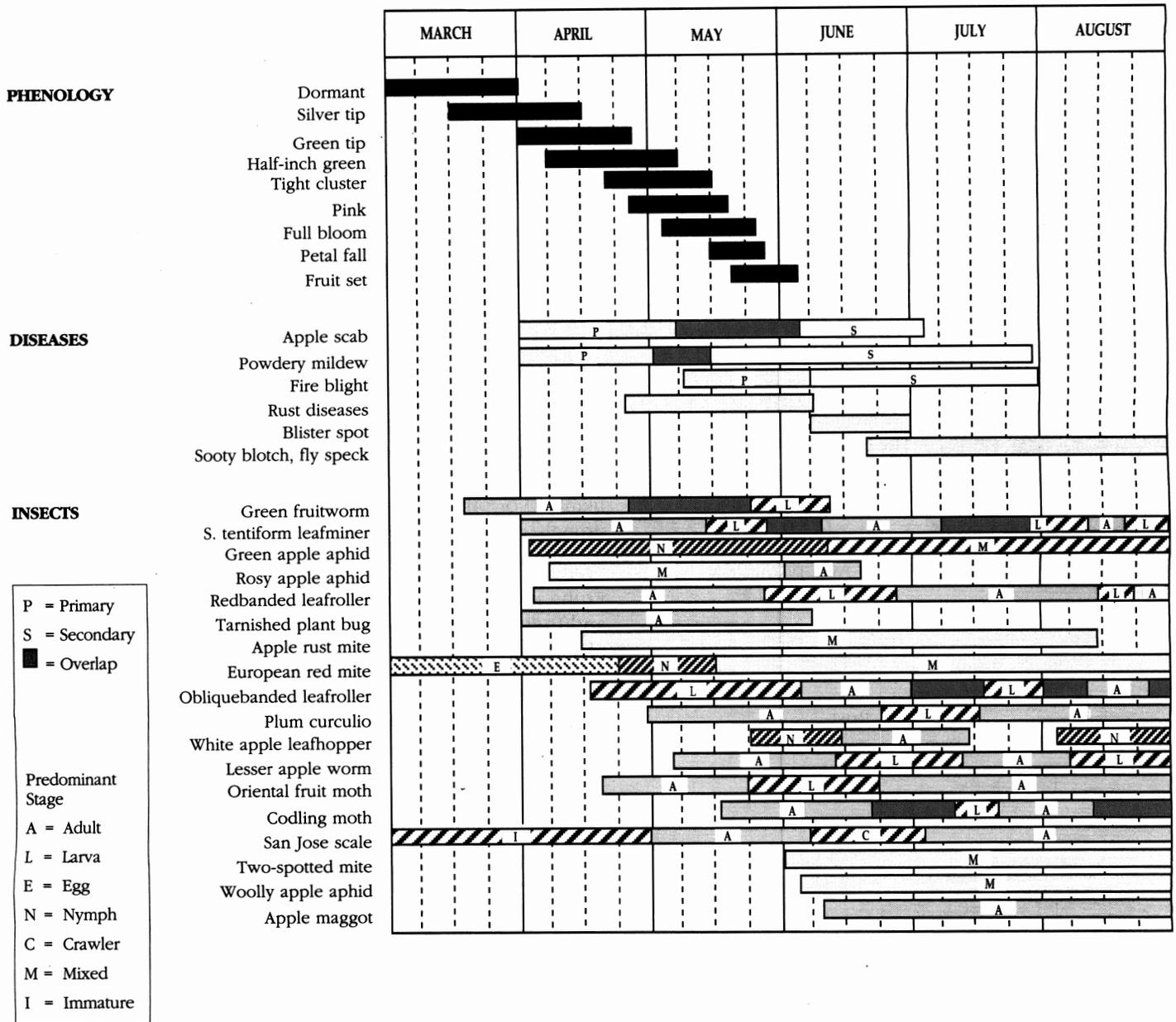


Figure 1. Calendar of events of apple in Lake Plains area of New York

Adapted with permission from 2000 Pest Management Guidelines for Commercial Tree-Fruit Production, 142RTE. College of Agriculture and Life Sciences at Cornell University, Ithaca, N.Y.

Table 12. Tree-fruit pest management

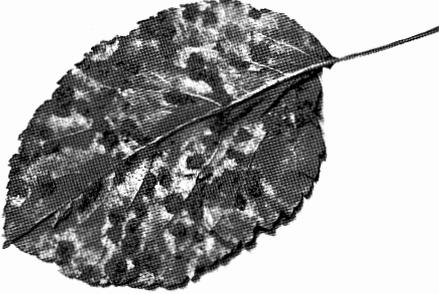
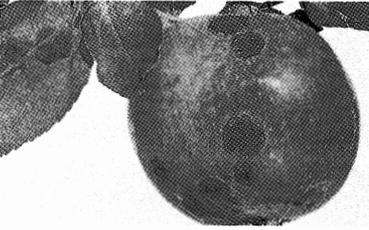
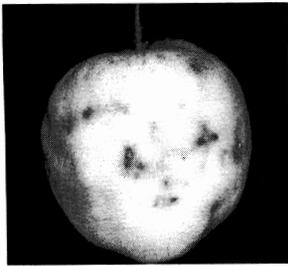
Plant	Pest/Disease	Description/Cultural Management
Apple (<i>Malus</i> sp.) 	Bitter rot	Primarily a problem in Hudson Valley and Long Island, New York, particularly in warm wet summers. Prune in early spring to remove all dead wood and promote good air circulation. Remove and destroy infected fruit as they appear in summer.
	Fire blight	Most serious on highly susceptible varieties (Fuji, Gala, Idared, Jonagold, Jonathan, Lodi, Mutsu, R. T. Greening, Paulared, Rome, Sir Prize, Spigold, 20-Ounce, York) and trees grown on fully dwarfing rootstocks. Practice plant sanitation: carefully remove and dispose of infected branches or fruit as soon as they appear, starting one to two weeks after bloom. Cut at least 6–12 in. below obvious signs of infection. Prune out remaining cankered branches during dormant season. Avoid high rates of nitrogen (including manure) or other practices that stimulate lush vegetative growth.
	Fire blight killing new shoot of apple	
	Powdery mildew	Prune out infected terminals as they develop late in summer. Prune in early spring to thin trees and allow air to circulate and fruit and leaves to dry quickly after rains. Highly susceptible varieties include Baldwin, Cortland, Idared, Jonathan, Monroe, Paulared, Rome, and Ginger Gold.
	Rust	Primarily a problem in southern half of state or in upstate locations where red cedars (<i>Juniperus</i> spp.) grow. Eliminate red cedars in and around orchard. Avoid highly susceptible varieties (Golden Delicious, Jonathan, Lodi, Prima, Roma, Summerred, 20-Ounce, York) in regions where rust is prevalent.
		
	Rust infections on an apple leaf	
	Scab	In autumn or as leaves or fruit drop in summer, rake and dispose of all fallen or diseased leaves and fruit. Prune in early spring to thin trees, which allows air to circulate and fruit and leaves to dry quickly after rains. Plant resistant varieties (Redfree, Prima, Liberty, Freedom, Jonafree, Macfree, Sir Prize, Gold Rush, Williams' Pride, Nova Spy, Enterpriz, and traditional russet apples such as Gold Russet and Rotburg Russet).
Apple scab infections on leaves and fruit		
	Sooty blotch and fly speck	Prune in early spring to remove dead wood, and thin trees to allow air to circulate and fruit and leaves to dry quickly after rains. Thin out crowded branches in late June to maintain good air circulation throughout summer. Adequate control can often be obtained with good pruning practices alone. These diseases more frequently a problem in downstate New York and in sites with abundant brambles nearby.

Table 12. Tree-fruit pest management (*continued*)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>	
Apple (<i>continued</i>)	Apple aphids	Small, often pear-shaped, soft-bodied insects that frequently occur in large colonies. Cause leaves to become twisted and rolled. Aphids excrete honeydew on which sooty mold, a black fungus, may grow. Rosy apple aphid may cause certain apple cultivars to become stunted and deformed and must be controlled early in growing season. Washing leaves with a strong stream of water may remove many aphids from plants. Green apple aphids on terminals will rarely require controls.	
	Apple maggot	Most destructive of all insects that attack apples. Commonly called railroad worm because of brownish trails larvae leave as they move through flesh of fruit. Late, hard "keeper" varieties more resistant. Infested fruit may drop prematurely. Pick up all drops in late August through September. Picking and destroying fallen apples weekly from early August through harvest destroys larvae within fruit and reduces potential for maggot injury the following year. This is most practical where trees are isolated and wild or abandoned trees are not nearby. Use visual traps for monitoring or control of one or a few dwarf trees. To help control flies, hang unbaited red sphere traps in trees at a rate of one trap per 100 to 150 fruit.	
		Apple maggot injury	
	Codling moth	Common "worm" found in apples. Pheromone traps can be used as monitoring tools. Band to trap. (To create substitute location for codling moth larvae to spin their cocoons and pupate, band tree trunks and large branches by tying 6-in. strips of burlap or cardboard around them. For central New York, band three times: May, mid-June to early July, and August. Timing in other locations may vary slightly. Check for larvae and cocoons and kill those you find.) Pick up all drops in late August and September.	
	European apple sawfly (eastern New York)	Distribution limited to Hudson Valley, Champlain Valley, and Long Island, New York. Adults lay eggs in calyx cup during bloom; larvae tunnel under skin of developing fruit, causing a characteristic spiral tunnel and misshapen apple. Later larval feeding in second- or even third-instar fruit may cause these fruit to drop. Pick up all drops in early June.	
	Leafrollers	Feed primarily on foliage, rolling and skeletonizing leaves, but may also feed on fruit, causing scarring. Sample frequently during July.	
	Mites	Cause bronzing of leaves. Predator mites usually keep them in check; if "soft," insecticides are used.	
	Plum curculio	One-quarter-inch-long roughened snout beetle that attacks all orchard fruit crops. Egg laying causes small crescent-shaped scar on fruit. Larvae bore toward center of fruit and feed there. Adults may cause injury by feeding either in fall or spring. Pick up and remove all drops in June and early	

continued

Table 12. Tree-fruit pest management (continued)

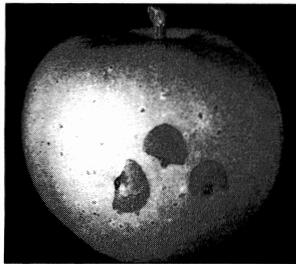
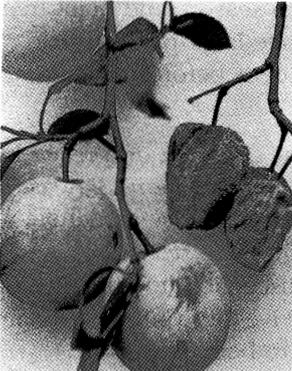
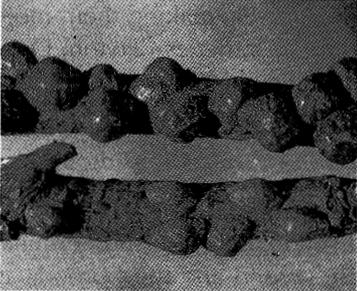
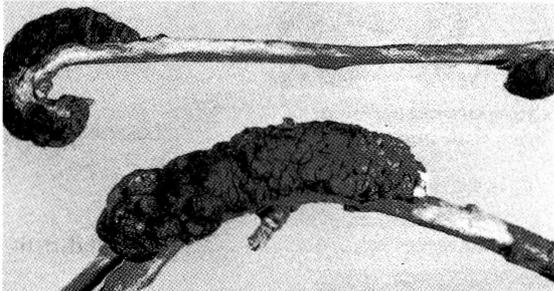
Plant	Pest/Disease	Description/Cultural Management
<p>Apple (continued)</p>		<p>July. Jarring, a mechanical method of control, is sometimes helpful; results may vary. If tree is suddenly jarred with a padded mallet, plum curculio beetles loosen their hold, contract their legs, and fall to the ground. Jarring should be done in early morning. Place sheets on ground to collect beetles and then destroy them. <i>Note:</i> Young trees can be severely damaged if hit too hard.</p>
<p>Plum curculio injury to apple</p>	<p>Roundheaded appletree borer</p>	<p>Redbanded leafroller Caterpillars feed on leaves and occasionally on fruit. Two broods present each year in New York. No cultural control available.</p>
	<p>Roundheaded appletree borer</p>	<p>Larvae bore into trunk and feed in sapwood. Tunnels weaken tree and may cut off sap flow, cause dieback, or kill tree. Injury predisposes tree to other pests. Downy woodpecker only known natural enemy. Ring bottom 12–24 in. of trunks with oviposition barriers in May. Oviposition barriers include wire mosquito netting, hardware cloth, tar paper, or several layers of newspaper. Barriers should be loose except at bottom (cover with soil) and top (tie with cord). Remove barriers at end of season (September). Remove borers from trees with knife and piece of wire with hooked tip. Clear litter away from bases of trees to help locate borers. Young borers can usually be cut out; older ones can be probed for with flexible wire. Cut with caution, being sure not to remove more wood than necessary. If cut carefully, wounds usually heal without noticeable injury to tree. Keeping trees healthy and vigorous by proper cultivation, fertilization, pest control, and watering will help infested trees overcome effects of borer injury.</p>
	<p>San Jose scale</p>	<p>Feeds by sucking sap from all parts of the tree and fruit. Fruit spotting may occur and branch dieback may result. Prune infested branches.</p>
<p>Cherry (<i>Prunus</i> sp.)</p>	<p>Black knot</p>	<p>Occurs on numerous cultivated and wild plums, prunes, and cherries (<i>Prunus</i> spp.). Disease is characterized by presence of warty, black gall and may vary in length from 1/2 in. to more than 1 ft. Remove wild choke cherries; remove and burn all cankers as soon as you notice them.</p>
	<p>Brown rot</p>	<p>See Peach, nectarine, and apricot.</p>
	<p>Fungal leaf spot</p>	<p>In autumn, rake and dispose of all fallen or diseased leaves and fruit. This will control leaf spot in addition to brown rot.</p>
	<p>Cherry fruit flies</p>	<p>Maggots attack developing cherries, feeding on flesh. Adult emergence begins in early June and continues about one month. Sticky traps can be used to monitor adult activity.</p>
	<p>Plum curculio</p>	<p>See Apple.</p>
<p>Peach, nectarine, and apricot (<i>Prunus</i> sp.)</p>	<p>Brown rot</p>	<p>Clean up fallen fruit before and during harvest; remove and dispose of all unharvested fruit and mummy fruit from trees after harvest.</p>

Table 12. Tree-fruit pest management (*continued*)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Peach, nectarine, and apricot (<i>continued</i>)  Cytospora canker on a stone-fruit branch	Cytospora canker	Delay annual pruning and bloom. Prune to thin trees and allow air to circulate and fruit and leaves to dry quickly after rains. Remove all weak, gumming, or dead twigs and branches during pruning; do not leave pruning stubs. Train new trees to promote wide angles between major scaffold branches and trunk. Promote winter hardiness: fertilize only early in season, withhold water late in season, and paint tree trunks with interior (water-based) white latex paint before winter. Remove old cankered peach trees before planting new peach trees.
	Peach leaf curl (peaches, nectarines)	Springtime disease of peach, nectarine, almond, and related ornamental species caused by <i>Taphrina deformans</i> . Disease not serious except in rainy years when it can cause defoliation of unsprayed trees early in the growing season. This weakens trees, making them more susceptible to winter injury. The varieties Clayton, Q 1-8, Five Star Curlless, Indian Blood Free, and others are reported to be resistant.
	Lesser peachtree borer	Adult is a clear-winged moth that feeds on cambium or inner bark of tree, often causing individual limbs to die back. Keep trees in good vigor and avoid wounding.
	Oriental fruit moth	First brood attacks young terminals of peach trees, causing death; second and third broods attack fruit. Plastic ties impregnated with sex pheromone are available commercially. Hang in trees (rate of 400/acre) after bloom to disrupt mating and prevent production of injurious larvae. Use in small orchard settings may not provide satisfactory control because mated females can move in from nearby alternate hosts.
	Peachtree borer	Adult is a clear-winged moth that feeds on cambium or inner bark of tree, girdling it. Entire tree may be killed. Gummosis often present but may be caused by other injuries. Keep trees in good vigor and avoid wounding. Painting lower 1 to 2 feet of trunk with white latex paint can help prevent bark splitting and may also deter egg laying by this pest.
	Plum curculio	See Apple.
Pear (<i>Pyrus</i> sp.)	Fabraea leaf spot	Primarily a problem in southern half of New York State. Use same control program as for scab.
	Fire blight	See Apple. Most common pear varieties, except for Seckel, are extremely susceptible. Resistant varieties include Harrow, Delight, Magness, and Moonglow.
	Scab	In autumn, rake and dispose of all fallen leaves. Scab seldom a problem on Bartlett.
	Aphids	See Apple.
	Pear psylla	Adults resemble tiny cicadas and may cause early defoliation of tree and loss of crop. Honeydew and sooty mold often found, soiling leaves and fruit. Three to four generations

continued

Table 12. Tree-fruit pest management (continued)

Plant	Pest/Disease	Description/Cultural Management
Pear (continued)		<p>occur each year. Entomopathogenic fungi are being investigated for control. Sucker trees regularly during the season to remove excess succulent leaf growth, which supports psylla populations.</p>
Plum and Prune (<i>Prunus</i> sp.)	<p>Black knot</p> <p>Brown rot</p> <p>Lecanium scale</p> <p>Plum curculio</p>	<p>Prune out and remove all knotted branches before bud-break. Rogue infected wild cherry trees in surrounding area.</p> <p>See Peach, nectarine, and apricot.</p> <p>Feed on branches and leaves, causing copious honeydew, sooty mold, and weakening or death of infested branches. Scales may predispose trees to other secondary pests. Prune out small infestations where practical.</p> <p>See Apple.</p>
		
<p>Brown rot-infected plums compared with healthy fruit</p>	<p>Lecanium scale</p>	<p>Black knot on plum trees</p>

FURTHER READING

Cornell Cooperative Extension Tree Fruit Fact Sheet Series. Cornell Cooperative Extension, Ithaca, N.Y.

Hall-Beyer, B., and J. Richard. 1989. *Ecological Fruit Production in the*

North. Bart Hall-Beyer, RR3, Scotstown, Que., JOB 3J0, Canada.

Howitt, A. H. 1993. *Common Tree Fruit Pests*. Michigan State University Extension. NCR63. 252 pp.

Jones, A. L., and A. S. Aldwinkle. 1990. *Compendium of Apple and Pear Diseases*. American Phytopathological Society, St. Paul, Minn. 100 pp.

11 SMALL-FRUIT PEST MANAGEMENT

The following list of IPM strategies is an example of good horticultural practices for small fruits. A similar list could be applied to any of the small fruits you grow. Note the summary of ideas at the end of the list.

IPM FOR RASPBERRY DISEASE CONTROL

The following outline reviews available techniques that raspberry growers can use to minimize or eliminate the need to spray fungicides to control specific diseases.

Cane diseases (anthracnose, cane blight, spur blight)

1. Prune dead or diseased canes before new primocanes emerge; burn, bury, or remove them from garden.

2. Promote air circulation to increase drying of young primocanes:
 - a. Regulate cane densities.
 - b. Regulate row width.
 - c. Use trellising systems.
3. Apply a single, delayed dormant spray of lime sulfur to reduce overwintering inoculum levels.
4. Minimize cane injuries (for cane blight).
5. Avoid summer tipping of canes if rain is expected within two to three days (for cane blight).

Gray mold

1. Promote air circulation to reduce humidity and improve drying in the fruiting zone.
 - a. Use same techniques as for cane diseases.

Phytophthora root rot

1. Plant on soils with good internal and surface drainage or plant on raised beds; plant highly suscepti-

ble cultivars only on soils that have excellent drainage.

2. If possible, establish new plantings from nursery material not previously exposed to garden or field soil (i.e., greenhouse-propagated plants).
3. Avoid contaminating new planting sites with soil, water, or plants from sites in which the disease has occurred.

Leaf spot

1. Promote air circulation to reduce humidity and improve drying of new leaves.
 - a. Use same techniques as for cane diseases.
2. Apply a single, delayed dormant spray of lime sulfur to reduce overwintering inoculum levels.

Viral diseases

1. Use only planting stock derived from virus-indexed sources.
2. If possible, avoid establishing new plantings adjacent to wooded areas or older raspberry plantings.
3. Eradicate wild brambles in nearby hedgerows.

Verticillium wilt

1. Avoid planting in locations where susceptible crops (such as potatoes or tomatoes) have been grown recently.

Summary

Four primary themes run throughout the preceding list:

1. Plant resistant or only moderately susceptible cultivars.
2. Exclude specific pathogens from the planting if possible.
3. Reduce inoculum levels for indigenous or established pathogens.
4. Choose or modify the crop environment to make it less conducive to growth and development of plant-pathogenic fungi.

Small-fruit cultural pest management guidelines follow in Table 13. Pesticide guidelines are found in Part II, Table 15.



Table 13. Small-fruit pest management

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Blueberry	Blossom and twig blight (<i>Botrytis</i>)	Improve air circulation. Practice plant sanitation. Avoid high rate of nitrogen.
	Cane cankers (<i>Phomopsis</i> and <i>Fusicoccum</i>)	Prune out dead or dying canes in early spring or as they appear. Promote vigor by weeding and fertilizing properly in spring. To promote winter hardiness, do not fertilize after late spring; allow weeds to grow after harvest. Jersey, Earliblue, and Bluecrop are very susceptible to <i>Fusicoccum</i> ; Rancocas is resistant.
	Mummy berry	Clean up mummified (pumpkin-shaped) berries in autumn. Before budbreak cultivate to bury remaining mummies or add 2 in. of sawdust mulch. Resistant varieties include Burlington, Collins, Jersey, Darrow, Rubel, Bluetta, and Dixi. Earliblue and Blueray are most susceptible.
	Blueberry maggot	Small white maggot feeds inside fruit, devouring flesh. Use visual (yellow board) traps for monitoring starting in late June. For small plantings it may be possible to reduce populations of adults by using a large number of baited sticky traps.
	Blueberry stem borer	Larvae hollow out tender growing terminals of plants for 1 to 2 in. Cut off and discard all affected tips below insect infestation before fall.
	Cranberry fruitworm, cherry fruitworm	Larvae enter fruit, feeding on flesh; as they develop they move from one berry to another within fruit cluster. Remove by hand when seen.
	Leaf tiers and leafrollers	Leaves may be tied together or rolled. Larvae usually feed inside, skeletonizing heads. Remove by hand and destroy larvae. Natural enemies often help keep populations at low level.
	Scales	Feed by sucking sap from plants, reducing vigor and causing dieback. Good pruning practices will reduce likelihood of scale problems.
Currant and gooseberry	<i>Botrytis</i> rot (Gray mold)	Prune in early spring to thin plants or plantings; allow air to circulate and fruit and leaves to dry off quickly after rains. Eliminate weeds around plants to improve air circulation. Remove and dispose of rotten or severely damaged fruit throughout season. In autumn, or as leaves of fruit drop in summer, rake and destroy or discard all fallen leaves and fruit.
	Powdery mildew (Gooseberry)	Plant resistant varieties and promote good air circulation.
	Currant aphid	Feeding causes distorted and discolored foliage. Yellowish-green aphids are on undersides of leaves. Damage often is not noticed until aphids are gone and it is too late to treat.
	Currant stem girdler	This sawfly deposits eggs in a cane, girdles tip, and causes it to wilt, die, and drop off. In May or June, cut off injured shoots about 3 to 4 in. below girdle and destroy. If left until later in season, remove about 8 in. and bury or burn.

Table 13. Small-fruit pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Currant and gooseberry <i>(continued)</i>	Gooseberry fruitworm	Greenish caterpillar feeds in fruit and causes it to color early, dry up, and drop to ground. Moves from one fruit to next, often webbing them together. If numerous, can destroy crop. Remove infested berries and destroy before larvae move into adjacent ones.
	San Jose Scale	Feeds by sucking sap from branches and twigs; when numerous may be encrusted on twigs. Good pruning practices will reduce likelihood of scale problems.
	Twospotted spider mite	Feeding may cause stippling and bronzing of foliage. Wash off with water occasionally as needed. A strong stream of water will dislodge many mites. Avoid overuse of nitrogen fertilizers.
Grape	Black rot	In autumn, or as leaves or fruit drop in summer, rake and destroy or discard all fallen leaves and fruit. Practice plant sanitation to remove mummified grapes and infected canes. In early spring, cultivate to bury mummies. Susceptible varieties include Aurore, Baco Noir, Canadice, Cabernet Sauvignon, Catawba, Concord, Dutchess, Gewürtztraminer, Niagara, Pinot Noir, Riesling, and Seyval.
	Downy mildew	In autumn, or as leaves or fruit drop in summer, rake and destroy or discard all fallen leaves and fruit. Remove from vine and destroy diseased berries or clusters as they appear in summer. Particularly susceptible varieties include Cabernet Sauvignon, Catawba, Chancellor, Chardonnay, Delaware, Fredonia, Gewürtztraminer, Ives, Niagara, Pinot Noir, Riesling, and Rougeon.
	Phomopsis cane and leaf spot	Prune out all dead wood and cane stubs before budbreak. Susceptible varieties include Catawba, Concord, Delaware, Niagara, and Rougeon.
	Grape berry moth	Caterpillars destroy developing grapes; silken webbing often present. Wormy grapes result in some crop loss. Vines adjacent to wood edges containing wild grape plantings especially susceptible to damage. Two to three generations occur during season. Individual larvae cause more damage later in year because berries are larger and closer together and larvae can move more easily from berry to berry. Destroy nearby wild and abandoned vines. Sample vineyard third week of July to see if August treatment needed. Visually inspect five groups of 20 clusters. For table grapes, if one cluster per group is infested in July, treatment is warranted. For processing grapes, anything below 6 percent infestation should not require August treatment. Remove by hand and dispose of



Black rot infections destroying a cluster of grapes

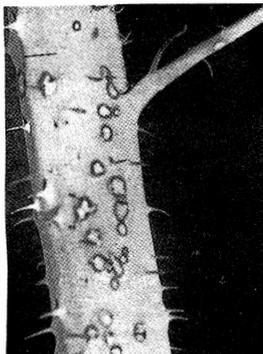


Downy mildew on the underside of a grape leaf

continued

Table 13. Small-fruit pest management (continued)

Plant	Pest/Disease	Description/Cultural Management
Grape (continued)	Grape cane girdler	<p>infested grapes for small plantings (do not discard on ground because insects may continue to develop).</p> <p>This very small black snout beetle girdles new grape shoots by chewing two series of holes a few inches apart around shoot. Shoot breaks and broken cane is noticeable. Larva is in portion of cane that remains on twig. Girdles are usually beyond grape cluster and, although unsightly, seldom cause serious damage. Soon after injury occurs, cut off and destroy canes about 4 in. below girdle.</p>
	Grape flea beetle	<p>Adult is a blue-black, steely-colored beetle that overwinters and feeds on and destroys developing buds in spring; larvae feed on upper surface of leaves. Bud damage usually occurs on vines located near wooded or trashy areas. In late fall cultivate to expose pupae in soil.</p>
	Grape leafhopper	<p>This small, wedge-shaped sucking insect feeds on undersides of grape leaves, causing them to be discolored or yellowed. Injury may result in reduced vine growth and, if severe, premature leaf drop. No cultural control available.</p>
Raspberry and blackberry	Anthracnose and cane blight	<p>Same as for spur blight. Avoid wounding; make all pruning or tipping cuts during dry weather (at least three to four days before next expected rain). Remove and destroy heavily infected canes.</p>
	Fruit rots	<p>Harvest regularly. Remove and dispose of rotten or severely damaged fruit throughout season. Prune in early spring to thin plants or plantings; allow air to circulate and fruit and leaves to dry off quickly after rains. Eliminate weeds around plants to improve air circulation.</p>
	Orange rust (black raspberries and blackberries)	<p>Fungus <i>Gymnoconia peckiana</i> infests black raspberry and blackberry. It is not known to infect red raspberry varieties. Orange rust is one of the more serious diseases of susceptible brambles in the Northeast. It should not be confused with late leaf rust of red raspberries. Rogue infested plants as they appear in spring, and rogue wild brambles nearby. Remove and dispose of entire infected plant, including all roots.</p>
	Phytophthora root rot	<p>Pathogen enters plants through root system, causing root rot and wilting of upper portion of plant. Often black discoloration can be observed under bark near root crown area. On marginally drained soils, establish plants on beds or mounds raised 8–12 in. high. Establish plants on well-drained soil. Plant highly susceptible varieties (Canby, Hilton,</p>



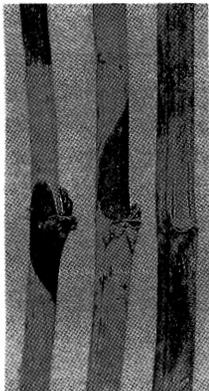
Recent anthracnose infection on bramble canes



Orange rust pustules on the undersides of black raspberry leaflets

Table 13. Small-fruit pest management (continued)

Plant	Pest/Disease	Description/Cultural Management
Raspberry and blackberry (continued)	Spur blight (red raspberries)	<p>Ruby, Titan) only on very well drained soils. Boyne, Killarney, Latham, and Nordic are relatively resistant.</p> <p>Prune out and discard fruiting canes after harvest. Prune in early spring to thin plants or plantings and allow air to circulate and fruit and leaves to dry off quickly after rains. Eliminate weeds around plants to improve air circulation.</p>
	Verticillium wilt (mainly black raspberries)	<p>Do not plant raspberries in same site where potatoes, tomatoes, eggplant, strawberry, cherry, squash, or cucumber have been grown in past three years. Weeds such as nightshade, ground cherry, redroot pigweed, and lambsquarters are also hosts for this disease and should be controlled.</p>
	Viral diseases	<p>Leaves may appear deformed and/or smaller than leaves on uninfected plants. Plant only virus-indexed stock from nurseries. Remove and dispose of entire infected plants. Eliminate wild brambles nearby.</p>
	Raspberry cane borer	<p>Causes early- to midsummer wilting of tips of new canes and laterals, which later blacken and drop off. Crush old cane stubs in early spring; as soon as wilted tips appear, cut off several inches below girdled portion, remove and destroy infected crowns, and eradicate wild brambles nearby.</p>
	Raspberry crown borer	<p>Bores into and damages lower canes and crowns. Cane vigor is reduced; canes often break off at ground level. Life cycle requires two years. In spring cut all weakened and infected canes close to crown. In May or June break over and crush old stubs; eradicate all wild brambles nearby.</p>
	Raspberry fruitworm	<p>Adult is a small, 1/8-in., light brown beetle that begins feeding in May on buds and tender leaves and later on blossoms. Leaves appear ragged or torn. Larvae feed on fruit by lying on receptacle and burrowing through berry. No cultural controls available. Fall-bearing varieties not injured. Cultivation around plants may help destroy pupae.</p>
	Raspberry sawfly	<p>Larvae feed on undersurfaces of leaves, causing round holes, and later devouring all but large veins. Larvae mature quickly and then are gone. No cultural controls available.</p>
	Sap beetle	<p>These small (12 mm or less), elongate beetles feed on over-ripe fruit. A common species, the picnic beetle, is dark with two yellow spots on each wing cover. Promptly harvest ripe berries; remove and dispose of rotten or severely damaged fruit throughout season. Do not leave overripe fruit in garden because it attracts the beetles.</p>
	Tarnished plant bug	<p>Sucking injury by this pest results in deformed berries. Keep planting and surrounding areas free of weeds.</p>
	Tree cricket	<p>Injury caused by egg-laying activities, sometimes girdling and causing death of cane tip above egg insertion. Remove and destroy canes that show egg-laying scars.</p>



Spur blight on bramble canes



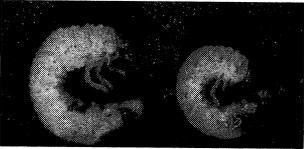
Tarnished plant bug

continued

Table 13. Small-fruit pest management (*continued*)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Raspberry and blackberry (<i>continued</i>)	Two-spotted spider mite	Feeding causes yellow stipple, bronzing, and possibly death of leaves. Mites feed on plant sap. Damage more severe during drought. Insecticides may encourage buildup of mites by killing predators. Wash off with water occasionally as needed. Do not overfertilize.
Strawberry	Black root rot	Infected plants often show overall decline in growth. Main root system has black discoloration with no feeder roots. Set new plants in a part of garden where strawberries have not grown for at least three years. Establish plants on well-drained soil.
	Fungal leaf spot	Renovate planting after harvest (mow off old leaves and incorporate into soil, narrow bed widths, fertilize, control weeds). Improve air circulation as for gray mold.
	Gray mold (<i>Botrytis</i> fruit rot)	Harvest regularly. Remove and dispose of rotten or severely damaged fruit throughout season. Improve air circulation around fruit by (1) narrowing bed widths in early spring, (2) avoiding spring application of nitrogen, which promotes excessive leaf growth (apply nitrogen in summer or early fall), (3) controlling weeds around plants.
	Leather rot (<i>Phytophthora cactorum</i>)	Fungus causes berries to turn brown and leathery. Infection favored by heavy rainfall, poor drainage, and excessive irrigation. Choose planting site and maintain soil structure to prevent water puddles from forming. Maintain thick mulch within and between rows.
	Red stele (<i>Phytophthora fragariae</i>)	Fungus causes all parts of infected plant to wilt and die. Cutting into tissue will reveal red discoloration. Establish plants on well-drained soil. Plant resistant varieties: Earliglow, Sunrise, Redchief, Midway, Scott, Guardian, Allstar, Tribute, Tristar, Surecrop, Sparkle, Stolemaster, Fairland.
	Verticillium wilt	Fungus <i>Verticillium albo-atrum</i> causes plant to lose outer leaves in early spring. New growth appears stunted. Avoid parts of garden where tomatoes, potatoes, eggplant, or peppers have been grown within three years. Plant resistant varieties: Earliglow, Guardian, Scott, Delite, Tribute, and Tristar.
	Bud weevil (blossom clipper)	Small ($1/10$ in.) red-brown snout beetle. Females puncture bud and deposit egg within, then girdle fruit stalk below injured bud, causing it to droop and fall. Remove foliage and mulch over winter. Monitor for damage and treat if more than two clipped buds per flower stalk per foot of row. Change site after three years if problem is severe. Row covers in weed-free gardens will act as barriers. (In weedy gardens row covers could increase damage because insects get a head start.)
	Cyclamen mite and two-spotted spider mite	This tiny (not visible to naked eye) whitish to caramel-colored mite occurs in groups in crevices of leaves, on stems, and among hairs of plants. Feeding causes severe distortion,

Table 13. Small-fruit pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Strawberry (continued)		
 <p>Slug</p>	Slugs	stunting, and sometimes death of leaves. Blossom feeding causes distortion of fruit. Infested plants usually become unproductive within a season. Cyclamen mite is difficult to control. Rogue infested plants.
	Spider mites	Damage worse in years with wet spring weather. Slugs feed at night, eating out large, irregular areas in fruit and foliage, hiding during the day in damp refuse. They leave a glistening slime trail that can be seen early in the day. Homemade traps can help; handpick and destroy slugs.
 <p>Tarnished plant bug</p>	Tarnished plant bug	Feeding on undersides of leaves causes foliage to turn yellow then develop rusty brown blotches. Plants may be stunted and yield reduced. Natural enemies often keep spider mites under control. Do not overfertilize; keep plants watered.
	White grubs	This 1/4-in.-long, brownish bug has yellow and black markings; immatures resemble wingless aphids (greenish) but much more active. Causes hard and nubby fruit and catfacing. Bug first appears just before bloom. Check for insects by striking plants over flat, light-colored dish. Treat when one to two nymphs are found per plant. Adults overwinter in weedy gardens.
 <p>White grubs</p>	White grubs	Larvae of May and June beetles, soft-bodied, C-shaped grubs in soil. Life cycle may be one or two years. Grubs feed on roots and may kill or severely weaken plants. Grubs also feed on roots of grasses. Avoid planting strawberries immediately following sod.

FURTHER READING

Converse, R. H. 1978 (rev.) *Controlling Diseases of Raspberries and Blackberries*. Farmers' Bulletin 2208, USDA, Washington, D.C. 18 pp.

Ellis, M. A. 1991. *Compendium of Raspberry and Blackberry Diseases and Insects*. American Phytopathological Society, St. Paul, Minn. 100 pp.

Hoffman, C. J., and T. J. Dennehy. 1987. *Assessing the Risk of Grape*

Berry Moth Attack in New York Vineyards. New York's Food & Life Sciences Bulletin 120, Geneva, N.Y. 4 pp.

Maas, J. L., ed. 1984. *Compendium of Strawberry Diseases*. American Phytopathological Society, St. Paul, Minn. 138 pp.

Maas, J. L. 1978 (rev.). *Strawberry Diseases*. Farmers' Bulletin 2140. USDA, Washington, D.C. 35 pp.

McGrew, J. R., and G. W. Still. 1979. *Control of Grape Diseases and*

Insects in the Eastern United States. Farmers' Bulletin 1893, USDA, Washington, D.C. 35 pp.

Pearson, R. A. 1988. *Compendium of Grape Diseases*. American Phytopathological Society, St. Paul, Minn. 100 pp.

Pritts, M. P., and D. Handley. 1989. *Bramble Production Guide*. NRAES-35, Ithaca, N.Y. 189 pp.

Highbush Blueberry Production Guide. 1992. NRAES-55, Ithaca, N.Y. 200 pp.

12 VEGETABLE PEST MANAGEMENT

Give the soil your utmost attention. Prevention of problems begins with good soil organic matter. Organic matter helps soil particles bind together. Good soil tilth has good nutrient and water holding capacities. It also stimulates the life of the soil—those things that in turn recycle nutrients into the forms that plants can readily use.

MANAGING INSECT PESTS

Several mechanical and cultural practices may be used to help reduce insect pests in home vegetable gardens. Some are more practical than others, and success will depend in part on your willingness to work at them. An integrated approach to pest management (combining strategies) is often best.

One of the most important strategies in dealing with insects is to learn about their habitat, behavior, life cycle, what they feed on, and whether they are actually pests. This information will help you decide what to do. Most insects found in the garden are not pests, and some are even beneficial. The following practices help manage insect pests in vegetable gardens:

1. Maintain vigorous, healthy plants. Evidence suggests that plants growing under stressful conditions are more likely to be attacked and suffer serious damage. Fertilization, liming, too little or too much water, and planting too close together can all adversely affect plants. Check the fertility and pH of soil regularly and make adjustments as needed. Thin plants to the recommended spacing.
 2. Planting the same crop in the same place year after year may cause pest buildup. Rotate crops, especially where soil insects such as grubs, wireworms, and maggots are a problem. Do not plant crops susceptible to grubs or wireworms where grass grew the previous year.
 3. Choose varieties recommended for your area and, where available, varieties resistant to pests known to occur in your area. For example, butternut squash is resistant to the squash vine borer.
 4. Sanitation in and around the garden is very important. Many vegetable pests overwinter on weeds or plant debris in or near the garden. Remove weeds and organic mulches, which can provide ideal homes for insects, slugs, and snails.
 5. Avoid bringing insect-infested plants into the garden. Carefully check transplants for the presence of insects before purchasing and planting.
 6. Consider altering time of planting: could the pest be avoided by planting earlier or later?
 7. Handpick pests off the plants and destroy them. Insects may be killed by placing them in a bucket of soapy water.
 8. Physical barriers placed around plants can control some insects. Barriers include:
 - a. Cardboard collars (or roofing paper), 4 in. high, placed around young transplants to prevent cutworms from cutting the stems. Squares of tarpaper or carpeting placed securely around the stems of young crops of the cabbage family can prevent the cabbage maggot fly from depositing eggs at the base of the plant.
 - b. Row covers placed over the plants until the pest is gone or the plants are large enough to need the covers removed. All covers should be removed about four to six weeks into the season because temperatures during midsummer get too hot. Remember that some plants such as cucumber, eggplant, melons, and squash need to be pollinated by insects to yield a crop. Peppers may also benefit from insect pollinators. Commercial covers made of polypropylene, polyester, or polyvinyl alcohol are available, but cheesecloth or screening can also be used. All of these covers let light and water in and allow continued plant growth. Even ventilated plastic row covers help keep out many pests.
 9. Mulching materials such as aluminum foil may repel aphids, thrips, and other insects. Although expensive, mulching may be practical on a small scale.
 10. Traps, such as yellow sticky boards, can be used to help monitor insect populations, but they are seldom sufficient to give control. They do, however, help keep whitefly populations low as long as the sticky material is replaced periodically when insects cover the boards.
 11. Take advantage of natural enemies, predators, and parasites. Learn to recognize those that are almost always present and conserve them. Small wasps parasitize aphids, leaving bronze or gray and bloated aphid “mummies.” Immature lady beetles and lacewings, which resemble small alligators, are also frequently present. Others include spiders, predatory mites, predatory bugs, predatory flies, and ground beetles.
- Augmentation.** The introduction of predators, parasites, or diseases is becoming more practical as we learn more about managing the pest system. Remember when introducing or maintaining predators or parasites, beneficial insects will move elsewhere if there are insufficient hosts to feed on.
12. Pesticides may also be used as part of the pest management program. Be sure to use only the amount you need and to treat only the crops that need treating. Spot treatments are effective and may be practical for home gardens.
 - a. *Note:* Even if a pesticide is botanical in origin, it may be toxic. Some botanical insecticides are more toxic than some of the commonly available synthetic chemicals.

- b. Biorational pesticides such as *Bacillus thuringiensis* (Bt), a toxin produced by bacteria that kills caterpillars, are an alternative to some chemical pesticides.
- c. Insecticidal soaps and horticultural oils are also an alternative to some traditional chemical pesticides and may be useful for certain pests, especially aphids, in the home garden.
- d. Diatomaceous earth, a desiccant, is sometimes used to control insects, slugs, and snails. Once it gets wet and compacted, however, it loses its effectiveness.

Before using any pesticide, check the label. Both the crop you want to treat and the pest you are treating for must be listed on the label. If not, do not use the pesticide. No matter which methods you choose, keep a record of what you did and whether it was successful. Such a record should be a great help in the future when you are faced with similar pest management decisions.

MINIMIZING VEGETABLE DISEASES

To grow a healthy vegetable garden—one with few or no diseases—some general practices can be followed. The following 10 steps will maintain healthy plants and reduce the need for fungicides. You may be able to devise others that are especially suited to your garden.

1. *Choose resistant or tolerant varieties.* This is the easiest and most important way to manage plant diseases. The letter abbreviations used to describe the resistance of a variety (e.g., VF = Verticillium and Fusarium wilt resistant, PM = powdery mildew resistant or tolerant) are listed in seed catalogs or can be explained by your county Cooperative Extension agent. Resistant varieties resist infection by a particular disease agent and show little or no disease. Tolerant varieties may show symptoms but still yield the same as resistant varieties or susceptible ones protected with pesticides. When available, choose varieties that are resistant or tolerant to a disease that has been a problem.
2. *Purchase treated seed.* Seed may come pretreated with a dusting of a fungicide, or you may dust the seed with a fungicide. See Part II, Table 16. This coating will help prevent the seed from rotting in the soil before germination and can help protect the emerging seedling from damping-off. If seed rot or damping-off has been a problem in your garden, treating the seed with a fungicide will help.
3. *Purchase disease-free seed, transplants, and propagating material.* Begin with healthy plant material to help plants quickly become established in the garden. Plant materials that are unhealthy to begin with never yield as much as healthy ones or may die while still young. Reputable seed companies sell only disease-free plant materials. Some seeds are hot-water treated to remove infectious agents. Some are tested to reduce the risk of seedborne viruses. When shopping for transplants or other propagating material, take time to examine the plant stock thoroughly to make sure it is healthy and vigorous. If you save your own seed, harvest it from healthy plants and dry it thoroughly. Store such seed in properly labeled, airtight containers in a cool, dry place.
4. *Select a sunny, well-drained location.* A sunny area with well-drained soil is an ideal site for vigorous growth of plants. Shaded, poorly drained areas result in weak and spindly plants that are easy targets for disease organisms. Even if such plants remain alive and free of infectious disease, they will not yield as much as strong and burly plants.
5. *Improve the soil environment.* When there is no other choice for a garden site but a heavy, wet soil, plant in raised beds or ridged rows so the soil around the plants' roots will be drier. Heavy, wet soils discourage healthy root growth and encourage root rots. When a garden is established on sloped terrain, plant in terraced beds to reduce soil erosion over delicate, young plants and newly sown seed. Soils that are dry and sandy may be mulched with a variety of materials (such as straw, grass clippings, or black plastic) to help retain moisture. A soil environment that is favorable to healthy root development supports the growth of healthy plants.
6. *Water and feed plants.* Plants require 1 inch of rainfall per week for best growth. If rainfall is inadequate, water the garden. Water plants in the morning so they will dry off quickly above ground, reducing the chances of disease spread. Avoid using overhead sprinkler irrigation because it can promote the development and spread of leaf, flower, and fruit infections. Trickle irrigation is best because it puts water directly in the root zone, does not wet the plants above ground, and does not encourage soil splashing. Plants that are fertilized properly at planting time and sidedressed will grow better and be healthier. Always use a complete fertilizer or incorporate a well-rotted manure or rich compost into the soil. Avoid overfertilization because this injures plant roots.
7. *Space plants to allow air circulation.* High humidity and moisture favor the development of diseases on plants. Allowing enough room for plants to grow and space for air to circulate around mature plants reduces humidity and promotes rapid drying of plant surfaces. This helps reduce incidence of disease.
8. *Practice cleanliness in the garden.* Always remove and destroy or discard (in the trash) plant materials that show signs of disease. Work in the garden when plants are dry because moisture on plants aids the spread of infectious diseases. Composting, unless the pile becomes very hot, does not effectively eliminate diseases from plant refuse under New York State climatic conditions. For this reason, it is unwise

to compost any diseased plant material. At the end of the growing season, clean up all crop debris because disease agents overwinter in debris and may infect new plants the following season.

9. *Plant a fall cover crop and plow it under the following spring.* After cleaning up the garden, sow a grass, such as perennial rye, that will begin to grow that fall. This cover crop will protect the topsoil from erosion during the winter. The following spring plow under the ryegrass to enrich the soil with fresh organic matter or "green manure." This practice also helps reduce the populations of certain soilborne disease agents. Noninfectious agents flourish on green manure in the soil and tend to inhibit the infectious ones.
10. *Rotate crops.* Successive planting of one crop family in the same area for many seasons promotes the buildup of disease agents in the soil. Thus the disease becomes more severe over time. Rotate plants to different areas of the garden to help reduce the losses caused by soilborne disease agents. Avoid successive planting within crop families or crop types such as crucifers (cabbage, broccoli, turnip, radish), cucurbits (melon, cucumber, squash), solanaceous plants (tomato, eggplant, potato, pep-

per), grasses (sweet corn, cover crops such as rye), legumes (bean, pea), and root crops (carrot, beet, onion).

TROUBLESHOOTING IN THE HOME GARDEN

The following are common problems many gardeners encounter during the growing season. Possible solutions are listed.

1. *Failure of tomatoes, peppers, and eggplant to set fruit (blossom drop).* If plants are growing well, this problem is frequently caused by adverse night temperature (below 60° F and above 70° F). Very seldom does heavy use of nitrogen fertilizers cause blossom drop, nor does sprinkler irrigation.
2. *Blossom-end rot of tomatoes and peppers.* This is caused by a calcium deficiency that develops when soil moisture fluctuates (drought, heavy rains) or there is excessive nitrogen fertilizer. Proper irrigation, fertilization, and adequate mulch usually prevent it. Some varieties are more susceptible than others.
3. *New leaves on cucumber plant suddenly wilt.* Leaves may show dead areas and fruit may be mottled. The most likely cause is cucumber mosaic virus, a common disease. Bacterial wilt and root rot are other possible causes of the wilting. A sudden rise in

temperature or depleted soil moisture also causes wilting, but plants soon recover.

4. *Lettuce and spinach go to seed.* This is normal for these crops under warm temperatures and long days. Planting in the spring and selecting the proper variety are remedies.
5. *Kernels develop irregularly on sweet corn ears.* This may be caused by inadequate pollination. Planting sweet corn in blocks of several short rows rather than a single long row may help.
6. *Snap bean flowers fail to develop.* High daytime temperature (above 90° F) is often the cause. Setting usually resumes when temperature drops.
7. *Tomato fruits are rough and misshapen.* This is often associated with low temperatures (50°–60° F) while flowers are forming. The problem is worse on some varieties. The first fruit often are the most misshapen.
8. *Cucumbers are off-shaped (e.g., crooked, nubbins).* This often occurs because of low soil moisture. Cool temperatures at the time flowers are developing can be a cause. Poor pollination because of lack of bees or low number or male flowers is also a possibility.

Table 14 gives cultural pest management practices. Pesticide guidelines are found in Part II. Table 16.

Table 14. Vegetable pest management

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Asparagus  Common asparagus beetle	Fusarium wilt and crown rot Asparagus beetles (common and spotted)	Use disease-free crowns or seed. If you are starting with seedlings, do not overharvest. Rogue plants that are severely diseased: remove and discard or destroy entire infested plant along with immediately surrounding soil and soil clinging to roots. Handpick in small plantings.
Beans	Bacterial blights Bean common mosaic virus, strains BV-1 and NY 15	Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space apart to allow air circulation. Eliminate weeds around plants and garden area to improve air circulation. Do not save your own seed. Rogue plants: remove and discard or destroy entire infested plant along with immediately surrounding soil and soil clinging to roots. Use resistant varieties, including Lancer, Provider, Blue Bush 274, Golden Butterwax, Royal Burgundy, Tendercrop, and Improved Tendergreen. Manage insect vectors.
		 Bean leaves showing mosaic and distortion caused by bean common mosaic virus
	White mold Aphids Leafhoppers	Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. The following recommendations are very important: Avoid crowding plants; space apart to allow air circulation. Eliminate weeds around plants and garden area to improve air circulation. In autumn, rake and dispose of all fallen or diseased leaves and fruit. Crop rotation is essential. Check for evidence of natural enemies such as gray-brown and bloated parasitized aphids (mummies) and alligatorlike larvae of lady beetles and lacewings. Wash off with water occasionally as needed early in the day. A hard stream of water can be used to remove many aphids from plants. Small, light green to gray wedge-shaped insects that suck plant juices, causing stunting, and carry virus diseases. No cultural control available.



Aphid

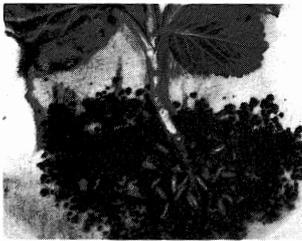
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Table 14. Vegetable pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Beans (continued)	Mexican bean beetle	Handpick beetles and eggs in small plantings. Plant early to avoid this pest. Plow under infested plants after harvest.
	Seedcorn maggot	Avoid heavy manure or organic matter in the garden, which attracts maggot flies and encourages egg laying. Purchase insecticide-treated seed. Use gloves to plant.
	Spider mites (two-spotted)	Wash off with water occasionally as needed early in the day. A hard stream of water can be used to remove many mites from plants.
Beet	Cercospora leaf spot	Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space apart to allow air circulation. Eliminate weeds around plants and garden area to improve air circulation. In autumn, rake and dispose of all fallen or diseased leaves and fruit.
	Leafminer	Cover plants with fine netting or cheesecloth or floating row cover to protect them from adult flies. Handpick and destroy infested (mined) leaves. Control weeds.
Cabbage, cauliflower, broccoli, Brussels sprouts, and other cole crops	Clubroot	Locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil. Purchase healthy transplants or start seed in sterile potting mix or fresh ground. Rogue plants: remove and discard or destroy entire infested plant along with immediately surrounding soil and soil clinging to roots. If soil is infested, add lime to raise soil pH to 7.2.
	Cabbage aphids	Check for natural enemies such as gray-brown and bloated parasitized aphids (mummies) and alligatorlike larvae of lady beetles and lacewings. Wash off with water occasionally as needed early in the day. A hard stream of water can be used to remove many aphids from plants.
	Cabbage root maggot	White maggot (larva) attacks all plants of cabbage family. Larvae tunnel in and feed on roots of plants. Damage causes wilting early on, death of plants a little later.
	Cabbageworms	Handpick. Row covers may be useful on small plantings to help protect plants from early damage. Put in place at planting and remove before temperatures get too hot (midsummer).
	Flea beetles	Use row covers to help protect plants from early damage. Put in place at planting and remove before temperatures get too hot (midsummer). Control weeds.



Clubroot of cabbage



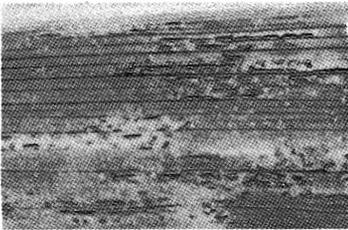
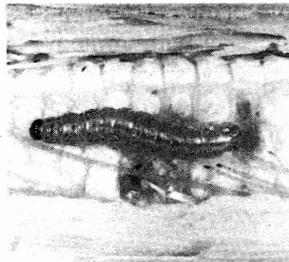
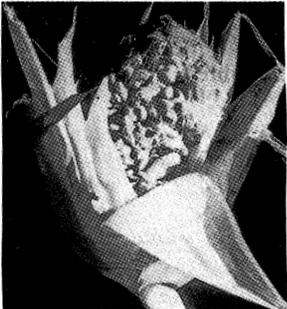
Cabbage root maggots



Imported cabbageworm



Table 14. Vegetable pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Carrot and parsnip	Carrot rust fly	Harvest all carrots by September 1 in upstate New York, by August 20 farther south, to avoid second brood injury.
	Carrot weevil	Clean up garden debris in autumn. Entomophagous nematodes are available: apply as directed on label.
	Leafhopper	Leafhoppers spread disease, causing carrots to be woody, hairy, and bitter. No cultural control is available.
Corn	Rust	Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space apart to allow air circulation. Eliminate weeds around plants and garden area to improve air circulation. Plant resistant or tolerant varieties: Top Notch, Temptation, Sweet Rhythm, Wizard, Sweet Symphony, Silverado. Standards like Sweet Sue and Silver Queen are very susceptible.
	 Closeup of rust pustules on a corn leaf	
	Smut	Pick and remove galls before they break open. Plant tolerant varieties: Top Notch, Temptation, Sweet Rhythm, Sweet, Symphony, Zenith.
	 European corn borer	Destroy cornstalks in fall to kill overwintering larvae of European corn borer. Plant early to avoid corn earworm.
	Seedcorn maggot	Avoid heavy manure or organic matter in garden, which attracts adults and encourages egg laying. Do not overwater. Use insecticide-treated seed; wear gloves when planting.
		 Corn smut
Cucumber	Bacterial wilt (<i>Erwinia tracheiphila</i>)	Rogue plants: remove and discard or destroy infested plants. Control cucumber beetles that spread the bacteria. See Striped or spotted cucumber beetles. Control as soon as they appear. Some varieties are less susceptible to bacterial wilt but may not be readily available. Watermelon is immune.
	Cucumber mosaic virus	Rogue plants: remove and discard or destroy infested plants. Plant resistant varieties such as Pacer, Marketmore 76, Dasher II, Slicemaster, Spacemaster, and Sweet Success. Manage aphids that spread virus. Eliminate perennial weeds such as milkweed, marshcress, and yellow rocket, and avoid planting next to susceptible ornamentals.
	Powdery mildew	Avoid crowding plants: space apart to allow air circulation. Eliminate weeds around the plants and garden area to improve air circulation. In autumn, rake and dispose of all fallen or diseased leaves and fruit. Plant resistant varieties such as Marketmore 76, Slicemaster, and Raider.
	Scab	Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space apart to allow air circulation.

continued

Table 14. Vegetable pest management (continued)

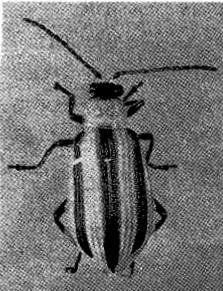
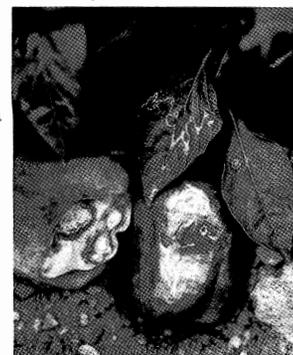
Plant	Pest/Disease	Description/Cultural Management
Cucumber (continued)		Eliminate weeds around plants and garden area to improve air circulation. In autumn, rake and dispose of all fallen or diseased leaves and fruit. Do not save your own seed. Plant resistant varieties such as Pacer, Marketmore 76, Raider, and Slicemaster.
	Aphids	Check for natural enemies such as gray-brown and bloated parasitized aphids (mummies) and alligatorlike larvae of lady beetles and lacewings. Wash off with water occasionally as needed early in the day. A hard stream of water can be used to remove many aphids from plants.
	Squash vine borer	Remove borers by hand. See Squash. Destroy crop residues after harvest.
	Striped or spotted cucumber beetles	Construct tents of fine netting or cheesecloth or use floating row cover over young transplants and seedlings. Put in place at planting and remove before temperatures get too hot (midsummer). Control of beetles is important to prevent bacterial wilt in cucumbers but less important with other vine crops.
	Striped cucumber beetle	
Eggplant	Verticillium wilt	Most serious disease of eggplant. Rogue plants: remove and discard or destroy entire infested plant along with immediately surrounding soil and soil clinging to roots. Set into soil never planted to tomatoes, peppers, or strawberries. If you cannot locate new plants in a part of the garden different from previous year's location, remove infested soil and replace with fresh soil.
	Aphids	Wash off or crush.
	Colorado potato beetle	Handpick beetles, larvae, and eggs.
	Flea beetles	Control weeds. Use row covers to help protect plants from early damage. Put in place at planting and remove before temperatures get too hot (midsummer).
	Colorado potato beetle	
	Flea beetle  ACTUAL SIZE	
Muskmelon	Bacterial wilt	See Cucumber.
	Fungal leaf spots	Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space apart to allow air circulation. Eliminate weeds around plants and garden area to improve air circulation. In autumn, rake and dispose of all fallen or diseased leaves and fruit. Verify diagnosis.
	Fusarium wilt	Locate new plants in a part of the garden different from the previous year's location. If that is not possible, remove infested soil and replace with fresh soil. Plant tolerant varieties such as Iroquois, Harper Hybrid, Saticoy, Pulsar, or Athena.
	Powdery mildew	See Cucumber. Choose varieties resistant to powdery mildew.
	Squash vine borer	See Squash.

Table 14. Vegetable pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Onion	Purple blotch (<i>Alternaria porri</i>) and Botrytis leaf blight	Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space apart to allow air circulation. Eliminate weeds around plants and garden area to improve air circulation. Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts. In autumn, rake and dispose of all fallen or diseased leaves and fruit.
	Onion maggot	Locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil.
	Thrips	No cultural controls are available.
Pea	Powdery mildew	Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space apart to allow air circulation. Eliminate weeds around plants and garden area to improve air circulation. Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts. In autumn, rake and dispose of all fallen or diseased leaves and fruit.
	Seed decay and seedling root rots	Locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil. Plant seed as early as possible. Improve soil drainage.
	Wilt	Locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil. Plant seed as early as possible. Improve soil drainage.
	Aphids	Check for natural enemies such as gray-brown and bloated parasitized aphids (mummies) and alligatorlike larvae of lady beetles and lacewings. Water off with water occasionally as needed early in the day. A hard stream of water can be used to remove many aphids from plants.
	Seedcorn maggot	Avoid heavy manure or organic matter in the garden because they attract maggot flies and encourage egg laying.
Pepper	Cucumber mosaic virus	Rogue plants: remove and discard or destroy entire infested plant. Control aphids that spread the virus (see following entry). Eliminate perennial weed sources (such as milkweed, marshmallow, and yellow rocket) and avoid planting next to susceptible ornamentals.



Cucumber mosaic virus infection of pepper causes ringspots and oak-leaf patterns

continued

Table 14. Vegetable pest management (continued)

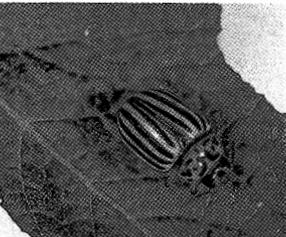
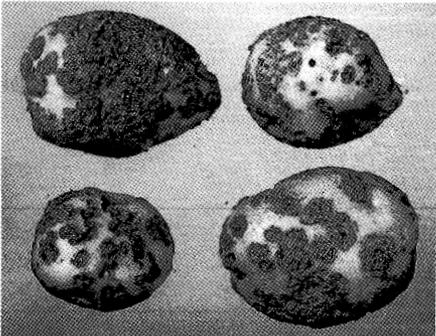
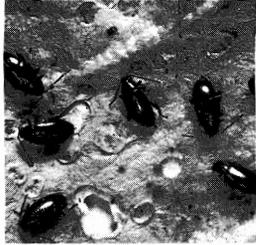
Plant	Pest/Disease	Description/Cultural Management
Pepper (continued)	Aphids	Check for natural enemies such as gray-brown and bloated parasitized aphids (mummies) and alligatorlike larvae of lady beetles and lacewings. Water off with water occasionally as needed early in the day. A hard stream of water can be used to remove many aphids from plants.
	Borers	Remove by hand. Destroy infested fruit.
	Early blight and late blight	Use certified seed. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space apart to allow air circulation. Eliminate weeds around plants and garden area to improve air circulation. In autumn, rake and dispose of all fallen or diseased leaves and fruit or tubers. Locate new plants in a part of the garden different from previous year's location. Resistant or moderately resistant varieties include Allegany, Elba, Rosa, and Sebago.
	Scab	The fungus that causes late blight has recently become a major threat to home gardens and commercial growers because of the migration of new strains (genotypes) into the United States. The disease can readily spread from home gardens to commercial fields. Verification of a late blight diagnosis and implementation of prompt control measures are highly recommended. The newly arrived strains are more aggressive than previous strains. Cultural control measures such as those listed above may not adequately control these new strains. It is highly recommended that the use of protectant fungicides (mancozeb, chlorothalonil, or copper) be seriously considered.
	Use certified seed. Locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil. Lower soil pH to 5.2 with sulfur. Plant resistant varieties: Chieftan, Norland, Russet Burbank, Russet Rural, and Superior.	
	Viral diseases	Use certified seed. Control aphids (see below)
Aphids	Check for natural enemies such as gray-brown and bloated parasitized aphids (mummies) and the alligatorlike larvae of lady beetles and lacewings. Water off with water occasionally as needed early in the day. A hard stream of water can be used to remove many aphids from plants.	
Colorado potato beetle	Handpick beetles, eggs, and larvae.	

Table 14. Vegetable pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Potato (continued)	Flea beetles	Use row covers to help protect plants from early damage. Put in place at planting and remove before temperatures get too hot (midsummer). Control weeds.
	Leafhoppers	Wash small nymphs off with a hard stream of water early in the day.
		
Flea beetles		
Pumpkins	Powdery mildew	Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space apart to allow air circulation. Eliminate weeds around plants and garden area to improve air circulation.
	Aphids	See Cucumber.
	Cucumber beetle	See Cucumbers.
	Spider mites	See Beans.
	Squash bug	Handpick. Bury or compost plant residues after harvest.
	Squash vine borer	See Squash.
Radish and turnip	Clubroot	See Cabbage.
	Maggots	Use row covers made of nonwoven fabrics. Hoops can be used to make a tent area over rows or as floating row covers. For radish, weekly plantings can be made. Some will avoid maggot attack.
Rhubarb	Fungal leaf spot	Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space apart to allow air circulation. Eliminate weeds around plants and garden area to improve air circulation. Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts. In autumn, rake and dispose of all fallen or diseased leaves and stalks.
	Curculio	Handpick adults. Remove broadstemmed weeds from area
Spinach	Leafminer	See Beet.
		
Leafminer injury		
Squash	Bacterial wilt	See Cucumber.
	Powdery mildew	See Pumpkins, except for resistant varieties.

continued

Table 14. Vegetable pest management (continued)

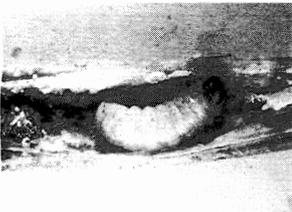
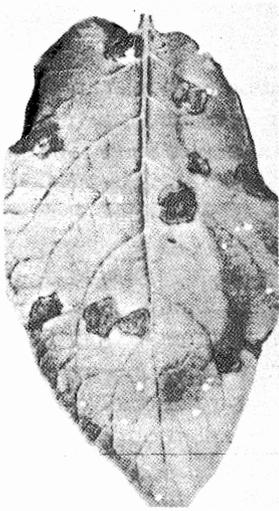
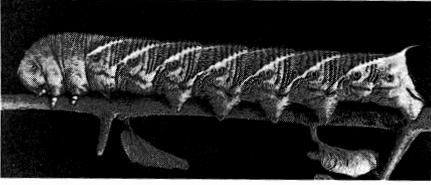
<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>	
Squash (continued)	Scab	See Cucumber, except for resistant varieties.	
	Viral disease	Rogue plants: remove and discard or destroy entire infested plant along with immediately surrounding soil and soil clinging to roots. Eliminate wild cucumber and milkweed nearby. Plant the variety Multipik to mask symptoms on fruit. Control aphids early in the season (see Cucumber).	
	Squash bug	See Pumpkins.	
	Squash vine borer	Remove by hand. Butternut squash is resistant.	
			
Squash vine borer			
Tomato	Blossom end rot	Water during drought or mulch to keep moisture level constant. Grow on soil high in organic matter. Fertilize properly. Avoid cultivating close to plants.	
	Catface	Grow locally recommended varieties and provide adequate fertilizer and water for vigorous growth.	
	Early blight, Septoria leaf spot	Locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil. Avoid wetting foliage if possible. Water early in the day so aboveground plant parts will dry as quickly as possible. Avoid crowding plants; space apart to allow air circulation. Eliminate weeds around plants and garden area to improve air circulation. Practice plant sanitation: when plants are not wet, carefully remove and destroy or discard affected plant parts. In autumn, rake and dispose of all fallen or diseased leaves and stalks. Septoria occurs early in the season, preferring cool, wet weather. Use clean transplants and remove lower infected leaves.	
			
	Large, dark spots caused by early blight infections on a tomato leaf		
	Fusarium wilt	Locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil. Rogue plants: remove and discard or destroy entire infected plant along with immediately surrounding soil and soil clinging to roots. Plant resistant varieties such as Pik-Red, Better Boy, Duke, Freedom, Supersonic, Jet Star, Springset, and Floramerica.	
Late blight	See Potato.		
Verticillium wilt	Locate new plants in a part of the garden different from previous year's location. If that is not possible, remove infested soil and replace with fresh soil. Rogue plants: remove and discard or destroy entire infected plant along with immediately surrounding soil and soil clinging to roots. Plant resistant varieties: Supersonic, Jackpot, Basketvee, Sunny, Jet Star, and Springset.		
			
		Scab infections on summer squash	

Table 14. Vegetable pest management (continued)

<i>Plant</i>	<i>Pest/Disease</i>	<i>Description/Cultural Management</i>
Tomato (continued)	Aphids	Check for natural enemies such as gray-brown and bloated parasitized aphids (mummies) and alligatorlike larvae of lady beetles and lacewings. Water off with water occasionally as needed early in the day. A hard stream of water can be used to remove many aphids from plants.
	Colorado potato beetle	Handpick and destroy beetles, eggs, and larvae.
Cutworm	Cutworms	Control weeds. Cardboard collars around each plant give good protection.
	Flea beetle	Use row covers to help protect plants from early damage. Put in place at planting and remove before temperatures get too hot (midsummer). Control weeds.
	Hornworm	Handpick larvae. This pest is frequently controlled by natural enemies.
	Whiteflies	Do not purchase whitefly-infested transplants; inspect carefully before purchasing.
Greenhouse whitefly		 Tomato hornworm

FURTHER READING

Flint, M. L. 1990. *Pests of the Garden and Small Farm*. University of California Statewide IPM Project, Publication 3332. 276 pp.

Flint, M. L., and S. H. Dreistadt. 1998. *Natural Enemies Handbook: The Illustrated Guide to Biological Pest Control*. University of California Statewide IPM Project, Publication 3386. 154 pp.

Hagedorn, D. J. 1984. *Compendium of Pea Diseases*. American Phytopathological Society, St. Paul, Minn. 57 pp.

Hall, R. 1991. *Compendium of Bean Diseases*. American Phytopathological Society, St. Paul, Minn. 90 pp.

Hoffmann, M. P., and A. C. Frodsham. 1993. *Natural Enemies of Vegetable Insect Pests*. Cornell Cooperative Extension, Ithaca, N.Y. 64 pp.

Hoffmann, M. P., E. R. Hoebeke, and H. Dillard. 1999. *Flea Beetle Pests of Vegetables*. Cornell University Fact Sheet 750.00, Cornell Cooperative Extension, Ithaca, N.Y. 4 pp.

Hooker, W. J., ed. 1983. *Compendium of Potato Diseases*. American Phytopathological Society, St. Paul, Minn. 125 pp.

Jones, J. B., J. P. Jones, R. E. Stall, and T. A. Zitter, eds. 1991. *Compendium of Tomato Diseases*. American Phytopathological Society, St. Paul, Minn. 100 pp.

MacNab, A. A., A. F. Sherf, and J. K. Springer. 1983. *Identifying Diseases of Vegetables*. Pennsylvania State University, University Park, Pa. 62 pp.

Mazza, C. P., S. J. Cunningham, and E. Z. Harrison. *Using Organic Matter in the Garden*. 1999. Cornell Cooperative Extension, Ithaca, N.Y. 12 pp.

Onion Diseases and Their Control. 1961. USDA Agricultural Handbook 208, Washington, D. C. 27 pp.

Pedersen, L. H., and C. J. Eckenrode. 1981. *Predicting Cabbage Maggot Flights in New York Using Common Wild Plants*. New York's Food & Life Sciences Bulletin 87, New York State Agricultural Experiment Station, Geneva, N.Y. 6 pp.

Shurtleff, M. C., ed. 1980. *Compendium of Corn Diseases*. American Phytopathological Society, St. Paul, Minn. 105 pp.

Topoleski, L. D. 1981. *The Home Vegetable Garden*. Cornell Cooperative Extension Information Bulletin 101, Ithaca, N.Y. 31 pp.

Vea, E. V., D. R. Webb, and C. J. Eckenrode. 1975. *Seedcorn Maggot Injury*. New York's Food & Life Sciences Bulletin 55, New York State Agricultural Experiment Station, Geneva, N.Y. 3 pp.

Ware, G. W. 1988. *Complete Guide to Pest Control: With and Without Chemicals*. Thomson Publications, Fresno, Calif. 304 pp.

Zitter, T. A., D. L. Hopkins, and G. E. Thomas, eds. 1996. *Compendium of Cucurbit Diseases*. American Phytopathological Society, St. Paul, Minn. 87 pp.

13 LAWN CARE WITHOUT PESTICIDES

The key to maintaining a lawn without pesticides is to understand the relationship between an organism and its environment. The key organism in a lawn, of course, is the grass and the relationship is known as ecology. The environment, which includes soil, light, temperature, moisture, and humans, is dynamic and intimately linked. Lawn care practices generally have many effects on the environment beyond those on the grass plant. For example, a lawn mowed very short not only weakens the plant but also results in increased light contacting the soil, thereby increasing soil temperature and promoting weed invasion.

Managing a healthy lawn that is less reliant on energy-intensive inputs and more competitive against pests requires a thorough understanding of the biology of grass plants, the physical and chemical aspects of soils, biology of the pests, and human expectations. Simply, care should be intimately linked to quality expectations to management practices that are based on the growth of cool-season lawn grasses.

Important ecological concepts at work in a lawn include (1) *adaptation*: selecting for plants that are adapted to an environment (e.g., temperature, moisture, traffic, mowing height) to make them more successful in competing for resources and help maintain a dense, healthy lawn; (2) *competition*: managing well-adapted plants in a healthy state so they will be more competitive against pests such as weeds; (3) *avoidance of open space*: making sure plants are properly managed and healthy so they will seek to develop a dense canopy and resist severe disturbance from pests and traffic. As plants suffer from poor adaptation, improper care, or excessive traffic, open space is created where other plants can invade to compete for resources.

GROWTH AND DEVELOPMENT OF LAWN GRASS

Lawn care without pesticides requires the selection of a species that is well adapted to the prevailing environmental conditions. Adaptation of lawn grasses in the northern United States from Maine to Virginia west to Iowa and Minnesota is determined by temperature, specifically low temperature. Traveling farther west into the Great Plains, moisture becomes a second limiting factor determining species adaptation.

Cool-season grasses produce optimal shoot growth between 67° and 75° F and optimal root growth from 55° to 65° F. This suggests that cool-season grasses grow best in spring and fall conditions and are less adapted to the warm, dry summer months. Root growth is most active in spring before significant shoot growth, then as temperatures warm, root growth is limited. In fact, substantial root loss can occur at temperatures above 85° F. As the soil cools in late summer, active root growth resumes in early fall with little competition from shoot growth for energy.

During summer months, as conditions for active cool-season grass growth decline (reducing competitiveness), populations of warm-season grassy weeds such as crabgrass (*Digitaria* spp.) become more competitive. In essence, the crabgrass plants, which grow actively at high temperatures, are more able to gather resources and persist. Therefore, proper selection of well-adapted lawn grasses to meet quality and use expectations, as well as prevailing environmental conditions, will be more able to compete with undesirable species throughout the growing season.

SELECTING LAWN GRASSES

Important cool-season lawn grass species include Kentucky bluegrass, perennial ryegrass, tall fescue, and the fine-leaf fescues. Other cool-season grasses found in lawns include rough-stalk bluegrass and creeping bentgrass. In addition to temperature, the grasses differ in adaptation to soil fertility, moisture, and pH, as well as mowing, traffic, and pest tolerance.

Visually, grasses differ in leaf width (texture), growth habit (bunch-type, rhizomatous, stoloniferous), density, and color. This variability exists between and within each species, which partially explains the increased number of cultivars available for each species.

Kentucky bluegrass (*Poa pratensis*) is the predominant high-quality lawn grass for northern climates. It is a well-adapted, perennial species that produces rhizomes (underground lateral stems) that enhance the species' ability to form a sod and recover from traffic injury. Kentucky bluegrass is most successful in sunny, well-drained, fertile sites that are fertilized regularly, although it will require 45 to 90 days to establish a dense lawn. Improved varieties will require supplemental irrigation to avoid summer dormancy associated with warm, dry conditions. Older, common varieties, however, have been successful with no irrigation in northern climates. The major pest problems associated with Kentucky bluegrass include fungal diseases such as leafspot, dollar spot, and necrotic ringspot, as well as major surface and root feeding insects such as billbugs and white grubs.

Perennial ryegrass is considered a bunch-type grass that does not produce lateral growth in the form of rhizomes and stolons. Rather, it spreads from the base with tillers. This makes ryegrass plants less competitive in a lawn under regular traffic that injures the plant and leaves open spaces. In addition, weeds in soil would also be able to fill the open spaces before the ryegrass filled in, unless more ryegrass seed was distributed on the soil. Ryegrass will germinate from seed in two to four days and will provide a uniform lawn within two weeks. Therefore, regular seeding of the lawn is vital to maintaining a dense stand of bunch-type grasses such as perennial ryegrass and tall fescue.

Perennial ryegrass is most successful in sunny, well-drained, fertile sites receiving regular care. The major pest problems associated with perennial ryegrass include fungal diseases such as red thread, rust, brown patch, and Pythium blight. Over the past several years, gray leafspot has become a damaging disease of perennial ryegrass, to which there is little to no

natural resistance. Ryegrass breeders have developed varieties that contain endophytic fungi (fungi that live in association with the grass plant in the leaf sheath, referred to as endophytes). The endophytes produce chemicals that deter surface-feeding insects such as chinch bugs and sod webworm but have no effect on white grubs or other subsurface feeders.

The fine-leaf fescues are comprised of a group of lawn grasses that includes creeping red fescue (*Festuca rubra*), chewings fescue (*Festuca rubra* var. *commutata*), hard fescue (*Festuca longifolia*), and sheep fescue (*Festuca ovina*). The fine-leaf fescues are characterized by medium to dark green color, narrow needle-like leaves, primarily bunch-type growth (except for creeping red, which can produce rhizomes), and are exceptionally slow growing, requiring little or no supplemental fertilizer.

The fine-leaf fescues are well adapted to infertile, acidic soils and are most tolerant of shaded conditions as compared to other cool-season grasses. As a group the fescues are not tolerant of traffic because the leaves cannot withstand the abrasion of wear; moreover, similar to ryegrass, they do not fill in open spaces as a result of bunch-type growth. The slow-growing nature of the fine fescues allows for improved shade tolerance in places where less light is available for growth.

The fine fescues have few major pest problems; under wet conditions, however, they can be attacked by red thread and leaf spot. Similar to the ryegrasses, certain fescue cultivars have endophytes to repel surface-feeding insects but are susceptible to white grub infestations.

Turf-type tall fescue (*Festuca arundinacea*) is a bunch-type grass with substantially wider leaves as compared to the fine leaf fescues. It is an exceptionally deep rooted grass, a trait that affords significant ability to persist under drought conditions. It is tolerant of the abrasion of wear, but because it lacks rhizome and stolon growth it will require regular seeding to be competitive in a heavily trafficked lawn.

Tall fescue is susceptible to brown patch, Pythium, and like the ryegrass-

es has suffered in recent years from rust infestations. Proper nitrogen fertilization is vital for avoiding and managing these pest problems. Tall fescue is most successful when established from seed in early August, several weeks before establishing other cool-season grasses, because it is less winter hardy in the seedling stage. In addition, while generally not recommended, spring establishment can be successful when soils warm and seed rate is increased slightly to compete with weed growth.

ESTABLISHING AND RENOVATING A LAWN

A healthy soil grows healthy, competitive plants. Although healthy plants should be the goal of any lawn care program, a program that strives to use a low-input approach requires consistent and vigilant plant health care. The foundation of plant health care is the enhancement and improvement of the soil, which is most effectively accomplished during the establishment of a new turf area or before renovation. This is the first step in an integrated pest management (IPM) program.

IPM is a method of pest management that uses a variety of options to maximize plant health. This approach indicates the importance of site assessment and modification, then selecting the right grass species, followed by proper culture. Proper implementation of these practices will assist in maximizing plant health because of the stable foundation from establishment through maintenance. Where this approach is not followed, pesticides often become the primary component of a management system.

The timing of establishing a new turf area generally coincides with a period of desirable soil temperatures (between 55° and 65° F for the cool-season grasses with adequate precipitation available). For most areas of the cool humid region these conditions are generally available in the late summer and early fall (mid-August to late-September). The farther north in the region, the earlier in the summer the conditions will be available. One of the ecological principles behind this timing is competition from weed infestations, especially annual

grassy and broadleaf weeds because their seeds are germinating at this time. The competition from weeds often results in a less than desirable stand of turf.

PRIMARY CULTURAL PRACTICES

Once the lawn has become established and actively growing, cultural practices must be employed to maximize plant health. In essence a healthy plant is more able than an unhealthy one to compete against weeds and other pests that may infest the stand. Ecologically, lawn care involves striving for what nature would not otherwise select, i.e., a monoculture. Therefore, cultural practices must be properly timed and executed to minimize disruption to the population balance in favor of the lawn grasses while preserving environmental quality.

Mowing

The single most common and time-consuming practice in lawn care is mowing. Still, mowing is probably the most poorly understood of all the cultural maintenance practices, especially the impact of close mowing on plant health. Simply, the lower the height of cut, the less root system available to extract water and nutrients from the soil and the high level of maintenance required to maintain acceptable quality.

The lawn should be mowed so that no more than one-third of the leaf tissue is removed with each mowing. For example, a low-maintenance lawn that is maintained at 3 inches should be mowed when it reaches 4.5 inches. Grass clippings should be left on the lawn, as long as there are no clumps, and have been shown to contribute to the nutrient pool in the soil after three to five years. In addition, leaving clippings on the lawn reduces the chance that they can blow onto paved surfaces and then wash into storm drains where they can contribute to reduction in surface water quality from the phosphorus contained in the tissue.

As mowing height increases, soil surface temperature is reduced as the canopy shades the soil. In fact, several studies have demonstrated a signifi-

cant reduction in weed infestations as a result of mowing heights that were shown to cool the soil and restrict germination of summer annual grasses such as crabgrass (*Digitaria* spp.)

Of all the cultural practices, the removal of leaf tissue by mowing can be the most severe if not done properly. Therefore, the four keys to a healthy mowing program are to (1) mow the lawn at 3 inches or higher to promote deep rooting and cool the soil surface, both of which discourage weed problems, (2) never remove more than one-third of the leaf blade at each mowing so as to minimize physiological shock and maintain health, (3) maintain a sharp cutting blade to reduce tearing and minimize water loss, especially on perennial ryegrass, and (4) return clippings to the lawn to take advantage of the nutrient cycling offered by the clippings.

Fertilizing

Proper nutrient management is as vital for maintaining healthy plants as humans eating a balanced diet. The more a person eats the wrong foods and not enough of the right foods, the greater the chance of not being healthy, especially if the person is experiencing stress or exposed to germs. Likewise, to maintain healthy plants a balanced amount of nutrients must be available.

The soil test provides a basis for the fertilizing program. For example, the soil test will indicate if supplemental applications of P and K will be required. If soil tests indicate adequate levels of these nutrients, there is little evidence that suggests fertilizing with them will provide a benefit. Yet, especially with phosphorus, there can be a significant detrimental effect if fertilizer is deposited on paved surfaces or applied and not watered in properly.

The primary nutrient for the growth of healthy turf is nitrogen. Nitrogen is vital for several important physiological aspects of plant growth, especially shoot and root growth. However, improper timing of nitrogen fertilizer can result in excessive shoot growth at the expense of root growth. This is typical with early spring applications of soluble nitrogen fertilizers.

Research has shown that early spring nitrogen does not enhance green-up as compared to nitrogen applied in late fall. In addition, when the soil warms (the actual cause of spring green-up) and water-soluble nitrogen is available, the plant produces top growth at the expense of root growth. Thus, plants fertilized in early spring are more stressed going into hot, dry summers because their roots have grown less.

Spring fertilization will occasionally be necessary to promote increased density following turf loss from winter injury. In addition, lawns that have not received late fall fertilizer will benefit from early spring fertilization as the soil warms above 55° F. This increased density from an ecological perspective will enhance grass competition for space before emergence of summer annual and perennial weeds.

A fertilizer program for the cool-season grasses should be focused on the fall months. Essentially, 50 to 75 percent of all nitrogen should be applied between August and November. At this time, shoot growth is declining and root growth increasing as temperatures cool but days remain long. Never apply fertilizer to frozen soil because this will increase the likelihood for runoff.

Lawns grown on mostly sandy soils should use a high percentage of slow-release nitrogen to minimize the potential for leaching past the root zone. Research has demonstrated that on most soils, with some silt and clay, leaching of nitrogen is extremely rare.

Regarding the human dimension, lawns whose owners have high visual quality expectations and are exposed to limited traffic will need less nitrogen than those receiving large amounts of traffic. From a species perspective, Kentucky bluegrass lawns have a higher nitrogen requirement than the fine-leaf fescues. If the correct amount of nutrition is not supplied to the bluegrass, it will be less competitive against weeds and other pests. Comparatively, if too much nitrogen is supplied to the fine-leaf fescues, which have a slow growth rate, they will produce lush, weak growth susceptible to pest injury.

Watering

Most lawns do not receive supplemental watering, and fortunately the northern climates rarely require additional water except for a few months in the summer. The lack of supplemental watering does not mean that it is impossible to maintain a healthy turf, only that to do so will require careful management before entering a stress period without precipitation.

Proper watering of lawn areas is vital for maintaining plant health during stressful periods. The most important rule to remember is to attempt to apply what the plant and soil would have lost to evapotranspiration (ET), approximately one inch of water per week and at a rate that matches how the water will infiltrate the soil.

The best time to apply supplemental watering is early in the morning. At this time evaporation rates are low, which improves efficiency. In addition, it is important to try to minimize the length of time grass blades are wet to reduce potential for fungi to cause disease.

It is normal for cool-season grasses to experience summer dormancy associated with lack of moisture. Studies have shown that one inch of water over a three-week period is all that is required to avoid desiccation. Under all but the most severe conditions, it is better to avoid lawn watering especially if application devices are not precise. Inadequate (too much or too little) water can weaken the plants, making them more susceptible to pest problems and less likely to recover when cool, moist conditions return.

PROBLEM SOLVING

Managing a lawn without pesticides includes attempting to solve existing problems that may be a result of poor growing conditions or excessive use of an area that results in reduced lawn health.

Weeds

A lawn with significant weed infestations can detract from visual appearance but often poses no functional or environmental problem. Weeds are best managed from an ecological perspective through prevention rather

than control. The most effective strategy employs a multifaceted approach: understand the biology of the weeds; properly evaluate site conditions to determine if they are conducive to poor lawn growth; and focus on maintaining a dense, healthy lawn. Simply, a chronic weed infestation means that something is awry with the lawn care practices that reduces the competitive ability of the plants. Increased fertility will improve turf density and competitive ability, but if weeds invade, hand pulling remains the only viable control option.

Diseases

Most lawn diseases are caused by fungi. The fungal pathogens (those that infect grasses) live mostly as saprophytes (feed on dead or decaying organic matter) until environmental conditions become favorable for infection (the fungi become parasites).

Most lawn diseases occur when the grasses are experiencing stress and are in a weakened condition, which usually coincides with environmental conditions that are conducive to pathogen growth. Once the infection process is initiated, chemical control is rarely effective and not recommended under lawn conditions.

Insects

Insects are abundant in nature and make up a substantial portion of all the forms of life on this planet. In fact, the lawn environment sustains high populations of insects. Few, however, cause damage.

Grass plants have a substantial ability to tolerate insect feeding. The principles of an IPM program are based on the population threshold of the insect, beyond which significant injury will occur. For white grubs, an actively growing lawn will often experience feeding pressure in early spring from European chafer and be able to tolerate between 10 to 15 grubs per square foot of lawn. In late August through October, Japanese beetle larvae will surface to feed on grass roots and should be monitored to determine if control strategy is required. Observing the population dynamics throughout a season is fun-

damental to developing a healthy lawn care program.

Surface feeder damage occurs on lawns from June through August. Proper inspection of the periphery of the damaged area is accomplished using a disclosing solution made with soapy water applied as a drench that causes the insects to float to the surface.

In addition, endophytes associated with perennial ryegrass, fine leaf, and tall fescues have been shown to provide resistance to surface-feeding insects. The insects are deterred from feeding by the presence of a chemical in the leaf sheath as a result of the association between the endophyte and the plant.

INSECT MANAGEMENT

Three basic types of insects feed on lawn grasses. The *surface feeders* include chinch bugs and sod webworms. *Billbugs* feed in turfgrass stems and crowns. *Root-feeding insects* include several white grub species (larvae of certain scarab beetles such as the Japanese beetle) and the European Chafer.

As with diseases and weeds, a properly maintained lawn is more tolerant of insects than a neglected or improperly maintained lawn. For example, a lawn that is watered and fertilized may tolerate 10 to 15 grubs per square foot with no visible damage. But the same number of grubs may devastate a weak, poorly maintained lawn.

Monitoring: Homeowners can check for grubs in their lawns by cutting three sides of a square-foot area with a shovel and peeling back the sod layer. The white, C-shaped grubs will be apparent on the soil surface of the underside of the sod mat. Several areas of the lawn should be checked and grub levels compared with thresholds listed in Table 15. Inspect lawns in mid- to late August in upstate New York and late July or early August in downstate and Long Island, New York.

In recent years, plant breeders have been working on varieties of lawn grasses that have insect resistance. They have introduced into the grass plant a fungus called an endophyte, which produces a chemical

that is toxic to insects. Perennial ryegrass cultivars with insect resistance include AllStar, Repell, Citation II, Dasher II, Pennant, Pinnacle, and Saturn. Fine fescues infected with the endophyte include Jamestown II and SR 3000. Unfortunately, the toxin does not move to the underground plant parts. Thus insect resistance is limited to surface- and stem-feeding insects such as sod webworm, chinch bug, and billbugs.

White grubs are the most damaging insects on home lawns in New York. There are actually five species of beetles in New York whose larvae feed on turfgrasses. In upstate New York the European chafer and the Japanese beetle cause the most damage. On Long Island we also commonly see grubs of the Asiatic garden beetle and Oriental beetle and Japanese beetle. Currently, one biological insecticide milky spore is labeled for turf, and nematodes may also be used.

Milky spore is a naturally occurring bacterial parasite that infects Japanese beetle grubs but is not effective on other white grub species. Each grub species is infected with its own strain of milky disease. Naturally occurring milky disease is found in most soils that will infect each of the scarab species. We find infected grubs when conditions are stressful for the grubs, that is high population, lack of food, crowding, etc. Population may crash after several years due to natural milky disease buildup. Commercial milky disease product will only infect Japanese beetle. Milky spore products on the market do not survive and spread very well. Grubs and moist, warm soil (>70° F) are needed for sufficient disease development. When soil temperatures reach 70° F or above is usually when adults are present, or eggs are present. These temperatures seldom occur for very long when grubs are active. Thus they have been, at best, marginally effective in New York. Supplies of milky spore have been limited over the last several years because of difficulty in producing sufficient quantities of a high-quality product.

Parasitic nematodes (microscopic worms) are also available to control insects, including grubs. Results with nematodes have been inconsistent

without irrigation, but with sufficient moisture applied they are a viable choice for soil insect control on lawns. Homeowners should choose the nematode product that is targeted to the insect pest causing problems and should follow label directions carefully. Active, living nematodes and sufficient soil moisture are essential for success. Homeowners who do nothing may have to renovate their lawns when heavy grub infestations occur. Nematodes might prevent this.

INTEGRATED PEST MANAGEMENT (IPM)

Integrated pest management integrates many factors into a pest management program. IPM is not, by definition, a pesticide-free program, but a homeowner may choose an IPM program that avoids the use of some or all insecticides. Proper culture, pest monitoring, sanitation (such as thatch control), and proper timing and selection of pesticides are all a part of an IPM program. Ultimately, if a pesticide is used, it will be used much

more efficiently than in a preventive program.

Home lawn IPM incorporates all the cultural practices discussed in this chapter. Following such a program greatly reduces reliance on pesticides. But there may come a time when a weed or insect population reaches an unacceptable or damaging threshold and use of a pesticide may be justified. Then IPM depends on the proper identification of the pest and selection of the pesticide that will effectively manage the pest with minimal hazard to the environment.

Tables 15 and 16 give cultural guidelines. Pesticide guidelines are found in Part II, Tables 17 and 18.

SUMMARY

The importance of efficient use of natural resources combined with preserving environmental quality demands a more holistic approach to managing the lawn environment. It is no longer possible to expect technology, in the form of energy-intensive

inputs, to provide solutions to managing a dynamic biological environment such as a lawn. Therefore, the time is right to approach lawn care from the perspective that all parts are intimately linked and that the alteration of one component will ultimately influence the performance of another.

The ecologically based approach embraces the human dimension as well as the biological aspects of lawn care. This begins with selection of adapted plants that can be competitive while meeting quality and use expectations, then timely and proper cultural management to maintain plant health, and pest management based on the ecology of the organism employing control programs that minimize environmental impact. The result is likely to be a more satisfied lawn care provider and a lawn that provides the environmental benefits that improve the quality of life.

Table 15. Turf pests

<i>Pest</i>	<i>Cultural Management</i>
INSECTS	
Ants	May nest in turfgrass areas, causing mounds. Although many ants are beneficial as predators and recyclers and are useful in cleaning up the environment, mounds are undesirable in lawn areas. Frequent disturbance may cause ants to move.
Bluegrass billbug	Scattered brown spots lead to destruction of entire lawn. Check for infestations by looking for adult billbugs walking on driveways and sidewalks on warm days in early June or when soil temperature reaches about 65° F. Endophytic grasses have shown resistance to billbug damage. Parasitic nematodes may be useful for controlling grubs, billbugs, sod webworms, and cutworms. Commercial nematode products tested have been inconsistent, especially for grub control. They may be useful for spot treatments in late June–early August, especially when turf is under water stress. Apply in evening or early morning as directed by supplier.
Chinch bugs	Adults are black with white wings folded over body, 1/5 inch in length. Nymphs are red to orange, early stages with white band across back. Damage leaves copper-colored area on lawn; closely resembles sunscald or drought injury. Chinch bugs injure grasses by puncturing stems and sucking out plant juices. They do best in thatchy lawns. In severe infestation the grass is killed and only cover and other nongrass weeds remain. Chinch bugs are more of a problem in warmer temperatures in late June through September. Monitor for chinch bugs in June. Check outer margin of injured area by getting down on hands and knees, parting grass, and looking carefully for nymphs and adults; or try a



Hairy chinch bug

Table 15. Turf pests (continued)

Pest	Cultural Management
Chinch bugs (continued)	flotation method: (a) water small areas heavily, cover with white cloth; within a short time bugs crawl up grass blades and hang onto cloth; or (b) use large can with both ends open, drive it into soil a few inches and fill with water. Adults and nymphs should float to surface within 5 to 7 minutes. If 15–20 nymphs are present per square foot you may want to consider treatment or may be able to reduce damage by keeping lawns watered.
Digger wasps	See Table 6, Annoying pests outside the home—Wasps and hornets.
Grubs (Japanese beetle, oriental beetle, Asiatic garden beetle, European chafer*, northern masked chafer)	General wilting and thinning of turf stand. Grubs, the larvae of scarab beetles, feed on grass roots within 1 in. of soil surface, cutting them off and killing grass plants. Before treatment, ask: (1) Is damage definitely caused by grubs? (2) Are grubs still present? (3) What species is causing the damage? (4) What is best time to treat for grubs? (Treat when grubs are young and actively feeding close to the soil surface: mid-August to late September in upstate New York; early August to mid-September in southeastern New York.) (5) Are there enough grubs to warrant treatment? (Rule of thumb: if there are more than eight grubs per square foot, soil should be treated.) (6) Are alternatives to synthetic soil insecticides available? (see Japanese beetle, below). Parasitic nematodes may be useful for controlling grubs, billbugs, sod webworms, and cutworms. Commercial nematode products tested have been inconsistent, especially for grub control. They may be useful for spot treatments or to control black vine weevil larvae in ornamentals. Apply in evening as directed on label.
	White grub
<p>*The European chafer may be the most serious pest of home lawns and low-maintenance turf. Feeding occurs from August to November and again in late April to June. Damage is most severe under drought conditions. Adults emerge from mid-June to early July in New York State. They fly on warm evenings at dusk to tall objects in a landscape. They make a sound like a swarm of bees. After mating, they deposit eggs in soil.</p>	
Japanese beetle	Japanese beetles are considered the number one turf pest in much of New England and the mid-Atlantic states. Use milky disease (a bacterium) spore powder: grubs must be present to spread and maintain the disease. Moist, warm soil (>70° F) is necessary for sufficient disease development to be of value. The powder is useful on large, marginal, or low-value turf areas; it is not effective against other grubs. Trapping adults is not recommended. Although large numbers of beetles may be caught, they have little effect on population levels. If used, keep traps as far away as possible from valued trees and shrubs. Traps contain a sex lure and a feeding lure and may be useful in monitoring activity. See Grubs.
Oriental beetles	This is one of the most damaging grub species on Long Island, New York, along with the Japanese beetle. Because adults are much less conspicuous than Japanese beetles they are often overlooked. Many times adult Japanese beetles are flying but the grub infestation is oriental beetles (OB). OB grubs are not susceptible to commercial milky disease and will not be attracted to Japanese beetle traps. Because oriental beetles oviposit slightly before Japanese beetles, treatment for grubs on Long Island should be slightly ahead of the rest of the state—the last week in July to mid-August would be ideal, but several weeks later would not cause major problems. Maintain healthy turf, use adequate lime, fertilization, and irrigation. Entomopathogenic nematodes may be helpful.
Sod webworms and cutworms	Young larvae (caterpillars) chew tender leaves and stems. Larger larvae may cut off grass blades and consume them. Adult moths deposit eggs at night as they fly over turf-grass areas. Determine presence of webworm and cutworm by mixing 1 to 2 Tbsp. of liquid dishwashing detergent in 1 gal. water and drenching lawn in selected spots. Insects will surface in 5 to 10 minutes. Larvae often hide in burrows in soil or thatch,

continued

Table 15. Turf pests (continued)

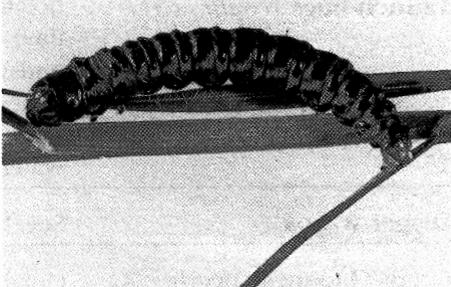
<i>Pest</i>	<i>Cultural Management</i>
<p>Sod webworms and cutworms (continued)</p> <p>coming out at night to feed. Endophyte-enhanced turfgrass can suppress cutworm activity. Entomopathogenic nematodes have been used for black cutworm on golf course greens.</p>	 <p>Sod webworm</p>
<p>Moles</p>	<p>Moles feed on grubs, earthworms, and other invertebrates. Traps are effective when carefully set. Look at improving draining in the area. Moles often inhabit the wettest portions of lawns because this is where earthworms are found.</p>

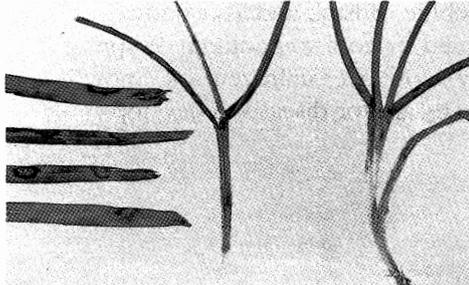
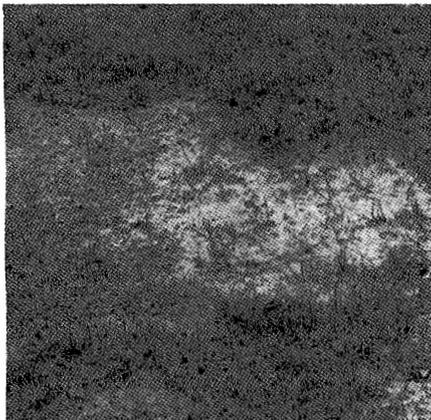
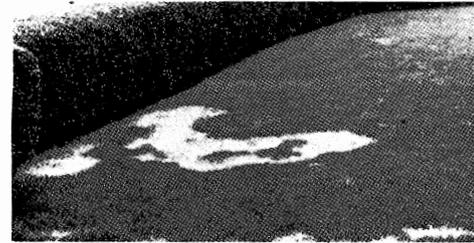
Table 16. Turf diseases

<i>Plant</i>	<i>Description and occurrence</i>	<i>Cultural Management</i>
<p>Anthracnose</p>	<p>Spots are vague or variable in shape. Leaf ends are often tan or brown, giving turf a brownish cast. This disease is most common on turf that is not growing rapidly. Spring through fall.</p>	<p>Maintain adequate nitrogen fertility, but avoid excess nitrogen in spring. Avoid drought and water early.</p>
<p>Brown patch (Rhizoctonia blight)</p>	<p>Brown patches a few inches to several feet in diameter. Bare spots may occur where turf is killed. Most common in summer during hot, humid weather.</p>	<p>Avoid excess nitrogen and excess water. Water early in the day. Use of some organic fertilizers may reduce disease severity.</p>
<p>Dollar spot</p>	<p>Bleached leaf spots with brown borders, often extending across entire leaf blade. Often in small silver dollar-sized patches at first, but may then spread over the lawn. June through September.</p>	<p>Assure adequate fertility. Avoid watering frequently or in late afternoon or evening. Use of some organic fertilizers may reduce disease severity. Resistant bluegrasses include Adelphi, America, Aquila, Bonnieblue, Eclipse, Majestic, Midnight, Parade, Park, Touchdown, Vantage, and Victa.</p>
<p>Fairy rings and toadstools</p>	<p>Arcs or rings of fast-growing, dark-green grass that often surrounds a ring of thin or dead grass where mushrooms may grow. Rings vary in size.</p>	<p>Mask symptoms with good fertility, watering, and mowing programs. Rake down or pick and discard mushrooms.</p>



Fairy ring in a lawn

Table 16. Turf diseases (continued)

<i>Plant</i>	<i>Description and occurrence</i>	<i>Cultural Management</i>
<p>Fungal leaf spots and blights</p> 	<p>Oblong brown leaf spots with dark red, brown, or purple borders. Overall yellowish cast to turf; generally does not occur in distinct patches. If severe, leaves shrivel and entire plants discolor and die. Spring through fall.</p> <p>Leaf spots on grass blades and melting-out infections on crowns</p>	<p>Avoid high-nitrogen nutrition in early spring. Water early in the day. Renovate lawn. Resistant bluegrasses include BonnieBlue, Challenger, Eclipse, Fylking, Midnight, Nassau, Parade, and Touchdown. Avoid systemic fungicides.</p>
<p>Gray snow mold (Typhula blight)</p> 	<p>Bleached, tan, small or large patches covered with white-gray, fluffy mycelial growth. Tiny, yet visible, red or brown spherical fungal sclerotia embedded in infected leaves. Rarely kills grass plants. December to March.</p> <p>Gray snow mold on a lawn</p>	<p>Rake matted grass in spring. Baron Kentucky bluegrass is resistant. Worsened by cool, wet autumn or spring and by deep compacted snow over unfrozen soil. Fertilize to prevent lush turf going into winter.</p>
<p>Necrotic ringspot and summer patch (formerly Fusarium blight syndrome)</p> 	<p>Irregularly shaped, bleached leaves or dying leaf ends. Irregular crescents or circles of dying grass with or without a small patch of healthy grass in the center. April to November.</p> <p>Summer patch "frog-eyes" and patches</p>	<p>Remove excess thatch. Avoid high-nitrogen nutrition, excessive watering, and drought stress. Avoid soil pH below 6.2 and drought stress. Resistant bluegrasses include Adelphi, America, Aspen, Columbia, Eclipse, Glade, Midnight, Mystic, Nassau, Parade, Ram I, Sydsport, Touchdown, Vantage, and Windsor. Mix perennial ryegrass seed with bluegrass seed when overseeding.</p>

continued

Table 16. Turf diseases (continued)

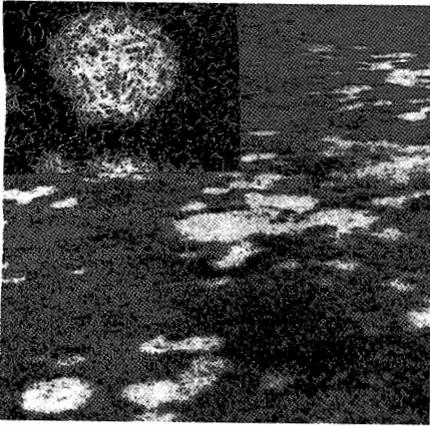
<i>Plant</i>	<i>Description and occurrence</i>	<i>Cultural Management</i>
<p>Pink snow mold (Gerlachia patch)</p> 	<p>Bleached brown, small or large patches covered with pinkish fluffy mycelium. No sclerotia. Can rot crowns and kill grass plants. Autumn to spring.</p>	<p>Avoid nitrogen application in late fall. Remove thatch. Rake matted grass in spring. Resistant bluegrasses include Adelphi, Birka, Bonnieblue, Bristol, and Touchdown. Worsened by cool wet autumn or spring and by snow over unfrozen soil. Snow is not necessary for disease to develop.</p>
	<p>Pink snow mold on a lawn</p>	
Powdery mildew	<p>White, powdery growth on leaves, which appear frosted. Usually found in shady areas. Infected leaves become yellow and then die. July to October.</p>	<p>Reduce shading and avoid excess nitrogen. Plant shade-tolerant varieties. Resistant bluegrasses include A-34, Bristol, Eclipse, Glade, Nugget, and Touchdown.</p>
Pythium blight	<p>Diseased patches often follow shapes of wettest areas. Plants that are killed feel slimy or greasy in early morning. Most common during hot weather on poorly drained sites.</p>	<p>Avoid excess nitrogen and excess water. Do not mow wet grass. Renovate lawn.</p>
Pythium root and crown rot	<p>Small or large areas of lawn appear thinned, off-color, and slow growing. A general decline. Year round.</p>	<p>Avoid excess water and frequent use of systemic fungicides. The use of some organic fertilizers will reduce disease severity.</p>
Red thread	<p>Pink to red threadlike fungus strands grow from ends of leaves. Entire leaves eventually die and turn brown. Irregularly shaped patches. June to July.</p>	<p>Maintain adequate fertility and avoid nitrogen deficiency. Resistant bluegrasses include A-34, Adelphi, Birka, Bonnieblue, Challenger, Monopoly, Nassau, and Touchdown. The use of some organic fertilizers will reduce disease severity.</p>
Rust	<p>Small orange spots occur on leaf blades; later grass develops a reddish discoloration and affected plants shrivel and die. July to September.</p>	<p>Avoid nitrogen deficiency and drought. Resistant bluegrasses include Fylking, Park, and Sydsport. Avoid systemic fungicides</p>
Slime mold	<p>White, yellow, bluish, or dark gray fungus fruiting structures appear on the lawn. Patches of grass become dull gray but do not die. Late summer.</p>	<p>Rake or wash slime mold off leaves. Do not use fungicides.</p>

Table 16. Turf diseases (*continued*)

<i>Plant</i>	<i>Description and occurrence</i>	<i>Cultural Management</i>
Smuts	Leaf blades become yellowish with gray or black stripes. Later the leaf turns brown, dies, and shreds into ribbons. Generally does not occur in distinct patches. May and October.	Avoid drought. Water early. Avoid early spring fertilizer application and excessive nitrogen. Resistant bluegrasses include A-34, Adelphi, Aquila, Baron, Birka, Bonnieblue, Challenger, Eclipse, Glade, Ram I, Sydsport, and Touchdown.

FURTHER READING

Lamboey, J., and M. Villani. 1998. *All About White Grubs*. NYS IPM Program, Ithaca N.Y. 2 pp.

Nelson, E. B. 1992. *Biological Control of Turfgrass Diseases*. Cornell Cooperative Extension Information Bulletin 220, Ithaca, N.Y. 12 pp.

Smiley, R. W. 1992. *Compendium of Turfgrass Diseases*. American Phytopathological Society, St. Paul, Minn. 98 pp.

Smiley, R. W., and M. C. Fowler. 1985. *Turfgrass Disease List and Identification Key for New York State*. Cornell Cooperative Extension Miscellaneous Bulletin 127, Ithaca, N.Y. 4 pp.

Tashiro, H. 1987. *Turfgrass Insects of the United States and Canada*. Cornell University Press, Ithaca, N.Y. 391 pp.

Thurn, M. C., N. W. Hummel, E. B. Nelson, and M. G. Villani. 1995 (rev.) *Home Lawns: Varieties and Pest Control Guide*. Cornell Cooperative Extension, Ithaca, N.Y. 8 pp.

Thurn, M. C., N. W. Hummel, and A. M. Petrovic. 1994. *Home Lawns: Establishment and Maintenance*. Cornell Cooperative Extension Information Bulletin 185, Ithaca, N.Y. 46 pp.

14 WEED MANAGEMENT

NEW LAWNS

The greatest source of weed seeds in new lawns is the soil itself. Planting at the proper season with the right turfgrass cultivars and adequate fertilization at seeding time are the most important practices in minimizing weed problems. In southeastern New York State and on Long Island, fall planting is almost the only means of preventing crabgrass from taking over the lawn. When planted in early fall into a finely prepared seed bed, the grass plants will spread laterally and the turf will be dense and mature before most troublesome lawn weeds appear the following spring.

ESTABLISHED LAWNS

Most common lawn weeds can be greatly reduced by improved lawn care, including proper fertilization and mowing. Sometimes, however, weeds persist in spite of good maintenance.

For small lawns or where only a few weeds are present, hand pulling as weeds appear can be a good source of exercise and provide good results. Weeds can be pulled more easily after a heavy rain or watering. The use of herbicides to control weeds is more practical for large areas, more difficult-to-pull weeds with deeper root systems, and small patches of persistent weeds. Large areas can be treated with sprays or granules, which give good weed control with minimal injury to turfgrass. Single clumps of weeds can be spot treated with phenoxy products for broadleaf weeds of glyphosate (Round-up), which is nonselective. Aerosol containers are available for such areas.

When weeds infest an area of any size and the populations are high enough throughout the area to be objectionable, an overall treatment with a selective chemical that will kill the weeds and leave the grass unharmed may be necessary.

Broadleaf weeds such as dandelion and chickweed require different management practices than do annual grasses such as crabgrass or goosegrass or perennial grasses such as quackgrass. Where weed infestation is serious and the turf is poor, consider renovating the lawn. See Part II for herbicide recommendations.

To minimize weed problems

- select the recommended turfgrass mixture for your site.
- plant your new lawn in the fall.
- use adequate fertilizer (and lime or sulfur if needed), especially when starting a new lawn.
- mow your lawn to a height of greater than 1 1/2 inches to compete better with weeds
- control disease and insects that damage turf and allow weed encroachment (see Tables 15 and 16).
- water the lawn frequently but thoroughly rather than too little too often.

Additional information on lawn care can be found in *Home Lawns: Varieties and Pest Control Guide* (see reference list, inside back cover).

Remember, the best strategy to prevent weed infestation is to maintain a dense, healthy turf.

WEED CONTROL IN VEGETABLE AND FLOWER GARDENS AND LANDSCAPE PLANTINGS

Annual weeds (those that grow from seed each year) can often be effectively controlled in flower and vegetable gardens as well as landscape plantings by hand weeding, cultivating, or mulching. Perennial weeds (those that regrow from large storage roots or rhizomes) are more difficult to eradicate in the garden or landscape and should be eliminated if possible before planting the garden.

Mulch

The use of mulch for weed control is highly recommended in flower and vegetable gardens as well as landscape plantings. Used correctly, mulch not only controls weeds but also conserves soil moisture and adds to soil organic matter content. To be effective, organic mulch should be

about 4 inches thick and cover all bare areas in the plantings.

Black plastic sheeting and the newer woven and spun-bonded geotextile fabrics can be effective deterrents to annual weeds. They are available in garden supply stores and some are relatively inexpensive. Planting can be done directly through small slits or holes in the plastic or along the edges of several plastic strips lying side by side on the cultivated soil. These materials must be covered with a substantial layer of mulch to prevent photodegradation.

Some perennial weeds can grow through plastic film and fabrics and therefore must be removed by hand or with chemical controls. Geotextiles are often expensive, difficult to install, and less suppressive.

See Table 17 for cultural weed management in vegetable gardens. See Part II for guidelines on chemical herbicides.

WEED CONTROL IN FRUIT PLANTINGS

One of the most important aspects of fruit culture is weed control. The growth of any fruit crop is negatively related to the amount of weed growth in the area surrounding the roots, especially when the crop is newly established and less competitive. In addition, weeds can harbor insect and disease pests or create an environment favorable for their development. Controlling weeds is the most important component of pest control. One should strive to maintain a weed-free area around the plant, and the size of this area depends on the growth habit and age of the plant. For example, at least 2 feet should separate a strawberry plant from any other weeds or grassy areas, and this distance should be 6 feet or more for large fruit trees. The successful fruit grower must employ several strategies for controlling weeds.

ELIMINATE ALL PERENNIAL WEEDS BEFORE PLANTING

A key to successful fruit and vegetable production is eliminating perennial weeds the year before the plants are set and reducing the annual weed population. One could

repeatedly cultivate an area for an extended period of time until few weeds regrow, or plant a cover crop such as rye, buckwheat, or sudan-grass to suppress the weeds. A heavy sheet of black plastic left in place for the season at this site will eliminate most weeds. The most effective method is to apply a nonselective herbicide such as glyphosate (Round-up) to the planting area one year before planting. Weeds will die within three weeks of application, after which the area can be worked and a cover crop planted. The cover crop will prevent weed seeds from germinating for the remainder of the year and add organic matter to the soil when it is plowed under in the spring.

PREVENT WEED SEEDS FROM GERMINATING

Organic mulches not only prevent seed germination but gradually improve soil structure and conserve moisture. Straw is an excellent mulch for strawberries and raspberries and certain transplanted vegetables, sawdust or shredded bark work well on blueberries, and wood chips or pine needles are best for tree fruits. Soil should be well drained if organic mulches are to be used. Wet soils can lead to root diseases. Landscape mats work well for blueberries and tree fruits but are expensive. A limited number of herbicides can also be used to prevent weeds from becoming established.

If mulches are not used, you should regularly cultivate the weed-free area around the plants, by hand

or mechanically, but cultivation should be no deeper than 1 to 2 inches. The root systems of most fruit crops are very shallow, and deeper cultivation can cause considerable damage. Keep the surrounding lawn, field, or border mowed to prevent weeds from flowering and releasing seeds into the weed-free area.

Remove established weeds when they appear. Hand weeding is unavoidable for the fruit grower. Regularly pull weeds that become established in the surrounding area so they will not flower or develop an extensive root system. Regular cultivation or use of an herbicide also helps eliminate established weeds.

Research has shown that weed competition in May and June is much more detrimental to plant growth and yield than competition in late summer or early fall.

Table 17. Cultural control of weeds in vegetable gardens

<i>Plant type</i>	<i>Weed</i>	<i>Cultural management</i>
Seeded crops	Annual weeds: pigweed, lambsquarters, purslane, crabgrass, foxtail. Perennial and biennial weeds: quackgrass, thistles bindweeds, yellow rocket, curly dock	Good cultivation before planting, shallow cultivation, hoeing, hand pulling. Mulches such as hay are also effective. Black plastic sheeting is of limited use.
Transplanted crops	Annual weeds: pigweed, lambsquarters, purslane, crabgrass, foxtail	Same as for seeded crops. Black plastic mulch (1.5–4 mils thick) or geotextile fabrics are generally most satisfactory.

NOTES

RESOURCES

The following publications, listed under "Further Reading" at the end of certain chapters, may be obtained from the Cornell University Media and Technology Resource Center, 7 Cornell Business and Technology Park, Ithaca, NY 14850. Please call 607-255-2080 or -2090 for price and availability. Or check the Cornell Cooperative Extension online catalog at www.cce.cornell.edu/publications/catalog.html.

Growing African Violets provides time-proven information on these hybrids, as well as tips on repotting, growth requirements, rejuvenating older plants, and crown division. Covers cultural problems and how to identify and correct them. 25 pp. 141IB135

The Selection, Care, and Use of Plants in the Home provides growth requirements, including light intensity, temperature, humidity, watering, nutrients, and general maintenance. Includes tips for correcting common problems. Includes a section on the care of flowering plants. 29 pp. 141IB117

Artificial Lighting for Decorative Plants tells which plants need what kinds of artificial lighting and which plants have low light requirements. 141HGFS500

Diseases of Geraniums describes bacterial, fungal, viral, and nonparasitic diseases. Discusses fungicides and soil treatment. 30 pp. 153IB201

Reducing Deer Damage to Home Gardens and Landscape Plantings provides comprehensive information on practical, proven deer damage management programs. Covers historical changes in the numbers of white-tailed deer and their feeding habits, food requirements, behavior, and social organization. Lists landscape plants that are rarely, seldom, occasionally, or frequently severely damaged by deer. 22 pp. 147DD

Wildlife Damage Management in Fruit Orchards reviews the problems, discusses methods to protect plants, and highlights promising experimental techniques to control wildlife damage. The information applies to deer, voles, woodchucks, rabbits, and birds. 28 pp. 147IB236

Resistance of Woody Ornamental Plants to Deer Damage tells which species to plant if you want to attract deer or repel them. 4 pp. 147HGGFS800

Herbaceous Perennials: Diseases and Insect Pests provides strategies for prevention and control of the diseases and pests that attack herbaceous perennials. Close-up color photographs will help identify insects and diseases. 25 pp. Includes insert of specific measures. 160IB207

Crown Gall, Diseases of Maples in Eastern North America, Anthracnose Diseases of Trees and Shrubs, and Verticillium Wilt are four leaflets that give specific information on the life cycle and damage with suggestions to help prevent or control each disease.

Suggested Practices for Planting and Maintaining Trees and Shrubs covers site and soil considerations, best planting times, and maintenance including pruning. 11 pp. 144IB24

Pruning: An Illustrated Guide to Pruning Ornamental Trees and Shrubs tells why, how, and when you should prune to obtain the desired configuration and maintain the health and vigor of trees and shrubs, including hedges, vines, and specialty plants. Includes topiary, pollarding, and espalier. Provides information on equipment needed; fully illustrated. 141IB23

Fireblight—Its Nature, Prevention, and Control: A Practical Guide to Integrated Disease Management includes color plates showing symptoms of fire blight on fruit and trees. The background and disease cycle help explain this serious bacterial disease. This is a practical guide for identifying conditions conducive to disease development, identifying disease symptoms, preventing disease, and predicting and controlling fire blight. Information is included on other disorders whose symptoms resemble fire blight. 83 pp. 153USDA631

Tree Fruit Fact Sheet Series. More than 30 two- to four-page fact sheets cover the disease or insect life cycle and suggest prevention or control methods—including powdery mildew, apple scab, brown rot, mites, aphids and more. Please contact the Resource Center for a current list of titles and prices.

Highbush Blueberry Production Guide includes 168 color photos of blueberry varieties, diseases, pests, and growing techniques. A series of tables helps to determine the financial feasibility of planting. A key helps identify and diagnose problems and pests. Includes lists of supplementary materials, work sheets for determining nutritional needs; comes in a three-ring binder for ease of use and updating text. 200 pp. 123NRAES55

Bramble Production Guide will help the serious hobbyist or established grower identify and diagnose bramble problems. Includes 115 color photos, sections on site selection and preparation, plant selection, planting, pest and weed control, irrigation, economics, and marketing. 188 pp. 123NRAES35

Natural Enemies of Vegetable Insect Pests contains 85 color photographs and numerous drawings of 25 key groups of natural enemies, including insect predators, parasitoids, and diseases. More than 90 beneficial species are described, including information on appearance and life cycle, pests attacked, and vegetable crops in which these natural enemies are important and commercially available. 64 pp. 139NVP (91 slides/script also available separately).

The Home Vegetable Garden is a popular how-to-do-it reference. Includes planting schedules, recommended varieties, pest control, and more. 31 pp. 161IB101

Flea Beetle Pests of Vegetables covers the life cycle of common species. Suggests prevention and control (cultural, natural, and chemical) strategies including scouting fields, considering thresholds, and varietal resistance. 5 pp. 139VCF5750.

Biological Control of Turfgrass Diseases provides the rationale and suggestions for using such control methods on turfgrass. Turf managers, pest control applicators, and homeowners will be interested in the research findings and suggested practices. 12 pp. 153IB220

Turfgrass Disease List and Identification Key for New York State lists common diseases and their agents, weather patterns before symptom expression, and symptoms. 4 pp. 153S127

Home Lawns: Varieties and Pest Control Guide discusses integrated pest management, including pesticide-free lawns. Covers cultural practices for prevention and control of weeds. Charts show turfgrass species and variety recommendations, suggested seed mixtures, and lawn insect cultural and chemical control. 8 pp. 141RHL

Home Lawns: Establishment and Maintenance tells you how to analyze the site, have the soil tested, eliminate existing vegetation, drain and grade the land, add fertilizer or other amendments, select seed, prepare the seedbed, plant, irrigate, and mow. Explains integrated pest management and how its use can reduce reliance on pesticides. Illustrations and maintenance calendar are included. 46 pp. 141IB185



Pest Management Around the Home has been a best seller from Cornell Cooperative Extension for more than 20 years.

This completely revised edition will help people solve and prevent problems with insects, plant diseases, and weeds, both indoors and out. It is divided into two parts, Cultural Methods and Pesticide Guidelines.

Part I contains suggestions for combating pests *without* using pesticides. Included are

- methods for preventing indoor pests.
- ways to discourage insects and diseases on houseplants.
- specific practices for managing wildlife.
- suggestions to manage pests of vegetables, fruit plantings, and the landscape.

This handbook is useful to everyone who enjoys houseplants, those who grow their own vegetables or fruit, flower gardeners, or to anyone who wants to get rid of unwanted critters.

Part II, Pesticide Guidelines, complements Part I. It offers specific, detailed information on management methods using chemical pesticides.



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