

Woody Ornamental Insect, Mite, and Disease Management



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College of
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INTRODUCTION

This guide summarizes insect, mite, and disease management practices and pesticide safety information for woody ornamentals and shade trees in Pennsylvania. Its use is intended primarily for arborists, nursery growers, landscape maintenance personnel, extension educators, and consultants.

The development and appearance of pests in Pennsylvania will vary depending on the location (north, south, elevation, etc.) where the woody ornamental plants are growing. The treatment times in this manual are based on the best information we have now, but they may vary from year to year. It is imperative that you closely monitor pest activity each year.

Pesticides are regulated by state and federal laws that are designed to protect the applicator, the consumer, and the environment. This updated guide includes what is current and legal for sale and use in Pennsylvania based on information that was available to the authors during the preparation of the manuscript. The pesticide suggestions are subject to change at any time due to constantly changing pesticide labels and product registrations. Not all products have been evaluated for each pest listed. If any information in these suggestions disagrees with the pesticide

specimen label, the suggestions in this guide must be disregarded. The user of this information assumes all risks for personal injury, plant damage, or property damage. The listing of a pesticide or the absence of a material herein does not constitute an endorsement or criticism of a material by the authors or by The Pennsylvania State University.

Created by Penn State Cooperative Extension specialists, this manual offers the latest on most of the key insects, mites, and diseases of key woody plants in Pennsylvania, current listings of chemical compounds labeled for effective management of these pests, integrated pest management (IPM) considerations for many of these pests, environmentally friendly alternatives in pest management, and information on growing degree days (GDD). Our goal is to present the management options available to the user. It is up to the user of the guide to select those management strategies most appropriate to the plants, pests, and growing conditions prevailing at the site.

To find contact information for the Penn State Cooperative Extension office in your county, go to extension.psu.edu/counties and click on your county on the map.

INSECTS AND MITES

PEST IDENTIFICATION

Most people do not recognize one insect from another and consider many insect and mite species to be harmful. If a plant has damage and there is an insect or mite close to that damage, people conclude that the insect or mite present is the causal organism. Most insects do not cause economic or aesthetic damage to woody ornamental plants. Unless the causal organism is accurately identified, we cannot be sure that the insect or mite is destructive. All too often, a beneficial insect has been sprayed because it was thought to be harmful. Once we know the correct identity of an insect or mite, we can investigate important facts regarding its life cycle in Pennsylvania. For example, we would be able to determine whether it is beneficial or harmful, whether it has chewing or piercing-sucking mouthparts, which stages are destructive, what it prefers to eat, where it lives, and the number of generations it has each year. All of this information is vital to any effective woody ornamental pest management program.

An essential step in an effective insect or mite pest management program is the correct identification of the pest in question. When in doubt, deliver or send several specimens to your county Penn State Cooperative Extension horticulture extension educator or to the authors of this publication. Include the following collection information: (1) name, address, telephone number, and e-mail address of the collector, (2) name of the plant being damaged, (3) date collected, and (4) city or county where the damage occurred. Any additional information about the infestation would be helpful. Small insects should be placed in small containers filled with 70 percent rubbing alcohol. Larger specimens may be sent dry packed between tissue or other protective material. Place vials and/or dry specimens in a cardboard box or mailing tube with packing material and either send them or take them to your county Penn State Cooperative Extension Office (see extension.psu.edu/counties for your county office's contact information). You may send the samples directly to the Insect Identification Laboratory, Department of Entomology, The Pennsylvania State University, 501 ASI Building, University Park, PA 16802.

INTEGRATED PEST MANAGEMENT

Integrated pest management (IPM) is not a new arthropod (i.e., insects, mites, and their relatives) management strategy. Some components of IPM have been practiced for over 100 years. The current philosophy of IPM has been around for about 40 years. Researchers sometimes refer to IPM as "intelligent pest management." A new description of IPM, sometimes called plant health care (PHC), has been discussed in some trade journals. PHC examines the basic causes of stress to a plant and suggests corrective measures that promote plant health.

IPM is a pest population management system that utilizes all suitable techniques (biorational, chemical, cultural, fertilization, irrigation, monitoring with sex pheromone traps, resistant plant varieties, etc.) and information to reduce or manipulate pest populations that are maintained at tolerable levels (i.e., a few pests will still be present) while providing protection against hazards to humans, domestic animals, and the Earth's environment.

Guidelines for Establishing an IPM Program

1. Acknowledge that pesticides are not the only or best solution to every problem.
2. Retain a properly trained IPM manager.
3. Be able and willing to develop and maintain IPM-related records.
4. Develop excellent lines of communication among scouts, managers, growers, field technicians, clients, etc.

Diagnosing Arthropod Problems

1. Be familiar with the host plant(s).
2. Have expertise in identifying pest damage.
3. Have expertise in identifying the key pest on the key host.
4. Implement a management strategy that may or may not include application of conventional pesticides.
5. Evaluate management strategies to determine if the one selected is appropriate.

Use of Symptomatology

A symptom of arthropod injury to a woody ornamental plant may be defined as the damage that's evident on the host plant as a result of successful attack by the pest. Some examples of symptoms of arthropod injury include chewed foliage or blossoms; stippled, yellowed, or bronzed foliage; distortion of plant parts; and dieback of plant parts.

A sign is defined as the presence of the pest or pest-related products that may remain on the woody ornamental host plant. Examples of signs of arthropod activity include honeydew/sooty mold, fecal specks, tents or webs, spittle, pitch tubes, waxy material, and cast exoskeletons or skins.

Sampling/Monitoring Arthropod Pests and Their Natural Enemies

1. Methods of sampling include counting the number of arthropods on plant parts, fecal pellet (frass) collections, physical removal of arthropods on a white substrate, timed counts of life stages of arthropods, and the use of sex pheromone traps.
2. The detection of the presence or absence of a key pest on a key host is the major objective of sampling; beneficial arthropods should also be noted.
3. A management decision will have to be made concerning the need to implement a particular control tactic.

Decision to Implement a Management Strategy

In deciding whether to implement a management strategy, you may need to consider variables such as population numbers (increasing or decreasing abundance), the species and location of the key host plant, and the species of arthropod present.

Methods of Control

Control methods include biological, biorational, chemical, cultural, physical, and other management tactics.

References

Ball, J. 1986. Public perception of an integrated pest management program. *J. Arboric.* 12:135–40.

———. 1987. Efficient monitoring for an urban IPM program. *J. Arboric.* 13:175–77.

Hermes, D. A., R. C. Akers, and D. G. Nielsen. 1984. The ornamental landscape as an ecosystem: Implications for pest management. *J. Arboric.* 10:303–307.

Hock, W. 1984. IPM—Is it for the arborist? *J. Arboric.* 10:1–3.

Holmes, J. J., and J. A. Davidson. 1984. Integrated pest management for arborists: Implementation of a pilot program. *J. Arboric.* 10:65–70.

Koehler, C. S. 1987. Symptomatology in the instruction of landscape ornamentals entomology. *J. Arboric.* 13:78–80.

Koehler, C. S., M. J. Raupp, E. Dutky, and J. A. Davidson. 1985. Standards for a commercial arboriculture IPM program. *J. Arboric.* 11:293–95.

Leslie, A. R., and R. L. Metcalf. 1989. *Integrated Pest Management for Turfgrass and Ornamentals*. Washington, D.C.: EPA, Office of Pesticide Programs, Field Operations Div.

Nielsen, D. G. 1983. Arborists and insect control: Past, present, and future. *J. Arboric.* 9:12–16.

———. 1986. Planning and implementing a tree health care practice. *J. Arboric.* 12:265–68.

Olkowski, W., and A. Zhang. 1987. Update: Agroforestry and IPM-issues and frontiers. *The IPM Practitioner* 9:1–8.

Raupp, M. J. 1985. Monitoring: An essential factor to managing pests of landscape trees and shrubs. *J. Arboric.* 11:349–55.

Raupp, M. J., and R. M. Noland. 1984. Implementing landscape plant management programs in institutional and residential settings. *J. Arboric.* 10:161–69.

Raupp, M. J., J. A. Davidson, J. J. Holmes, and J. Lee Hellman. 1985. The concept of key plants in integrated pest management for landscapes. *J. Arboric.* 11:317–22.

Raupp, M. J., J. A. Davidson, C. S. Koehler, C. S. Sadof, and K. Reichelderfer. 1988. Decision-making considerations for aesthetic damage caused by pests. *Bull. Entomol. Soc. Amer.* 34:27–32.

Reardon, R., M. McManus, D. Kolodny-Hirsch, R. Tichenor, M. Raupp, C. Schwalbe, R. Webb, and P. Meckley. 1987. Development and implementation of a gypsy moth integrated pest management program. *J. Arboric.* 13:209–16.

Sherald, J. L., and C. L. J. DiSalvo. 1987. Integrated pest management in the national capital region of the National Park Service. *J. Arboric.* 13:229–35.

Walker, J. T. 1981. A need for urban IPM. *J. Arboric.* 7:204–207.

GROWING DEGREE DAYS

Effective woody ornamental pest management depends our ability not only to accurately diagnose the causal organism but also to predict when the vulnerable life stage of a pest will be active. Insect and mite development sometimes varies from one year to the next by several days or even weeks. It is important for pest managers to consider additional methods to better time their management strategies. The use of the calendar method and experience is helpful, but when applying management materials with a short residual life, you need to more precisely determine when a pest will be in a vulnerable stage.

The development of arthropods, like many other organisms on Earth, is affected by temperature. Insects and mites begin development when the temperature of their environment exceeds a lower developmental threshold or base temperature. The rate of their development increases as the environmental temperature exceeds the threshold temperature and decreases as the temperature declines. For example, arthropod development will occur more quickly during warmer growing seasons and is slower during cooler growing seasons.

The concept of growing degree days (GDD) is an arithmetical conversion of daily temperature records to heat units. While the concept has been recognized for many years, the base or threshold temperature is known for just a few of our key woody ornamental pests. The threshold or base temperature varies from one insect or mite species to another. Organisms that are active when temperatures are cool usually have a lower threshold temperature than those that become active during warmer months of the growing season. For the sake of consistency, a threshold or base temperature of 50°F has been adopted by most woody ornamental pest managers. Several equations such as the average, triangulation, and sine can be used to calculate GDD based on minimum and maximum temperature. A simple method that is often used involves averaging the daily maximum and minimum temperatures and subtracting the base or threshold temperature from the daily average as described below:

Formula for calculating GDD:

Maximum + minimum daily temperature – threshold temperature = GDD

			Total GDD Accumulated
Examples:			
March 1:	$\frac{52^{\circ}\text{F} + 48^{\circ}\text{F}}{2} =$	$\frac{100}{2} = 50 - 50^{\circ}\text{F} = 0 \text{ GDD}$	0
March 2:	$\frac{56^{\circ}\text{F} + 50^{\circ}\text{F}}{2} =$	$\frac{106}{2} = 53 - 50^{\circ}\text{F} = 3 \text{ GDD}$	3
March 3:	$\frac{60^{\circ}\text{F} + 50^{\circ}\text{F}}{2} =$	$\frac{110}{2} = 55 - 50^{\circ}\text{F} = 5 \text{ GDD}$	8
March 4:	$\frac{51^{\circ}\text{F} + 49^{\circ}\text{F}}{2} =$	$\frac{100}{2} = 50 - 50^{\circ}\text{F} = 0 \text{ GDD}$	8
March 5:	$\frac{62^{\circ}\text{F} + 48^{\circ}\text{F}}{2} =$	$\frac{110}{2} = 55 - 50^{\circ}\text{F} = 5 \text{ GDD}$	13

Growing Degree Days (GDD) at a Threshold Temperature of 50°F

[illegible]

INSECTS AND MITES DESTRUCTIVE TO WOODY ORNAMENTALS*A Guide to Host Plants and Common Insects as an Aid for Diagnosis*

Alder Fall webworm Gypsy moth Leafminer Woolly alder aphid	Gypsy moth Hickory tussock moth Japanese beetle Leafhoppers Oystershell scale Whitemarked tussock moth Yellownecked caterpillar	Japanese maple scale Leafhoppers Oystershell scale	<i>Nuculaspis pseudomeyeri</i> (armored scale insect) Spruce spider mite
Arborvitae Arborvitae leafminer Bagworm Fletcher scale <i>Nuculaspis pseudomeyeri</i> (armored scale insect) Spruce spider mite Tip dwarf mite	Boxelder Boxelder bug	Douglas-fir Bagworm Cooley spruce gall adelgid Pine needle scale Spruce spider mite White pine weevil	Hickory Aphids Cankerworm Elm spanworm European fruit lecanium Fall webworm Flatheaded appletree borer Gypsy moth Hickory leafstem gall phylloxera Hickory tussock moth Mites Twig girdler Twig pruner Yellownecked caterpillar
Ash Aphids Ash borer Ash flower gall mite Banded ash clearwing Cankerworm Emerald ash borer European fruit lecanium Fall webworm Flatheaded appletree borer Japanese maple scale Oystershell scale Plant bug	Catalpa Catalpa sphinx White peach scale	Elm Bark beetles Calico scale Cankerworm Elm leaf aphids Elm leaf beetle Elm spanworm European elm scale Fall webworm Japanese beetle Japanese maple scale Leafhoppers Spiny elm caterpillar Whitemarked tussock moth Yellownecked caterpillar	Holly Cottony taxus scale Indian wax scale Inkberry leafminer Native holly leafminer Putnam scale Southern red mite
Azalea Azalea bark scale Azalea lace bug Azalea leafminer Azalea sawflies Azalea stem borer Black vine weevil Cottony azalea scale Mealybugs Rhododendron borer Southern red mite Twobanded Japanese weevil Whitefly	Chamaecyparis Juniper scale <i>Nuculaspis pseudomeyeri</i> (armored scale insect)	Euonymus Aphids Euonymus alatus scale Euonymus caterpillar Euonymus scale Indian wax scale Japanese maple scale Twobanded Japanese weevil Twospotted spider mite	Honeylocust Bagworm Calico scale Honeylocust plant bug Honeylocust pod gall midge Mimosa webworm Painted hickory borer Spider mites
Barberry Twobanded Japanese weevil	Cherry (flowering ornamental) Eastern tent caterpillar Fall webworm Flatheaded appletree borer Japanese beetle Japanese maple scale Lesser peachtree borer Peachtree borer San Jose scale White peach scale White prunicola scale	Fir Aphids Bagworm Cryptomeria scale Elongate hemlock scale Pine needle scale Spruce spider mite	Honeysuckle Aphids
Basswood (linden) Aphids Basswood lace bug Cankerworm Gypsy moth Hickory tussock moth Japanese beetle Leaf beetle Oystershell scale Whitemarked tussock moth	Cotoneaster Hawthorn lace bug Japanese maple scale Mites Pear sawfly San Jose scale	Forsythia Foullined plant bug	Ivy Aphids Cottony taxus scale Japanese beetle Mites
Beech Beech scale Cankerworm Elm spanworm Woolly beech aphids Yellownecked caterpillar	Crabapple (ornamental nonedible flowering) Aphids Cankerworm Calico scale Eastern tent caterpillar Fall webworm Flatheaded appletree borer Gypsy moth Japanese beetle Japanese maple scale Leafroller Mites Oystershell scale Pear sawfly Roundheaded appletree borer Yellownecked caterpillar	Hawthorn Aphids Eastern tent caterpillar Fall webworm Flatheaded appletree borer Hawthorn lace bug Hawthorn leafmining sawfly Leafhopper Mites Oystershell scale Pear sawfly Roundheaded appletree borer	Japanese pieris Azalea bark scale Lace bug Putnam scale Southern red mite
Birch Aphids Bagworm Birch leafminer Bronze birch borer Fall webworm	Cryptomeria Cryptomeria scale Spruce spider mite	Hemlock Bagworm Black vine weevil Cryptomeria scale Elongate hemlock scale Hemlock looper Hemlock rust mite Hemlock scale Hemlock woolly adelgid	Japanese zelkova Calico scale Elm leaf beetle Japanese maple scale
	Dogwood Calico scale Dogwood borer Dogwood sawfly		Juniper Bagworm Eriophyid mite Juniper midge Juniper scale Juniper tip midge Juniper webworm <i>Nuculaspis pseudomeyeri</i> (armored scale insect) Spruce spider mite
			Larch Bagworm Larch casebearer Larch sawfly Woolly larch adelgid

Lilac

Fall webworm
Japanese maple scale
Lilac borer
Lilac leafminer
Lilac rust mite
Oystershell scale
White prunicola scale

Locust (black)

Locust borer
Locust leafminer

Magnolia

Japanese maple scale
Magnolia scale
Tuliptree scale

Maple

Aphids
Bagworm
Calico scale
Cankerworm
Cottony maple scale
Elm spanworm
European fruit lecanium
Fall webworm
Forest tent caterpillar
Gloomy scale
Greenstriped mapleworm
Japanese beetle
Japanese maple scale
Leafhopper
Maple callus borer
Maple gall mites (eriphyid)
Maple leafcutter
Maple petiole borer
Oystershell scale
Pear thrips
Whitemarked tussock moth
Yellownecked caterpillar

Mimosa

Mimosa webworm

Mountain ash

Aphids
European red mite
Japanese beetle
Mountain ash sawfly
Pear sawfly
Roundheaded appletree borer

Mountain laurel

Azalea bark scale
Mulberry whitefly
Redbanded leafhopper
Rhododendron borer
Rhododendron lace bug
Rhododendron stem borer
Southern red mite
Twobanded Japanese weevil

Oak

Aphids
Borers
Cankerworm
Elm spanworm
Fall webworm
Forest tent caterpillar
Gall midges
Gall wasps
Golden oak scale
Gypsy moth

Leafhopper

May/June beetle
Oak kermes scale
Oak lace bug
Oak skeletonizer
Obscure scale
Orangestriped oakworm
Spider mites
Twig pruner
Twolined chestnut borer
Yellownecked caterpillar

Pachysandra

Euonymus scale
Oystershell scale
Twospotted spider mite

Pear (flowering ornamental)

Aphids
Calico scale
Cottony maple scale
European fruit lecanium
Forest tent caterpillar
Japanese maple scale
Oystershell scale
Pearleaf blister mite

Pine

Aphids
Bagworm
Engraver beetle
Eriophyid mite
European pine shoot moth
Gypsy moth
Nantucket pine tip moth
Northern pine weevil
Pales weevil
Pine bark adelgid
Pine bark beetle
Pine needle midge
Pine needleminer
Pine needle scale
Pine oystershell scale
Pine root collar weevil
Pine tortoise scale
Pine tube moth
Pine webworm
Sawflies
Spittlebugs
Spruce spider mite
Striped pine scale
White pine weevil
Zimmerman pine moth

Privet

Privet rust mite
Privet thrips
Twobanded Japanese weevil
White peach scale
White prunicola scale

Purpleleaf plum

Globose scale
Pear sawfly

Pyracantha

Aphids
Globose scale
Hawthorn lace bug
Indian wax scale
Japanese maple scale
San Jose scale
Spider mites

Redbud

European fruit lecanium
Spider mites
Twig girdler
Twig pruner
Whitemarked tussock moth

Rhododendron

Azalea bark scale
Black vine weevil
Cottony azalea scale
Leafhoppers
Mealybugs
Putnam scale
Rhododendron borer
Rhododendron gall midge
Rhododendron lace bug
Rhododendron stem borer
Southern red mite
Twobanded Japanese weevil
Whitefly

Rose

Aphids
Black vine weevil
Bristly roseslug
Curled roseslug
European red mite
Fall webworm
Fourlined plant bug
Japanese beetle
Leafhoppers
Mossyrose gall wasp
Obliquebanded leafroller
Raspberry cane borer
Rose chafer
Rose midge
Rose scale
Roseslug
Thrips
Twospotted spider mite

Serviceberry

Aphids
Hawthorn lace bug
Pear sawfly

Spirea

Aphids
Twobanded Japanese weevil

Spruce

Aphids
Bagworm
Cooley spruce gall adelgid
Eastern spruce gall adelgid
Elongate hemlock scale
Gypsy moth
Pine needle scale
Sawflies
Spruce bud scale
Spruce needleminer
Spruce spider mite
White pine weevil

Sweetgum

Bagworm
Calico scale
Fall webworm
Gypsy moth
Sweetgum scale

Sycamore

Aphids
Bagworm
Fall webworm
Japanese beetle
Sycamore lace bug
Sycamore plant bug
Terrapin scale
Tussock moth

Tuliptree

Aphids
Tuliptree scale
Yellow poplar weevil

Viburnum

Aphids
Fourlined plant bug
Indian wax scale
Southern red mite
Twobanded Japanese weevil
Viburnum leaf beetle

Weigela

Fourlined plant bug
Japanese beetle
Twobanded Japanese weevil

Willow

Aphids
Eastern tent caterpillar
Gypsy moth
Japanese beetle
Imported willow leaf beetle
Japanese maple scale
Oystershell scale
Spider mites
Spiny elm caterpillar

Wisteria

Calico scale
Japanese beetle

Yew

Black vine weevil
Cottony taxus scale
Fletcher scale
Taxus bud mite
Taxus mealybug

PLANT PHENOLOGICAL INDICATORS

Phenology is the study of periodic occurrences in nature and their relation to weather. The growth of plants is, in part, a response to an accumulation of heat units. Some examples of growth stages of plants that can be correlated to heat units include bud swell, leaf emergence/expansion, stages of flowering, or elongation of new growth (conifers). Specific plant growth stages can be correlated to certain life stages of insects and mites. Length of day, other environmental factors, and different cultivars may affect specific events in a plant's development so that correlations of plant phenology are not as precise as the use of growing degree day information. Using plant phenological indicators is useful in establishing monitoring times and is more accurate than referring to calendar dates to time a particular management strategy. An example of the use of a plant phenological indicator would be the correlation of gypsy moth egg hatch with the bloom of shadbush or serviceberry (*Amelanchier*). Donald Orton's book *Coincide* contains many observations on relationships of plant phenology and some key arthropod pest life stages. It is available from Labor of Love Conservatory, 468 South President Street, Unit #103, Carol Stream, IL 60188, phone: 630-668-8597.

Data collection and observations of growing degree days and plant phenological indicators in Pennsylvania were conducted for 15 years by an applied group of arborists, nurserymen, landscape managers, and Penn State extension educators. This organization was originally known as the Southeast Pennsylvania IPM Research Group. The name of this group was changed to the Penn-Del IPM Research Group when cooperators from Delaware were included in this applied research effort. Information regarding this group's activities may be obtained by calling 814-865-3256.

BEE WARNING

Many insecticides are highly toxic to honey bees, bumble bees, and other native pollinating insects. Certain materials should not be applied any time during bloom, while many others should be applied only in the early morning hours and/or late evening when pollinators are not foraging. Avoid spraying materials on ornamentals that are surrounded by blooming flowers or weeds. Simple steps like removing (mowing) blooming clover from lawns or covering the plants that are in bloom prior to applying a treatment in a landscape should always be practiced before applying materials that are harmful to bees. Select the least hazardous material (if given the choice) when plants in the infested area are in bloom. Always read and follow label directions for bee safety.

INSECT TRAPS AND ATTRACTANTS

Insect monitoring traps can be useful tools for determining the activity of some key pests of trees and shrubs. They can also help determine the proper timing of an insecticide application to effectively manage an infestation of a pest. Some traps may even help reduce insect pest populations. Because these traps and their associated chemical attractants are not harmful to animals or humans and do not leave residues, they are suited to environmentally sound arthropod pest management programs in nurseries and landscapes. The effective use of these tools requires species-specific knowledge of the targeted pest's biology.

Insects use different semiochemicals (chemicals that carry messages either within a species or between species) that transmit messages between organisms. Pheromones (chemicals that are produced and detected by members of the same species) are one of these semiochemicals. Effective and practical use of pheromones in a woody ornamental pest management program requires that a specific active chemical be isolated and identified. A synthetically reproduced version of this compound must then be manufactured and made commercially available. Pheromones may be used in several ways—for example, as lures in insect monitoring traps, as lures in traps to remove individuals in a pest population, and to disperse a signal that may disrupt mating in a pest population.

Insect traps may be used to detect the presence of an invasive arthropod pest, get an estimate of the relative density of a key pest population, or determine the first emergence or peak flight of an insect pest in an area. The latter purpose is often used to time an effective insecticide application. One example is the use of clearwing borer pheromone-baited traps that assist a plant health care specialist in detecting when adult males are active in a nursery or landscape. When the first male of a particular clearwing borer pest species has been captured in a monitoring trap, application of a registered insecticide host plant should follow 7 to 10 days later.

Two examples of insect monitoring traps that are used in woody ornamental pest management programs include those used to detect new infestations of the gypsy moth, *Lymantria dispar*, and the large sticky traps that are used to detect the flight of the smaller European elm bark beetle, *Scolytus multistriatus*.

Listed below are some sources of insect monitoring traps and pheromones for landscape and nursery pests.

Bedoukian Research Inc.
21 Finance Drive
Danbury, CT 06810
Phone: 203-830-4000
www.bedoukian.com

Contech Inc.
7572 Progress Way
Delta, BC V4G 1E9
Phone: 800-767-8658
www.pherotech.com

Gempler's
PO Box 44993
Madison, WI 53744
Phone: 800-382-8473
www.gemplers.com

Great Lakes IPM Inc.
10220 E Church Road
Vestaburg, MI 48891
Phone: 800-235-0285
www.greatlakesipm.com

Scentry Biologicals Inc.
610 Central Ave.
Billings, MT 59102
Phone: 800-735-5323
www.scentry.com

Trece Incorporated
7569 Highway 28 West
PO Box 129
Adair, OK 74330
Phone: 866-785-1313
www.trece.com

BIOLOGICAL CONTROLS

Parasites and predators can be purchased from a wide array of companies throughout the United States and Canada. Frequently, addresses are listed in various trade magazines and other gardening resource reading material. Also, the California Department of Food and Agriculture has assembled a listing of commercial businesses that sell beneficial organisms, such as insects, mites, and nematodes, that can be used for pest control, either as an alternative to chemical control or in an integrated program with chemicals. The title of this publication is *Beneficial Organisms of North America*, which can be found at www.cdpr.ca.gov/docs/ipminov/bensuppl.htm. For additional information on the availability of this publication, contact California Department of Pesticide Regulation, 1001 I Street, PO Box 4015, Sacramento, CA 95812-4015, phone: 916-445-4300.

Video/DVD on Biological Control

A 39-minute video titled *Insects and Spiders and Mites, OH MY!: Recognizing Beneficials in the Nursery and Landscape* was produced by Information and Communication Technologies and the Department of Entomology at The Pennsylvania State University. This video chronicles the life stages of beneficial arthropods. Some are familiar, and some you may have never seen before. Almost 90 percent of the footage is devoted to high-quality, close-up microscopy of beneficials in their egg, larval, nymphal, pupal, or adult stages. It covers 17 different groups of beneficial insects and their relatives commonly found on woody landscape and nursery plants.

The video is useful in educating green-industry professionals such as nurserymen, landscapers, and arborists. Teachers, 4-H leaders, students, master gardeners, and the public will also find this video helpful regarding the recognition and importance of beneficial arthropods.

This video was awarded a first prize in the education category during a competition conducted by the Broadcast Education Association, a prestigious organization composed of land grant institutions, colleges, universities, and commercial companies.

Copies (VHS or DVD) are available from Ag Communications and Marketing, The Pennsylvania State University, 229 Ag Administration Building, University Park, PA 16802, 814-865-6309. The cost is \$20.00 each (includes shipping and handling).

INVASIVE ARTHROPOD PESTS OF WOODY ORNAMENTAL PLANTS

There are many concerns for the health of trees and shrubs in our landscapes, nurseries, and forests due to recent unintentional introduction of some exotic insect pest species into the northeastern and midwestern United States. Currently, the two species most often discussed by regulatory agencies and covered by the news media are the Asian longhorned beetle (ALB), *Anoplophora glabripennis* (Motschulsky) (Coleoptera: Cerambycidae), and the emerald ash borer (EAB), *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae). To date, ALB was known to occur in New York, Illinois, New Jersey, Toronto, Canada, and more recently in Massachusetts.

The emerald ash borer was first detected in southeastern Michigan in July 2002. This pest was discovered in Ohio early in 2003, in Maryland later in 2003, in Virginia in 2003, in Indiana

in 2004, and in Illinois in 2006. In late June 2007 an adult EAB was collected on a green ash tree in a nonresidential landscape in Butler County, Cranberry Township, and in Allegheny County, Marshall Township, in Pennsylvania. Since this initial detection, EAB infestations have been discovered in Mercer (2008), Westmoreland (2009), Washington (2009), Armstrong (2009), and Indiana (2009) Counties in western Pennsylvania and in Mifflin (early in 2009) and Juniata (late in 2009) Counties in central Pennsylvania. In 2010 EAB was confirmed in Bedford, Somerset, Fulton, Centre, Cumberland, Union, and Clarion Counties in Pennsylvania. EAB has also been found in West Virginia (2007), Missouri (2008), Wisconsin (2008), Minnesota (2009), Kentucky (2009), New York (2009), Tennessee (2010), and Iowa (2010), making EAB a national pest problem. These infestations likely originated from EAB-infested nursery stock, firewood, or ash logs that were transported from southeastern Michigan.

Two task forces have been formed in Pennsylvania to address concerns regarding ALB and EAB. These two groups comprise scientists from federal and state regulatory agencies, natural resource management agencies, and Penn State. The main objective of these task forces was to develop action plans for ALB and EAB in Pennsylvania. Another objective of these two groups is to work collaboratively in order to prevent the spread of these invasive pests into the landscapes, nurseries, and forests of Pennsylvania. Additionally, the goal of these scientists is to educate green-industry professionals and the public regarding these exotic pests. The contact person for any observations on invasive arthropod pests is Sven-Erik Spichiger, survey entomologist, Division of Plant Protection, Bureau of Plant Industry, Pennsylvania Department of Agriculture in Harrisburg, Pennsylvania. The phone number for the survey entomologist is 717-772-5229.

Below are some useful Web sites for additional information on the Asian longhorned beetle and the emerald ash borer.

Asian longhorned beetle:

University of Vermont Entomology Research Laboratory: www.uvm.edu/albeetle

USDA-APHIS: www.aphis.usda.gov/plant_health/plant_pest_info/asian_lhb/index.shtml

USDA PestAlert: www.na.fs.fed.us/pubs/palerts/alb/alb_pa.pdf

U.S. Forest Service, Northeastern Area: www.na.fs.fed.us/fhp/alb

Emerald ash borer:

Center for Invasive Species and Ecosystem Health: www.invasive.org/browse/subject.cfm?sub=7171

Maryland Department of Agriculture: www.mda.state.md.us/plants-pests/eab

Michigan Department of Agriculture: www.michigan.gov/mda/0,1607,7-125--65294--,00.html

Ohio Department of Agriculture Emerald Ash Borer Program: www.agri.ohio.gov/eab

Penn State Department of Entomology: ento.psu.edu/extension/trees-shrubs/emerald-ash-borer

U.S. Forest Service, Northeastern Area: na.fs.fed.us/fhp/eab

USDA Forest Service, Michigan State University, Purdue University, and Ohio State University Emerald Ash Borer Info: www.emeraldashborer.info

Tree-Age (Emamectin Benzoate)—Insecticide (Injection Treatment) for Management of Emerald Ash Borer

In addition to the emerald ash borer, this insecticide is also labeled for management of mites, spruce spider mite, European red mite, twospotted spider mite, leafminers, flatheaded borers, bronze birch borer, twolined chestnut borer, pine borer, roundheaded wood borers, pales weevil, white pine weevil, bark beetles, spruce beetle, *Ips* engraver beetles, scolytids (bark beetles), sawflies, gall wasps (cynipid), horntails, fall webworm, winter moth, tent caterpillars, eastern tent caterpillar, forest tent caterpillar, gypsy moth, bagworm, pine coneworms, orangestriped oakworm, clearwing borers, ash borers, borers, and pine nematode on ornamental trees, ornamental trees (deciduous), and ash.

The registrant of this product is Arborjet, Inc., Delta Analytical Corporation, 12510 Prosperity Drive, Suite 160, Silver Spring, MD 20904.

Azatin XL (Insect Growth Regulator) and Ornazin 3% EC—Botanical Insecticides

These botanical insecticides are labeled for management of pests such as aphids, whiteflies, thrips, mealybugs, leafhoppers, leafminers, loopers, sawflies, cankerworms, psyllids, beetles, and caterpillars on ornamentals, trees, and shrubs in ornamental greenhouses, shadehouses, commercial nurseries, and interiorscapes.

HORTICULTURAL SPRAY OIL

Horticultural spray oil has become an essential management tool in the development of integrated pest management programs to control landscape pests. A wide array of oils is available to control insect and mite pests; however, it is essential that you closely examine the label for each individual oil formulation prior to application. Some formulations of horticultural spray oils are labeled for dormant, delayed dormant, and summer application. Likewise, you need to follow all label precautions when any formulation of oil is applied to prevent plant phytotoxicity.

Johnson (1985) defines a horticultural oil as “a highly refined paraffinic petroleum product made solely for use on plants at specific dosages and acts as an insecticide and miticide.” Johnson also states that “no horticultural label to date provides enough information to properly identify the substance in the container.” Johnson notes that “the minimal information necessary is the U.R. (unsulfonated residue) rating (92 percent) and distillation temperature.”

Johnson also states, “The most recent innovation in oil use has been the production of a 412 oil (plus or minus 8°F) that performs best in summer use. It is effective against summer eggs and against a wide range of immature forms, if spray particles strike the insect’s body, i.e., scale crawlers, mealybugs, aphids, leafhoppers, sawfly larvae, naked caterpillars, and beetle larvae.”

Plant phytotoxicity remains our biggest concern in the application of horticultural spray oils. The following list summarizes factors that cause phytotoxicity (Johnson 1985):

- 1. Overdose of oil
- 2. Wrong timing of spray
 - a. No spraying when buds have fully opened and shoot elongation is occurring
 - b. No spraying when there is an obvious moisture deficit observed in leaves

- c. No spraying of sensitive plants when the relative humidity is expected to remain over 90 percent for a period of 48 hours
- 3. Mistaken dormancy in the fall
- 4. Genetic variability

Johnson also lists the following as some oil-sensitive plants:

Oil-sensitive plants*		Leaning toward sensitivity	
Maples	Dormant	Beech	Dormant
Hickories	Dormant	Holly Japanese	Summer/dormant
Black walnut	Dormant	Redbud	Dormant
Cryptomeria	Summer	Savin junipers	Summer
Azalea (limited)	Summer	Photinia sp.	Summer
		Spruce	Dormant
		Douglas-fir	Dormant

Source: Johnson 1985

*Horticultural spray oil labels are not identical. Hence, it is crucial that you follow all label directions. Individual horticultural oil formulations (dormant, delayed dormant, and summer applications) have not been included to control each insect or mite pest because of variations in labels; however, certain formulations can be applied as dormant, delayed dormant, and/or summer treatments. Read each label and apply according to label directions.

INSECTICIDAL SOAP

Registered formulations of insecticidal soap are important management tools for effective pest management programs designed to reduce populations of insect and mite pests on landscape and nursery plants. A mode of action of insecticidal soap is a physical one. The active ingredients in insecticidal soaps (potassium salts of fatty acids) disrupt the cell membrane of the life stage of a vulnerable pest. Some formulations of insecticidal soap are labeled for management of adelgids, aphids, elm leaf beetle larvae, sawfly larvae, lace bugs, leafhoppers, mealybugs, rust mites, spider mites, plant bugs, psyllids, scale insects, exposed thrips, and whiteflies. Application of insecticidal soaps may help conserve the adult stages of beneficial insects such as lady beetles, lacewings, flower or hover flies, and wasps because these insects have a thicker cuticle. Hard water in a tank mix may cause precipitation of the active ingredient in insecticidal soaps. Be sure to check the hardness of your tank mix water before you mix and apply a formulation of insecticidal soap. Follow all specimen label precautions when applying any formulation of insecticidal soap in order to prevent plant phytotoxicity.

References

Baxendale, R. W., and W. T. Johnson. 1988. An evaluation of dormant oil phytotoxicity on six species of woody ornamentals. *J. Arboric.* 14:102–105.

———. 1988. Evaluation of summer oil spray on amenity plants. *J. Arboric.* 14:220–25.

Davidson, N. A., J. E. Dibble, M. L. Flint, P. J. Marer, and A. Guye. 1991. Managing insects and mites with spray oils. Univ. Calif., Div. Agri. and Nat. Res., Publ. 3347.

Johnson, W. T. 1989. Dormant spraying with horticultural oils. *Arbor Age* 9:12–14.

———. 1986. Horticultural oils. *Pennsylvania Nurserymen’s News* (newsletter), 13–16.

- 1985. Horticultural oils. *J. Environ. Hort.* 3:188–91.
- 1983. New label of horticultural spray oil. *J. Arboric.* 9:206–207.
- 1980. Spray oils as insecticides. *J. Arboric.* 6:169–74.

Johnson, W. T., and D. L. Caldwell. 1987. Horticultural oil sprays to control pests of landscape plants: An industry survey. *J. Arboric.* 13:121–25.

Miller, F. D. 1989. The use of horticultural oils and insecticidal soaps for control of insect pests of amenity plants. *J. Arboric.* 15:257–62.

ARBORSYSTEMS LLC

ArborSystems markets a tree injection system called the Wedge Direct-Inject Tree Injection Unit. This system does not require the use of a drill and drill bits to introduce insecticide into host plants. Pointer insecticide and Greyhound insecticide delivered by this system are labeled for systemic insect control on landscape ornamentals and interior plantscapes. For assistance, contact them at PO Box 34645, Omaha, NE 68134; phone: 800-698-4641; Web site: www.arborsystems.com.

Pointer (Active ingredient: imidacloprid)	Greyhound (Active ingredient: abamectin)
PESTS LISTED ON SPECIMEN LABEL	PESTS LISTED ON SPECIMEN LABEL
Adelgids	Aphids
Armored scales	Elm leaf beetle
Aphids	Lace bugs
Bark beetles	Leafminers
Elm leaf beetles	Mites
Black vine weevil larvae	Thrips
Eucalyptus longhorned borer	Whiteflies
Flatheaded borers (including bronze birch borer, emerald ash borer, and alder-birch borer)	
Hemlock woolly adelgid	
<i>Ips</i> beetles	
Japanese beetle	
Lace bugs	
Leafhoppers	
Leafminers	
Longhorned beetles	
Mealybugs	
Pine bark beetles	
Pine tip moths (larvae)	
Psyllids	
Royal palm bugs	
Sawflies (larvae)	
Soft scale insects	
Thrips	
White grub larvae (such as Japanese beetle larvae, chafer, <i>Phyllophaga</i> spp., Asiatic garden beetle, oriental beetle)	
Whiteflies	

MAUGET MICROINJECTION METHOD (Nonedible Crops Only)

Mauget Inject-A-Cide B contains bidrin, which is a restricted-use pesticide. Mauget Inject-A-Cide B is only available to certified applicators or persons under their direct supervision, and only for those uses covered by the applicator's certification.

Mauget Inject-A-Cide B is for internal treatment by microinjection for systemic suppression of certain insects on ornamental trees. The Mauget microinjection method of treating trees places systemic chemicals directly into the sapline of the tree, where they are distributed throughout the crown and roots. Make all applications according to label directions.

Crop/use	Insect/pest
Ash	Aphids Leafhopper Emerald ash borer
Beech	Gypsy moth
Birch	Aphids Bronze birch borer Gypsy moth Birch leafminer
Flowering crabapple (noncrop)	Eastern tent caterpillar
Dogwood	Dogwood twig borer
Elms	Aphids European elm scale Elm leaf beetle
Black gum	Gypsy moth
Hackberry	Nipple gall psyllid Hackberry psyllid
Linden	Aphids
Locust	Aphids Leafhopper
Maples (noncrop)	Aphids Gypsy moth
Oaks	Aphids California oakworm California tent caterpillar Gouty and oak gall wasps Gypsy moth Obscure scale Pit-making scale Sycamore borer (American plum borer)
Pines	European pine sawfly Pine spittlebug Spider mites
Flowering stone fruit (noncrop)	Lesser peachtree borer
Sycamore (plane tree)	Sycamore borer (American plum borer)
Willow	Aphids

Imicide (active ingredient: imidacloprid) is another J. J. Mauget Co. insecticide that is registered for application on forest and ornamental trees. This product is for use by commercial arborists and professional gardeners. Adelgids, aphids, black vine weevil larvae, bronze birch borer, elm leaf beetle, emerald ash borer, eucalyptus longhorned beetles, flatheaded borers, gall wasps, Japanese beetle, lace bugs, leafhoppers, leafminers, mealybugs, pine tip moth larvae, psyllids (including lerp psyllid), royal palm bugs, scale insects, thrips, cone moths, and whiteflies are listed on the specimen label. This product is also registered for use in seed orchards and seed production areas on conifers against Douglas-fir gall midge and Douglas-fir cone moth larvae. Read and follow all directions on the specimen label for safe and effective use of this insecticide.

Another J. J. Mauget Co. product, Imisol, is a systemic insecticide/fungicide. The active ingredients in this formulation are imidacloprid, debacarb, and carbendazim. This product is registered for tree injection use for seasonal suppression of certain insects and diseases of ornamental trees. Imisol is for the control of adelgids, aphids, black vine weevil larvae, bronze birch borer, cottonwood borer, elm leaf beetle, eucalyptus longhorned borer, flatheaded borer (including alder birch borer), Japanese beetle, lace bugs, leafhoppers, leafminers, mealybugs, pine tip moth larvae, psyllids (including lerp psyllid), royal palm bugs, scale insects, thrips, and whiteflies. Read and follow all directions on the specimen label for safe and effective use of this insecticide.

Abacide 2 is a systemic insecticide for tree injection used for seasonal suppression of certain insects of ornamental trees. The active ingredient in this formulation is abamectin. Abacide 2 is intended for use by commercial arborists (applicators) on ornamental trees for control of spider mites, leafminers, thrips, elm leaf beetle, sycamore lace bug, whiteflies, aphids, lepidopterous insects, fall webworm, winter moth, tent caterpillars, eastern tent caterpillar, gypsy moth, mimosa webworm, and pinewood nematode. It can be applied in commercial or residential landscapes, interior and exterior plantscapes, and other areas where ornamental trees and woody shrubs are grown. Follow all directions on the specimen label for safe and effective use of this insecticide.

Tree Azin Systemic Insecticide with azadirachtin A and azadirachtin B was developed by Bioforest Technologies, Inc., a Canadian firm. Tree Azin Systemic Insecticide is a natural extract of the neem tree seed. It is the only tree-injected neem seed product with an Organic Materials Review Institute (OMRI) listing. Tree Azin is a WARNING labeled antifeedant and growth-disruptor insecticide labeled for use against defoliating insects. Research has also shown that very low doses of Tree Azin inhibit larval development and prevent adult emergence of emerald ash borer, working best when used in advance of infestation. Some pest species listed on the product label are the emerald ash borer, gypsy moth, leafminers, tent caterpillars, and sawflies.

Contact information for the J. J. Mauget Company is 5435 Peck Road, Arcadia, CA 91006; phone: 800-873-3779; Web site: www.mauget.com.

TREE TECH MICROINJECTION SYSTEMS

Dendrex is a systemic insecticide applied internally by Tree Tech Microinjection Systems for control of certain insects on noncrop trees and shrubs. The active ingredient of Dendrex is acephate. Dendrex is registered for control of the following insects on trees (except flowering crabapple, see below) and shrubs: aphids, bagworms, birch leafminer, tent caterpillar, lace bugs, tussock moth larvae, gypsy moth larvae, scale insects (crawlers), cankerworms (spring and fall), Nantucket pine tip moth larvae, Zimmerman pine moths, root weevil adults, boxelder bugs, thrips, whiteflies, sawflies, budworms, coneworms, casebearer, webworms, leafminers, pine needleminer, bronze birch borer, Japanese beetle, and elm leaf beetle larvae. Dendrex is registered for control of aphids, tent caterpillars, and leafrollers on flowering crabapples with the caution that phytotoxicity has occurred on the following crabapple varieties: 'Hopa', 'Ichonoski', 'Malusfloribunda', 'Pink Perfection', 'Red Wine', and 'Snow Cloud'.

Harpoon is a restricted-use pesticide. It contains oxydemeton-methyl (the active ingredient in MSR Spray Concentrate), which is applied internally by Tree Tech Microinjection System as a forest, ornamental, non-crop-bearing, and Christmas tree insecticide. Harpoon is registered for control of lecanium scale on ash; bark beetles on cedars; borers and bagworm on conifers, general; aphids on cottonwoods; cone moths and engraver beetles on Douglas-fir; elm leaf beetles, lecanium scale, cankerworm on elm; hemlock woolly adelgid on hemlock; bark beetles on junipers; engraver beetles (six-spined), engraver beetles (Monterey), flathead borer, red turpentine beetle, black turpentine beetle, mites, Nantucket pine tip moth, pine needle aphid, and pine needle scale on pine (except pinyon); and adelgids and mites on spruce.

Vivid II contains abamectin insecticide and miticide applied internally by Tree Tech Microinjection System for the control of mites, scale insects, and other insect pests of ornamental trees. Vivid II is registered for the control of the following insects on ornamental trees (including forest, ornamental, and non-crop-bearing, as well as woody shrubs): adelgids, aphids, cankerworms, elm leaf beetle, engraver beetles, lace bugs, mites, oakworms, scale insects, white pine weevil, engraver beetle, and flathead borers.

Merit Injectable (3-milliliter dosage) is labeled for injection into trees in nurseries, greenhouses, and interior and exterior plantscapes, and in private, municipal, state, and national forested areas. It is registered for control of adelgids, aphids, armored scales (suppression), flatheaded borers (including bronze birch borer and alder borer), Japanese beetle adults, lace bugs, leaf-feeding beetles (including elm and viburnum leaf beetles), leafhoppers, leafminers, mealybugs, pine tip moth, psyllids, roundheaded borers (including eucalyptus longhorned borer), sawfly larvae, soft scales, thrips (suppression), and whiteflies.

Make all applications according to label directions. Dendrex, Harpoon, Merit Injectable (3-milliliter dosage), and Vivid II are made available by Tree Tech Microinjection Systems, 950 SE 215th Avenue, Morriston, FL 32668; phone number: 800-622-2831; Web site: www.treetech.net.

GYPSY MOTH

Limited numbers of valuable trees can be protected from severe defoliation by wrapping the trunks with a burlap apron in early June. Mid- to late instar gypsy moth larvae crawl down the tree each morning and seek shelter under the apron. They must be disposed of each day. This procedure requires daily attention for about 3 weeks or until male moths begin to fly.

Trees can also be protected with insecticide sprays. Insecticides are most effective if applied while caterpillars are still young (early to mid-May) but are no longer ballooning to other areas.

Formulations of the following materials are labeled to control gypsy moth larvae. Prior to applying any product, refer to individual labels for host-plant clearance information.

Common name	Trade name
acephate	Orthene, Acephate
acetamiprid	TriStar
azadirachtin	Ornazin
<i>Bacillus thuringiensis</i>	DiPel, Foray, Crymax, Javelin, Deliver, among others
bifenthrin	Talstar
bifenthrin and imidacloprid	Allectus
carbaryl	Sevin
chlorpyrifos	Dursban
cryolite	Kryocide
cyfluthrin	Tempo
cyfluthrin and imidacloprid	Discus
diflubenzuron	Dimilin
indoxacarb	Provaunt
lambda-cyhalothrin	Scimitar, Demand
naled	Dibrom
permethrin	Astro
phosmet	Imidan
pyrethrins and piperonyl butoxide	Pyrenone Crop Spray
spinosad	Conserve
tau-fluvalinate	Mavrik Aquaflow
tebufenozide	Mimic, Confirm

Note: Apply all of the above formulations according to label directions. Refer to pages 20 and 21 for comments on each product. Always refer to individual labels for host-plant clearance information.

**WHITE GRUB MANAGEMENT
IN ORNAMENTAL PLANTINGS**

Management of infestations of white grub larvae (such as Japanese beetle larvae, chafers, *Phyllophaga* spp., Asiatic garden beetle, oriental beetle) may be achieved by applying registered formulations of imidacloprid (Merit 0.5 G, Merit 2, Merit 75 WP, and Merit 75 WSP) made according to label directions. These products are for use only in and around industrial and commercial buildings and residential areas.

White grubs may also be managed in ornamentals (preplant incorporation treatment of field-grown nursery stock) with Dursban 50W insecticide. Dursban 50W is to be applied to soil and incorporated before transplanting or planting to control white grubs during transplant or seedling establishment.

Chlorpyrifos Pro 4 is labeled to treat potted, containerized, or balled-and-burlapped nursery stock in ornamental nurseries to control white grubs attached to the roots of these plants.

Discus Nursery Insecticide (supplemental label) can be used for the control of soil-inhabiting pests of grassy areas of nurseries, such as northern and southern masked chafers, *Cyclocephala borealis*, *C. immaculata*, and/or *C. lurida*; Asiatic garden beetle, *Maladera castanea*; European chafer, *Rhizotrogus majalis*; green June beetle, *Cotinis nitida*; May or June beetle, *Phyllophaga* spp.; Japanese beetle, *Popillia japonica*; oriental beetle, *Anomala orientalis*; billbugs, *Sphenophorus* spp.; black turfgrass ataenius, *Ataenius spretulus* and *Aphodius* spp.; and mole crickets, *Scapteriscus* spp. Discus Nursery Insecticide can also be used for suppression of cutworms and as directed on nursery grass in sites such as under or around field- or container-grown plants, on roadways, or on other grassy areas in or around nurseries. Discus Nursery Insecticide cannot be used on commercial sod farms.

Flagship 25WG is recommended for application to soil or other growing media of ornamental plants grown in greenhouses, lath and shadehouses, containers, field nurseries (including nonbearing fruit and nut trees), and as Christmas trees. Flagship 25WG is labeled for larvae of Japanese beetle, *Popillia japonica*; northern masked chafer, southern masked chafer, European chafer, *Rhizotrogus majalis*; May or June beetle, *Maladera castanea*; oriental beetle, *Exomala orientalis*, and green June beetle; and black turfgrass ataenius, *Aphodius* spp.

INSECTICIDE AND MITICIDE RESISTANCE MANAGEMENT

Insect and especially spider mite infestations in landscapes and nurseries provide examples of potential resistance development on woody ornamental plants. Resistance development to insecticides and miticides has been documented for many products. Some of this resistance is unstable. Mite pest species are known to develop resistance to products when they're used repeatedly. As a guideline to follow for resistance management, it is suggested that you rotate the application of insecticides and miticides with different modes of action. If the miticide specimen label allows, you should use another miticide with a different mode of action after two applications that target an infestation. If possible, reducing the number of applications according to miticide specimen label directions may also help manage resistance development in an insect or mite population on ornamental plants in nurseries and landscapes.

The Insecticide Resistance Action Committee (IRAC) is an international group of more than 150 members of the crop protection industry organized by sector and region to provide advice on the prevention and management of insecticide and miticide resistance. IRAC defines resistance to insecticides as a heritable

change in the sensitivity of a pest population that is reflected in the repeated failure of a product to achieve the expected level of control when used according to the label recommendation for that pest species. Resistance to a pesticide arises through the misuse of an insecticide or miticide against a pest species. The results are from the selection of resistant genetic forms of the pest and the consequent evolution of pest populations that are resistant to that insecticide or miticide.

The IRAC mode of action (MoA) classification provides growers, advisers, extension staff, consultants, and crop protection professionals with a guide to selecting insecticides or miticides for use in an effective and sustainable insecticide or miticide resistance management strategy. Some of these chemical subgroups are now being displayed on insecticide specimen labels. Consideration of the modes of action of an insecticide or miticide will preserve these pest management tools for the future.

On the next page is a reference table developed from information listed on the IRAC Web site (www.irac-online.org) for your use in making decisions regarding the modes of action of insecticides or miticides and the management of resistance to insecticides and miticides in Pennsylvania.

Main group and primary site of action	Chemical subgroup or exemplifying active ingredient	Active ingredients applied on woody ornamentals
1 Acetylcholinesterase (AChE) inhibitors Nerve action	1A Carbamates	Carbaryl
	1B Organophosphates	Acephate, chlorpyrifos, dicotophos, dimethoate, malathion, methidathion, naled, oxydemeton-methyl, phosmet, trichlorfon
2 GABA-gated chloride channel antagonists Nerve action	2A Cyclodiene organochlorines	
	2B Phenylpyrazoles	
3 Sodium channel modulators Nerve action	3A Pyrethroids, pyrethrins	Bifenthrin, cyfluthrin, lambda-cyhalothrin, esfenvalerate, fenpropathrin, tau-fluvalinate, permethrin, pyrethrins (pyrethrum)
	3B DDT, methoxychlor	
4 Nicotinic acetylcholine receptor (nAChR) agonists Nerve action	4A Neonicotinoids	Acetamiprid, clothianidin, dinotefuran, imidacloprid, thiamethoxam
	4B Nicotine	
5 Nicotinic acetylcholine receptor (nAChR) allosteric activators Nerve action	Spinosyns	Spinosad
6 Chloride channel activators Nerve and muscle action	Avermectins, milbemycins	Abamectin, emamectin benzoate, milbemectin
7 Juvenile hormone mimics	7A Juvenile hormone analogues	Pyriproxyfen
Growth regulation	7B Fenoxycarb	
	7C Pyriproxyfen	
8 Miscellaneous nonspecific (multisite) inhibitors	8A Alkyl halides	
	8B Chloropicrin	
	8C Sulfuryl fluoride	
	8D Borax	
	8E Tartar emetic	
9 Selective homopteran feeding blockers Nerve action	9B Pymetrozine	Pymetrozine
	9C Flonicamid	Flonicamid
10 Mite growth inhibitors Growth regulation	10A Clofentezine, hexythiazox, diflovidazin	Clofentezine, hexythiazox
	10B Etoxazole	Etoxazole

(continued on next page)

Main group and primary site of action	Chemical subgroup or exemplifying active ingredient	Active ingredients applied on woody ornamentals
11 Microbial disruptors of insect midgut membranes	11A <i>Bacillus thuringiensis</i> or <i>Bacillus sphaericus</i> and the insecticidal proteins they produce	<i>Bacillus thuringiensis</i> subsp. <i>aizawai</i> , <i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i> , <i>Bacillus thuringiensis</i> subsp. <i>tenebrionis</i>
12 Inhibitors of mitochondrial ATP synthase Energy metabolism	12A Diafenthiuron	
	12B Organtin miticides	Fenbutatin oxide
	12C Propargite	
	12D Tetradifon	
13 Uncouplers of oxidative phosphorylation via disruption of the proton gradient Energy metabolism	Chlorfenapyr, DNOC, sulfuramid	
14 Nicotinic acetylcholine receptor (nAChR) channel blockers Nerve action	Nereistoxin analogues	
15 Inhibitors of chitin biosynthesis, type 0 Growth regulation	Benzoylureas	Diflubenzuron, novaluron
16 Inhibitors of chitin biosynthesis, type 1 Growth regulation	Buprofezin	Buprofezin
17 Molting disruptor, dipteran Growth regulation	Cyromazine	
18 Ecdysone receptor agonists Growth regulation	Diacylhydrazines	Tebufenozide
19 Octopamine receptor agonists Nerve action	Amitraz	
20 Mitochondrial complex III electron transport inhibitors Energy metabolism	20A Hydramethylnon	
	20B Acequinocyl	Acequinocyl
	20C Fluacrypyrim	
21 Mitochondrial complex I electron transport inhibitors Energy metabolism	21A METI miticides and insecticides	Pyridaben
	21B Rotenone	
22 Voltage-dependent sodium channel blockers Nerve action	22A Indoxacarb	Indoxacarb
	22B Metaflumizone	

(continued on next page)

Main group and primary site of action	Chemical subgroup or exemplifying active ingredient	Active ingredients applied on woody ornamentals
23 Inhibitors of acetyl CoA carboxylase Lipid synthesis, growth regulation	Tetronic and tetramic acid derivatives	Spiromesifen
24 Mitochondrial complex IV electron transport inhibitors Energy metabolism	24A Phosphine	
	24B Cyanide	
25 Mitochondrial complex II electron transport inhibitors Energy metabolism	Cyenopyrafen	
28 Ryanodine receptor modulators Nerve and muscle action	Diamides	
Un Compounds of unknown or uncertain MoA Target protein responsible for biological activity is unknown or uncharacterized	Azadirachtin	Azadirachtin
	Benzoximate	
	Bifenazate	Bifenazate
	Bromopropylate	
	Chinomethionat	
	Cryolite	Cryolite
	Cyflumetofen	
	Dicofol	Dicofol
	Prydalyl	

To assist decision makers and applicators in the selection of insecticides and miticides for use in a resistant management program, rotation, or alternation of the MoA groups, IRAC has been encouraging pesticide registrants to clearly indicate the IRAC MoA group number and description on the product's specimen label.

For example, if an insecticide is an IRAC MoA Group 15 insecticide/miticide, any insect or mite population may contain individuals naturally resistant to the insecticide/miticide and other Group 15 insecticides/miticides. If these pest management products are used repeatedly, the resistant individuals may eventually dominate the pest population. These resistant insects may not be controlled by the insecticide/miticide or by other IRAC

MoA Group 15 products. IRAC suggests the following to delay the development of resistance:

- Avoid exclusive repeated use of insecticides from the same chemical subgroup (indicated by the IRAC MoA Group number)
- Alternate with products from other IRAC MoA Groups
- Utilize other effective integrated pest management methods (cultural, biological, etc.) into pest management programs

Additional information on insecticide/miticide resistance management may be found on the IRAC Web site, www.irac-online.org.

COMMON NAMES AND TRADE NAMES OF INSECTICIDES AND MITICIDES

These chemicals are registered for use on woody ornamentals (trees and shrubs). Legal use of certain materials is restricted for use only by licensed commercial growers and professional applicators. We do not have effectiveness data for all the insecticides and miticides listed below and have decided to arrange them in alphabetical order. Thus, the insecticides and miticides in this publication are not listed in order of effectiveness. Please refer to individual footnotes below.¹

Common name	Trade name (formulation)
abamectin ²	Abacide 2 ² , Avid 0.15EC ²
acephate ^{3,4}	Acephate Pro 75 ^{3,4} , Acephate Pro 75 WSP ^{3,4} , Lepitect, Orthene (Turf, Tree & Ornamental Spray 97) ^{3,4}
acequinocyl	Shuttle 15SC
acetamiprid ³	TriStar 70 WSP Insecticide ³
azadirachtin ²	Azatin (XL), Ornazin (3% EC) ²
Bacillus thuringiensis ³	Biobit, Crymax, Deliver, DiPel, Foray, Javelin, etc. ³
Beauveria bassiana	BotaniGard (ES, 22WP)
bifenazate	Floramite SC
bifenthrin ²	BaseLine Insecticide ² , Onyx (Insecticide ² , Pro ²), Talstar (GC Granular ² , Nursery Granular ² , Professional ² , Select ²)
bifenthrin and imidacloprid	Allectus SC Insecticide
buprofezin ²	Talus 40SC Insect Growth Regulator ²
carbaryl ^{2,3,5}	Carbaryl 4L ^{2,3,5} , Sevin (SL, 80 WSP) ^{2,3,5}
chlorpyrifos ^{2,3,6}	Chlorpyrifos E Pro 2 ² , Chlorpyrifos E Pro 4 ² , Dursban (50W) ^{2,3}
clofentezine ²	Ovation SC ²
cryolite	Kryocide
cyfluthrin ^{2,3}	Tempo 20 WP ^{2,3} , Decathlon 20 WP ²
cyfluthrin and imidacloprid ⁷	Discus Nursery Insecticide ⁷
cyromazine	Citation
dicofol ²	Kelthane 50 WSP ²
dicrotophos ²	Inject-A-Cide B ²
diflubenzuron ²	Dimilin (25W, 4L) ²
dimethoate ^{2,8}	Dimethoate 4EC ^{2,8}
dinotefuran	Safari 20 SG, Transtect 70 WSP
emamectin benzoate ²	Tree-Age ²
etoxazole	TetraSan 5 WDG
esfenvalerate ^{2,9}	Asana XL ^{4,9}
fenbutatin-oxide ²	Vendex 50 WP ²
fenpyroximate	Akari 5SC
fenpropathrin ²	Tame 2.4 EC ²
flonicamid	Aria Insecticide ²
hexythiazox ²	Hexygon DF ² , Savey DF ²
horticultural spray oil ³	Damoil, Sunspray Ultra-Fine Spray Oil, Purespray Green, etc. ³
hydrophobic extract of neem oil ²	Triact 70 ²
imidacloprid ^{2,3,10,11,12}	Marathon (1% G ¹¹ , 60 WP ¹²), Marathon II ¹³ , Merit (2F, 75 WP, 75 WSP, 2.5 G) ^{3,10} , Imicide ² , Pointer, Xytect (2F, 75 WSP)
indoxacarb	Provaunt
insecticidal soap ^{3,14}	M-Pede ^{3,14}
lambda-cyhalothrin ²	Scimitar (CS, GC ²), Demand CS ²
malathion ^{3,15}	5-lb Malathion Spray ^{3,15}
methidathion ^{2,16}	Supracide (2E, 25-W) ^{2,16}
naled ²	Dibrom 8 ²
novaluron ¹⁷	Pedestal ¹⁷
oxydemeton-methyl ²	MSR Spray Concentrate ² , Harpoon ²
permethrin ²	Astro, Pounce 25WP ^{2,18}
phosmet ²	Imidan 70-WP ²
pymetrozine ²	Endeavor ²
pyrethrins and piperonyl butoxide	Pyrenone Crop Spray
pyridaben ²	Sanmite ²
pyriproxyfen	Distance R Insect Growth Regulator
spinosad	Conserve SC
spiromesifen	Forbid 4F, Judo ¹³
tau-fluvalinate	Mavrik Aquaflow
tebufenozide	Mimic 2LV, Confirm 2F
thiamethoxam ²	Flagship 25WG ²
trichlorfon ²	Dylox 80 T&O ²

Notes

1. Refer to individual pesticide formulations for dosage recommendations, host-plant clearance, pest clearance, phytotoxicity information, worker protection standard, restricted-entry interval, safety precautions, and method of application. Changes in registration status may occur at any time. It is the responsibility of the applicator to always read the specimen label and apply the product according to label directions. Due to constantly changing labels and product registration, some of the suggestions given in this publication may no longer be legal by the time you read them. If any information in these suggestions disagrees with the label, the label must be followed and the suggestions here must be disregarded.
2. Legal use of these formulations is restricted for application only by commercial growers or professional restricted-use-licensed applicators. Apply all materials according to label directions.
3. Certain formulations of this material may be available to the homeowner, whereas others are restricted for application by only commercial growers and professional restricted-use-licensed applicators.
4. Specialty uses for Christmas tree plantings, conifer plantations, conifer seed orchards, forest tree nurseries.
5. Do not use on Boston ivy, Virginia creeper, and maidenhair fern as injury may result. Carbaryl may also injure Virginia and sand pines.
6. Some varieties of azaleas, camellias, poinsettias, rose bushes, or variegated ivy have shown varying degrees of phytotoxicity following treatment.
7. For broad-spectrum foliar and systemic insect control on ornamentals, nonbearing fruit and nut trees, and in-field and container nurseries.
8. Some species such as river birch, *Prunus*, ornamental cherry, hawthorn, Japanese lace maple, and aspens may show toxic effects at label rates. Do not use on bearing fruit trees. Do not apply to huckleberry, balm of Gilead, cottonwood, Lombardy poplar, and *Viburnum suspensum*.
9. For foliar and systemic insect control on ornamentals, fruit and nut trees, and vegetable plants in greenhouses, nurseries, and interior landscapes.
10. Not for use in commercial greenhouses and nurseries or on sod farms, research plots, or grass grown for seed.
11. For systemic insect control in field-grown nursery stock; and indoor and outdoor ornamentals grown in flats, benches, beds and containers. May be used to manage root weevil larvae in container-grown ornamentals.
12. For use only on greenhouse and nursery ornamental plants using soil drenches, microirrigation, drip irrigation, overhead irrigation, ebb and flood irrigation, or hand-held or motorized calibrated irrigation equipment.
13. Apply to shrubs; trees (including nonbearing fruit trees); flowers and foliage plants in greenhouses and shade houses; and plants grown in field and container nurseries.
14. Do not apply to very sensitive plants such as horse chestnut, Japanese maple, or mountain ash, and others listed on the specimen label. River birch, redbud, ornamental ivy, and some other plants listed on the label may be sensitive to this product. Flowers of azalea, begonia, dahlia, impatiens, marigold, rose, and other plants listed on the label may be injured when sprayed with this product. Potential for plant injury increases when this product is used when plants are stressed, such as under hot (> 90°F), humid, and/or drought conditions. Application of this product may result in removal of the glaucous bloom from spruces.
15. Injury may occur on ferns, hickory, viburnum, lantana, crassula, and 'Canaertii' juniper following the use of Prentox 5 lb Malathion Spray. Slight injury has also been reported on Boston, Pteris, and maidenhair ferns, petunias, small-leaf spirea, white pine, and maples. Under extreme heat, drought, and disease conditions some of these formulations may cause slight damage to elms.
16. For use on nursery stock (woody ornamental or herbaceous plants commercially grown for transplanting).
17. For control of insect pests on container- and field-grown ornamentals in greenhouses, shadehouses, and nurseries.
18. For application to field-grown ornamental nursery stock.

CLASSES OF INSECTICIDES AND MITICIDES FOR ARTHROPOD PEST MANAGEMENT

Awareness of insecticide and miticide classification has become important in woody ornamental pest management programs. Knowledge and application of different classes of pesticides slows resistance development in pest populations. Insect pests are known to develop resistance to insecticides when they're used repeatedly. Informed selection of insecticides and miticides will also extend the time period in which these products will be available as effective pest management tools for the green industry.

It is important to change classes of pesticides with different modes of action, not just trade names, when managing pest populations. Listed below are insecticides and miticides included in this guide. Use this list as a resource when managing resistance development in the arthropod pest populations that you are trying to control.

Pesticide Class and Trade Name

Botanical	Imidan
Azatin	Inject-A-Cide B
Ornazin	Lepitect
Pyrenone Crop Spray	Malathion
Triact	Metasystox-R
Carbamate	Orthene Turf, Tree and Ornamental Spray
Sevin	Supracide
Carboxamide	Organotin
Hexygon	Vendex
Chlorinated hydrocarbon	Petroleum oil
Kelthane	Damoil
Growth regulator	Purespray Spray Oil
Dimilin	Sunspray Ultra Fine Oil
Distance	Phenoxypyrazole group
Mimic	Akari
Talus	Potassium salts of fatty acids
Microbial	M-Pede
Biobit	Pyridazinone
BotaniGard	Sanmite
Conserve	Pyridine azomethine
Crymax	Endeavor
Deliver	Synthetic pyrethroids
DiPel	Asana
Foray	Astro
Javelin	Decathlon
Microbial toxins	Demand
Abacide	Discus (in part)
Avid	Mavrik Aquaflo
Vivid	Onyx
Neonicotinoid	Pounce
Discus (in part)	Scimitar
Flagship	Talstar
Imicide	Tame
Marathon	Tempo
Merit	Tetramic acid
Safari	Forbid
Transtect	Judo
TriStar	Tetrazne
Organophosphate	Ovation
Acephate	Trizine growth inhibitor
Dendrex	Citation
Dibrom	Unclassified miticides
Dimethoate	Floramite
Di-Syston	TetraSan
DuraGuard	
Dursban	
Dylox	
Harpoon	

CONTROL MEASURES FOR INSECTS AND MITES

How to Use This Section

Many of the insects and mites that are recognized as key pests of woody ornamental plants in Pennsylvania are listed in the following section. Registered chemical controls are included for most of the key pests, but a plant health care specialist should not consider this the only option for management of a pest. When indicated, other management strategies are listed for each key pest. For users of this guide, the page reference provided at the end of each management hint for a key pest is from *Insects That Feed on Trees and Shrubs* (2nd ed.) by Warren T. Johnson and Howard H. Lyon, published in 1991 by Cornell University Press.

Alder

Fall webworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, tebufenozide, and trichlorfon are labeled for fall webworm management. **MANAGEMENT HINTS:** Treat when webs first appear from late June through July. (p. 166)

Gypsy moth: Refer to comments under "Gypsy Moth" on page 15. Prior to applying any control material, read individual labels for host-plant clearance information. (pp. 138, 140)

Leafminer: Formulations of azadirachtin, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin and imidacloprid, imidacloprid, lambda-cyhalothrin (for adult leafminers), oxydemeton-methyl, permethrin, and pyrethrins and piperonyl butoxide are labeled for leafminer management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds. **MANAGEMENT HINTS:** Treat when adults are first noticed from late May through early June. (p. 188)

Woolly alder aphid: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, acephate, acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for management of woolly alder aphid. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds. **MANAGEMENT HINTS:** Select and apply horticultural spray oil according to label directions. Treat when aphids first appear and repeat as needed, but follow label directions. (p. 304)

Amelanchier—see Serviceberry (Shadbush)

Arborvitae

Bagworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, dimethoate, indoxacarb, lambda-cyhalothrin, malathion, permethrin, pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, tebufenozide, and trichlorfon are labeled for bagworm management. **MANAGEMENT HINTS:** Bagworm cases (containing overwintering eggs) can be handpicked from infested host plants during winter and early spring. Otherwise, management measures can be applied after eggs hatch and caterpillars are small during early to mid-June. (p. 176)

Fletcher scale: Horticultural spray oil can be applied as a dormant treatment. Crawler treatments include acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds. **MANAGEMENT HINTS:** Select and apply horticultural spray oils according to label directions. Crawler treatments should be applied after eggs hatch in June. The crawler stage may be active through mid-July. Repeat applications may be needed. (p. 98)

Leafminer: Formulations of azadirachtin, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin and imidacloprid, diflubenzuron, lambda-cyhalothrin (for adult leafminers), oxydemeton-methyl, permethrin, and pyrethrins and piperonyl butoxide are labeled for leafminer management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds. **MANAGEMENT HINTS:** Adult moths lay eggs on new growth from late May through July. Young larvae hatch from eggs and excavate areas of the new growth. A management measure should be applied when larvae are hatching from eggs, or against adult moths prior to egg laying. (p. 42)

Nuculaspis pseudomeyeri (an armored scale insect): Crawler treatments include acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, and methidathion. **MANAGEMENT HINTS:** Select and apply horticultural spray oils according to label directions. Crawler treatments should be applied when eggs hatch in May for the first generation and in late July through August for the second generation. Repeat applications may be needed.

Spruce spider mite: Horticultural spray oil can be applied as a dormant treatment. Motile mite stages can be managed with formulations of abamectin, acequinocyl, bifenazate, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only),

dicofol, dimethoate, etoxazole, fenbutatin-oxide, fenpyroximate, hexythiazox, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, spinosad, spiromesifen, and tau-fluvalinate. **MANAGEMENT HINTS:** Apply horticultural spray oils according to label directions. Other materials can be used to manage motile stages when they first appear. Repeat applications may be necessary; hence, follow label directions. Populations frequently are heavy from May through June and September. (p. 118)

Ash

Aphids: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, acephate, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, naled, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for aphid management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when aphids first appear and repeat as needed according to label directions. (p. 304)

Ash (lilac) borer: Formulations of bifenthrin (Onyx only), chlorpyrifos (Dursban 50W only), and permethrin (Astro only) are labeled for borer management.

MANAGEMENT HINTS: To optimize control measures, deploy sex pheromone traps to determine adult flight activity. Treat trunk and large branches from mid-May through early August. The first insecticide application should be made 7 to 10 days after the first male is captured in a pheromone trap. (p. 260)

Ash flower gall mite (eriphyid): Formulations of carbaryl, horticultural oil, and tau-fluvalinate are labeled for eriophyid mite management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Use the other products when blossoms appear. (p. 478)

Banded ash clearwing: Formulations of bifenthrin (Onyx only), chlorpyrifos (Dursban 50W only), and permethrin (Astro only) are labeled for borer management.

MANAGEMENT HINTS: Examine the trunk and main branches for cracked and stained regions. To optimize control measures, deploy sex pheromone traps to determine adult flight activity. Treat trunks and large branches from August through October. The first insecticide application should be made 7 to 10 days after the first male is captured in a pheromone trap. (p. 260)

Cankerworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin,

cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), naled, permethrin (Astro only), phosmet (spring cankerworm only), pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, and tebufenozide (fall cankerworm only) are labeled for cankerworm management.

MANAGEMENT HINTS: Treat when caterpillars are first noticed and while they are small (mid-May). (pp. 142, 144)

Emerald ash borer: Formulations of bifenthrin (Onyx only), dicrotophos, dinotefuran, emamectin benzoate, imidacloprid (Merit 2F, 75 WP, 75 WSP; Imicide; Xytect 2F, 75 WSP), and permethrin (Astro only) are labeled for emerald ash borer management.

MANAGEMENT HINTS: Examine host plant trunks, branches, and leaves for symptoms and signs of the emerald ash borer such as $\frac{1}{8}$ inch, D-shaped emergence holes. Products labeled for trunk injection are best applied according to label directions from early May through mid-June. Systemic bark sprays are best applied according to label directions from early May through mid-June. Formulations labeled for soil injection or soil drenches are best applied according to label directions during mid- to late spring and/or mid-fall. Products labeled for preventive bark and foliar application should first be made according to label directions when black locust is in bloom in mid- to late May. A second application should occur four weeks after the first application. Management of this pest on large trees that exceed 15 inches dbh is often less effective. All emerald ash borer management activities should be conducted in accordance with both state and federal regulatory agencies orders of quarantine.

European fruit lecanium: Apply horticultural spray oil as a dormant treatment. Formulations of acephate, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin, methidathion, and thiamethoxam are labeled for crawler management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Crawlers are active from mid-June through mid-July. Repeat applications may be necessary. This species is frequently attacked by natural enemies when population levels are high, resulting in the decline of an infestation after 2 or 3 years. (p. 364)

Fall webworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, naled, permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, tebufenozide, and trichlorfon are labeled for fall webworm management.

MANAGEMENT HINTS: Treat when webs first appear from late June through July. (p. 166)

Flatheaded appletree borer: Formulations of bifenthrin (Onyx only), chlorpyrifos (Dursban 50W only), and permethrin (Astro only) are labeled for wood-boring beetle management.

MANAGEMENT HINTS: Fertilization and irrigation will promote a healthy plant and reduce successful attack by this pest. Treat trunks in early June, July, and August. Repeat applications according to label directions. (p. 270)

Japanese maple scale: Formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion are labeled for crawler management.

MANAGEMENT HINTS: Treat when crawlers are present from late May through mid-August. Repeat applications may be needed.

Oystershell scale: Formulations of acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, and methidathion are labeled for crawler management.

MANAGEMENT HINTS: Select and apply horticultural spray oils according to label directions. Crawler sprays should be applied from late May through early June. Repeat applications may be needed. Be sure to follow label directions. Prune and destroy heavily infested twigs and branches. (p. 370)

Plant bug: Formulations of acetamiprid, *Beauveria bassiana* (BotaniGard ES only), bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, flonicamid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), pyrethrins and piperonyl butoxide, and thiamethoxam are labeled for plant bug management.

MANAGEMENT HINTS: Apply a registered insecticide when young nymphs are active in May. (p. 402)

Azalea

Azalea bark scale: Apply horticultural spray oil as a dormant treatment. Formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, methidathion, and thiamethoxam are labeled for crawler management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Crawler sprays should be applied from June through mid-July. Repeat applications may be necessary. Test insecticidal soap on azalea varieties before applying. (p. 336)

Azalea lace bug: Formulations of acephate, *Beauveria bassiana* (BotaniGard ES only), bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dimethoate, fenpropathrin, horticultural oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, permethrin, pyrethrins and piperonyl butoxide, and thiamethoxam are labeled for lace bug management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Treat when lace bugs are first seen in the spring. A second generation is usually active from late July through August. Test insecticidal soap on azalea varieties before applying. (p. 424)

Azalea leafminer: Formulations of azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos, cyfluthrin and imidacloprid, dimethoate, imidacloprid, lambda-cyhalothrin (for adult leafminers), naled, oxydemeton-methyl, permethrin, and pyrethrins and piperonyl butoxide are labeled for leafminer management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Treat when larvae are present. Female moths lay eggs on the lower surface of azalea leaves in late May. Eggs hatch in 4 to 6 days. Three generations may occur annually; therefore, repeat applications may be necessary. (p. 202)

Azalea sawflies: Formulations of acephate, azadirachtin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, horticultural oil (larvae), imidacloprid (Merit 75 WP and Merit 75 WSP only), insecticidal soap, lambda-cyhalothrin, and spinosad are labeled for sawfly management.

MANAGEMENT HINTS: Treat infested plants when larvae are feeding during April through the end of June. Larvae feed mostly on the edges of young foliage of mollis hybrid azaleas. (p. 134)

Azalea stem borer: Formulation of chlorpyrifos (Dursban 50W only) is labeled for borer management.

MANAGEMENT HINTS: Larvae hatch from eggs deposited by females in late June through early July. Direct control applications against emerging adults from mid- to late June before females deposit eggs under the epidermis between girdled out areas of the host plant. Prune and destroy wilting branches. (p. 288)

Black vine weevil (taxus weevil): Formulations of acephate, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin and imidacloprid, fenpropathrin, lambda-cyhalothrin, permethrin (Astro only), pyrethrins and piperonyl butoxide, and tau-fluvalinate are labeled to manage adults. Acephate Pro 75, Acephate 75 WSP, and Orthene Turf, Tree & Ornamental Spray are labeled to be applied as a soil drench (container-grown nursery stock only). Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in contain-

ers, flats, benches, or beds. Merit 2.5 G is labeled for use on ornamental shrubs and small trees in outdoor landscapes and interior plantscapes against black vine weevil larvae in soil. Merit 2, Merit 75 WP, and Merit 75 WSP are labeled for black vine weevil larvae and are for use only in and around industrial and commercial buildings and residential areas. Talstar Nursery Granular is labeled for soil incorporation into potting media used in containerized plantings of ornamental trees, shrubs, plants, flowers, conifers, and Christmas trees. The use of insect-parasitic nematodes applied as soil drenches in container-grown plant material may be effective in reducing larval populations of this pest. Follow label directions for all methods of application and stage of insect to treat.

MANAGEMENT HINTS: Spray foliage and surface to manage adults in May and June. Soil drenches can be applied from July to mid-October. Follow all label directions. (p. 240)

Cottony azalea scale: Apply horticultural spray oil as a dormant treatment. Formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, methidathion, and thiamethoxam are labeled for crawler management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Crawler sprays should be applied from June through early July. Repeat applications may be necessary. Test insecticidal soap on azalea varieties before applying. (p. 342)

Mealybugs: Formulations of acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos, cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin, malathion, permethrin (Astro only), phosmet, pyrethrins and piperonyl butoxide, pyriproxyfen, and thiamethoxam are labeled for mealybug management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds. Talstar Nursery Granular is labeled for soil incorporation into potting media used in containerized plantings of ornamental trees, shrubs, plants, flowers, conifers, and Christmas trees.

MANAGEMENT HINTS: These insects overwinter as nymphs on the host plant. Females lay eggs in loose, white, waxy ovisacs on the lower leaf surface. Nymphs can be managed when they begin feeding in the spring. Repeat applications may be needed.

Rhododendron borer: Formulations of bifenthrin (Onyx only), chlorpyrifos (Dursban 50W only), and permethrin (Astro only) are labeled for borer management.

MANAGEMENT HINTS: Treat trunk and larger twigs from mid-May through early June. Sex pheromone traps may assist you in determining adult flight activity and in optimizing control

measures. The first insecticide application should be made 7–10 days after the first male is captured in a pheromone trap. Prune and destroy wilting branches in late summer. (p. 258)

Southern red mite: Apply horticultural spray oil as a dormant treatment. Formulations of abamectin, bifenazate, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos, dimethoate, etoxazole, fenbutatin-oxide, fenpropathrin, fenpyroximate, hexythiazox, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin, malathion, oxydemeton-methyl, pyridaben, spinosad, spiromesifen, and tau-fluvalinate are labeled for mite management.

MANAGEMENT HINTS: Treat in May before populations start to increase. Test insecticidal soap on azalea varieties before applying. (p. 475)

Twobanded Japanese weevil: Formulations of acephate, *Beauveria bassiana*, bifenthrin, cyfluthrin and imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), and pyrethrins and piperonyl butoxide are labeled for management of adult weevils.

MANAGEMENT HINTS: This brown weevil feeds during the day. Marginal notching of new foliage is a symptom of adult feeding. Treat infested plants when new foliage has notched margins during early July through August. (p. 244)

Whitefly: Formulations of abamectin, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, buprofezin, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dimethoate, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin, malathion, naled, novaluron, permethrin, pymetrozine, pyrethrins and piperonyl butoxide, pyridaben, spiromesifen, tau-fluvalinate, and thiamethoxam are labeled for whitefly management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds. Naled is labeled for adult whitefly management on azalea.

MANAGEMENT HINTS: Treat when whiteflies are first noticed. Repeat applications may be needed. Test insecticidal soap on azalea varieties before applying. (p. 318)

Barberry

Twobanded Japanese weevil: Formulations of acephate, *Beauveria bassiana*, bifenthrin, cyfluthrin and imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), and pyrethrins and piperonyl butoxide are labeled for management of adult weevils.

MANAGEMENT HINTS: This brown weevil feeds during the day. Marginal notching of new foliage is a symptom of adult feeding. Treat infested plants when new foliage has notched margins during early July through August. (p. 244)

Basswood (Linden)

Aphids: Apply horticultural spray oil as a dormant treatment. Formulations of abamectin, acephate, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and

imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for aphid management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when aphids are first observed in the spring. Repeat application of an insecticide may be needed to manage an aphid infestation. (pp. 302, 310)

Basswood lace bug: Formulations of acephate, *Beauveria bassiana* (BotaniGard ES only), bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, fenpropathrin, horticultural oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, permethrin, pyrethrins and piperonyl butoxide, and thiamethoxam are labeled for lace bug management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Treat when lace bugs are small in May. Repeat applications may be necessary. (p. 426)

Cankerworm: Refer to comments under “Ash.” Naled is not labeled for cankerworm management on basswood. (pp. 142, 144)

Gypsy moth: Refer to comments under “Gypsy Moth” on page 15. Prior to applying any control material, read individual labels for host-plant clearance information. (pp. 138, 140)

Hickory tussock moth: Formulations of azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, and tau-fluvalinate are labeled for management of this pest.

MANAGEMENT HINTS: Young larvae feed in groups. Caterpillars require about 3 months to complete their development. Hairy, oval cocoons are built on the ground in September. Treat infestations when larvae are small from late June through early August. (p. 160)

Japanese beetle: Formulations of acephate, acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, imidacloprid, lambda-cyhalothrin, malathion, permethrin (Astro only), phosmet, and pyrethrins and piperonyl butoxide are labeled for management of adults. Formulations of imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP) are also labeled for management of white grub larvae such as Japanese beetle, chafers, oriental beetle, Asiatic garden beetle, and *Phyllophaga* spp. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

Merit 2.5 G is labeled for use on ornamental shrubs and small trees in outdoor landscapes and interior plantscapes against Japanese beetle adults.

MANAGEMENT HINTS: Apply registered materials from late June through July when adults are active. (p. 236)

Leaf beetle: Formulations of azadirachtin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin and imidacloprid, horticultural oil (larvae only), imidacloprid, pyrethrins and piperonyl butoxide, and spinosad are labeled for leaf beetle management.

MANAGEMENT HINTS: Treat when beetles are active from late June through early July. (p. 226)

Oystershell scale: Refer to comments under “Ash.” (p. 370)

Whitemarked tussock moth: Formulations of azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, and tau-fluvalinate are labeled for management of this pest.

MANAGEMENT HINTS: This insect may produce two or three generations each year. Treat foliage when larvae are first seen in late May. Repeat applications when necessary. (p. 158)

Beech

Beech scale: Formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and thiamethoxam are labeled for crawler management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Eggs are laid from late June through July. Crawlers should be managed when they are active in August. Feeding by this scale insect kills inner tissue of the bark. Severe injury occurs when a *Nectria* fungus enters the tree through wounds caused by this scale insect. (p. 332)

Cankerworm: Refer to comments under “Ash.” Naled is not labeled for cankerworm management on beech. (pp. 142, 144)

Elmspanworm: Formulations of acephate (Turf, Tree & Ornamental Spray only), azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), phosmet, pyrethrins and piperonyl butoxide, tau-fluvalinate, and tebufenozide are labeled for management of this pest.

MANAGEMENT HINTS: Apply when small larvae are active in mid- to late May. (pp. 144, 146)

Woolly beech aphids: Apply horticultural spray oil as a dormant treatment. Formulations of abamectin, acephate, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled to manage aphids. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Aphids should be managed during late May through mid-June before populations increase on host plants. (p. 296)

Yellownecked caterpillar: Formulations of azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, indoxacarb, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, and tebufenozide are labeled for management of this pest.

MANAGEMENT HINTS: Applications may be made from July through mid-September when larvae are present and infestations are severe. Buds are usually set on host plants late in the growing season so that lowering population levels will be more aesthetic in nature than for plant health care reasons. Remove and destroy colonies of young larvae when observed on the foliage of trees. (p. 154)

Birch

Aphids: Apply horticultural spray oil as a dormant treatment. Formulations of abamectin, acephate, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dimethoate, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, naled, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled to manage aphids. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when aphids are first noticed in the spring. Repeat insecticide applications as needed. (p. 296)

Bagworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, malathion, naled, permethrin, pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, tebufenozide, and trichlorfon are labeled for bagworm management.

MANAGEMENT HINTS: Bagworm cases (containing overwintering eggs) can be handpicked from infested host plants during winter and early spring. Treat when caterpillars are small during early to mid-June. (p. 176)

Birch leafminer: Formulations of acephate, azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin and imidacloprid, dimethoate, imidacloprid, lambda-cyhalothrin, malathion, naled, oxydemeton-methyl, phosmet, permethrin, and pyrethrins and piperonyl butoxide are labeled for leafminer management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Application of a registered insecticide should occur when adults are active in May and mid- to late June. Apply acephate or dimethoate if larvae are inside the foliage. (p. 184)

Bronze birch borer: Formulations of bifenthrin (Onyx only), bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin and imidacloprid, imidacloprid (Marathon 60 WP, Merit 2, Merit 75 WP, Merit 75 WSP only), and permethrin (Astro only) are labeled for borer management.

MANAGEMENT HINTS: Fertilization and irrigation will promote a healthy plant and reduce successful attack by this pest. Prune and destroy infested branches before May. Spray trees thoroughly, especially the upper part, from late May through early June. (p. 272)

Fall webworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, naled, permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, tebufenozide, and trichlorfon are labeled for fall webworm management.

MANAGEMENT HINTS: Treat when webs first appear from late June through July. (p. 166)

Gypsy moth: Refer to comments under “Gypsy Moth” on page 15. Prior to applying any control material, refer to individual labels for host-plant clearance. (pp. 138, 140)

Hickory tussock moth: Refer to comments under “Basswood.”
MANAGEMENT HINTS: Young larvae feed in groups. Caterpillars require about three months to complete their development. Hairy oval cocoons are built on the ground in September. Treat infestations when larvae are small from late June through early August. (p. 160)

Japanese beetle: Refer to comments under “Basswood.” (p. 236)

Leafhoppers: Formulations of acephate, acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, fenpropathrin, flonicamid, hydrophobic extract of neem oil, imidacloprid, indoxacarb, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, permethrin, phosmet, pyrethrins and

piperonyl butoxide, tau-fluvalinate, and thiamethoxam are labeled for leafhopper management.

MANAGEMENT HINTS: Treat when leafhoppers are first noticed and repeat as necessary according to label directions. (pp. 414, 416, 418)

Oystershell scale: Refer to comments under “Ash.” (p. 370)

Whitemarked tussock moth: Refer to comments under “Basswood.” Naled is labeled for tussock moth management on birch. (p. 158)

Yellownecked caterpillar: Refer to comments under “Beech.” (p. 154)

Boxelder

Boxelder bug: Formulations of acephate, azadirachtin (Ornazin 3% EC only), carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), naled, and pyrethrins and piperonyl butoxide are labeled for boxelder bug management.

MANAGEMENT HINTS: Direct sprays against the pest in early summer. If boxelder bugs continue to be a nuisance, consider removing pistillate (female) boxelder trees near buildings. (p. 398)

Boxwood

Boxwood leafminer: Formulations of abamectin, acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyromazine, cyfluthrin and imidacloprid, dimethoate, imidacloprid, lambda-cyhalothrin (for adult leafminers), malathion, novaluron, oxydemeton-methyl, permethrin, pyrethrins and piperonyl butoxide, spinosad, and trichlorfon are labeled for leafminer management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Apply registered insecticides in May when weigela is in bloom. (p. 204)

Boxwood psyllid: Formulations of acetamiprid, azadirachtin (Ornazin 3% EC only), *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin and imidacloprid, horticultural oil (for immature psyllids), imidacloprid, insecticidal soap, and pyrethrins and piperonyl butoxide are labeled for psyllid management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Treat when young psyllids are present in early May. (p. 290)

Boxwood spider mite: Formulations of bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), dimethoate, fenpyroximate, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, spinosad, spiromesifen, and tau-fluvalinate are labeled for mite management.

MANAGEMENT HINTS: Treat when mites are active in the spring. If repeat applications are needed, follow label directions. (p. 475)

Indian wax scale: Crawlers may be managed with acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. This species overwinters as adult females. Treat the crawler stage when they are active on an infested plant from June through mid-July. Repeat applications may be needed. (p. 356)

Catalpa

Catalpa sphinx: Formulations of bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, indoxacarb, lambda-cyhalothrin, pyrethrins and piperonyl butoxide, spinosad, and tau-fluvalinate are labeled for the management of catalpa sphinx infestations.

MANAGEMENT HINTS: The larval stage of this insect feeds gregariously (in groups). Mature larvae are about 50 to 65 millimeters long. Larvae are often parasitized by a small wasp whose successful attack is indicated by the presence of small, white cocoons on the outside of the caterpillar's body. Direct sprays against infestations of this pest when larvae are present from mid-May through September.

White peach scale: Formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion are labeled for crawler management.

MANAGEMENT HINTS: Treat when crawlers are first present in late May or early June. A second generation occurs from late July through early August. (p. 392)

Chamaecyparis

Juniper scale: Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, and methidathion.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Egg laying begins in mid-May, and newly hatched crawlers appear throughout June. Repeat applications may be needed for effective crawler management; follow label directions. Malathion may injure 'Canaertii' juniper. (p. 106)

Nuculaspis pseudomeyeri (an armored scale insect): Crawler treatments include acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, and methidathion.

MANAGEMENT HINTS: Select and apply horticultural spray oils according to label directions. Crawler treatments should be applied when eggs hatch in May for the first generation and in late July through August for the second generation. Repeat applications may be needed.

Cherry (Flowering Ornamental)

Eastern tent caterpillar: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, insecticidal soap, lambda-cyhalothrin, malathion, naled, permethrin (Astro only), phosmet, pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, and tebufenozide are labeled for tent caterpillar management.

MANAGEMENT HINTS: Spray areas around web when first noticed in April and May. Do not apply acephate more often than three times in a growing season at a 4-week interval. (p. 168)

Fall webworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, tebufenozide, and trichlorfon are registered for webworm management.

MANAGEMENT HINTS: Treat when webs are small in late June through July. (p. 166)

Flatheaded appletree borer: Formulations of bifenthrin (Onyx only), chlorpyrifos (Dursban 50W only), and permethrin (Astro only) are labeled for wood-boring beetle management.

MANAGEMENT HINTS: Fertilization and irrigation will promote a healthy plant and reduce successful attack by this pest. Treat trunks in early June, July, and August. Repeat applications according to label directions. (p. 270)

Japanese beetle: Formulations of acephate, acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, imidacloprid, lambda-cyhalothrin, malathion, permethrin (Astro only), phosmet, and pyrethrins and piperonyl butoxide are labeled for management of adults. Formulations of imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP) are also labeled for management of white grub larvae such as Japanese beetle, chafers, oriental beetle, Asiatic garden beetle, and *Phyllophaga* spp. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

Merit 2.5 G is labeled for use on ornamental shrubs and small trees in outdoor landscapes and interior plantscapes against Japanese beetle adults.

MANAGEMENT HINTS: Apply registered materials from late June through July when adults are active. (p. 236)

Japanese maple scale: Formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion are labeled for crawler management.

MANAGEMENT HINTS: Treat when crawlers are present from late May through mid-August. Repeat applications may be necessary.

Lesser peachtree borer: Formulations of bifenthrin (Onyx only), chlorpyrifos (Dursban 50W only), and permethrin (Astro only) are labeled for management of this pest.

MANAGEMENT HINTS: Use pheromone traps and treat with a registered formulation 10 days after the first males are captured, usually in late May or early June. Newly hatched larvae of this clearwing moth gain access to the host near a branch crotch, or by boring at a site with injured bark. Successful attack by this pest may result in an amberlike gum mass that may accumulate near the injury site. (p. 258)

Peachtree borer: Formulations of azadirachtin (Ornazin 3% EC only), bifenthrin (Onyx only), chlorpyrifos (Dursban 50W only), permethrin (Astro only), and pyrethrins and piperonyl butoxide are labeled for management of this pest.

MANAGEMENT HINTS: Use pheromone traps and treat with a registered formulation 10 days after the first males are captured. Adults may emerge from the host in late June and females may lay eggs during a period of 6 weeks. The larval stage of this clearwing moth feeds on the inner bark at the base of the host. Feeding by this life stage may girdle the tree. Registered formulations may be applied at the trunk and root collar regions during mid- to late July. Do not place mulch in high piles around *Prunus* trunks because it may attract females to lay eggs at that site on the host plant. (p. 258)

San Jose scale: Formulations of acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin, bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos, cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and pyriproxyfen are labeled for crawler management.

MANAGEMENT HINTS: Apply horticultural spray oils according to label directions. San Jose scales mature in the spring when apple is in bloom. Two to five generations can occur per year. Treat when crawlers are first observed in early May. Repeat applications may be necessary through early September. (p. 386)

White peach scale: Formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion are labeled for crawler management.

MANAGEMENT HINTS: Treat when crawlers are first present in late May or early June. A second generation occurs from late July through early August. This species overwinters as females. (p. 392)

White prunicola scale: Formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion are labeled for crawler management.

MANAGEMENT HINTS: This scale insect has three generations per year. Treat when crawlers are first observed in early May, late June, and late August. This species overwinters as females. (p. 392)

Cotoneaster

Hawthorn lace bug: Formulations of acephate, *Beauveria bassiana* (BotaniGard ES only), bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, fenpropathrin, horticultural oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, permethrin, pyrethrins and piperonyl butoxide, and thiamethoxam are labeled for lace bug management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Treat when lace bugs are first seen in the spring. Repeat applications may be needed. (p. 426)

Japanese maple scale: Refer to comments under “Cherry (Flowering Ornamental).”

Mites: Apply horticultural spray oil as a dormant treatment. Formulations of abamectin, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin, malathion, oxydemeton-methyl, spinosad, spiromesifen, and tau-fluvalinate are labeled for mite management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when mites are first observed in the spring. Repeat applications may be necessary. (p. 486)

Pear sawfly: Formulations of acephate, azadirachtin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, insecticidal soap, diflubenzuron, horticultural oil (larvae), imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP only), insecticidal soap, lambda-cyhalothrin, spinosad, and thiamethoxam are labeled for sawfly management.

MANAGEMENT HINTS: Treat infested plants when larvae are present in early June and early August. (p. 130)

San Jose scale: Formulations of acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin, bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos, cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and pyriproxyfen are labeled for crawler management.

MANAGEMENT HINTS: Apply horticultural spray oils according to label directions. San Jose scales mature in the spring when apple is in bloom. Two to five generations can occur per year. Treat when crawlers are first observed in early May. Repeat applications may be necessary through early September. (p. 386)

Crabapple (Ornamental Nonedible Flowering)

Aphids: Apply horticultural spray oil as a dormant treatment. Formulations of abamectin, acephate, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, naled, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for management of aphids. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when aphids are present. Do not apply acephate more than three times in a growing season at a 4-week interval. Phytotoxicity has occurred from acephate on the following crabapple varieties: 'Hopa', 'Ichonoski', 'Malusfloribunda', 'Pink Perfection', 'Red Wine', and 'Snow Cloud'. (p. 300)

Calico scale: Horticultural spray oil can be applied as a dormant treatment. Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oils according to label directions. Crawlers may be managed when they are active in June through early July. Phytotoxicity has occurred from acephate on the following crabapple varieties: 'Hopa', 'Ichonoski', 'Malusfloribunda', 'Pink Perfection', 'Red Wine', and 'Snow Cloud'. Repeat applications may be needed. (p. 354)

Cankerworm: Formulations of azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), naled, permethrin (Astro only), phosmet (spring cankerworm only), pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, and tebufenozide (fall cankerworm only) are labeled for cankerworm management.

MANAGEMENT HINTS: Apply in May after leaves have formed, but only if caterpillars are present. (pp. 142, 144)

Eastern tent caterpillar: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, insecticidal soap, lambda-cyhalothrin, malathion, naled, permethrin (Astro only), phosmet, pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, and tebufenozide are labeled for tent caterpillar management.

MANAGEMENT HINTS: Spray areas around web when first noticed in April and May. Do not apply acephate more often than three times in a growing season at a 4-week interval. Phytotoxicity has occurred from acephate on the following crabapple varieties: 'Hopa', 'Ichonoski', 'Malusfloribunda', 'Pink Perfection', 'Red Wine', and 'Snow Cloud'. Prune viable egg masses from small twigs during the winter. (p. 168)

Fall webworm: Formulations of azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, naled, permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, tebufenozide, and trichlorfon are registered for webworm management.

MANAGEMENT HINTS: Treat when webs are small in late June through July. (p. 166)

Flatheaded appletree borer: Formulations of bifenthrin (Onyx only), chlorpyrifos (Dursban 50W only), and permethrin (Astro only) are labeled for borer management.

MANAGEMENT HINTS: Fertilization and irrigation will promote a healthy plant and reduce successful attacks by this pest. Treat trunks in early June, July, and August. Be sure to follow label directions for repeat applications. (p. 270)

Gypsy moth: Refer to comments under "Gypsy Moth" on page 15. Prior to applying any control material, refer to individual labels for host-plant clearance. (pp. 138, 140)

Japanese beetle: Formulations of acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, imidacloprid, lambda-cyhalothrin, malathion, permethrin (Astro only), phosmet, and pyrethrins and piperonyl butoxide are labeled to manage adults. Formulations of imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP) are also labeled for management of white grub larvae such as Japanese beetle, chafers, oriental beetle, Asiatic garden

beetle, and *Phyllophaga* spp. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds. Merit 2.5 G is labeled for use on ornamental shrubs and small trees in outdoor landscapes and interior plantscapes against Japanese beetle adults.

MANAGEMENT HINTS: Treat when adults are first observed from late June through July. (p. 236)

Japanese maple scale: Refer to comments under “Cherry (Flowering Ornamental).”

Leafroller: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, lambda-cyhalothrin, naled, permethrin (Astro only), pyrethrins and piperonyl butoxide, and spinosad are labeled for leafroller management.

MANAGEMENT HINTS: Products should be applied before leaves are tightly rolled in the spring. Do not apply acephate more often than three times in a growing season at a 4-week interval. Phytotoxicity has occurred from acephate on the following crabapple varieties: ‘Hopa’, ‘Ichonoski’, ‘Malus-floribunda’, ‘Pink Perfection’, ‘Red Wine’, and ‘Snow Cloud’. (pp. 172, 214)

Mites: Apply horticultural spray oil as a dormant treatment. Formulations of abamectin, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin, malathion, oxydemeton-methyl, spinosad, spiromesifen, and tau-fluvalinate are labeled for mite management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Apply registered insecticides when mites are first seen in the spring. Repeat applications may be needed. Be sure to follow label directions. (p. 482)

Oystershell scale: Formulations of acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, and methidathion are labeled for crawler management.

MANAGEMENT HINTS: Select and apply horticultural spray oils according to label directions. Crawler sprays should be applied from late May through early June. Repeat applications may be needed. Be sure to follow label directions. Prune and destroy heavily infested twigs and branches. Phytotoxicity has occurred from acephate on the following crabapple varieties: ‘Hopa’, ‘Ichonoski’, ‘Malus-floribunda’, ‘Pink Perfection’, ‘Red Wine’, and ‘Snow Cloud’. (p. 370)

Pear sawfly: Formulations of azadirachtin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, horticultural oil (larvae), imidacloprid (Merit 2, Merit 75 WP, and Merit 75

WSP only), insecticidal soap, lambda-cyhalothrin, naled, spinosad, and thiamethoxam are labeled for sawfly management.

MANAGEMENT HINTS: Treat infested plants when larvae are present in early June and early August. (p. 130)

Roundheaded appletree borer: A formulation of chlorpyrifos (Dursban 50W only) is labeled for borer management.

MANAGEMENT HINTS: Fertilization and irrigation will promote a healthy plant and reduce successful attack by this pest. Treat trunks in early June and early July. Repeat applications may be needed. Be sure to follow label directions for repeat applications. (p. 278)

Yellownecked caterpillar: Refer to comments under “Beech.” (p. 154)

Cryptomeria

Cryptomeria scale: Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Yellow crawlers may begin to emerge from eggs in June. Treat the crawler stage during June and in September. (p. 110)

Spruce spider mite: Horticultural spray oil can be applied as a dormant treatment. Oil may injure Douglas-fir flower buds. Formulations of abamectin, acequinocyl, bifenazate, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), dicofol, etoxazole, fenbutatin-oxide, fenpyroximate, hexythiazox, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, spinosad, spiromesifen, and tau-fluvalinate are labeled for mite management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Apply registered materials to destroy mites hatching from eggs. This will occur from May through June. Additional generations may need to be managed in September through early October. If repeat applications are needed, follow label directions. (p. 118)

Dogwood

Calico scale: Horticultural spray oil can be applied as a dormant treatment. Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oils according to label directions. Crawlers may be managed when they are active in June through early July. Repeat applications may be needed. (p. 354)

Dogwood borer: Formulations of azadirachtin (Ornazin 3% EC only), bifenthrin (Onyx only), chlorpyrifos (Dursban 50W only), and permethrin (Astro only) are labeled for borer management.

MANAGEMENT HINTS: The use of sex pheromone traps will aid in determining adult flight activity. Make two applications at 7- to 10-day intervals in late May and early June. Treat trunk and lower branches, and keep trees growing vigorously. If an infestation is severe, additional applications may need to be made according to label directions in early July, early August, and early September. Place mulch around the base of trees to protect trunks from injury caused by lawn mowers and other machines. (p. 262)

Dogwood sawfly: Formulations of acephate, azadirachtin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, horticultural oil (larvae), imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP only), insecticidal soap, lambda-cyhalothrin, naled, and spinosad are labeled for sawfly management.

MANAGEMENT HINTS: Treat infested trees when larvae are active during late June through July. Light infestations may be handpicked and destroyed. (p. 126)

Japanese maple scale: Refer to comments under “Cherry (Flowering Ornamental).”

Leafhoppers: Refer to comments under “Birch.” (p. 412)

Oystershell scale: Refer to comments under “Ash.” (p. 370)

Douglas-Fir

Bagworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, malathion, permethrin, pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, tebufenozide, and trichlorfon are labeled for bagworm management.

MANAGEMENT HINTS: Bagworm cases (containing overwintering eggs) can be handpicked from infested host plants during winter and early spring. Otherwise, management measures can be applied after eggs hatch and caterpillars are small during early to mid-June. (p. 176)

Cooley spruce gall adelgid: Horticultural spray oil can be applied as a dormant treatment; however, horticultural oil may injure Douglas-fir flower buds. Formulations of acetamiprid, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin and imidacloprid, horticultural oil, imidacloprid, insecticidal soap, oxydemeton-methyl, and tau-fluvalinate are labeled for adelgid management. Marathon 1% G and Marathon 60 WP are labeled for use only in plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Apply horticultural spray oil according to label directions. Apply materials before buds break in April. Adelgids can be managed on Douglas-fir in the summer months, but results obtained seldom reach optimum levels. To manage overwintering adelgids, apply a registered material from mid-September through October. (p. 112)

Pine needle scale: Crawlers may be managed with formulations of acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin, bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, methidathion, and oxydemeton-methyl (on field grown nursery stock).

MANAGEMENT HINTS: Apply horticultural spray oil according to label directions. Please note that oil may injure Douglas-fir flower buds. Crawlers may start to emerge from eggs during late April through May. Emergence of second generation crawlers will occur during mid- to late July. Crawler activity will vary from year to year due to climatic conditions. To obtain maximum control, monitor infested trees on a regular basis. Two applications of a registered insecticide may be necessary to manage heavy populations. Be aware that the adult female has a fairly long egg-laying period, and newly hatched crawlers may remain beneath the protective scale cover, especially on overcast days. (p. 108)

Spruce spider mite: Horticultural spray oil can be applied as a dormant treatment. Oil may injure Douglas-fir flower buds. Formulations of abamectin, acequinocyl, bifenazate, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), dicofol, etoxazole, fenbutatin-oxide, fenpyroximate, hexythiazox, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, spinosad, spiromesifen, and tau-fluvalinate are labeled for mite management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Apply registered materials to destroy mites hatching from eggs. This will occur from May through June. Additional generations may need to be managed in September through early October. If repeat applications are needed, follow label directions. (p. 118)

White pine weevil: Formulations of bifenthrin, chlorpyrifos (Dursban 50W only), and pyrethrins and piperonyl butoxide (Pyrenone Crop Spray) are labeled for weevil management. Naled (Dibrom 8) is labeled for pine weevil management on Douglas-fir. Oxydemeton-methyl (Metasystox-R) is labeled for management of white pine weevil on field grown nursery stock. Diflubenzuron is not labeled for application to Douglas-fir.

MANAGEMENT HINTS: To manage egg-laying weevils, apply a registered formulation to only the top of the host tree (terminal) as weather warms during late March through April. Timing can vary since conditions change from year to year. (p. 54)

Elm

Bark beetles: Formulations of azadirachtin (Ornazin 3% EC only), bifenthrin (Onyx only), carbaryl, chlorpyrifos (Dursban 50W only), permethrin (Astro only), and pyrethrins and piperonyl butoxide are labeled for bark beetle management. A 2(ee) recommendation for Mavrik Aquaflow Insecticide is in place for the control of elm bark beetles in trees and shrubs within the states of Pennsylvania (and New Jersey). The 2(ee) recommendation for Mavrik Aquaflow Insecticide states that it is for application only under the recommendation and supervision of a certified arborist. The use of elm bark beetle pheromone traps may assist in the timing of spray applications. Make applications against the native elm bark beetle during April and against the smaller European elm bark beetle in the spring and summer according to label directions, to reduce adults before they mate and lay eggs.

MANAGEMENT HINTS: Fertilization and irrigation will promote a healthy plant. Prune and destroy weak, dead branches and trees as soon as noticed. This is one effective method of reducing the spread of Dutch elm disease to healthy trees. Spraying offers some additional protection but is suggested only for valuable trees. (pp. 246, 248)

Calico scale: Refer to comments under “Dogwood.” (p. 354)

Cankerworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), naled, permethrin (Astro only), phosmet (spring cankerworm only), pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, and tebufenozide (fall cankerworm only) are labeled for cankerworm management.

MANAGEMENT HINTS: Apply when small larvae are active in May. (pp. 142, 144)

Elm leaf aphids: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, acephate, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, naled, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for aphid management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when aphids are first noticed in the spring. Repeat insecticide applications as needed. Malathion may cause slight damage to elms. (p. 306)

Elm leaf beetle: Formulations of acephate, azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, horticultural oil (larvae only), imidacloprid, insecticidal soap

(M-Pede only to manage larvae), lambda-cyhalothrin, naled, oxydemeton-methyl, phosmet (larvae only), pyrethrins and piperonyl butoxide, spinosad (adults and larvae), and tau-fluvalinate are labeled for beetle management. Marathon 1% G and Marathon 60 WP are labeled for use against elm leaf beetles only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Apply materials from late May through June and in July. (p. 222)

Elm spanworm: Formulations of acephate (Turf, Tree & Ornamental Spray only), azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), phosmet, pyrethrins and piperonyl butoxide, tau-fluvalinate, and tebufenozide are labeled for management of this pest.

MANAGEMENT HINTS: Apply when small larvae are active in mid- to late May. (pp. 144, 146)

European elm scale: Horticultural spray oil can be applied as a dormant treatment. Formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, oxydemeton-methyl, and thiamethoxam are labeled for crawler management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Crawler sprays should be applied in late June through mid-July. (p. 368)

Fall webworm: Refer to comments under “Crabapple (Ornamental Nonedible Flowering).”

MANAGEMENT HINTS: Treat when webs are small in late June through July. Acephate is labeled to manage fall webworm on elm. (p. 166)

Japanese beetle: Formulations of acephate, acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, imidacloprid, lambda-cyhalothrin, malathion, permethrin (Astro only), phosmet, and pyrethrins and piperonyl butoxide are labeled for management of adults. Formulations of imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP) are also labeled for management of white grub larvae such as Japanese beetle, chafers, oriental beetle, Asiatic garden beetle, and *Phyllophaga* spp. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds. Merit 2.5 G is labeled for use on ornamental shrubs and small trees in outdoor landscapes and interior landscapes against Japanese beetle adults.

MANAGEMENT HINTS: Apply when adults are active from late June through July. (p. 236)

Japanese maple scale: Refer to comments under “Cherry (Flowering Ornamental).”

Leafhoppers: Formulations of acephate, acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, fenpropathrin, flonicamid, hydrophobic extract of neem oil, imidacloprid, indoxacarb, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, permethrin, phosmet, pyrethrins and piperonyl butoxide, tau-fluvalinate, and thiamethoxam are labeled for management of leafhoppers.

MANAGEMENT HINTS: Treat when leafhoppers are first seen. Repeat treatment according to label directions. Malathion may cause slight damage to elms. (pp. 412, 414, 416)

Spiny elm caterpillar: Formulations of azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos, cryolite, cyfluthrin, cyfluthrin and imidacloprid, indoxacarb, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), pyrethrins and piperonyl butoxide, and tau-fluvalinate are labeled for caterpillar management.

MANAGEMENT HINTS: Apply when caterpillars are small from mid- to late July. (p. 152)

Whitemarked tussock moth: Refer to comments under “Basswood.” Naled is labeled for tussock moth management on elm. (p. 158)

Yellownecked caterpillar: Refer to comments under “Beech.” (p. 154)

Euonymus

Aphids: Refer to comments under “Basswood.” Cyfluthrin and dimethoate are labeled for aphid management on euonymus. BotaniGard ES and BotaniGard 22WP are not labeled for application on euonymus. (p. 300)

Euonymus alatus scale: Formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dimethoate, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, Scimitar GC only), and methidathion are labeled to manage crawlers.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Crawler sprays are effective when made from late June through July. Repeat applications may be necessary due to an extensive egg-laying period. One generation occurs each year. (p. 388)

Euonymus caterpillar: Formulations of acephate, bifenthrin, bifenthrin and imidacloprid, carbaryl, cryolite, cyfluthrin, cyfluthrin and imidacloprid, indoxacarb, lambda-cyhalothrin, permethrin (Astro only), pyrethrins and piperonyl butoxide, and tau-fluvalinate are registered for management of this pest.

MANAGEMENT HINTS: Treat when caterpillars are first observed in late May or early June. (p. 174)

Euonymus scale: Crawlers may be managed with formulations of acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dimethoate, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, methidathion, and pyriproxyfen.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Apply crawler treatments in late May through June. Second generation crawlers may require treatment from late July through early August. Repeat applications may be necessary. Prune and destroy heavily infested twigs and branches. (p. 388)

Indian wax scale: Crawlers may be managed with acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. This species overwinters as adult females. Treat the crawler stage when they are active on an infested plant from June through mid-July. Repeat applications may be needed. (p. 356)

Japanese maple scale: Refer to comments under “Cherry (Flowering Ornamental).”

Twobanded Japanese weevil: Formulations of acephate, bifenthrin, cyfluthrin and imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), and pyrethrins and piperonyl butoxide are labeled for management of adult weevils.

MANAGEMENT HINTS: This brown weevil feeds during the day. Marginal notching of new foliage is a symptom of adult feeding. Treat infested plants when new foliage has notched margins during early July through August. (p. 244)

Twospotted spider mite: Formulations of abamectin, acequinocyl, bifenazate, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos, clofentezine, dicofol, etoxazole, fenbutatin-oxide, fenpropathrin, fenpyroximate, hexythiazox, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, pyridaben, spinosad, spiromesifen, and tau-fluvalinate are labeled for management of this pest.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when mites first appear in late June or early July. Repeat applications may be needed. (p. 476)

Fir

Aphids: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, acephate, acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, esfenvalerate (for balsam twig aphid only), fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin, malathion, naled, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled to manage aphids on fir. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Apply registered insecticides when aphids are first seen. (p. 80)

Bagworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, malathion, permethrin, pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, tebufenozide, and trichlorfon are labeled for bagworm management.

MANAGEMENT HINTS: Bagworm cases (containing overwintering eggs) can be handpicked from infested host plants during winter and early spring. Apply treatments when caterpillars are small during early to mid-June. (p. 176)

Cryptomeria scale: Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Yellow crawlers may begin to emerge from eggs in June. Treat the crawler stage during June and in September. (p. 110)

Elongate hemlock scale: Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion.

MANAGEMENT HINTS: Select and apply horticultural spray oils according to label directions. Crawlers may be managed from late May through early June. Egg-laying and crawler activity occur throughout the growing season. Crawler sprays made need to be applied at 7- to 10-day periods from mid-May to mid-September if an infestation is severe. (p. 104)

Pine needle scale: Crawlers may be managed with formulations of acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin, bifenthrin and imidacloprid, buprofezin, carba-

ryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, methidathion, and oxydemeton-methyl (on field grown nursery stock).

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Crawlers may start to hatch from eggs during late April through May, and a second generation will begin hatching from mid- to late July. Repeat applications may be necessary. (p. 108)

Spruce spider mite: Apply horticultural spray oil as a dormant treatment. Motile stages of mites can be managed with formulations of abamectin, acequinocyl, bifenazate, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), dicofol, etoxazole, fenbutatin-oxide, fenpyroximate, hexythiazox, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, spinosad, spiromesifen, and tau-fluvalinate.

MANAGEMENT HINTS: Select and apply a dormant horticultural spray oil before new growth starts and before buds separate into clusters. A dormant application should be made while temperatures remain above freezing and always according to label directions. *Note:* Apply a registered material to kill mites hatching from eggs (miticide). This will occur from May through June. Infestations may need to be managed in September through early October. If mite populations persist, repeat applications may be necessary. Monitor mite populations prior to applying a control material. Heavy rainfalls may reduce mite populations for a short time. (p. 118)

Forsythia

Fourlined plant bug: Formulations of acetamiprid, *Beauveria bassiana* (BotaniGard ES only), bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, flonicamid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, permethrin (Astro only), pyrethrins and piperonyl butoxide, and thiamethoxam are labeled for plant bug management.

MANAGEMENT HINTS: This species overwinters as an egg in slits made in plant tissue. Young bright red nymphs with black dots on the second body segment (thorax) are active in May and June. Adults are bright green with four black stripes. Feeding by this species causes small black spots to form on the leaf surface. Eventually these small circular areas turn brown and drop from the leaf, leaving small holes in the foliage. Treat when young nymphs are active in mid- to late May. (p. 396)

Hawthorn

Aphids: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, acephate, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar

CS, and Scimitar GC only), malathion, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for aphid management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when aphids first appear and repeat as needed. (p. 300)

Eastern tent caterpillar: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, insecticidal soap, lambda-cyhalothrin, malathion, permethrin (Astro only), phosmet, pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, and tebufenozide are labeled for tent caterpillar management.

MANAGEMENT HINTS: Treat areas around web when first noticed in April and May. Prune viable egg masses from small twigs during the winter. (p. 168)

Fall webworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, lambda-cyhalothrin, permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, tebufenozide, and trichlorfon are labeled for webworm management.

MANAGEMENT HINTS: Treat when webs are small in late June through July. (p. 166)

Flatheaded appletree borer: Formulations of bifenthrin (Onyx only), chlorpyrifos (Dursban 50W only), and permethrin (Astro only) are labeled for wood-boring beetle management.

MANAGEMENT HINTS: Fertilization and irrigation will promote a healthy plant and reduce successful attack by this pest. Treat trunks in early June, July, and August. Repeat applications according to label directions. (p. 270)

Hawthorn lace bug: Formulations of acephate, *Beauveria bassiana* (BotaniGard ES only), bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, fenpropathrin, horticultural oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, permethrin, pyrethrins and piperonyl butoxide, and thiamethoxam are labeled for lace bug management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Treat when lace bugs are small in May. Repeat applications may be necessary. (p. 426)

Hawthorn leafmining sawfly: Formulations of acephate, azadirachtin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP only), insecticidal soap, lambda-cyhalothrin, and spinosad are labeled for sawfly management.

MANAGEMENT HINTS: Treat infested plants when the host plant's first leaf clusters begin to unfold and flower buds begin to open. Mature larvae abandon the leaves during mid-June and drop to the ground where they spend the winter. At the beginning of the growing season this species is in the pupal stage in the ground. (p. 188)

Leafhoppers: Refer to comments under "Birch." (pp. 412, 416)

Mites: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, acequinocyl (for the management of European red mite), bifenthrin, bifenthrin and imidacloprid (for the management of European red mite), chlorpyrifos (Dursban 50W only), clofentezine (for management of European red mite), dicofol (for management of European red mite), etoxazole (for management of European red mite), fenpropathrin (for management of European red mite), fenpyroximate (for management of spider mites), hexythiazox (for European red mite), horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, spinosad, spiromesifen, and tau-fluvalinate are labeled for mite management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when mites are first seen. Repeat applications may be necessary. (pp. 475, 486)

Oystershell scale: Formulations of acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, and methidathion are labeled for crawler management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when crawlers are active from late May through early June. Repeat applications may be needed. Prune and destroy heavily infested twigs and branches. (p. 370)

Pear sawfly: Formulations of acephate, azadirachtin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, horticultural oil (larvae), imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP only), insecticidal soap, lambda-cyhalothrin, spinosad, and thiamethoxam are labeled for sawfly management.

MANAGEMENT HINTS: Treat infested plants when larvae are present in early June and early August. (p. 130)

Roundheaded appletree borer: A formulation of chlorpyrifos (Dursban 50W only) is labeled for borer management.

MANAGEMENT HINTS: Fertilization and irrigation will promote a healthy plant and reduce successful attack by this pest. Treat trunks in early June and early July. Repeat applications may be needed. Be sure to follow label directions for repeat applications. (p. 278)

Hemlock

Bagworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, malathion, permethrin, pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, tebufenozide, and trichlorfon are labeled for bagworm management.

MANAGEMENT HINTS: Bagworm cases (containing overwintering eggs) can be handpicked from infested host plants during winter and early spring. Otherwise, management measures can be applied after eggs hatch and caterpillars are small during early to mid-June. (p. 176)

Black vine weevil (taxus weevil): Formulations of acephate, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin and imidacloprid, fenpropathrin, lambda-cyhalothrin, permethrin (Astro only), pyrethrins and piperonyl butoxide, and tau-fluvalinate are labeled to manage adults. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds. Merit 2.5 G is labeled for use on ornamental shrubs and small trees in outdoor landscapes and interior plantscapes against black vine weevil larvae in soil. Merit 2, Merit 75 WP, and Merit 75 WSP are labeled for black vine weevil larvae and are for use only in and around industrial and commercial buildings and residential areas. Talstar Nursery Granular is labeled for soil incorporation into potting media used in containerized plantings of ornamental trees, shrubs, plants, flowers, conifers, and Christmas trees. The use of insect-parasitic nematodes applied as soil drenches in container-grown plant material may be effective in reducing larval populations of this pest. Follow label directions for all methods of application.

MANAGEMENT HINTS: Spray foliage and surface to manage adults in May and June. Soil drenches can be applied from July to mid-October. Follow all label directions. (p. 240)

Cryptomeria scale: Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dimethoate, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Yellow crawlers may begin to emerge from eggs in early June. Treat the crawler stage during June and in September. (p. 110)

Elongate hemlock scale: Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dimethoate, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion.

MANAGEMENT HINTS: Select and apply horticultural spray oils according to label directions. Crawlers may be managed from late May through early June. Egg laying and crawler activity occur throughout the growing season. Crawler sprays made need to be applied at 7- to 10-day periods from mid-May to mid-September if an infestation is severe. (p. 104)

Hemlock looper: Formulations of *Bacillus thuringiensis* (DiPel DF, DiPel ES, DiPel Pro DF, and formulations of Foray), bifenthrin, bifenthrin and imidacloprid, cryolite, cyfluthrin, diflubenzuron, indoxacarb, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), pyrethrins and piperonyl butoxide, tau-fluvalinate, and tebufenozide are labeled for management of this pest.

MANAGEMENT HINTS: Manage caterpillars from late May through early June. The larvae feed on needles from the top of the tree downward, dropping on a silk thread when disturbed. (p. 24)

Hemlock rust mite (eriphyid): Formulations of abamectin, carbaryl, dimethoate, horticultural oil, insecticidal soap (M-Pede only), spiromesifen, and tau-fluvalinate are labeled to manage eriophyid mites.

MANAGEMENT HINTS: Manage mites in late March through April before they cause significant damage. This pest frequently goes unnoticed. If foliage looks suspicious, place it under a stereomicroscope to observe these very small mites. (p. 122)

Hemlock scale: Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dimethoate, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. First-generation-crawler treatments should be made in June and early July. Application of sprays directed against second generation crawlers should be made during early August through September. Repeat applications may be needed. (p. 102)

Hemlock woolly adelgid: Horticultural spray oil may be applied as a dormant treatment. Formulations of acetamiprid, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin and imidacloprid, dinotefuran, horticultural oil, imidacloprid, insecticidal soap, oxydemeton-methyl, tau-fluvalinate, and thiamethoxam are labeled for management of this key pest. Marathon 1% G and Marathon 60 WP are labeled for use only in plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Apply horticultural spray oil according to label directions. Adelgids may be managed by applying registered insecticides from mid- to late June and in late September through October. (pp. 78, 80)

Nuculaspis pseudomeyeri (an armored scale insect): Crawler treatments include acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl,

chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dimethoate, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, and methidathion.

MANAGEMENT HINTS: Select and apply horticultural spray oils according to label directions. Crawler treatments should be applied when eggs hatch in May for the first generation and in late July through August for the second generation. Repeat applications may be needed.

Spruce spider mite: Refer to comments under “Arborvitae.” Dimethoate is labeled to manage mites on hemlock. (p. 118)

Hickory

Aphids: Apply horticultural spray oil as a dormant treatment. Formulations of abamectin, acephate, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for aphid management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when aphids are first observed in the spring. Repeat application of an insecticide may be needed to manage an aphid infestation. (p. 310)

Cankerworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), phosmet (spring cankerworm only), pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, and tebufenozide (fall cankerworm only) are labeled for cankerworm management.

MANAGEMENT HINTS: Apply when small larvae are active in May. (pp. 142, 144)

Elm spanworm: Formulations of acephate (Turf, Tree & Ornamental Spray only), azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), phosmet, pyrethrins and piperonyl butoxide, tau-fluvalinate, and tebufenozide are labeled for management of this pest.

MANAGEMENT HINTS: Apply when small larvae are active in mid- to late May. (pp. 144, 146)

European fruit lecanium: Apply horticultural spray oil as a dormant treatment. Formulations of acephate, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, horticultural oil, imidacloprid,

insecticidal soap, lambda-cyhalothrin, methidathion, and thiamethoxam are labeled for crawler management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Crawlers are active from mid-June through mid-July. Repeat applications may be necessary. Natural enemies frequently attack this species when population levels are high. That results in the decline of an infestation after 2 or 3 years. (p. 364)

Fall webworm: Refer to comments under “Crabapple (Ornamental Nonedible Flowering).” Formulations of acephate are labeled to manage fall webworm on hickory. Naled is not labeled for management of fall webworm on hickory.

MANAGEMENT HINTS: Treat when webs are small in late June through July. (p. 166)

Flatheaded appletree borer: Formulations of bifenthrin (Onyx only), chlorpyrifos (Dursban 50W only), and permethrin (Astro only) are labeled for wood-boring beetle management.

MANAGEMENT HINTS: Fertilization and irrigation will promote a healthy plant and reduce successful attack by this pest. Treat trunks in early June, July, and August. Repeat applications according to label directions. (p. 270)

Gypsy moth: Refer to comments under “Gypsy Moth” on page 15. Prior to applying any control material, refer to individual labels for host-plant clearance information. (pp. 138, 140)

Hickory leafstem gall phyloxera: There are no chemical treatments registered for effective management of this insect.

MANAGEMENT HINTS: These galls may be 1 inch in diameter and are formed from plant tissues associated with shoot bark and petioles of hickory. The overwintering egg stage hatches into a life stage known as the stem mother. This stage can be found on the host plant from mid- to late April. The gall is fully formed by mid-May. While the gall is growing, the cavity inside is being filled with 1,000 or more eggs. The life cycle is completed in one year. To maintain the health of an infested hickory, you may prune all galls before adults emerge in mid-May. Fertilization and irrigation will also promote a healthy plant. (p. 460)

Hickory tussock moth: Refer to comments under “Basswood.”

MANAGEMENT HINTS: Young larvae feed in groups. Caterpillars require about 3 months to complete their development. Hairy oval cocoons are built on the ground in September. Treat infestations when larvae are small, from late June through early August. (p. 160)

Mites: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin, oxydemeton-methyl, spinosad, spiromesifen, and tau-fluvalinate are labeled for mite management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Apply in the spring before populations start to increase. Repeat applications according to label directions. (p. 475)

Twig girdler: There are no chemical treatments registered for management of this insect.

MANAGEMENT HINTS: A symptom of attack by this longhorned beetle is an abundance of twigs and small branches under a tree late in the growing season. Twigs and small branches killed by this pest may be more than 0.5 meter long. Pick up and destroy the dropped twigs and branches before May to reduce the impact of this borer. (p. 264)

Twig pruner: There are no chemical treatments registered for management of this insect.

MANAGEMENT HINTS: A symptom of attack by this pest is an abundance of twigs under a tree late in the growing season. Twigs and small branches up to 30 millimeters in diameter may accumulate on the ground beneath trees. A cleanly cut concave end on a twig with a hole in the center that may be plugged with fibrous woody tissue could also confirm the presence of this pest. Pick up and destroy the dropped twigs and branches before May to reduce the impact of this longhorned beetle. (p. 264)

Yellownecked caterpillar: Refer to comments under "Beech." (p. 154)

Holly

Cottony taxus scale: Horticultural spray oil can be applied as a dormant treatment. Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dimethoate (only on American and English hollies; not labeled for use on Burford variety hollies), dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. One white egg sac may contain more than 1,000 eggs. Eggs begin to hatch in late May and June. Crawlers settle on foliage and sprays should be applied during June. Repeat applications may be needed. One generation occurs each year. (p. 344)

Indian wax scale: Crawlers may be managed with acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dimethoate (only on American and English hollies; not labeled for use on Burford variety hollies), dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. This species overwinters as adult females. Treat the crawler stage when they are active

on an infested plant from June through mid-July. Repeat applications may be needed. (p. 356)

Inkberry leafminer: Formulations of acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos, cyfluthrin and imidacloprid, cyromazine, imidacloprid, lambda-cyhalothrin (for adult leafminers), novaluron, oxydemeton-methyl, permethrin, pyrethrins and piperonyl butoxide, spinosad, and trichlorfon are labeled for leafminer management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Apply a registered formulation from mid-April through mid-May and during mid-August through September. This species of agromyzid fly mines the foliage of inkberry, *Ilex glabra*, in Pennsylvania. Two generations are produced each year. (pp. 206, 208)

Native holly leafminer: Formulations of acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos, cyfluthrin and imidacloprid, cyromazine, dimethoate (only on American and English hollies; not labeled for use on Burford variety hollies), imidacloprid, lambda-cyhalothrin (for adult leafminers), novaluron, oxydemeton-methyl, permethrin, pyrethrins and piperonyl butoxide, spinosad, and trichlorfon are labeled for leafminer management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Apply a registered formulation in early May. There are four species of agromyzid flies in Pennsylvania that mine holly foliage. The native holly leafminer overwinters as a larva in the leaf mine. Adults emerge after a few new leaves have formed on holly (early May). This species feeds on American holly, Japanese holly, and related cultivars, but it lays eggs only in American holly. The native holly leafminer has one generation per year. When light infestations are noted, remove mined leaves before May. (p. 206)

Putnam scale: Crawlers may be managed with acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat first-generation crawlers from mid-May through June. Second-generation crawlers should be treated during mid-July through mid-September. Repeat applications may be needed.

Southern red mite: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, bifenazate, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos, dimethoate (only on American and English hollies; not labeled for use on Burford variety hollies), etoxazole, fenbutatin-oxide, fenpropathrin, fenpyroximate, hexythiazox, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin, malathion, oxydemeton-methyl, pyridaben,

spinosad, spiromesifen, and tau-fluvalinate are labeled for mite management.

MANAGEMENT HINTS: Horticultural spray oil should be selected and applied according to label directions. Apply remaining products when motile stages of the mite are present in the spring. Repeat applications may be needed. Be sure to follow label directions. (p. 475)

Honeylocust

Bagworm: Refer to comments under “Arborvitae.” (p. 176)

Calico scale: Horticultural spray oil can be applied as a dormant treatment. Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oils according to label directions. Crawlers may be managed when they are active in June through early July. Repeat applications may be needed. (p. 354)

Honeylocust plant bug: Formulations of acetamiprid, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, flonicamid, horticultural oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), pyrethrins and piperonyl butoxide, and thiamethoxam are labeled for plant bug management.

MANAGEMENT HINTS: Registered insecticides should be directed against young nymphs 7 to 10 days after bud break in early May. (p. 404)

Honeylocust pod gall midge: Formulations of carbaryl, cyfluthrin, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), pyrethrins and piperonyl butoxide, spinosad, and thiamethoxam are labeled for gall midge management. Formulations of cyfluthrin are labeled for the management of midges.

MANAGEMENT HINTS: Treat growing tips as new growth starts in the spring. If repeat applications are needed, be sure to follow label directions. (p. 466)

Mimosa webworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, and trichlorfon are labeled for webworm management.

MANAGEMENT HINTS: First-generation adults appear in June and lay eggs on flowers and foliage. Manage first-generation larvae as they hatch from eggs in mid- to late June. Second-generation larvae may require treatment in August. (p. 180)

Painted hickory borer: Formulations of carbaryl and chlorpyrifos (Dursban 50W only) are labeled for borer management.

MANAGEMENT HINTS: Fertilization and irrigation will promote a healthy plant and reduce successful attack by this pest. Spray bark of trunk and large branches in late May. There is one generation per year. (p. 274)

Spider mites: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), fenpyroximate, hexythiazox (for honeylocust spider mite), horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, spinosad, spiromesifen, and tau-fluvalinate are labeled for mite management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Manage vulnerable life stages in the spring as they hatch from eggs. Repeat applications may be needed. (p. 472)

Honeysuckle

Aphids: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, acephate, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dimethoate (only labeled for honeysuckle aphid), dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for aphid management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when aphids first appear. Repeat applications may be needed. (p. 314)

Ivy

Aphids: Formulations of abamectin, acephate, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for aphid management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Treat when aphids are first noticed. (p. 300)

Cottony taxus scale: Horticultural spray oil can be applied as a dormant treatment. Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only),

bifenthrin and imidacloprid, buprofezin, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. One white egg sac may contain more than 1,000 eggs. Eggs begin to hatch in late May and June. Sprays should be applied as crawlers settle on foliage in June. Repeat applications may be needed. One generation occurs each year. (p. 344)

Japanese beetle: Formulations of acephate, acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, imidacloprid, lambda-cyhalothrin, malathion, permethrin (Astro only), phosmet, and pyrethrins and piperonyl butoxide are labeled for management of adults. Formulations of imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP) are also labeled for management of white grub larvae such as Japanese beetle, chafers, oriental beetle, Asiatic garden beetle, and *Phyllophaga* spp. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds. Merit 2.5 G is labeled for use on ornamental shrubs and small trees in outdoor landscapes and interior plantscapes against Japanese beetle adults.

MANAGEMENT HINTS: Treat when beetles are active from late June through July. (p. 236)

Mites: Formulations of bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin, malathion, oxydemeton-methyl, spinosad, spiromesifen, and tau-fluvalinate are labeled for mite management.

MANAGEMENT HINTS: Treat when mites are young in the spring. Repeat applications may be needed. (p. 482)

Japanese Pieris

Azalea bark scale: Apply horticultural spray oil as a dormant treatment according to the label. Formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, methidathion, and thiamethoxam are labeled for crawler management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Crawler controls should be applied from June through mid-July. Repeat applications may be necessary. (p. 336)

Lace bug: Formulations of acephate, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, fenpropathrin, horticultural oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, permethrin, pyrethrins and piperonyl butoxide, and thiamethoxam are labeled for lace bug management on Japanese Pieris. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Treat when lace bugs are active in May, and July through August. Repeat applications may be needed. (p. 424)

Putnam scale: Crawlers may be managed with acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat first-generation crawlers from mid-May through June. Second generation crawlers should be treated during mid-July through mid-September. Repeat applications may be needed.

Southern red mite: Apply horticultural spray oil as a dormant treatment. Formulations of abamectin, bifenazate, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), etoxazole, fenbutatin-oxide, fenpropathrin, fenpyroximate, hexythiazox, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin, malathion, oxydemeton-methyl, pyridaben, spinosad, spiromesifen, and tau-fluvalinate are labeled for mite management.

MANAGEMENT HINTS: Treat in May before populations start to increase. (p. 475)

Japanese Zelkova

Calico scale: Refer to comments under "Honeylocust." (p. 354)

Elm leaf beetle: Formulations of acephate, azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, horticultural oil (larvae only), imidacloprid, insecticidal soap (M-Pede only to manage larvae), lambda-cyhalothrin, naled, oxydemeton-methyl, phosmet (larvae only), pyrethrins and piperonyl butoxide, spinosad (adults and larvae), and tau-fluvalinate are labeled for beetle management. Marathon 1% G and Marathon 60 WP are labeled for use against elm leaf beetles only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Apply materials from late May through June and in July. (p. 222)

Japanese maple scale: Formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and

Scimitar GC only), and methidathion are labeled for crawler management.

MANAGEMENT HINTS: Treat when crawlers are present from late May through mid-August. Repeat applications may be needed.

Juniper

Bagworm: Refer to comments under “Arborvitae.” Malathion may injure ‘Canaertii’ juniper. Formulations of dimethoate are labeled to manage bagworm on juniper. (p. 176)

Eriophyid mite: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, carbaryl, dimethoate, horticultural oil, spiromesifen, and tau-fluvalinate are labeled for eriophyid mite management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. The remaining products should be applied against motile stages of mites when new growth appears. (p. 122)

Juniper midge: Formulations of cyfluthrin, dimethoate, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and pyrethrins and piperonyl butoxide are labeled for midge management.

MANAGEMENT HINTS: Apply material in late June when adults are present. Adults emerge from their pupae from early to late May. (p. 46)

Juniper scale: Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, and methidathion.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Egg laying begins in mid-May, and newly hatched crawlers appear throughout June. Repeat applications may be needed for effective crawler management; follow label directions. Malathion may injure ‘Canaertii’ juniper. (p. 106)

Juniper tip midge: Formulations of carbaryl, cyfluthrin, dimethoate, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and pyrethrins and piperonyl butoxide are labeled for midge management.

MANAGEMENT HINTS: Treat foliage when adults are active in mid- to late May. Repeat applications may be needed in late June, early August and mid-September. Four generations occur annually in Pennsylvania. (p. 46)

Juniper webworm: Formulations of acephate, azadirachtin, bifenthrin, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, naled, permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, and trichlorfon are labeled for webworm management.

MANAGEMENT HINTS: Adult moths emerge in June and early July. Eggs are laid in leaf axils of new terminal growth. Treat

foliage in early May to manage the overwintering stage. Otherwise, treat foliage in July to kill young larvae hatching from eggs. (p. 30)

Nuculaspis pseudomeyeri (an armored scale insect): Crawler treatments include acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, and methidathion.

MANAGEMENT HINTS: Select and apply horticultural spray oils according to label directions. Crawler treatments should be applied when eggs hatch in May for the first generation and in late July through August for the second generation. Malathion may injure ‘Canaertii’ juniper. Repeat applications may be needed.

Spruce spider mite: Horticultural spray oil can be applied as a dormant treatment. Motile forms of mites can be managed with formulations of abamectin, acequinocyl, bifenazate, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos, dicofol, dimethoate, etoxazole, fenbutatin-oxide, fenpyroximate, hexythiazox, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, spinosad, spiromesifen, and tau-fluvalinate.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Apply treatments during mid-May through June before populations increase. Mite resurgence may occur from September through early October. Repeat applications may be needed. Malathion may injure ‘Canaertii’ juniper. (p. 118)

Larch

Bagworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, malathion, permethrin, pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, tebufenozide, and trichlorfon are labeled for bagworm management.

MANAGEMENT HINTS: Bagworm cases (containing overwintering eggs) can be handpicked from infested host plants during winter and early spring. Otherwise, control measures can be applied after eggs hatch and caterpillars are small during early to mid-June. (p. 176)

Larch casebearer: Formulations of carbaryl, cyfluthrin, indoxacarb, and lambda-cyhalothrin are labeled for management of this pest.

MANAGEMENT HINTS: Apply registered materials in late April through early May and in late August through mid-September according to label directions. (p. 36)

Larch sawfly: Formulations of acephate, azadirachtin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, horticultural oil (larvae), imidacloprid (Merit 2, Merit 75 WP, and

Merit 75 WSP only), insecticidal soap, lambda-cyhalothrin, and spinosad are labeled for sawfly management.

MANAGEMENT HINTS: Eggs are laid by females from late May through July. Treat when larvae are first noticed. (p. 18)

Woolly larch adelgid: Horticultural spray oil may be applied as a dormant treatment. Formulations of acetamiprid, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, horticultural oil, imidacloprid, insecticidal soap, oxydemeton-methyl, and tau-fluvalinate are labeled for management of this pest. Marathon 1% G and Marathon 60 WP are labeled for use only in plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Needles may appear to be white. Treat foliage with registered products in early to mid-May when adelgids first appear. (p. 78)

Lilac

Fall webworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, tebufenozide, and trichlorfon are labeled for fall webworm management.

MANAGEMENT HINTS: Treat when webs first appear from late June through July. (p. 166)

Japanese maple scale: Refer to comments under “Maple.”

Lilac (ash) borer: Formulations of bifenthrin (Onyx only), chlorpyrifos (Dursban 50W only), and permethrin (Astro only) are labeled for borer management.

MANAGEMENT HINTS: Clearwing borer sex pheromone traps can assist in determining when an insecticide should be applied. Treat stems from mid-May through early August. The first insecticide application should be made 7 to 10 days after the first male is captured in a pheromone trap. (p. 260)

Lilac leafminer: Formulations of azadirachtin, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin and imidacloprid, diflubenzuron, imidacloprid, lambda-cyhalothrin (for adult leafminers), oxydemeton-methyl, permethrin, and pyrethrins and piperonyl butoxide are labeled for leafminer management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Eggs are laid by female moths along the midrib and other veins on the underside of the foliage. Several generations occur each year. Adult moths may be found throughout the summer months. Registered insecticides should be applied when larvae are hatching from eggs or against adults prior to egg laying. (p. 196)

Lilac rust mite (erriophyid mite): Formulations of abamectin, carbaryl, horticultural oil, insecticidal soap (M-Pede only), spiromesifen, and tau-fluvalinate are labeled for erriophyid mite management.

MANAGEMENT HINTS: A management material should be applied when an infestation is detected and mite life stages are present on the host foliage during the growing season.

Oystershell scale: Refer to comments under “Ash.” (p. 370)

White prunicola scale: Formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion are labeled for crawler management.

MANAGEMENT HINTS: This scale insect has three generations per year. Treat when crawlers are first observed in early May, late June, and late August. (p. 392)

Linden—see Basswood

Locust (Black)

Locust borer: Formulations of carbaryl and chlorpyrifos (Dursban 50W only) are labeled for locust borer management.

MANAGEMENT HINTS: Adults may be found in early September feeding on goldenrod pollen. They do not harm the tree, but larvae affect the wood with their feeding and tunneling. Fertilization and irrigation will promote a healthy plant and may reduce successful attack by this pest. Spray bark of trunk and large branches in late August through September. There is one generation per year. (p. 274)

Locust leafminer: Formulations of azadirachtin, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin and imidacloprid, imidacloprid, lambda-cyhalothrin (for adult leafminers), naled, oxydemeton-methyl, permethrin, and pyrethrins and piperonyl butoxide are labeled for leafminer management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Injury by this insect is primarily a problem on black locust. In a severe infestation, the combined feeding by larvae and adults may destroy the foliage of a tree in July and again in September. In some areas of Pennsylvania, hillsides covered with black locust may turn completely brown. Manage overwintering adults when they start feeding in the spring as black locust foliage develops. First generation adults are frequently seen in July. Repeat applications may be necessary since two generations of this leafmining beetle occur annually in Pennsylvania. (p. 190)

Magnolia

Japanese maple scale: Refer to comments under “Maple.”

Magnolia scale: Apply horticultural spray oil as a dormant treatment. Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil,

imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Adult females give birth to live crawlers during late August. Females may continue to produce young through September. Apply crawler sprays in late August and early September. Repeat applications may be necessary. (p. 354)

Tuliptree scale: Horticultural spray oil can be applied as a dormant treatment. Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Crawlers usually are active from mid-August through mid-September. Repeat applications may be needed. (p. 362)

Maple

Aphids: Formulations of abamectin, acephate, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, naled, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for aphid management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Treat when aphids first appear in the spring. Repeat applications may be needed. Malathion may cause slight injury to maples. (pp. 302, 304)

Bagworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, dimethoate, indoxacarb, lambda-cyhalothrin, malathion, permethrin, pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, tebufenozide, and trichlorfon are labeled for bagworm management.

MANAGEMENT HINTS: Bagworm cases (containing overwintering eggs) can be handpicked from infested host plants during winter and early spring. Otherwise, management measures can be applied after eggs hatch and caterpillars are small during early to mid-June. (p. 176)

Calico scale: Refer to comments under “Dogwood.” Do not apply insecticidal soap to Japanese maple. (p. 354)

Cankerworm: Refer to comments under “Crabapple.” Formulations of acephate and phosmet are labeled to manage cankerworm on maple. (pp. 142, 144)

Cottony maple scale: Apply horticultural spray oil as a dormant treatment. Formulations of acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and thiamethoxam are labeled for crawler management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. This species is frequently attacked by natural enemies when population levels are high, resulting in the decline of an infestation after 2 or 3 years. Crawlers emerge from eggs during mid-June through mid-July. Repeat applications may be needed. Do not apply insecticidal soap to Japanese maple. (p. 340)

Elm spanworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), phosmet, pyrethrins and piperonyl butoxide, tau-fluvalinate, and tebufenozide are labeled to manage this pest.

MANAGEMENT HINTS: Apply when small larvae are active in mid- to late May. (pp. 144, 146)

European fruit lecanium: Refer to the suggestions above under “Cottony Maple Scale” for management strategies and timing only. Do not apply insecticidal soap to Japanese maple. (p. 364)

Fall webworm: Refer to comments under “Ash.” (p. 166)

Forest tent caterpillar: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, malathion, naled, permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, and tebufenozide are labeled for management of this pest.

MANAGEMENT HINTS: Apply when small larvae are active in mid-May. Malathion may cause slight injury to maple. (p. 168)

Gloomy scale: Formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap,

lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion are labeled for crawler management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Crawlers are active from early July through August. Repeat applications may be needed. Do not apply insecticidal soap to Japanese maple. (p. 384)

Greenstriped mapleworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis* (DiPel DF, DiPel ES, DiPel Pro DF, and Foray 48F), bifenthrin, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, indoxacarb, lambda-cyhalothrin, permethrin (Astro only), pyrethrins and piperonyl butoxide, and tau-fluvalinate are labeled for management of this pest.

MANAGEMENT HINTS: This insect may produce two to three generations annually. Treat foliage when larvae are first seen and repeat applications when necessary. (p. 156)

Japanese beetle: Formulations of acephate, acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, imidacloprid, lambda-cyhalothrin, malathion, permethrin (Astro only), phosmet, and pyrethrins and piperonyl butoxide are labeled for management of adults. Formulations of imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP) are also labeled for management of white grub larvae such as Japanese beetle, chafer, oriental beetle, Asiatic garden beetle, and *Phyllophaga* spp. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds. Merit 2.5 G is labeled for use on ornamental shrubs and small trees in outdoor landscapes and interior plantscapes against Japanese beetle adults.

MANAGEMENT HINTS: Manage adults when they are active from late June through July. Malathion may cause slight injury to maples. (p. 236)

Japanese maple scale: Formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion are labeled for crawler management.

MANAGEMENT HINTS: Treat when crawlers are present from late May through mid-August. Repeat applications may be needed. Do not apply insecticidal soap to Japanese maple.

Leafhopper: Refer to comments under "Birch." Malathion may cause slight injury to maples. Do not apply insecticidal soap to Japanese maple. (p. 412)

Maple callus borer: Formulations of bifenthrin (Onyx only) and chlorpyrifos (Dursban 50W only) are labeled for borer management.

MANAGEMENT HINTS: This is a clearwing borer that can seriously injure hard and soft maples. Adults are active from late May through June. (p. 260)

Maple gall mites (eriphyid): Formulations of carbaryl, horticultural oil, and tau-fluvalinate are labeled for eriophyid mite management.

MANAGEMENT HINTS: Adults may be managed when they move from their overwintering site to new growth in the spring. These mites seldom cause significant damage. (p. 482)

Maple leafcutter: Formulations of carbaryl and chlorpyrifos (Dursban 50W only) are labeled for maple leafcutter management.

MANAGEMENT HINTS: The favorite host plants for this insect are sugar and red maples. A symptom of attack by this pest is circular holes in the foliage that may be observed in late July. This insect is usually unimportant, but sometimes populations may be severe in limited areas. When indicated, treat the infested foliage in late May through early June when larvae are just hatching. (p. 212)

Maple petiole borer: No specific materials are labeled for management of this pest.

MANAGEMENT HINTS: This insect is a sawfly that infests maples. Larvae tunnel in leaf petioles from May through June. This insect seldom causes serious damage to host trees. (p. 200)

Oystershell scale: Formulations of acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, and methidathion are labeled for crawler management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Crawler sprays should be applied from late May through early June. Repeat applications may be needed. Do not apply insecticidal soap to Japanese maple. Malathion may cause slight injury to maples. Prune and destroy heavily infested twigs and branches. (p. 370)

Pear thrips (exposed): Formulations of abamectin, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, naled, novaluron, pyrethrins and piperonyl butoxide, spinosad, and tau-fluvalinate are labeled to manage thrips. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: This pest is more vulnerable to management when it is exposed on the lower leaf surface. This usually occurs during mid- to late May. Do not apply insecticidal soap to Japanese maple. Malathion may cause slight injury to maples. (p. 432)

Whitemarked tussock moth: Formulations of azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, naled,

permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, and tau-fluvalinate are labeled for management of this pest.

MANAGEMENT HINTS: This insect may produce two to three generations each year. Treat foliage when larvae are first seen in late May. Repeat applications when necessary. (p. 158)

Yellownecked caterpillar: Refer to comments under “Beech.” (p. 154)

Mimosa

Mimosa webworm: Refer to comments under “Honeylocust.” (p. 180)

Mountain Ash

Aphids: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, acephate, acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for aphid management. Carbaryl is labeled to specifically manage apple aphid. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when aphids are first noticed. Repeat applications may be needed. (p. 300)

European red mite: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, acequinocyl, bifenazate, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), clofentezine, dicofol, etoxazole, fenpropathrin, fenpyroximate, hexythiazox, horticultural oil, hydrophobic extract of neem oil, lambda-cyhalothrin, malathion, oxydemeton-methyl, pyridaben, spinosad, spiromesifen, and tau-fluvalinate are labeled to manage mites.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat for mites with registered insecticides in the spring before populations increase. Repeat applications may be necessary. (p. 472)

Japanese beetle: Refer to comments under “Maple.” (p. 236)

Mountain ash sawfly: Formulations of acephate, azadirachtin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, horticultural oil (larvae), imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP only), insecticidal soap, lambda-cyhalothrin, and spinosad are labeled for sawfly management.

MANAGEMENT HINTS: Manage larvae when they are small. Larvae are active feeders from early June through mid-July. Light infestations may be handpicked and then destroyed. (p. 128)

Pear sawfly: Formulations of acephate, azadirachtin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, horticultural oil (larvae), imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP only), insecticidal soap, lambda-cyhalothrin, spinosad, and thiamethoxam are labeled for sawfly management.

MANAGEMENT HINTS: Treat infested plants when larvae are present in early June and early August. (p. 130)

Roundheaded appletree borer: A formulation of chlorpyrifos (Dursban 50W only) is labeled for borer management.

MANAGEMENT HINTS: Fertilization and irrigation will promote a healthy plant and reduce successful attack by this pest. Treat trunks in early June and early July. Repeat applications may be needed. Be sure to follow label directions for repeat applications. (p. 278)

Mountain Laurel

Azalea bark scale: Apply horticultural spray oil as a dormant treatment. Formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, methidathion, and thiamethoxam are labeled for crawler management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Crawler sprays should be applied from June through mid-July. Repeat applications may be necessary. Test insecticidal soap on azalea varieties before applying. (p. 336)

Mulberry whitefly: Formulations of abamectin, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, buprofezin, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin, malathion, novaluron, permethrin, pymetrozine, pyrethrins and piperonyl butoxide, pyridaben, spiromesifen, tau-fluvalinate, and thiamethoxam are labeled for whitefly management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Treat when whiteflies are first noticed. Repeat applications may be needed. (p. 324)

Redbanded leafhopper: Formulations of acephate, acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, fenpropathrin, flonicamid, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, Scimitar GC only), permethrin, phosmet, pyrethrins and piperonyl butoxide, tau-fluvalinate, and thiamethoxam are labeled for leafhopper management.

MANAGEMENT HINTS: Treat when leafhoppers are first noticed and repeat as necessary according to label directions. An infestation of first generation redbanded leafhopper should be managed during late April through early May, and second generation should be treated during mid- to late July. (p. 418)

Rhododendron borer: Formulations of bifenthrin (Onyx only), chlorpyrifos (Dursban 50W only), and permethrin (Astro only) are labeled for borer management.

MANAGEMENT HINTS: Clearwing borer sex pheromone traps can be used to pinpoint adult emergence to assist in proper timing of sprays. Treat trunk and larger twigs from mid-May through early June. Repeat applications may be needed. The first insecticide application should be made 7 to 10 days after the first male is captured in a pheromone trap. Prune and destroy wilting branches in late summer. (p. 258)

Rhododendron lace bug: Formulations of acephate, *Beauveria bassiana* (BotaniGard ES only), bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, fenpropathrin, horticultural oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, permethrin, pyrethrins and piperonyl butoxide, and thiamethoxam are labeled for lace bug management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Treat when lace bugs are first seen in the spring. A second generation is usually active from late July through August. (p. 424)

Rhododendron stem borer: A formulation of chlorpyrifos (Dursban 50W only) is labeled for borer management.

MANAGEMENT HINTS: Larvae hatch from eggs deposited by females in late June through early July. Apply registered insecticides against emerging adults from mid- to late June before females deposit eggs under the epidermis between girdled out areas of the host plant. Prune and destroy wilting branches. (p. 288)

Southern red mite: Apply horticultural spray oil as a dormant treatment. Formulations of abamectin, bifenazate, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos, etoxazole, fenbutatin-oxide, fenpropathrin, fenpyroximate, hexythiazox, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin, malathion, oxydemeton-methyl, pyridaben, spinosad, spiromesifen, and tau-fluvalinate are labeled for mite management.

MANAGEMENT HINTS: Treat in May before populations start to increase. (p. 475)

Two-banded Japanese weevil: Formulations of acephate, *Beauveria bassiana*, bifenthrin, cyfluthrin and imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), and pyrethrins and piperonyl butoxide are labeled for management of adult weevils.

MANAGEMENT HINTS: This brown weevil feeds during the day. Marginal notching of new foliage is a symptom of adult feeding. Treat infested plants when new foliage has notched margins during early July through August. (p. 244)

Oak

Aphids: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, acephate, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, naled, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for aphid management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when aphids are first noticed. Repeat applications may be necessary. (p. 304)

Borers: Formulations of bifenthrin (Onyx only for oak borer—a clearwing borer), chlorpyrifos (Dursban 50W only) and permethrin (Astro only for oak borer—a clearwing borer) are labeled for borer management.

MANAGEMENT HINTS: Fertilization and irrigation will promote a healthy plant and reduce successful attack by these pests. Clearwing borer traps can be used to pinpoint adult emergence to assist in proper timing of sprays. Spray trunks thoroughly when adults are active. Timing of an application is dependent upon accurate species identification. (pp. 270, 278, 282)

Cankerworm: Refer to comments under “Crabapple.” Formulations of acephate are labeled for management of cankerworm on oak. (pp. 142, 144)

Elm spanworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), phosmet, pyrethrins and piperonyl butoxide, tau-fluvalinate, and tebufenozide are labeled to manage this pest.

MANAGEMENT HINTS: Apply when small larvae are active in mid- to late May. (pp. 144, 146)

Fall webworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, naled, permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, tebufenozide, and trichlorfon are labeled for webworm management.

MANAGEMENT HINTS: Treat when webs are small from late June through July. (p. 166)

Forest tent caterpillar: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, malathion, naled, permethrin (Astro only),

pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, and tebufenozide are labeled for management of this pest.

MANAGEMENT HINTS: Apply when small larvae are active in mid-May. (p. 168)

Gall midges and gall wasps: Formulations of carbaryl, cyfluthrin, and lambda-cyhalothrin (only Demand CS, Scimitar CS, and Scimitar GC are for midges) are labeled to manage gall midges and gall wasps. Spinosad is labeled to manage dipterous (flies) gall midges. Pyrethrins and piperonyl butoxide is labeled to manage midges.

MANAGEMENT HINTS: Application timing is difficult. Treatment seldom is necessary, especially with leaf galls. Pruning of woody galls before adults emerge usually will reduce populations of these pests. (pp. 440, 442, 446)

Golden oak scale: Horticultural spray oil can be applied as a dormant treatment. Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dimethoate, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. This scale insect makes small pits in the bark on twigs. Crawlers are active in mid-May. Repeat applications may be needed. (p. 352)

Gypsy moth: Refer to comments under “Gypsy Moth” on page 15. Prior to applying any control material, refer to individual labels for host-plant clearance information. (pp. 138, 140)

Leafhoppers: Refer to comments under “Birch.”

MANAGEMENT HINTS: Treat foliage when leafhoppers are first noticed. (p. 412)

May/June beetle: Formulations of carbaryl (June beetle only), chlorpyrifos, cyfluthrin (June beetle only), lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC—for June beetle adults only), and pyrethrins and piperonyl butoxide are labeled for beetle management.

MANAGEMENT HINTS: Treat foliage when May/June beetle adults are first noticed in May, June, or July.

Oak kermes scale: Horticultural spray oil can be applied as a dormant treatment. Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos, cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Crawlers should be managed in mid-May. Repeat applications as needed. (pp. 364, 366)

Oak lace bug: Formulations of acephate, *Beauveria bassiana* (BotaniGard ES only), bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, fenpropathrin, horticultural oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, permethrin, pyrethrins and piperonyl butoxide, and thiamethoxam are labeled for lace bug management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Treat young nymphs as they hatch from eggs in the spring. Repeat applications may be necessary since there are two generations per year. (p. 426)

Oak skeletonizer: Formulations of *Bacillus thuringiensis* (DiPel ES and Foray 48F), bifenthrin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, indoxacarb, and lambda-cyhalothrin (Demand CS, Scimitar CS, Scimitar GC only) are labeled for management of this pest.

MANAGEMENT HINTS: These insects feed first as leafminers. When partly grown, they leave the mines and feed on the lower surface of oak leaves. Two generations occur each year. Larvae of the spring generation feed during June and early July. The next generation of larvae is active during late August through September. (p. 220)

Obscure scale: Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Egg laying and crawler activity occur over an extended period. Sprays may be applied when crawlers are first active, from mid- to late July through early August. Crawler sprays may need to be applied into early September when an infestation is severe. (p. 384)

Orangestriped oakworm: Formulations of acephate, *Bacillus thuringiensis* (Foray 48B and Foray 76B), bifenthrin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, and tau-fluvalinate are labeled for management of this pest.

MANAGEMENT HINTS: Apply registered materials when small larvae are active from early July through August. Remove and destroy colonies of young larvae when observed on the foliage of trees. (p. 156)

Spider mites: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), fenbutatin-oxide, fenpyroximate, horticultural oil,

hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, spinosad, spiromesifen, and tau-fluvalinate are labeled for spider mite management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Apply registered materials from mid-June through July before mite populations increase. Repeat applications according to label directions. (p. 475)

Twig pruner: There are no chemical treatments registered for management of this insect.

MANAGEMENT HINTS: A symptom of attack by this pest is an abundance of twigs under a tree late in the growing season. Twigs and small branches up to 30 mm in diameter may accumulate on the ground beneath trees. A cleanly cut end on a twig with a hole in the center that may be plugged with fibrous woody tissue could also confirm the presence of this pest. Pick up and destroy the dropped twigs and branches before May to reduce the impact of this borer. (p. 264)

Twolined chestnut borer: Formulations of chlorpyrifos (Dursban 50W only) and imidacloprid (Marathon 60 WP, Merit 2, Merit 75 WP, Merit 75 WSP only) are labeled for management of this insect.

MANAGEMENT HINTS: Fertilization and irrigation will promote a healthy plant and may reduce successful attack by this pest. Spray trunks thoroughly when adults are active from early June through late August. Outbreaks of defoliators are often followed by an increase in populations of this insect. Adults chew a D-shaped emergence hole in the bark like those made by the bronze birch borer. The twolined chestnut borer usually produces one generation per year. Remember, timing of an application is dependent upon accurate species identification. (p. 270)

Yellownecked caterpillar: Refer to comments under “Beech.” (p. 154)

Pachysandra

Euonymus scale: Crawlers may be managed with formulations of acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, and methidathion.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Apply crawler sprays in late May through June. Second generation crawlers may require treatment from late July through early August. (p. 388)

Oystershell scale: Crawlers may be managed with formulations of acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, and methidathion.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Crawler sprays should be applied from late May through early June. Repeat applications may be needed. (p. 370)

Twospotted spider mite: Formulations of abamectin, acequinocyl, bifenazate, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos, clofentezine, dicofol, etoxazole, fenbutatin-oxide, fenpropathrin, fenpyroximate, hexythiazox, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, pyridaben, spinosad, spiromesifen, and tau-fluvalinate are labeled for management of this pest.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when mites first appear in late June or early July. Repeat applications may be needed. (p. 476)

Pear (Flowering Ornamental)

Aphids: Apply horticultural spray oil as a dormant application.

Formulations of abamectin, acephate, acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for aphid management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when an aphid infestation is first noticed. Repeat applications may be needed. (p. 300)

Calico scale: Horticultural spray oil can be applied as a dormant treatment. Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oils according to label directions. Crawlers may be managed when they are active in June through early July. Repeat applications may be needed. (p. 354)

Cottony maple scale: Apply horticultural spray oil as a dormant treatment. Formulations of acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar

CS, and Scimitar GC only), methidathion, and thiamethoxam are labeled for crawler management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. This species is frequently attacked by natural enemies when population levels are high, resulting in the decline of an infestation after 2 or 3 years. Crawlers emerge from eggs during mid-June through mid-July. Repeat applications may be needed. (p. 340)

European fruit lecanium: Refer to the suggestions above under cottony maple scale for management strategies and timing only. (p. 364)

Forest tent caterpillar: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, malathion, permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, and tebufenozide are labeled for management of this pest.

MANAGEMENT HINTS: Apply when small larvae are active in mid-May. (p. 168)

Japanese maple scale: Refer to comments under “Maple.”

Oystershell scale: Refer to comments under “Pachysandra.” (p. 370)

Pearleaf blister mite (erriophyd): Horticultural spray oil may be applied as a dormant treatment. Formulations of abamectin, carbaryl, dicofol, horticultural oil, spiromesifen, and tau-fluvalinate are labeled for eriophyd mite management.

MANAGEMENT HINTS: This eriophyd mite overwinters beneath bud scales and moves to foliage in the spring. They feed on the lower leaf surface. The leaf epidermis ruptures where feeding occurs and the mites enter the opening to lay eggs. (p. 486)

Pieris—see Japanese Pieris

Pine

Aphids: Apply horticultural spray oil as a dormant application. Formulations of abamectin, acephate, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dimethoate, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, naled, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for aphid management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when an aphid infestation is first noticed. Repeat applications may be needed. Malathion may cause slight injury to white pine. (p. 84)

Bagworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, dimethoate, diflubenzuron, indoxacarb, lambda-cyhalothrin, malathion, permethrin, pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, tebufenozide, and trichlorfon are labeled for bagworm management.

MANAGEMENT HINTS: Bagworm cases (containing overwintering eggs) can be handpicked from infested host plants during winter and early spring. Otherwise, control measures can be applied after eggs hatch and caterpillars are small during early to mid-June. Malathion may cause slight injury to white pine. (p. 176)

Engraver beetles: Formulations of bifenthrin (Onyx only), carbaryl, chlorpyrifos (Dursban 50W only), and permethrin (Astro only) are labeled for engraver beetle management.

MANAGEMENT HINTS: Treatment should be directed at adults before they bore into host plants. (p. 62)

Eriophyd mite: Formulations of abamectin, carbaryl, dimethoate, horticultural oil, spiromesifen, and tau-fluvalinate are labeled for eriophyd mite management.

MANAGEMENT HINTS: Treat adults in late March through April. Additional treatment may be necessary in September. These key pests frequently go undetected. If foliage looks suspicious, place it under a stereomicroscope to observe these very small mites. (p. 122)

European pine shoot moth: Formulations of azadirachtin (Azatin XL and Ornazin 3% EC only), carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, dimethoate, malathion, phosmet, pyrethrins and piperonyl butoxide, and tebufenozide are labeled for management of this pest.

MANAGEMENT HINTS: Apply a registered material during the first two weeks of April to kill larvae as they migrate to new shoots. Trees also can be treated in late June or early July after larvae hatch from eggs. Malathion may cause slight injury to white pine. Prune dead shoots when they are detected. (p. 48)

Gypsy moth: Refer to comments under “Gypsy Moth” on page 15. Prior to applying any control measure, refer to individual labels for host-plant clearance information. (pp. 138, 140)

Nantucket pine tip moth: Formulations of acephate, azadirachtin (Azatin XL and Ornazin 3% EC only), bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, dimethoate, esfenvalerate, imidacloprid (Merit 75 WP and Merit 75 WSP only), lambda-cyhalothrin, permethrin, phosmet, pyrethrins and piperonyl butoxide, spinosad, tebufenozide, and trichlorfon are labeled for management of this pest.

MANAGEMENT HINTS: Apply a registered material between mid-May and mid-June to manage young larvae before they conceal themselves. Another application may be needed between mid-July and late August to manage second-generation larvae. (p. 48)

Northern pine weevil: Young seedlings (or foliage) may be sprayed with registered formulations of bifenthrin, chlorpyrifos (Dursban 50W only), esfenvalerate, naled, and pyrethrins and piperonyl butoxide according to label directions.

MANAGEMENT HINTS: Fertilization and irrigation will promote a healthy plant and reduce successful attack by this pest. Young seedlings (foliage) can be protected by spraying in April through early May, and from August through September. (p. 56)

Pales weevil: Young seedlings (or foliage) may be sprayed with registered formulations of bifenthrin, chlorpyrifos (Dursban 50W only), esfenvalerate, pyrethrins, phosmet, and piperonyl butoxide according to label directions. Naled is labeled for pine weevil management on pine.

MANAGEMENT HINTS: Young seedlings (foliage) can be protected by spraying in April through mid-May, and from August through September. (p. 56)

Pine bark adelgid: Apply horticultural oil as a dormant treatment. Formulations of acetamiprid, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin and imidacloprid, horticultural oil, imidacloprid, insecticidal soap, oxydemeton-methyl, and tau-fluvalinate are labeled for management of this pest. Marathon 1% G and Marathon 60 WP are labeled for use only in plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural oil according to label directions during the dormant season. Apply a registered insecticide from late April through May when insects are active. (p. 76)

Pine bark beetle: Formulations of azadirachtin (Ornazin 3% EC only), bifenthrin (Onyx only), chlorpyrifos (Dursban 50W only), and permethrin (Astro only) are labeled for pine bark beetle management.

MANAGEMENT HINTS: Fertilization and irrigation will promote a healthy plant and reduce successful attack by this pest. Apply registered insecticides to reduce adult beetles before they mate and lay eggs in late April to early May, mid-July, and early September. (p. 62)

Pine needle midge: Formulations of chlorpyrifos (Dursban 50W only), cyfluthrin, dimethoate, esfenvalerate, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and pyrethrins and piperonyl butoxide are labeled for management of this pest.

MANAGEMENT HINTS: Apply registered formulations from mid-May to early June as needles start to elongate, to manage adult midges. (p. 44)

Pine needleminer: A formulation of chlorpyrifos (Dursban 50W only) and pyrethrins and piperonyl butoxide are labeled for pine needleminer management.

MANAGEMENT HINTS: Apply registered formulations during June and early to mid-July before caterpillars bore into needles. (p. 40)

Pine needle scale: Crawlers may be managed with formulations of acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin, bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos, cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, methidathion, and oxydemeton-methyl (on field grown nursery stock).

MANAGEMENT HINTS: Apply horticultural spray oil according to label directions. Crawlers may start to emerge from eggs during late April through May. Emergence of second-generation crawlers occurs during mid- to late July. Crawler activity will vary from year to year due to weather conditions. To obtain maximum control, monitor infested trees on a regular basis. Two applications of a registered insecticide may be necessary to manage heavy populations. Be aware that the adult female has a fairly long egg-laying period, and newly hatched crawlers will remain beneath the protective scale cover, especially on overcast days. Malathion may cause slight injury to white pine. (p. 108)

Pine oystershell scale: Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos, cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion.

MANAGEMENT HINTS: Apply horticultural spray oil according to label directions. Crawlers may start to emerge from eggs beneath the waxy cover of the female in May. To obtain maximum control, monitor infested trees on a regular basis. Newly hatched crawlers settle beneath the needle sheath making this a difficult pest to effectively manage on infested plants. Malathion may cause slight injury to white pine.

Pine root collar weevil: Acephate (Turf, Tree & Ornamental Spray only) is labeled for root weevil management. Bifenthrin is labeled for weevil management. Chlorpyrifos (Dursban 50W only) is labeled for pine reproduction weevil control. Pyrethrins and piperonyl butoxide (Pyrenone Crop Spray) is labeled for weevil management. Phosmet (Imidan 70-W) is labeled for adult root collar weevil.

MANAGEMENT HINTS: This insect attacks Scots, Austrian, red, and occasionally white pine. Mix and apply registered formulations according to label directions. The optimum time to treat is in mid-May before adults lay eggs. Timing of treatment can vary from year to year due to changing weather conditions. Also apply registered formulations in mid-August through early September to manage newly emerging adults. (p. 56)

Pine tortoise scale: Apply horticultural spray oil as a dormant treatment. Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand

CS, Scimitar CS, and Scimitar GC only), methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Apply crawler treatments between mid-June and mid-July. Repeat applications may be necessary. (p. 96)

Pine tube moth: Formulations of bifenthrin, bifenthrin and imidacloprid, cyfluthrin, indoxacarb, pyrethrins and piperonyl butoxide, and tau-fluvalinate are labeled for pine tube moth management.

MANAGEMENT HINTS: Apply registered formulations to trees from mid-May through mid-June while tubes are being formed. (p. 46)

Pine webworm: Formulations of acephate, azadirachtin, bifenthrin, carbaryl, cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, and trichlorfon are labeled for pine webworm management.

MANAGEMENT HINTS: Apply a registered formulation when larvae are feeding and building nests. This usually occurs in Pennsylvania during the period from July through August. (p. 22)

Sawflies: Formulations of acephate, acetamiprid (for European pine sawfly), azadirachtin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, esfenvalerate (for European pine sawfly and redheaded pine sawfly), horticultural oil (larvae), imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP only), indoxacarb, (for European pine sawfly), insecticidal soap, lambda-cyhalothrin, permethrin (Astro only), phosmet, spinosad, and thiamethoxam (for European pine sawfly) are labeled for sawfly management.

MANAGEMENT HINTS: Treat infested trees when the larvae are first observed, preferably when they are small. Larvae may be observed at different times throughout the spring and summer (e.g., European pine sawfly—April through May; redheaded pine sawfly—July through early September; introduced pine sawfly—June through September). Light infestations may be handpicked or pruned and then destroyed. (pp. 16, 18)

Spittlebugs: Formulations of azadirachtin (Ornazin 3% EC only), bifenthrin, carbaryl (pine spittlebug), chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, esfenvalerate, lambda-cyhalothrin, naled, and pyrethrins and piperonyl butoxide are labeled for management of these insects.

MANAGEMENT HINTS: Apply a registered formulation when 90 to 95 percent of the masses of spittle on the twigs are empty. This usually occurs during July in Pennsylvania. (p. 86)

Spruce spider mite: Apply horticultural spray oil as a dormant treatment. Motile stages of mites can be managed with formulations of abamectin, acequinocyl, bifenazate, bifenthrin,

bifenthrin and imidacloprid, chlorpyrifos, dicofol, dimethoate, etoxazole, fenbutatin-oxide, fenpyroximate, hexythiazox, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, spinosad, spiromesifen, and tau-fluvalinate.

MANAGEMENT HINTS: Select and apply a dormant horticultural spray oil before new growth starts and before buds separate into clusters. A dormant horticultural spray oil application should be made while temperatures remain above freezing. Malathion may cause slight injury to white pine.

NOTE: Apply a registered formulation to kill mites hatching from eggs (miticide). This will occur from May through June. Additional generations may need to be managed in September through early October. If mite populations persist, repeat applications may be necessary. Monitor mite populations prior to applying a control measure. Heavy rainfalls may reduce mite populations for a short time. (p. 118)

Striped pine scale: Apply horticultural spray oil as a dormant treatment. Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Apply crawler treatments between mid-June and mid-July. Repeat applications may be needed. (p. 96)

White pine weevil: Formulations of bifenthrin, chlorpyrifos (Dursban 50W only), and pyrethrins and piperonyl butoxide (Pyrenone Crop Spray) are labeled for weevil management. Diflubenzuron is labeled for management of terminal weevils of pine and spruce (*Pissodes* spp.). Naled (Dibrom 8) is labeled for pine weevil management on pine. Oxydemeton-methyl (Metasystox-R) is labeled for management of white pine weevil on field grown nursery stock.

MANAGEMENT HINTS: Apply a registered formulation only to the top of the host tree (terminal) as weather warms during late March through April to manage egg-laying weevils. Timing can vary since conditions change from year to year. (p. 54)

Zimmerman pine moth: Formulations of chlorpyrifos (Dursban 50W only), diflubenzuron, dimethoate, naled, permethrin (Astro only), tebufenozide, and trichlorfon are labeled for management of this pest.

MANAGEMENT HINTS: Apply a registered insecticide to destroy larvae from early April through early May and in early August. (p. 48)

Privet

Privet rust mite (eriphyid): Formulations of abamectin, carbaryl, dicofol, horticultural oil, insecticidal soap (M-Pede only), spiromesifen, and tau-fluvalinate are labeled for eriophyid mite management.

MANAGEMENT HINTS: Treat when mites are first seen. Repeat applications as needed during the growing season. (p. 480)

Privet thrips (exposed): Formulations of abamectin, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, naled, novaluron, pyrethrins and piperonyl butoxide, spinosad, and tau-fluvalinate are labeled for privet thrips management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Treat at the first sign of an infestation, which usually occurs from early May through early June. A repeat application may be necessary in late June through early July. (p. 432)

Twobanded Japanese weevil: Formulations of acephate, *Beauveria bassiana*, bifenthrin, cyfluthrin and imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), and pyrethrins and piperonyl butoxide are labeled for management of adult weevils.

MANAGEMENT HINTS: This brown weevil feeds during the day. Marginal notching of new foliage is a symptom of adult feeding. Treat infested plants when new foliage has notched margins during early July through August. (p. 244)

White peach scale: Refer to comments under “Cherry (Flowering Ornamental).” (p. 392)

White prunicola scale: Refer to comments under “Cherry (Flowering Ornamental).” (p. 392)

Purpleleaf Plum

Globose scale: Horticultural spray oil can be applied as a dormant treatment. Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oils according to label directions. This species has one generation per year, and females may produce 3,000 eggs. Crawlers may be managed when they are active in June. Repeat applications may be needed. (p. 366)

Pear sawfly: Formulations of acephate, azadirachtin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, horticultural oil (larvae), imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP only), insecticidal soap, lambda-cyhalothrin, naled, spinosad, and thiamethoxam are labeled for sawfly management.

MANAGEMENT HINTS: Treat infested plants when larvae are present in early June and early August. (p. 130)

Pyracantha

Aphids: Apply horticultural spray oil as a dormant application. Formulations of abamectin, acephate, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for aphid management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when an aphid infestation is first noticed. Repeat applications may be needed. (pp. 314, 316)

Globose scale: Refer to comments under “Purpleleaf Plum.” (p. 366)

Hawthorn lace bug: Formulations of acephate, *Beauveria bassiana* (BotaniGard ES only), bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, fenpropathrin, horticultural oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, permethrin, pyrethrins and piperonyl butoxide, and thiamethoxam are labeled for lace bug management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Treat when lace bug nymphs are first observed in the spring. Two to four generations may occur each year in Pennsylvania. Repeat applications may be necessary. (p. 426)

Indian wax scale: Crawlers may be managed with acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, methidathion, and thiamethoxam.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. This species overwinters as adult females. Treat the crawler stage when they are active on an infested plant from June through mid-July. Repeat applications may be needed. (p. 356)

Japanese maple scale: Refer to comments under “Maple.”

San Jose scale: Formulations of acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin, bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos, cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and pyriproxyfen are labeled for crawler management.

MANAGEMENT HINTS: Apply horticultural spray oils according to label directions. San Jose scales mature in the spring when apple is in bloom. Two to five generations can occur per year. Treat when crawlers are first observed in early May. Repeat applications may be necessary through early September. (p. 386)

Spider mites: Apply horticultural spray oil as a dormant treatment. Formulations of abamectin, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), fenpyroximate, hexythiazox, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, spinosad, spiromesifen, and tau-fluvalinate are labeled for mite management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat mite populations in May and June and again in September. Repeat applications may be needed. (p. 475)

Redbud

European fruit lecanium: Apply horticultural spray oil as a dormant treatment. Formulations of acephate, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin, methidathion, and thiamethoxam are labeled for crawler management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Crawlers are active from mid-June through mid-July. Repeat applications may be necessary. This species is frequently attacked by natural enemies when population levels are high, resulting in the decline of an infestation after 2 or 3 years. (p. 364)

Spider mites: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), fenpyroximate, hexythiazox, horticultural oil, hydrophobic extract of neem oil, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, spinosad, spiromesifen, and tau-fluvalinate are labeled for spider mite management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Apply in the spring before populations start to increase. Repeat applications according to label directions. (pp. 474, 476)

Twig girdler: Refer to comments under “Oak.” (p. 264)

Twig pruner: Refer to comments under “Oak.” (p. 264)

Whitemarked tussock moth: Formulations of azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, and tau-fluvalinate are labeled for management of this pest.

MANAGEMENT HINTS: This insect may produce two or three generations each year. Infested foliage should be treated when larvae are first observed during late May. Repeat applications when necessary. (p. 158)

Rhododendron

Azalea bark scale: Apply horticultural spray oil as a dormant treatment. Crawlers may be managed with acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Crawlers begin to hatch from eggs in June. Repeat applications may be needed. (p. 336)

Black vine weevil (*taxus weevil*): Formulations of acephate, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin and imidacloprid, fenpropathrin, lambda-cyhalothrin, permethrin (Astro only), pyrethrins and piperonyl butoxide, and tau-fluvalinate are labeled to manage adults. Acephate Pro 75, Acephate Pro 75 WSP, and Orthene Turf, Tree & Ornamental Spray are labeled to be applied as a soil drench (container-grown nursery stock only). Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds. Merit 2.5 G is labeled for use on ornamental shrubs and small trees in outdoor landscapes and interior plantscapes against black vine weevil larvae in soil. Merit 2, Merit 75 WP, and Merit 75 WSP are labeled for black vine weevil larvae and are for use only in and around industrial and commercial buildings and residential areas. Talstar Nursery Granular is labeled for soil incorporation into potting media used in containerized plantings of ornamental trees, shrubs, plants, flowers, conifers, and Christmas trees. The use of insect-parasitic nematodes applied as soil drenches in container-grown plant material may be effective in reducing larval populations of this pest. Follow label directions for all methods of application and stage of insect to treat.

MANAGEMENT HINTS: Spray foliage and surface to manage adults in May and June. Soil drenches can be applied from July to mid-October. Follow all label directions. (p. 240)

Cottony azalea scale: Apply horticultural spray oil as a dormant treatment. Formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, methidathion, and thiamethoxam are labeled for crawler management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Crawler sprays should be applied from June through early July. Repeat applications may be necessary. (p. 342)

Leafhoppers: Formulations of acephate, acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos, cyfluthrin, cyfluthrin and imidacloprid, fenpropathrin, flonicamid, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin, phosmet, pyrethrins and piperonyl butoxide, tau-fluvalinate, and thiamethoxam are labeled for leafhopper management.

MANAGEMENT HINTS: Treat when leafhoppers are first noticed and repeat as necessary according to label directions. An infestation of first generation redbanded leafhopper should be managed during late April through early May, and second generation should be treated during mid- to late July. (p. 418)

Mealybugs: Formulations of acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos, cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin, malathion, permethrin (Astro only), phosmet, pyrethrins and piperonyl butoxide, pyriproxyfen, and thiamethoxam are labeled for mealybug management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds. Talstar Nursery Granular is labeled for soil incorporation into potting media used in containerized plantings of ornamental trees, shrubs, plants, flowers, conifers, and Christmas trees.

MANAGEMENT HINTS: These insects overwinter as nymphs on the host plant. Females lay eggs in loose, white, waxy ovisacs on the lower leaf surface. Nymphs can be managed when they begin feeding in the spring. Repeat applications may be needed.

Putnam scale: Crawlers may be managed with acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat first-generation crawlers from mid-May through June. Second generation crawlers

should be treated during mid-July through mid-September. Repeat applications may be needed.

Rhododendron borer: Formulations of bifenthrin (Onyx only), chlorpyrifos (Dursban 50W only) and permethrin (Astro only) are labeled for borer management.

MANAGEMENT HINTS: Clearwing borer sex pheromone traps can be used to pinpoint adult emergence to assist in proper timing of sprays. Treat trunk and larger twigs from mid-May through early June. Repeat applications may be needed. The first insecticide application should be made 7 to 10 days after the first male is captured in a pheromone trap. Prune and destroy wilting branches in late summer. (p. 258)

Rhododendron gall midge: Formulations of carbaryl, cyfluthrin, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), pyrethrins and piperonyl butoxide, and spinosad (for dipterous gall midges) are labeled for management of midges.

MANAGEMENT HINTS: *Rhododendron catawbiense* and its hybrids and *Rhododendron maximum* are attacked by this gall midge. Distorted foliage is a symptom of gall formation caused by this pest. Peak emergence of this species occurs during full flower bloom or as leaf buds begin to swell. Eggs are laid on the lower leaf surface as soon as the foliage is free from bud scales. Apply registered formulations during mid- to late May. Repeat applications may be necessary because rhododendrons may produce second and occasionally third flushes of plant growth that may result in two additional generations of this gall midge. (p. 470)

Rhododendron lace bug: Formulations of acephate, *Beauveria bassiana* (BotaniGard ES only), bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, fenpropathrin, horticultural oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, permethrin, pyrethrins and piperonyl butoxide, and thiamethoxam are labeled for lace bug management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Treat when lace bugs are first seen in the spring. A second generation usually is active from late July through August. (p. 424)

Rhododendron stem borer: Formulation of chlorpyrifos (Dursban 50W only) is labeled for borer management.

MANAGEMENT HINTS: Larvae hatch from eggs deposited by females in late June through early July. Apply registered insecticides against emerging adults from mid- to late June before females deposit eggs under the epidermis between girdled out areas of the host plant. Prune and destroy wilting branches. (p. 288)

Southern red mite: Apply horticultural spray oil as a dormant treatment. Formulations of abamectin, bifenazate, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos, etoxazole, fenbutatin-oxide, fenpropathrin, fenpyroximate, hexythiazox, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin, malathion, oxydemeton-methyl,

pyridaben, spinosad, spiromesifen, and tau-fluvalinate are labeled for mite management.

MANAGEMENT HINTS: Treat in May before populations start to increase. (p. 475)

Twobanded Japanese weevil: Formulations of acephate, *Beauveria bassiana*, bifenthrin, cyfluthrin and imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), and pyrethrins and piperonyl butoxide are labeled for management of adult weevils.

MANAGEMENT HINTS: This brown weevil feeds during the day. Marginal notching of new foliage is a symptom of adult feeding. Treat infested plants when new foliage has notched margins during early July through August. (p. 244)

Whitefly: Formulations of abamectin, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, buprofezin, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin, malathion, novaluron, permethrin, pymetrozine, pyrethrins and piperonyl butoxide, pyridaben, spiromesifen, tau-fluvalinate, and thiamethoxam are labeled for whitefly management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Treat when whiteflies are first noticed. Repeat applications may be needed. (p. 318)

Rose

Aphids: Apply horticultural spray oil as a dormant application. Formulations of abamectin, acephate, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos, cyfluthrin, cyfluthrin and imidacloprid, dimethoate, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, naled, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for aphid management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when an aphid infestation is first detected. Repeat applications may be needed. (pp. 300, 308)

Black vine weevil (taxus weevil): Formulations of acephate, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin and imidacloprid, fenpropathrin, lambda-cyhalothrin, permethrin (Astro only), pyrethrins and piperonyl butoxide, and tau-fluvalinate are labeled to manage adults. Acephate Pro 75, Acephate Pro 75 WSP, and Orthene Turf, Tree & Ornamental Spray are labeled to be applied as a soil drench (container-grown nursery stock only). Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds. Merit 2.5 G is labeled for

use on ornamental shrubs and small trees in outdoor landscapes and interior plantscapes against black vine weevil larvae in soil. Merit 2, Merit 75 WP, and Merit 75 WSP are labeled for black vine weevil larvae and are for use only in and around industrial and commercial buildings and residential areas. Talstar Nursery Granular is labeled for soil incorporation into potting media used in containerized plantings of ornamental trees, shrubs, plants, flowers, conifers, and Christmas trees. The use of insect-parasitic nematodes applied as soil drenches in container-grown plant material may be effective in reducing larval populations of this pest. Follow label directions for all methods of application and stage of insect to treat.

MANAGEMENT HINTS: Spray foliage and surface to manage adults in May and June. Soil drenches can be applied from July to mid-October. Follow all label directions. (p. 240)

Bristly roseslug: Formulations of acephate, azadirachtin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, horticultural oil (larvae), imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP only), insecticidal soap, lambda-cyhalothrin, and spinosad are labeled for sawfly management.

MANAGEMENT HINTS: Young larvae of this sawfly begin feeding as skeletonizers from the lower leaf surface. As the larval stage matures, it chews large holes in the leaves. When full grown, the larva is pale green and 16 millimeters long. There may be two to six generations produced each year. Treat infested plants when larvae are small. (p. 132)

Curled roseslug: Formulations of acephate, azadirachtin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, horticultural oil (larvae), imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP only), insecticidal soap, lambda-cyhalothrin, and spinosad are labeled for sawfly management.

MANAGEMENT HINTS: Young larvae of this sawfly begin feeding as skeletonizers and later consume the entire leaf except for the main vein. Mature larvae bore into the pith of pruned twigs to pupate. A few larvae can damage a rose plant. Two generations occur each year. Treat infested plants from late May through mid-June and again in mid-August. (p. 132)

European red mite: Apply horticultural spray oil as a dormant treatment. Formulations of abamectin, acequinocyl, bifenazate, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), clofentezine, dicofol, etoxazole, fenpropathrin, fenpyroximate, hexythiazox, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin, malathion, oxydemeton-methyl, pyridaben, spinosad, spiromesifen, and tau-fluvalinate are labeled for mite management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat mite populations in May and June. Repeat applications may be needed. (p. 472)

Fall webworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, permethrin (Astro only), pyrethrins and

piperonyl butoxide, spinosad, tau-fluvalinate, tebufenozide, and trichlorfon are registered for webworm management.

MANAGEMENT HINTS: Treat when webs are small in late June through July. (p. 166)

Fourlined plant bug: Refer to comments under “Forsythia.” (p. 396)

Japanese beetle: Formulations of acephate, acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, imidacloprid, lambda-cyhalothrin, malathion, permethrin (Astro only), phosmet, and pyrethrins and piperonyl butoxide are labeled to manage adults. Formulations of imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP) are also labeled for management of white grub larvae such as Japanese beetle, chafers, oriental beetle, Asiatic garden beetle, and *Phyllophaga* spp. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds. Merit 2.5 G is labeled for use on ornamental shrubs and small trees in outdoor landscapes and interior plantscapes against Japanese beetle adults.

MANAGEMENT HINTS: Treat when adults are first observed from late June through July. (p. 236)

Leafhoppers: Formulations of acephate, acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos, cyfluthrin, cyfluthrin and imidacloprid, dimethoate, fenpropathrin, flonicamid, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, permethrin, phosmet, pyrethrins and piperonyl butoxide, tau-fluvalinate, and thiamethoxam are labeled for leafhopper management.

MANAGEMENT HINTS: Treat when leafhoppers are first noticed and repeat as necessary according to label directions. (pp. 412, 418)

Mossyrose gall wasp: Formulations of carbaryl are labeled for management of gall wasps.

MANAGEMENT HINTS: This tiny wasp causes a large hairy mass to form on one-year-old rose twigs. At first the galls are light green and moss like. They turn brown later in the year. One generation is produced per year. Prune the galls before spring to reduce the presence of this insect. (p. 438)

Obliquebanded leafroller: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, lambda-cyhalothrin, permethrin (Astro only), pyrethrins and piperonyl butoxide, and spinosad are labeled for leafroller management.

MANAGEMENT HINTS: Products should be applied before leaves are tightly rolled in the spring. (p. 216)

Raspberry cane borer: There are no chemical treatments registered for management of this insect.

MANAGEMENT HINTS: This longhorned beetle attacks canes of roses about eight inches below the tip, causing the leaves to wilt and the stem to droop. The larval stage bores down the

cane to the base, where pupation occurs. Prune and destroy infested canes below the affected area.

Rose chafer: Formulations of azadirachtin (Ornazin 3% EC only), carbaryl, and chlorpyrifos (Dursban 50W only) are registered for management of this insect.

MANAGEMENT HINTS: Flowers are damaged and foliage is skeletonized by this pest. Apply a registered insecticide during late May through June to manage this insect. (p. 236)

Rose midge: Formulations of cyfluthrin, cyfluthrin and imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and pyrethrins and piperonyl butoxide are registered for rose midge management.

MANAGEMENT HINTS: This insect attacks leaf buds, shoots, and flower buds, sometimes causing abnormal flower development. Apply a registered material at budbreak followed by two additional treatments at 10-day intervals. (p. 470)

Rose scale: Formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion are labeled for crawler management.

MANAGEMENT HINTS: Apply horticultural spray oil according to label directions. This armored scale attacks canes, twigs, or stems of roses. There are two generations each year. Crawler sprays should be applied during late May and early June and in August. Repeat applications may be necessary. (p. 366)

Roseslug: Formulations of acephate, azadirachtin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, horticultural oil (larvae), imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP only), insecticidal soap, lambda-cyhalothrin, and spinosad are labeled for sawfly management.

MANAGEMENT HINTS: Young larvae of this sawfly skeletonize the upper leaf surface. A few larvae can damage a rose plant. Mature larvae are 13 millimeters long and drop to the ground to pupate by early July. One generation is produced each year. Treat infested plants from late May through mid-June. (p. 132)

Thrips (exposed): Formulations of abamectin, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dimethoate, dinotefuran, fenpropathrin, flonicamid, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, naled, novaluron, pyrethrins and piperonyl butoxide, spinosad, and tau-fluvalinate are labeled to manage thrips. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: These pests are more vulnerable to management when they are exposed on the foliage or flowers. This usually occurs during May. Remove and destroy infested flower buds when infestations are heavy. (p. 432, 434)

Twospotted spider mite: Formulations of abamectin, acequinocyl, bifenazate, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos, clofentezine, dicofol, dimethoate, etoxazole, fenbutatin-oxide, fenpropathrin, fenpyroximate, hexythiazox, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, naled, oxydemeton-methyl, pyridaben, spinosad, spiromesifen, and tau-fluvalinate are labeled for management of this pest.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when mites first appear in late June or early July. Repeat applications may be needed. (p. 476)

Serviceberry (Shadbush)

Aphids: Apply horticultural spray oil as a dormant treatment. Formulations of abamectin, acephate, acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for management of aphids. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when aphids are present on the foliage. (pp. 300, 306)

Hawthorn lace bug: Formulations of acephate, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, fenpropathrin, horticultural oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, permethrin, pyrethrins and piperonyl butoxide, and thiamethoxam are labeled for lace bug management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Treat when lace bugs are first seen in the spring. Repeat applications may be needed. (p. 426)

Pear sawfly: Formulations of acephate, azadirachtin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, horticultural oil (larvae), imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP only), insecticidal soap, lambda-cyhalothrin, spinosad, and thiamethoxam are labeled for sawfly management.

MANAGEMENT HINTS: Treat infested plants when larvae are present in early June and early August. (p. 130)

Spirea

Aphids: Apply horticultural spray oil as a dormant treatment. Formulations of abamectin, acephate, acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos, cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil,

imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for aphid management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Apply horticultural spray oil according to label directions. Treat when aphids are first noticed. Malathion has been reported to cause slight injury on small-leaf spirea. (p. 298)

Twobanded Japanese weevil: Formulations of acephate, bifenthrin, cyfluthrin and imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), and pyrethrins and piperonyl butoxide are labeled for management of adult weevils.

MANAGEMENT HINTS: This brown weevil feeds during the day. Marginal notching of new foliage is a symptom of adult feeding. Treat infested plants when new foliage has notched margins during early July through August. (p. 244)

Spruce

Aphids: Refer to comments under "Pine." Dimethoate is not labeled for use on spruce. Horticultural spray oil removes glaucous (blue) color from evergreens such as Colorado blue spruce and Koster spruce.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat infested plants when aphids are first detected. Repeat applications may be necessary. (pp. 82, 84)

Bagworm: Refer to comments under "Pine." Dimethoate is not labeled for use on spruce. (p. 176)

Cooley spruce gall adelgid: Formulations of acetamiprid, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin and imidacloprid, horticultural oil, imidacloprid, insecticidal soap, oxydemeton-methyl, and tau-fluvalinate are labeled for spruce gall adelgid management. Marathon 1% G and Marathon 60 WP are labeled for use only in plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Horticultural spray oil and insecticidal soap remove the glaucous bloom (blue color) from spruces such as Colorado blue spruce and Koster spruce. When practical, galls on spruce may be pruned and destroyed before they start opening in July. To manage overwintering adelgids on spruce, apply a registered insecticide from mid-September through October or just before buds break in April. Repeat applications may be necessary. (p. 112)

Eastern spruce gall adelgid: Apply horticultural spray oil as a dormant treatment. Formulations of acetamiprid, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin and imidacloprid, horticultural oil, imidacloprid, insecticidal soap, oxydemeton-methyl, and tau-fluvalinate are labeled for spruce gall adelgid management. Marathon 1% G and Marathon 60 WP are labeled for use only in plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural oil spray before new growth starts and before buds separate into clusters. Apply horticultural spray oil according to label directions. Applications should be made while temperatures remain above freezing. Horticultural spray oil and insecticidal soap remove the glaucous bloom (blue color) from spruces such as Colorado blue spruce and Koster spruce. When practical, galls on spruce may be pruned and destroyed before they start opening in July. To manage overwintering adelgids, apply a registered material from mid-September through October or just before buds break in April. Repeat applications may be needed. (p. 114)

Elongate hemlock scale: Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion.

MANAGEMENT HINTS: Select and apply horticultural spray oils according to label directions. Crawlers may be managed from late May through early June. Egg laying and crawler activity occur throughout the growing season. Crawler sprays made need to be applied at 7- to 10-day periods from mid-May to mid-September if an infestation is severe. (p. 104)

Gypsy moth: Refer to comments under “Gypsy Moth” on page 15. Prior to applying any control material, refer to individual labels for plant clearance information. (pp. 138, 140)

Pine needle scale: Refer to comments under “Pine.” Horticultural spray oil and insecticidal soap remove the glaucous bloom (blue color) from spruces such as Colorado blue spruce and Koster spruce. Oxydemeton-methyl (Metasystox-R) is labeled for management of pine needle scale on field grown nursery stock.

MANAGEMENT HINTS: Apply horticultural spray oil according to label directions. Crawlers may emerge from eggs during late April through May. A second generation will start hatching from mid- to late July. Crawler activity will vary from year to year due to varying weather conditions. To obtain maximum control, monitor infested trees on a regular basis. Two applications of a registered insecticide may be necessary to manage heavy populations. Be aware that the adult female has a fairly long egg-laying period, and newly hatched crawlers may remain beneath the protective scale cover, especially on overcast days. (p. 108)

Sawflies: Formulations of acephate, azadirachtin (pine sawflies only), bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, horticultural oil (larvae), imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP only), insecticidal soap, lambda-cyhalothrin, permethrin (Astro only for pine sawflies), phosmet, and spinosad are labeled for sawfly management. Horticultural oil and insecticidal soap remove the glaucous bloom (blue color) from spruces such as Colorado blue spruce and Koster spruce.

MANAGEMENT HINTS: Treat infested trees when the larvae are first observed, preferably when they are small. Larvae may be observed at different times throughout the spring and summer (e.g., redheaded pine sawfly—July through early September). Redheaded pine sawfly occasionally will attack spruce planted with pine. Light infestations may be handpicked or pruned and then destroyed. (pp. 16, 18)

Spruce bud scale: Apply horticultural spray oil as a dormant treatment. Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Horticultural spray oil and insecticidal soap remove the glaucous bloom (blue color) from spruces such as Colorado blue spruce and Koster spruce. Crawlers are active from June through July. Scales closely resemble buds on spruce and are difficult to detect. Large quantities of honeydew may attract bees. Honeydew will also serve as a medium for the development of black sooty mold. (p. 96)

Spruce needleminer: Formulations of carbaryl and chlorpyrifos (Dursban 50W only) are labeled for needleminer management.

MANAGEMENT HINTS: Adult moths of *Epinotia* spp. are active in June and July and lay eggs on needles. Manage larvae before they enter needles and start mining the host foliage. Adult moths of *Taniva* spp. lay eggs on needles from mid-May to mid-June. Treat foliage before larvae enter needles. (p. 32)

Spruce spider mite: Refer to comments under “Pine.” Dimethoate is not labeled for application on spruce. Horticultural spray oil and insecticidal soap remove the glaucous bloom (blue color) from spruces such as Colorado blue spruce and Koster spruce. (p. 118)

White pine weevil: Formulations of bifenthrin, chlorpyrifos (Dursban 50W only), and pyrethrins and piperonyl butoxide (Pyrenone Crop Spray) are labeled for weevil management. Diflubenzuron is labeled for management of terminal weevils of pine and spruce (*Pissodes* spp.). Naled (Dibrom 8) is labeled for pine weevil management on spruce. Oxydemeton-methyl (Metasystox-R) is labeled for management of white pine weevil on field grown nursery stock.

MANAGEMENT HINTS: Apply a registered formulation to only the top of the host tree (terminal) as weather warms during late March through April, to manage egg-laying weevils. Timing can vary since conditions change from year to year. (p. 54)

Sweetgum

Bagworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, malathion, permethrin, pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, tebufenozide, and trichlorfon are labeled for bagworm management.

MANAGEMENT HINTS: Bagworm cases (containing overwintering eggs) can be handpicked from infested host plants during winter and early spring. Registered insecticides may be applied after eggs hatch and caterpillars are small during early to mid-June. (p. 176)

Calico scale: Horticultural spray oil can be applied as a dormant treatment. Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oils according to label directions. Crawlers may be managed when they are active in June through early July. Repeat applications may be needed. (p. 354)

Fall webworm: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, tebufenozide, and trichlorfon are labeled for management of fall webworm.

MANAGEMENT HINTS: Treat when caterpillars are small from late June through July. (p. 166)

Gypsy moth: Refer to comments under “Gypsy Moth” on page 15. Prior to applying any control material, refer to individual labels for plant clearance information. (pp. 138, 140)

Sweetgum scale: Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion.

MANAGEMENT HINTS: Treat the affected host plant with a registered insecticide when first-generation crawlers appear during mid-May through June. Second-generation crawlers appear in mid-July and may be present until early October. (p. 382)

Sycamore

Aphids: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, acephate, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, naled, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for aphid management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat the host plant with registered insecticides when an aphid infestation is first detected. (pp. 308, 310)

Bagworm: Refer to comments under “Sweetgum.” Naled is labeled to manage bagworm on sycamore. (p. 176)

Fall webworm: Refer to comments under “Sweetgum.” Naled is labeled for management of fall webworm on sycamore. (p. 166)

Japanese beetle: Formulations of acephate, acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, imidacloprid, lambda-cyhalothrin, malathion, permethrin (Astro only), phosmet, and pyrethrins and piperonyl butoxide are labeled for management of adults. Formulations of imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP) are also labeled for management of white grub larvae such as Japanese beetle, chafers, oriental beetle, Asiatic garden beetle, and *Phyllophaga* spp. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds. Merit 2.5 G is labeled for use on ornamental shrubs and small trees in outdoor landscapes and interior plantscapes against Japanese beetle adults.

MANAGEMENT HINTS: Treat when beetles are active from late June through July. (p. 236)

Sycamore lace bug: Formulations of acephate, *Beauveria bassiana* (BotaniGard ES only), bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, fenpropathrin, horticultural oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, permethrin, pyrethrins and piperonyl butoxide, and thiamethoxam are labeled for lace bug management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: The sycamore lace bug overwinters as an adult. Spray when nymphs are present on the lower leaf surface. Repeat applications may be needed since two generations are produced each year. (p. 428)

Sycamore plant bug: Formulations of acetamiprid, *Beauveria bassiana* (BotaniGard ES only), bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, flonicamid, horticultural oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), pyrethrins and piperonyl butoxide, and thiamethoxam are labeled for plant bug management.

MANAGEMENT HINTS: This plant bug species overwinters in the egg stage in woody tissue at the base of leaf buds. Registered insecticides should be directed against young nymphs when the foliage reaches a length of about 2 inches sometime in early May. (p. 400)

Terrapin scale: Horticultural spray oil can be applied as a dormant treatment. Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Mature females give birth to living young in June. Young nymphs migrate to foliage for 6 weeks and move back to twigs and branches to overwinter. (p. 364)

Tussock moth: Formulations of azadirachtin, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, lambda-cyhalothrin, naled, permethrin (Astro only), pyrethrins and piperonyl butoxide, spinosad, and tau-fluvalinate are labeled for tussock moth management.

MANAGEMENT HINTS: Caterpillars may be present from late April through June. Adult females may lay eggs that will produce a second generation of caterpillars, which feed in August and September. (p. 158)

Tuliptree

Aphids: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, acephate, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for aphid management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat host plant with a registered

insecticide when aphids are first detected. Repeat applications may be necessary. (p. 292)

Tuliptree scale: Horticultural spray oil can be applied as a dormant treatment. Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Crawlers usually are active from mid-August through mid-September. Repeat applications may be needed. (p. 362)

Yellow poplar weevil: Formulations of bifenthrin, carbaryl, chlorpyrifos (Dursban 50W only), and pyrethrins and piperonyl butoxide are labeled for weevil management.

MANAGEMENT HINTS: Adults can usually be managed by applying a registered insecticide to the lower leaf surface in early July. (p. 210)

Viburnum

Aphids: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, acephate, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for aphid management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when aphid infestations are first detected. Do not apply acephate to *Viburnum suspensum*. (pp. 300, 310)

Fourlined plant bug: Formulations of acetamiprid, *Beauveria bassiana* (BotaniGard ES only), bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, flonicamid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), pyrethrins and piperonyl butoxide, and thiamethoxam are labeled for plant bug management.

MANAGEMENT HINTS: This species overwinters as an egg in slits made in plant tissue. Young, bright-red nymphs with black dots on the second body segment (thorax) are active in May and June. Adults are bright green with four black stripes. Feeding by this species causes small black spots to form on the leaf surface. Eventually these areas turn brown and drop from the

leaf, leaving small holes in the foliage. Treatment should be made against the young nymphs in mid- to late May. (p. 396)

Indian wax scale: Crawlers may be managed with acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. This species overwinters as adult females. Treat the crawler stage when they are active on an infested plant from June through mid-July. Do not apply acephate to *Viburnum suspensum*. Repeat applications may be needed. (p. 356)

Southern red mite: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), etoxazole, fenbutatin-oxide, fenpropathrin, fenpyroximate, hexythiazox, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), oxydemeton-methyl, pyridaben, spinosad, spiromesifen, and tau-fluvalinate are labeled for spider mite management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat in spring before populations begin to increase. Repeat applications may be necessary. (p. 475)

Twobanded Japanese weevil: Formulations of acephate, *Beauveria bassiana*, bifenthrin, cyfluthrin and imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), and pyrethrins and piperonyl butoxide are labeled for management of adult weevils.

MANAGEMENT HINTS: This brown weevil feeds during the day. Marginal notching of new foliage is a symptom of adult feeding. Treat infested plants when new foliage has notched margins during early July through August. Do not apply acephate to *Viburnum suspensum*. (p. 244)

Viburnum leaf beetle: Formulations of azadirachtin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin and imidacloprid, horticultural oil (larvae only), imidacloprid, pyrethrins and piperonyl butoxide, and spinosad (larvae) are labeled for leaf beetle management. Marathon 1% G and Marathon 60 WP are labeled for use against viburnum leaf beetles only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Planting resistant viburnum species such as Koreanspice viburnum (*Viburnum carlesii*), Burkwood viburnum (*V. burkwoodii*), doublefile viburnum (*V. plicatum* var. *tomentosum*), Judd viburnum (*V. x juddii*), lantanaphyllum viburnum (*V. x rhytidophylloides*), and leatherleaf viburnum (*V. rhytidophyllum*) should reduce the need to manage this pest. This species overwinters in the egg stage in twigs. Larvae

and adults feed on the host plant foliage. Larvae may consume all but the major veins of the leaves. After leaves drop in the fall, sites on the twigs where eggs have been laid become more noticeable. Prune out these eggs from late October through March before they hatch in the spring. Infested plants should be treated when young larvae are actively feeding on the foliage from late April through early May. (p. 224)

Weigela

Fourlined plant bug: Refer to comments under “Viburnum.” *Beauveria bassiana* is not labeled for management of plant bugs on weigela. Malathion is labeled for management of this pest on weigela. (p. 396)

Japanese beetle: Formulations of acephate, acetamiprid, azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, imidacloprid, lambda-cyhalothrin, malathion, permethrin (Astro only), phosmet, and pyrethrins and piperonyl butoxide are labeled for management of adults. Formulations of imidacloprid (Merit 2, Merit 75 WP, and Merit 75 WSP) are also labeled for management of white grub larvae such as Japanese beetle, chafers, oriental beetle, Asiatic garden beetle, and *Phyllophaga* spp. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds. Merit 2.5 G is labeled for use on ornamental shrubs and small trees in outdoor landscapes and interior plantscapes against Japanese beetle adults.

MANAGEMENT HINTS: Apply registered materials from late June through July when adults are active. (p. 236)

Twobanded Japanese weevil: Formulations of acephate, bifenthrin, cyfluthrin and imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), permethrin (Astro only), and pyrethrins and piperonyl butoxide are labeled for management of adult weevils.

MANAGEMENT HINTS: This brown weevil feeds during the day. Marginal notching of new foliage is a symptom of adult feeding. Treat infested plants when new foliage has notched margins during early July through August. (p. 244)

Willow

Aphids: Horticultural spray oil can be applied as a dormant treatment. Formulations of abamectin, acephate, acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, naled, oxydemeton-methyl, permethrin (Astro only), pymetrozine, pyrethrins and piperonyl butoxide, pyriproxyfen, tau-fluvalinate, and thiamethoxam are labeled for aphid management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when aphids first appear. Repeat applications may be needed. (pp. 292, 308, 310)

Eastern tent caterpillar: Formulations of acephate, azadirachtin, *Bacillus thuringiensis*, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cryolite, cyfluthrin, cyfluthrin and imidacloprid, diflubenzuron, indoxacarb, insecticidal soap, lambda-cyhalothrin, malathion, naled, permethrin (Astro only), phosmet, pyrethrins and piperonyl butoxide, spinosad, tau-fluvalinate, and tebufenozide are labeled for tent caterpillar management.

MANAGEMENT HINTS: Young larvae hatch from eggs as leaves start to unfold in the spring. Eastern tent caterpillars leave their web during the day to feed on foliage but return at night or during periods of rainy weather. Prune viable egg masses from small twigs during the winter. (p. 168)

Gypsy moth: Refer to comments under “Gypsy Moth” on page 15. Prior to applying any control measure, refer to individual labels for host-plant clearance information. (pp. 138, 140)

Japanese beetle: Refer to comments under “Sycamore.” (p. 236)

Japanese maple scale: Formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), and methidathion are labeled for crawler management.

MANAGEMENT HINTS: Treat when crawlers are first present from late May through mid-August. Repeat applications may be needed.

Imported willow leaf beetle: Formulations of azadirachtin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin and imidacloprid, horticultural oil (larvae only), imidacloprid, pyrethrins and piperonyl butoxide, and spinosad (adults and larvae) are labeled for willow leaf beetle management.

MANAGEMENT HINTS: Damage by this pest results in the foliage becoming skeletonized and notched. Treat infested foliage from mid-May through June. Repeat applications may be needed since this species may have two or three generations per year. (p. 228)

Oystershell scale: Crawlers may be managed with applications of acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, and methidathion.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Manage crawlers as they hatch from eggs in late May or early June. Repeat applications may be needed. Prune and destroy heavily infested twigs and branches. (p. 370)

Spider mite: Horticultural spray oil can be applied as a dormant application. Formulations of abamectin, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), fenpyroximate, horticultural oil, hydrophobic extract of neem oil, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), malathion, oxydemeton-methyl, spinosad, spiromesifen, and tau-fluvalinate are labeled for mite management.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Treat when mites first appear, to prevent an increase in population levels. Repeat applications may be necessary. (p. 474)

Spiny elm caterpillar: Formulations of azadirachtin, bifenthrin, bifenthrin and imidacloprid, carbaryl, chlorpyrifos, cryolite, cyfluthrin, cyfluthrin and imidacloprid, indoxacarb, lambda-cyhalothrin, permethrin (Astro only), pyrethrins and piperonyl butoxide, and tau-fluvalinate are labeled for management of this pest.

MANAGEMENT HINTS: Apply registered materials when caterpillars are small from mid- to late July. (p. 152)

Wisteria

Calico scale: Horticultural spray oil can be applied as a dormant treatment. Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oils according to label directions. Crawlers may be managed when they are active in June through early July. Repeat applications may be needed. (p. 354)

Japanese beetle: Refer to comments under “Sycamore.” (p. 236)

Yew (*Taxus*)

Black vine weevil (*taxus weevil*): Formulations of acephate, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, chlorpyrifos (Dursban 50W only), cyfluthrin and imidacloprid, fenpropathrin, lambda-cyhalothrin, permethrin (Astro only), pyrethrins and piperonyl butoxide, and tau-fluvalinate are labeled to manage adults. Acephate Pro 75, Acephate 75 WSP, and Orthene Turf, Tree & Ornamental Spray are labeled to be applied as a soil drench (container-grown nursery stock only). Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds. Merit 2.5 G is labeled for use on ornamental shrubs and small trees in outdoor landscapes and interior landscapes against black vine weevil larvae in soil. Merit 2, Merit 75 WP, and Merit 75 WSP are labeled for black vine weevil larvae and are for use only in and around industrial and commercial buildings and residential areas. Talstar

Nursery Granular is labeled for soil incorporation into potting media used in containerized plantings of ornamental trees, shrubs, plants, flowers, conifers, and Christmas trees. The use of insect-parasitic nematodes applied as soil drenches in container-grown plant material may be effective in reducing larval populations of this pest. Follow label directions for all methods of application.

MANAGEMENT HINTS: Spray foliage and surface to manage adults in May and June. Soil drenches can be applied from July to mid-October. Follow all label directions. (p. 240)

Cottony taxus scale: Horticultural spray oil can be applied as a dormant treatment. Crawlers may be managed with formulations of acephate, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos (Dursban 50W only), cyfluthrin, cyfluthrin and imidacloprid, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin (Demand CS, Scimitar CS, and Scimitar GC only), methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. One white egg sac may contain more than 1,000 eggs. Eggs begin to hatch in late May and June. Crawlers settle on foliage and sprays should be applied during June. Repeat applications may be needed. One generation occurs each year. (p. 344)

Fletcher scale: Horticultural spray oil can be applied as a dormant treatment. Crawlers may be managed with formulations of acephate, acetamiprid, azadirachtin (Ornazin 3% EC only), bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos, cyfluthrin, cyfluthrin and imidacloprid, dimethoate, dinotefuran, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin

(Demand CS, Scimitar CS, and Scimitar GC only), malathion, methidathion, and thiamethoxam. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds.

MANAGEMENT HINTS: Select and apply horticultural spray oil according to label directions. Eggs are laid by females during late May. Crawlers usually are active from June through the first half of July. Repeat applications may be needed. (p. 98)

Taxus bud mite (eriphyid): Formulations of abamectin, carbaryl, dimethoate, horticultural oil, spiromesifen, and tau-fluvalinate are labeled for eriophyid mite management.

MANAGEMENT HINTS: Apply a registered formulation to manage mites in May and from mid- to late June. Repeat applications may be needed. (p. 478)

Taxus mealybug: Formulations of acetamiprid, azadirachtin, *Beauveria bassiana*, bifenthrin, bifenthrin and imidacloprid, buprofezin, carbaryl, chlorpyrifos, cyfluthrin, cyfluthrin and imidacloprid, dimethoate, dinotefuran, fenpropathrin, flonicamid, horticultural oil, hydrophobic extract of neem oil, imidacloprid, insecticidal soap, lambda-cyhalothrin, malathion, permethrin (Astro only), phosmet, pyrethrins and piperonyl butoxide, pyriproxyfen, and thiamethoxam are labeled for mealybug management. Marathon 1% G and Marathon 60 WP are labeled for use only on plants grown in containers, flats, benches, or beds. Talstar Nursery Granular is labeled for soil incorporation into potting media used in containerized plantings of ornamental trees, shrubs, plants, flowers, conifers, and Christmas trees.

MANAGEMENT HINTS: This insect overwinters as a nymph. Nymphs can be managed when they begin feeding in the spring or as mature adults are giving birth to living young in June. Repeat applications may be needed. (p. 88)

Zelkova—see Japanese Zelkova

DISEASES

DISEASE DIAGNOSIS

An essential first step in managing a plant disease is to know exactly what is causing the disease. If you are unable to diagnose a disease or are uncertain about its cause, send or deliver samples that are typical of various stages of the problem to your local county Penn State Cooperative Extension horticulture extension educator's office. Often, that person is able to diagnose the problem immediately and recommend appropriate control measures. If the extension educator is uncertain or wants confirmation of the diagnosis, samples can be sent to the Penn State Plant Disease Clinic, Department of Plant Pathology, 220 Buckhout Laboratory, University Park, PA 16802. It is important to provide the name of the plant, date collected, description of symptoms of concern, and other vital data so that the diagnostician has all the information necessary to send you an accurate and timely report and an appropriate management recommendation. Fill out the Specimen Information Form (pp. 107–108 of this guide) as completely as possible, place it in a waterproof bag, and attach it to the specimen. Never add water to a sample. A wet sample will begin to break down rapidly and make completing an accurate diagnosis extremely difficult. Place the sample in a plastic bag with a dry paper towel or newspaper. If you mail the sample to the clinic, be sure to do so early in the week so that it does not deteriorate in shipment over a weekend. If the cause of the problem is thought to be due to an insect, mite, or horticultural practice rather than a disease, it will be forwarded from the clinic to the appropriate expert in another department.

SCHEDULING WOODY ORNAMENTAL PLANT DISEASE MANAGEMENT PRACTICES

Scheduling effective disease management measures is not a simple task, nor can it be standardized. The activities of the organisms that cause plant diseases are not governed by the clock or the calendar. Their activity is influenced by temperature, relative humidity, soil moisture, and other highly changeable environmental factors. Strict scheduling is made even more difficult in the landscape because many different species of plants are being maintained, each with their own, often unique, diseases. As a result, the timing of pesticide applications as well as other disease management practices must be tailored to the plant species being grown, the diseases that are present or could pose a serious threat, and the environmental conditions at the site.

Tailoring a very effective disease management plan is possible if notes are taken and records kept on the plants, planting site, weather conditions, and the diseases that occur. With such records, the plan can be adjusted and improved over the years, increasing its effectiveness and, in some cases, reducing the use of pesticides. Use the following information as an outline of the kinds of data to keep.

1. Make an inventory of the plants at the site, noting the identity and location of the plants. Mapping and numbering their location on the map will help. You may be able to create a map using aerial photographs from Google Earth.

2. Note the important characteristics of the site, such as exposure to wind, proximity to roads and walks, and drainage patterns. Record the date of any site changes, such as excavation, paving, and removal of overstory trees.
3. Record the general weather conditions at the site during the year, especially drought, severe winter conditions, flooding, and wind.
4. Record the general appearance and health of each plant being maintained. Especially note unusual characteristics, such as smaller-than-average leaves, unusually light green leaves, smaller-than-average internode length, and mechanical injuries. Record for each species the approximate date of leaf bud break and first flowering. Note the date of the first occurrence of the diseases you most want to control.
5. Record the use of insecticides, fungicides, herbicides, fertilizers, or any other chemicals on or near the individual plants or near the general site. Note the chemical, formulation, rate and method of application, and weather conditions at the time of application.

This history allows you to accurately identify those plants already diseased, new diseases, general declines in growth, or chemical damage. Knowing what diseases are present and when they occur will greatly improve disease management effectiveness.

KEY PLANTS, KEY DISEASES, AND KEY TIMES FOR DISEASE CONTROL

Of all the plants used in the landscape or grown in the nursery, certain ones often have diseases. These are the “key plants.” Key plants should be scouted and monitored on a regular basis in order to detect the onset of disease. Although each plant is susceptible to many diseases, only certain diseases are very common and occur each year. These “key diseases” are the ones that you should especially learn to identify, understand their biology, and know what measures to implement for effective control. For each disease, there are “key times” for control when disease management practices are most effective. The occurrence of key diseases and the timing of important disease management activities can be roughly grouped into four different categories because of the activity of the plant or general weather conditions.

1. Dormant season: late autumn through winter
 - a. Conduct inventories to determine what plants are present at the site. Identify the key plants.
 - b. Run soil tests to check pH and fertilizer status.
 - c. Mulch to protect roots.
 - d. Protect evergreens from drying winds, salt sprays, and ice damage.
 - e. Prune dead, cankered twigs and branches.
 - f. Rake and destroy fallen leaves around trees and shrubs that had leaf spotting diseases, especially rose black spot, apple scab, and anthracnose.
 - g. Examine the plants for galls. Remove infected branches or remove severely affected plants entirely.

2. Bud break: spring through early summer

- a. Spray to protect emerging leaves of plants that have a history of severe anthracnose, leaf spots, or twig blights, or are at high risk for these diseases. Diseases of primary concern include:

Apple scab	Juniper twig blight
Cedar-apple rust	Ovulinia petal blight
Diplodia tip blight	Phytophthora dieback
Dogwood anthracnose	Pine-pine gall rust
Douglas-fir needlecasts	Rose black spot
Fire blight	<i>Volutella</i> on pachysandra

- b. Pick off and destroy any gall or gall-like tissue, such as cedar-apple rust galls from junipers and leaf and flower galls from azaleas.
- c. Apply soil drench or granular fungicides to plants prone to *Phytophthora* root rot.

3. Summer

- a. Apply fungicides during wet weather periods to prevent the further spread of diseases such as rose black spot and *Volutella* blight on pachysandra. Cease spraying when the weather is dry.
- b. Apply soil drench or granular fungicides to continue the *Phytophthora* protection. Do this at the recommended interval noted on the product label.
- c. Apply fungicides to control pine and spruce needlecasts.

4. Cool weather: late summer to autumn

- a. Spray to control powdery mildew on highly susceptible plants, particularly when there have been 3 or more days of cool, humid nights followed by warm, dry days.
- b. Spray to protect the new autumn growth from twig blight and cedar-rust infections on juniper.
- c. Prepare new planting sites that should be fumigated and treat them while soil temperatures remain above 55°F and soil moisture is 50 to 85 percent of field capacity. Allow the site to aerate several weeks before planting or cover the treated area with a plastic tarp and plant in the spring.
- d. Update the site inventory and be certain you have recorded all the diseases that developed on each plant.

In addition to these four key periods of disease control, times during which plants are under drought stress or defoliated should be shortened as much as possible through watering and controlling insects. Stresses weaken plant vigor, rendering them more susceptible to diseases such as cankers.

GUIDE TO SELECTED PLANTS AND THE KEY TIMES TO CONTROL DISEASES

The plants marked ◇ are considered key plants (those that usually have diseases each year). The plant diseases marked ◇ are the key diseases that most commonly occur in Pennsylvania.

Abbreviations of suggested control techniques to employ at each key management time:

* Only if the disease has been severe

BSp Begin spray schedule; discontinue when weather dries

CSp Continue spraying if wet; discontinue when weather dries

D Apply soil-drench fungicides

F Fumigate before planting

I Irrigate to prevent drought stress

NAC No adequate control available

NT No treatment required

P Prune

R Rake and destroy fallen leaves

X Remove infected plant

	Bud			
	Dormant	Break	Summer	Autumn
Arborvitae (<i>Thuja</i>)				
Kabatina twig blight	P	BSp		BSp
Phomopsis twig blight	P	BSp		BSp
Root rot			D	
◇ Ash (<i>Fraxinus</i>)				
◇ Anthracnose				R
◇ Azalea (<i>Rhododendron</i>)				
Botrytis blight		BSp		
◇ Leaf gall		P-BSp*		
Leaf spots		BSp		R
Nematodes				F
Ovulinia flower blight		BSp		
Phytophthora dieback	P	BSp	CSp	CSp-P
◇ Powdery mildew			BSp	CSp
◇ Root rots		D	D	F
Boxwood (<i>Buxus</i>)				
Canker	P	BSp		BSp
Macrophoma leaf spot	P		I	
Nematodes				F
Root rot				F
Catalpa (<i>Catalpa</i>)				
Leaf spots				R
Powdery mildew				NT
Verticillium wilt				NAC
◇ Cherry (<i>Prunus</i>)				
Bacterial leaf spot		NAC		
◇ Black knot	P-X*			
◇ Cocomyces leaf spot			BSp	
Chestnut (<i>Castanea</i>)				
◇ Blight	P-X*			
Leaf spot				R

	Dormant	Bud Break	Summer	Autumn		Dormant	Bud Break	Summer	Autumn
Cotoneaster (<i>Cotoneaster</i>)					♦ Juniper (<i>Juniperus</i>)				
♦ Fire blight	P				♦ Cedar-apple rust	P-X*			BSp
Scab		BSp	CSp		♦ Cedar-quince rust	P-X*			BSp
♦ Crabapple (<i>Malus</i>)					♦ Kabatina twig blight	P	BSp		BSp
♦ Cedar-apple rust			NT		♦ Phomopsis twig blight	P	BSp		BSp
♦ Fire blight	P-BSp*	CSp*	CSp*		Root rot	X*		D	
Powdery mildew			NT		Leucothoe (<i>Leucothoe</i>)				
♦ Scab		BSp	CSp	R	Leaf spot		BSp	CSp	
♦ Dogwood (<i>Cornus</i>)					Root rot		D		
♦ Anthracnose	P-X*	BSp	CSp-I	P-I	♦ Lilac (<i>Syringa</i>)				
Bacterial leaf scorch	NAC				Bacterial leaf blight	P			
♦ Powdery mildew			Bsp	CSp	♦ Powdery mildew			BSp	CSp
Septoria leaf spot		BSp	CSp		Witches' broom	NAC,X			
Douglas-fir (<i>Pseudotsuga</i>)					Maple (<i>Acer</i>)				
Rhabdocline needlecast		BSp			Anthracnose				P-R
Swiss needlecast		BSp			Bacterial leaf scorch	NAC			
♦ Elm (<i>Ulmus</i>)					Bleeding canker				NAC,X*
Bacterial leaf scorch	NAC				Leaf spots				NT
♦ Botryodiplodia canker	P		I	I	♦ Verticillium wilt				NAC,X*
♦ Dutch elm disease			X	X	Mountain ash (<i>Sorbus</i>)				
♦ Black leaf spot			NT	R	Cytospora canker	P		I	
Elm yellows			X		Fire blight	P			
♦ Wetwood			NT		Leaf spot		BSp*		R
Euonymus (<i>Euonymus</i>)					Mountain laurel (<i>Kalmia</i>)				
Anthracnose		BSp	CSp	R	Leaf spot		BSp*	CSp*	R
Crown gall	P-X*				♦ Oak (<i>Quercus</i>)				
♦ Powdery mildew			Bsp		♦ Anthracnose				R
Root rot			D		♦ Bacterial leaf scorch	NAC			
Forsythia (<i>Forsythia</i>)					Decline			I	
Crown gall	P-X*				♦ Leaf blister	BSp*			
Hackberry (<i>Celtis</i>)					♦ Wilt			X	
Witches' broom	P				♦ Pachysandra (<i>Pachysandra</i>)				
♦ Hawthorn (<i>Crataegus</i>)					♦ Volutella blight	X	BSp	CSp,I	X
♦ Fire blight	P				Pear (<i>Pyrus</i>)				
♦ Leaf spot		BSp*	CSp*		Fire blight	P-BSp*	CSp	CSp	
♦ Rust		BSp*			Scab		BSp	CSp	
Holly (<i>Ilex</i>)					Pieris (<i>Pieris</i>)				
Nematodes				F	Phytophthora dieback	P	BSp	CSp	CSp-R
Thielaviopsis root rot			D		Root rot			D	F
Honeysuckle (<i>Lonicera</i>)					♦ Pine (<i>Pinus</i>)				
Powdery mildew				BSp	♦ Diplodia tip blight	P	BSp-P		
♦ Ivy, Boston (<i>Parthenocissus</i>)					Needle blights		BSp		
♦ Black rot		BSp	CSp	CSp	♦ Cyclaneusma needlecast		BSp	CSp	CSp
♦ Ivy, English (<i>Hedera</i>)					Lophodermium needlecast			BSp	
♦ Fungal leaf spot	P	BSp	CSp		Ploiderma needlecast		BSp	CSp	
♦ Bacterial leaf spot	P	BSp	CSp		Root rots			D	F
					Gall and cankering rusts	P-X*	BSp		

(continued on next page)

		Bud		
	Dormant	Break	Summer	Autumn
Pyracantha (<i>Pyracantha</i>)				
Fire blight	P			
Scab		BSp	CSp	
♦ Rhododendron (<i>Rhododendron</i>)				
♦ Botryosphaeria dieback	P		I	I
♦ Cercospora leaf spot		BSp*	CSp*	R
Ovulinia flower blight		BSp		R
♦ Phytophthora dieback	P	BSp	CSp	CSp
♦ Root rot			D	F
♦ Rose (<i>Rosa</i>)				
♦ Black spot	P	BSp	CSp	CSp-R-P
♦ Cankers	P-X*			
♦ Powdery mildew			BSp	CSp
Rust	P-R	BSp	CSp	R
♦ Spruce (<i>Picea</i>)				
♦ Cytospora canker	P	NAC		
Needlecast		BSp		
Needlerust	X*	X*	X*	X*
♦ Sycamore (<i>Platanus</i>)				
♦ Anthracnose	P			R
♦ Bacterial leaf scorch	NAC			
♦ Canker stain	X	X	X	X
♦ Powdery mildew				NT
Viburnum (<i>Viburnum</i>)				
Leaf spot				R
Vinca (<i>Vinca</i>)				
Blight	X*	BSp	CSp	X*
Walnut and Butternut (<i>Juglans</i>)				
Anthracnose	P			R
Bacterial blight		BSp		
Willow (<i>Salix</i>)				
Crown gall	P-X*			
Leaf blight	P			R

DISINFESTING TOOLS AND EQUIPMENT

Wash or thoroughly wipe tools and equipment to remove heavy deposits of soil and plant sap because disinfectants do not penetrate these well. Then disinfect as noted below. Rest clean tools in a bucket of disinfectant, on clean newspaper or plastic sheeting, or in an empty, clean container. Or hang them up so they do not become contaminated with soil or plant debris.

When using pruning tools, disinfectant can be carried in a squeeze, spray, or mist bottle. Thoroughly wet the cutting surfaces with the disinfectant and allow the tool to drain and air-dry. If sap or resin builds up on the tool, scrub this off with a rag kept in the disinfectant. Then dip, pour, or spray more disinfectant onto the tool. Let it drain and air-dry or let the tool soak in disinfectant for 10 minutes. When pruning specifically to remove diseased plant parts, alternate using two tools so that one can soak in disinfectant while the second is in use.

Steam or dry heat: Heat materials to 180 to 200°F for 30 minutes under a cover to retain the heat.

70 percent alcohol (grain, rubbing, wood): Dip or swab object and let dry.

Ammonium compounds (Green-Shield, Triathlon): Dip or swab object and keep the tool wet for 10 minutes.

Hydrogen dioxide (ZeroTol): Dip or swab object and thoroughly wet the surface.

Sodium hypochlorite (Clorox, 1 gallon diluted in 9 gallons of water): Dip, spray, or brush on and keep the tool wet for 10 minutes. Let drain and rinse with clean water immediately.

COMMON PLANT DISEASES

Fire Blight

Fire blight is caused by the bacterium *Erwinia amylovora*, which can attack more than 75 species of trees and shrubs, including apple, pear, quince, mountain ash, crabapple, hawthorn, cotoneaster, serviceberry, and pyracantha. The bacterium overwinters on infected plants in darkened, slightly sunken cankers. In the spring, the bacterium is dispersed by insects, rain, wind, and animals.

Symptoms

- Twigs, branches, and leaders on trees and shrubs wilt and blacken, especially during flowering.
- Affected twigs and branches may bend over into the shape of shepherd's crook.
- Blackened flower parts remain attached to the tree.
- Cream-colored liquid may ooze out of the cankers and run down the trunk and branches in the spring if conditions are very wet.

Life History

The bacterium is carried from infected tissue or from liquid oozing from the infected tissue to natural openings or wounds in susceptible plants by flower-visiting insects, rain, wind, birds, and various crawling insects. The nectaries and other flower parts, hydathodes and stomates on leaves, and small wounds on succulent twigs and branches all can be sites of initial infection. Succulent plant parts are blackened and killed. The bacterium then moves farther into and girdles branches and the trunk. A slightly sunken, darkened canker forms in the invaded wood. Close examination will reveal a dark line at the edge of the canker. While plants are

most susceptible during flowering and new shoot development, fire blight can continue to spread later in the season.

Favorable Conditions

- Fertilization practices that produce very succulent growth render plants more susceptible to fire blight.
- Moderately high temperatures (70–81°F = 21–27°C), high relative humidity, and rainfall during flowering provide optimum conditions for fire blight development.
- Injury due to hail or windblown soil opens tissue to infection.

Management

- Grow resistant varieties whenever possible. See a list of resistant cultivars elsewhere in this guide under crabapple, cotoneaster, hawthorn, mountain ash, and pyracantha.
- Do not purchase or plant infected material. Plant fire blight-free trees and shrubs.
- Remove severely infected plants.
- Once the disease has begun, a three-pronged management scheme must be implemented:
 1. During the dormant season, closely examine susceptible plants and prune out infected tissues. Look for blackened twigs, branches, and flower parts. Find the sunken, darkened cankers on the wood. Prune when the weather is dry, cutting at least 4 inches below the canker. Disinfect pruning tools between cuts by placing them in 70 percent alcohol or hydrogen dioxide and letting them air-dry.
 2. During the growing season, do not prune infected tissues. Wait for the following dormant season to prune infected tissue.
 3. To plants for which copper or copper + mancozeb, phosphite salts, fosetyl-Al, or potassium salts of phosphorus acid is registered, apply it before bud break.

Bacterial Leaf Scorch

Leaf scorch, sometimes called marginal leaf burn, describes the death of tissue along the edge of the leaf. This symptom develops when sufficient water does not reach the leaf margin cells. This can occur if (1) there is insufficient moisture in the soil; (2) water is lost too quickly from the leaves to be replaced adequately; (3) roots have been killed by plant pathogens, excavation, or compaction; or (4) fungi or bacteria invade and plug the water-conducting vessels (xylem) in the plant.

One living organism found to inhabit the xylem and cause leaf scorching is *Xylella fastidiosa*. These bacteria are very small, stain-gram negative, have no flagella, do not form a spore, have a thick, rippled cell wall, and do not grow on conventional bacteriological media. *Xylella* has been associated with leaf scorch on oak, elm, sycamore, mulberry, red maple, and sweetgum, and Pierce's disease on grapevine, phony peach disease, plum leaf scald, periwinkle wilt, almond leaf scorch, alfalfa dwarf, and ragweed stunt. Phony peach disease was first reported in California in 1890 and Pierce's disease on grapevines (*Vitis vinifera* L.) in 1892 in California. Elm leaf scorch has been observed in the Washington, D.C., area since the 1950s. Oak leaf scorch is widespread and severe in the eastern half of Pennsylvania. It has been shown that injecting oaks with

oxytetracycline will suppress symptoms during the year injection is performed. The injection will not cure a tree of the disease even if it is done for several years.

Red maple leaf scorch: Leaf scorch occurs on localized, individual branches, and more branches are affected each year. While leaves appear normal early in the season, leaf discoloration begins at the leaf margin and migrates with an undulating front toward the midrib and base of leaf beginning mid- to late July. The light brown dead tissue along leaf margin is frequently bordered by narrow to wide zones of dark, reddish-brown tissue. The dead tissue is separated from green tissue by a narrow but distinct yellow border or halo. Premature defoliation can occur in late August. This disease may make affected trees more sensitive to damage caused by site-related stresses such as deicing salts and limited growing space.

Elm leaf scorch: Leaf margins die and have a distinct yellow border separating the dead tissue from the green tissue. Scorching begins on leaves at the base of the tree and moves upward through the canopy. Leaves on branches that were affected during the previous season appear normal in the spring but show symptoms later. Some premature defoliation may occur. Affected trees are very attractive to elm bark beetles and are much more susceptible to Dutch elm disease than trees free of leaf scorch.

Oak leaf scorch: This disease affects primarily pin and red oak but has also been found in white oak. Leaf margins die and have a distinct yellow border separating the dead tissue from the green tissue. The symptoms progress toward the base of the leaf in an undulating front. Defoliation is not usually a symptom on red oak, but water sprouts (epicormic shoots) develop on red oak as the disease progresses. In Georgia, the bacteria were successfully isolated from twigs from November to January but not from February through July. White, black, swamp, scarlet, southern red, shingle, bluejack, turkey, laurel, bur, water, pin, willow, chestnut, northern red, shumard, post, and live oaks are known to be susceptible to this disease.

Sycamore and London plane leaf scorch: In late June or July, olive-green discoloration of leaf margin develops and the margin dies. Affected leaves remain attached. The leaves at branch tips are the last to scorch or may not scorch at all. Trees with a history of scorch are slow to leaf out and develop fewer leaves and smaller leaves than scorch-free trees. Branch dieback and tree death eventually occur.

Dogwood leaf scorch: The tips and margins of leaves burn toward the base and midrib of the leaf. Symptoms on *Cornus florida* and *Cornus kousa* are almost indistinguishable from those caused by drought.

Spread

Nymph and adult spittlebugs, treehoppers, and leafhoppers are known to carry *Xylella* from plant to plant. Once the bacteria are picked up, they are in some cases immediately transmittable or, in other cases, have a two-hour latent period before they are transmittable. The insect will continue to carry the bacteria until it molts and the bacteria can actually multiply inside the insect foregut. As the insect feeds, bacteria are egested into the feeding site.

Diagnosis

Although the symptoms seem distinctive, it is difficult to be certain of the cause of a marginal leaf burn. Commercial diagnostic services can confirm the presence of *Xylella*.

Management

These bacteria require several years to kill trees. The bacteria may be so widespread in the wild plant population that removal of infected trees may not prevent the spread of the bacteria to neighboring trees. The antibiotic tetracycline, when injected into an infected tree, will temporarily alleviate the symptoms. However, as the tetracycline breaks down in the tree, symptoms reappear. It must be injected each year for continued symptom suppression. The tree will not be cured.

Botryosphaeria Canker

The fungus *Botryosphaeria* can cause a branch dieback on horsechestnut, redbud, dogwood, beech, walnut, tulip poplar, sweetgum, crabapple, pine, oak, rhododendron, azalea, rose, willow, elm, yew, and many other woody ornamentals. Cankers girdle and kill twigs and branches. Small, black, fungal fruiting structures that contain fungal spores develop in the canker.

Symptoms

- Rough, sunken, dark-brown to black areas form around wounds or natural openings in the bark.
- The wood and pith of the branch is blackened or turns dark brown.
- Dead bark falls off the cankered area.
- Leaves on affected branches wilt as affected branches die.
- Cankers enlarge along the branch more quickly than around its circumference.

Botryosphaeria enters natural openings in the bark, such as lenticels, or through pruning cuts and other wounds. Plants most susceptible to the disease are wounded plants that are under drought stress. The fungus remains dormant in the wood during the winter. Spores are windblown from branch to branch in the spring as the fungus resumes activity.

Management

- Prune affected branches late in dormancy before bud break. Destroy the infected tissue. Disinfect pruning tools between cuts.
- Irrigate plants to prevent drought stress, especially during late summer and autumn.
- Protect plants from wounding.
- Plant resistant cultivars in areas prone to drought. The following hybrids of rhododendron have had less than 10 percent dieback per plant and, therefore, are considered to have some resistance to *Botryosphaeria*: 'Boursault', 'Cunningham's White', 'English Roseum', 'Lebar's Red', 'Roseum Elegans', and 'Roseum 2'.
- Susceptible cultivars should not be planted in areas prone to drought stress or where there is severe competition for water. The following hybrids often have greater than 10 percent dieback per plant and are considered susceptible: 'Anna Rose Whitney', 'Catawbiense Album', 'Chionoides White', 'Doncaster',

'Dr. Rutgers', 'Lady C. Mitford', 'Nova Zembla', 'Spring Dawn', 'Sweet Simplicity', and 'Wissahickon'.

Reference

D. M. Benson, B. I. Daughtry, and R. K. Jones. Botryosphaeria dieback in hybrid rhododendron, 1986–1990. *Biological and Cultural Tests* 6 (1991): 108.

Crown Gall

Crown gall is caused by bacterium belonging to the genus and species *Agrobacterium tumefaciens*. This bacterium can infect a wide range of herbaceous and woody plants. Actually, the bacterium only carries the gall-causing entity—a plasmid that contains its own genetic material. After the bacterium enters the host, the plasmid is transferred into the host plant cell where it stimulates the production of more plant cells.

Symptoms

- Galls or overgrowth (¼ inch to several inches in diameter) of host plant tissue typically form at the soil line but also can form on branches or roots.
- Galls are initially white, spherical, and soft but darken with age as outer cells die.
- Galls can either be almost entirely on the surface of the plant and easily detached or can be almost indistinguishable from normal plant tissue except for its greatly enlarged appearance.
- The bacterium survives and persists in the soil for many years. It invades recent wounds on stems or roots. Swelling can be seen 14 days following entry. Tissue near the gall is crushed. If vascular tissue is crushed, wilting can result from restricted water movement.

Management

NURSERY

- Purchase crown gall-free plants.
- Propagate only from crown gall-free plants.
- Pot and propagate in sterile mix.
- Avoid wounding plants near soil line.
- Bud graft tissue well above soil line rather than grafting near soil line.
- Disinfect grafting tools.
- Avoid planting in areas known to be infested with the bacterium.
- In infested areas first plant corn or other grain crop for several years before planting nursery stock.
- Dip or spray seedlings or cuttings in Galltrol A. This is a preparation of strain 84 of *Agrobacterium radiobacter*, which is a biological control agent.

HOME OR COMMERCIAL PLANTING

- Plant only crown gall-free plants.
- Remove severely affected plants and do not replace with susceptible cultivars.
- Plants not severely affected can be grown if fertilized, watered, and otherwise cared for well. The disease will continue but probably not kill the plant.

Powdery Mildew

Powdery mildew occurs on many different flowers, woody ornamentals, and trees. Several different genera of fungi cause powdery mildew. Even though one genus typically attacks specifically one or two different plants, some species of powdery mildew (such as *Golovinomyces cichoracearum*) attack a wide range of plants. All powdery mildew fungi are obligate parasites, requiring live tissue to grow and reproduce. Outdoors, fungal structures form on leaves and twigs that allow the fungus to survive winter conditions. Spores produced on one plant in the summer can be blown many miles to other susceptible plants.

Symptoms

White powdery fungus grows on the upper leaf surface of the lower leaves. This growth may be heavy and obvious on some plants (lilac) or very thin and subtle on other plants (dogwood). Leaves may be twisted, distorted, then wilt and die.

Conditions Favoring Powdery Mildew

- High relative humidity at night
- Low relative humidity during day
- 70–80°F (22–27°C) temperatures, which prevail in spring and fall

The spores are carried by air currents and germinate on the leaf surface. Liquid water on leaves inhibits spore germination. The fungus grows on the leaf surface but sends fine threads (haustoria) into the cells to obtain nutrients. From the time a spore germinates to the time new spores form may require only 48 hours. High humidity favors spore formation, while low humidity favors spore dispersal.

Some powdery mildews are inhibited by free moisture on leaves, while others are favored by wetness on leaf surfaces.

Management

GREENHOUSES

- When conditions are favorable for 3–6 consecutive days, heat and ventilate in late afternoon to reduce night humidity.
- Apply a fungicide, biological control, or antitranspirant to protect the plants. Be certain the crop is on the label.
- Liquid water inhibits spore germination of some powdery mildews. Therefore, syringing the leaves during the day at times of low humidity greatly inhibits infection and can protect the plant. Only syringe if other leaf diseases are not a problem since other pathogens require liquid water to infect. Syringing may be the best approach at locations where chemical use is not feasible or desirable and on crops for which there are no registered fungicides.

See individual plants listed elsewhere in this guide for specific chemical control recommendations. However, note that powdery mildew on most deciduous trees does little damage and does not require fungicides.

Pseudomonas syringae

The bacterium *Pseudomonas syringae* is an opportunistic pathogen that can attack a wide variety of woody plants, especially when they are damaged by frost or injured in some way. While there are a number of strains or pathovars (pv.) of this organism, pv. *syringae* is most important on woody plants. *Pseudomonas*

syringae pv. *syringae* occurs on nursery and landscape plants throughout the United States and much of the world and can cause shoot and flower blights, cankers, and diebacks.

Symptoms

- Common, Persian, Chinese, and Japanese lilac leaves develop round to irregularly shaped brown spots with yellow halos. These spots enlarge and blight entire leaves. Succulent twigs are girdled, killed, and turn black.
- Red, Norway, and Japanese maple leaves can be spotted, their veins blackened, and branch tips killed.
- Other plants known to be susceptible include apple, pear, cherry, plum, basswood, saucer magnolia, poplar, dogwood, golden-chain tree, forsythia, and some herbaceous plants. In nurseries, even Monterey pine seedlings have been killed by this bacterium.

Sources

- On or in bud and twig tissue
- In cankers formed the previous season
- In or on grasses and herbaceous weeds

Effects

Pseudomonas invades damaged tissue and produces a toxin that kills surrounding cells where the bacteria can then multiply. Also, when present on plants, it produces a protein around which ice crystals form. As the ice crystals enlarge, they pierce and severely damage the plant cells. These damaged cells are then colonized by *Pseudomonas*.

Spread

- Wind-driven rain
- Insects
- Use of infected budwood and nursery stock
- On pruning tools
- In plant debris and sap, scattered by weed-eaters and rotary mowers

Management

- Do not use infected plants as stock or sources of budwood.
- Avoid planting susceptible species in frost-prone areas.
- Avoid fertilization practices that result in very succulent growth in the early spring or in the fall.
- Prune in the winter or very early spring.
- Disinfect pruning shears between plants.
- Resistance: ‘Edith Cavell’, ‘Glory’, and ‘Pink Elizabeth’ common lilac varieties are less susceptible than many other cultivars. *Syringae josikaea*, *S. komarowii*, *S. microphylla*, *S. pekinensis*, and *S. reflexa* have greater resistance than common lilac (*Syringa vulgaris*).
- Fall sprays of copper or combinations of copper and mancozeb are reported to reduce bacteria populations. Great care must be exercised if these sprays are used in the spring since young tissue is easily damaged by copper. *Note:* Some populations of *Pseudomonas syringae* are resistant to copper.

NEMATODE-CAUSED DISEASES

Nematodes are soil-dwelling, nonsegmented roundworms, usually less than 0.5 millimeter (0.02 inch) long. Those that feed on plants have a hollow, spearlike mouth part (stylet) that is pushed into the plant cell. The worm forces enzymes through its hollow stylet into the cells where cell components are digested and then drawn back into the nematode's digestive system through the stylet.

The life histories and longevity of plant parasitic nematodes vary greatly from species to species. While some live inside host tissue and produce two or more generations per year, others live outside the plant and feed on outer cell layers, and others may have only one generation per year. Certain species lay hundreds of eggs in a season while others lay very few.

Those nematodes causing damage on woody ornamentals belong to the genera *Meloidogyne* (root knot), *Criconebella* (ring), *Pratylenchus* (lesion), *Tylenchorhynchus* (stunt), *Paratrichodorus* (stubby-root), *Rotylenchus* (reniform), and *Xiphinema* (dagger). Often more than one species is found associated with a plant's roots. The effects of mixed populations of nematode species on woody ornamentals are largely unknown.

Always determine first whether the problem indeed is due to nematode activity. Many factors unrelated to nematode feeding can cause symptoms similar to nematode feeding. Both soil and roots should be sent promptly to the Penn State Plant Disease Clinic for analysis.

Symptoms

- Plant decline occurs over several seasons
- Chlorosis similar to iron deficiency
- Foliage bronzing (characteristic of boxwood)
- Foliage may die and fall
- Branch dieback
- Small root systems with necrotic or galled areas
- Stunted plants

In nurseries, plants with some of the above symptoms characteristically occur in scattered clumps. Nematodes may already be present in the nursery soil and be spread by tilling, soil movement, and runoff. Nematodes can be brought into a nursery on rooted plants.

Management**NURSERY**

- Field: Fumigate planting area with a registered material before planting. Plant nematode-free material.
- Containers: Use sterile potting mix. Avoid contaminating potting mix with untreated soil. Plant nematode-free material.

HOME OR COMMERCIAL PLANTINGS

- Plant nematode-free material.
- Areas known to be infested can be fumigated before planting by a landscaper or nurseryman licensed to perform fumigation.
- Postplant chemical treatments by homeowners are not recommended. Remove severely affected plants. Plants not severely affected can be grown if watered and fertilized and protected from other environmental stresses.

Host plant	Nematode reaction			
	Root knot	Stunt	Lesion	Ring
Azalea	T	S	O	T
<i>Aucuba japonica</i>	HS	S	O	S
<i>Buxus microphylla</i> (Japanese boxwood)	HS	T	O	O
<i>Buxus sempervirens</i> (American boxwood)	O	T	HS	O
<i>Buxus sempervirens</i> (English boxwood)	O	O	HS	O
<i>Camellia japonica</i>	T	T	O	O
<i>Camellia sasanqua</i>	T	T	O	O
<i>Gardenia jasminoides</i>	S	T	T	T
<i>Gardenia radicans</i>	HS	T	T	T
<i>Ilex cornuta</i> (Chinese holly)				
cv. <i>Burfordi</i>		T	O	T
cv. <i>Rotunda</i>	S	S	O	S
<i>Ilex crenata</i> (Japanese holly)				
cv. <i>Compacta</i>	HS	T	T	S
cv. <i>Convexa</i>	HS	T	O	S
cv. <i>Helleri</i>	HS	S	O	S
cv. <i>Rotundifolia</i>	HS	S	O	S
<i>Ilex vomitoria nana</i> (Yaupon holly)	T	T	O	T
<i>Juniper</i> sp.				
cv. <i>Blue rug</i>	T	T	HS	T
cv. <i>Shore juniper</i>	T	T	O	T
cv. <i>Spiney Greek</i>	T	T	S	T
<i>Ligustrum</i> (privet)	T	T	O	T
<i>Nandina domestica</i>	T	T	T	T
<i>Photinia fraseri</i> (red tip)	T	T	O	T
Rose	S	S	S	T

HS = highly susceptible (severe stunting, branch dieback, and death); S = susceptible (some stunting, but plants will grow satisfactorily); T = tolerant (plants will grow satisfactorily); O = plants have not been tested

Adapted from R. K. Jones, D. M. Benson, and K. R. Barker. "Nematodes and Their Control in Woody Ornamentals in the Landscape." Plant Path Info Note #63. Raleigh: Department of Plant Pathology, North Carolina State University, 1982.

PHYTOTOXICITY

Plant injury (phytotoxicity) may occur when chemicals are employed to protect plants from pests, fertilize plants, regulate plant growth, and so forth. Phytotoxicity can occur in the following situations:

- A material is properly applied directly to the plant during adverse environmental conditions.
- A material is applied improperly.
- A spray, dust, or vapor drifts from the target crop to a sensitive crop.
- Runoff carries a chemical to a sensitive crop.
- Persistent residues accumulate in the soil or on the plant.

Symptoms

- Poor germination, especially if a soil drench was used
- Death of seedlings
- Death of rapidly growing succulent tissues
- Stunting or delayed plant development
- Misshaped or distorted plants, fruits, or leaves
- Russetting or bronzing of leaves or fruit
- Dead spots or flecks on leaves
- Dead leaf tips or leaf margins
- Dead areas between the veins of the leaves

Other Clues

- No signs of plant-pathogenic organisms.
- Injured leaf tissue is sharply defined with little or no color gradation from dead areas into healthy areas.
- Dead spots are of uniform color and may go entirely through the leaf.
- Cropping history indicates that the previous crop or a nearby crop was treated with a chemical to which the injured crop is sensitive.
- Injury occurs over a relatively short period and does not spread from plant to plant.
- Only tissue of a certain age may show damage.
- Plants on ends of rows or ends of benches are primarily affected.

Factors That Influence Phytotoxicity

Chemical. Certain crops are very sensitive to certain chemicals. The crop to be treated must be listed on the chemical label. Some chemicals are persistent. Repeated applications result in accumulation of the chemical to a toxic level.

Formulation. Dusts and wettable powders are generally less phytotoxic than emulsifiable concentrates (EC).

Additives. Adjuvants such as spreaders, stickers, and wetting agents may cause injury.

Concentrations. Using a chemical concentration higher than label recommendation or using it more frequently than the label recommends is illegal and is likely to cause plant injury.

Method of application. Always use the method recommended by the label. Apply the chemical thoroughly and evenly. Spray dripped on the ends of rows or benches when slowing down to begin the next sweep and excessive overlapping result in some plants receiving too much chemical. High-pressure sprays may force chemical into sensitive tissues.

Temperature. Temperatures during and after treatments should be moderate. High temperatures favor chlorinated hydrocarbon and sulfur toxicity. Low temperatures favor oil, carbamate, and organophosphate toxicity.

Humidity or plant wetness. Wet foliage at the time of application or prolonged wetness of foliage after spraying can result in injury.

Growth stage of plants. Seedlings and fast-growing succulent plants are usually sensitive to chemical treatment.

Mixing incompatible chemicals. Can occur when two materials are deliberately applied as a mix or if a material is applied too soon after a previous material was used.

TREE DISEASES THAT CREATE HAZARDS

Certain diseases weaken tree structure and create a hazardous situation where property damage or serious bodily injury could result from falling limbs or the toppling of the entire tree. It is imperative that arborists, landscapers, and grounds maintenance personnel recognize the signs of a particular tree presenting a real hazard.

Fungi, in most cases, are involved in tree diseases that result in the tree becoming a hazard. The activity of these fungi often has the following pattern:

1. A wound occurs through pruning; wind damage; lawn mower injury; excavation for buildings, curbs, or sidewalks; and trenching for water and gas lines, as well as other human activities.
2. The fungus enters the wound and causes a discoloration of the wood. Or a fungus can begin to rot roots directly with no wound required for entry.
3. Enzymes produced by the fungus decay the internal portions of the trunk or limbs to release nutrients for the fungus, greatly weakening the wood fibers.
4. Limbs die and give the crown of the tree an asymmetrical shape. Small twigs and branches may litter the ground under the tree. Wood of the internal portions of the trunk, limbs, or roots is so weakened that physical support is greatly reduced.
5. The fungus begins to reproduce by forming a mushroom, conk, or shelflike structure (fruiting structure in which spores are formed) directly on the limbs, trunk, butt, or root flares or on roots at some distance from the base of the tree.
6. Larger limbs die and may fall. In the case of root rot, the entire tree may topple in a wind storm.

Symptoms and Management

A tree with slowed growth, branch dieback, smaller-than-normal leaves or needles, excessive cone or seed set, premature autumn leaf coloration, or severe winter twig kill may be exhibiting early symptoms of a disease in which one of the fungi noted below is involved. Nothing can be done for the tree once it is infected, nor is it likely that the fungus can be completely eliminated from the soil or general area around the tree once the tree is removed.

A tree with fungal fruiting structures on several limbs, the trunk, butt, or roots should be removed promptly if it is in a location where property damage may occur or where people or pets could be struck by falling limbs or the falling tree. If most of the tree appears healthy, any single branches with fungal fruiting structures should be removed promptly, regardless of the identity of the fungus present.

Many fungi can be involved in these diseases. The following information deals with those fungi most often found in trees that are hazardous. The pages noted below each disease name refer to text and photographs in *Diseases of Trees and Shrubs* by W. A. Sinclair, H. H. Lyon, and W. T. Johnson, 1987 edition, and *Diseases of Trees and Shrubs* by W. A. Sinclair and H. H. Lyon, 2005 edition, Cornell University Press (page numbers listed as 1987 edition; 2005 edition).

***Armillaria*.** Fungi belonging to this genus cause *Armillaria* root rot or shoestring root rot on a wide variety of conifers and hardwoods. The fruiting structure is a fleshy, firm, honey-colored mushroom that forms annually in the autumn in groups of a few up to 100 or more in a cluster. The cap of the mushroom is 1.5 to 6 inches in diameter with a slightly depressed center and may have brown, scalelike spots. Although the cap is usually dry, it may be slimy after a rain. Its stem is 0.5 to 1 inch thick and may be 2 to 6 inches long. The spores are formed on flat, platelike structures (gills) that radiate from the stem toward the margin of the cap. A white fan of fungal growth is often found just under the bark at the base of the infected tree. Dark-brown rhizomorphs (very coarse shoestringlike threads) may be found under the bark or on the surface of the roots or trunk of hardwoods but rarely on conifers. Those hardwoods and conifers most susceptible are ones under stress from multiple years of defoliation by insects (gypsy moth larvae, leaf rollers, and others), drought, mechanical injury, or improper planting (J-rooting of conifers, etc.). Recently transplanted material is very susceptible. The mushroom is edible, but only an expert sure of the identification should attempt to collect and consume it. (308–13; 326–30)

***Fomes fomentarius*.** The fruiting structure of this fungus is hard, gray on top, hoof shaped, and 6 to 8 inches across. This structure enlarges perennially. The underside of the “hoof” is white with millions of tiny pores in which the spores are formed. While cherry, hickory, apple, maple, and other trees are susceptible; beech and birch are most frequently infected. (346; 308–9)

***Ganoderma lucidum*.** This fungus causes a root rot and forms a very distinctive shelflike structure on the wood. Fruiting structures formed annually occur singly or in overlapping clusters, are brown to reddish brown on top with a cream to white-colored margin, and may become 14 inches across. The upper surface may appear to have been varnished. Apple, ash, European beech, birch, cherry, elm, sweetgum, hickory, locust, maple, oak, redbud, sassafras, willow, and other trees are susceptible. (332; 346–51)

***Ganoderma applanatum* (formerly *Fomes applanatus*).** The butt rot caused by this fungus on apple, basswood, beech, birch, cherry, elm, sweetgum, horsechestnut, locust, maple, oak, poplar, spruce, hemlock, sycamore, and willow may take several years to kill the tree but makes the tree very susceptible to windthrow. A very distinctive shelflike fruiting structure forms singly on the wood at or near the soil line. It is brown to reddish brown on top

with a cream to white-colored margin. The brown portion appears to have been varnished. The shelf grows perennially for 5 to 10 years and may reach 8 to 12 inches across. The underside of the shelf is light colored with millions of tiny pores in which the spores are formed. The underside burns brown where scratched and forms an interesting drawing surface, thus the common name “Artist’s Conk.” Infected trees slow their growth rate, have dying branches, and have leaves that are small and yellowed. Although it may require several years for the tree to die, an infected tree poses a hazard. (334; 346–51)

***Inonotus dryadeus* (formerly *Polyporus dryadeus*).** This fungus can cause a root and butt rot, particularly on oaks. Trees may topple before any obvious symptoms are noted. Infected trees often have branch dieback and fewer than normal leaves, which are yellowed. Although the root rot begins well out on the root system, the fungus eventually reaches the butt of the tree where it forms large, tough, irregularly shaped, light-brown to dark-brown shelves at or just above the soil line. With age, these become very rough and dark brown to black. Cutting the shelf reveals a reddish-brown center. The underside of the shelf is brown with millions of tiny pores in which the spores are formed. A sure sign of severe damage to the tree is the presence of the fruiting structures. Infected trees should be removed immediately. (328; 344)

***Laetiporus sulfureus* (formerly *Polyporus sulfureus*).** This fungus forms massive clusters of bright, sulfur-yellow to salmon to bright-orange, shelflike fruiting structures that turn white with age. These initially form in the summer or autumn on the wood of the tree but fall off during the winter. The underside of the fruiting structure has millions of tiny pores in which the spores are formed. New ones form on the wood the following summer and autumn. The margins of young fruiting structures are edible but should be collected and consumed only by experts sure of their identification. The bark where the fruiting structure forms is slightly depressed and cracked. Fruiting occurs long after most of the damage has been done. Infected trees are very prone to wind breakage even before the fungus begins to form fruiting structures and should be removed at the first sign of infection. Ash, beech, cherry, butternut and walnut, elm, pine, spruce, maple, oak, locust, and other trees are susceptible. (346; 310)

FUNGICIDES AND MANAGING FUNGICIDE RESISTANCE

A fungicide disrupts either energy-producing reactions or a chemical-building (synthesis) reaction within the target fungus. The way it kills the fungus is termed the fungicide’s “mode of action.” Certain fungicides, usually systemics, have very specific modes of action and are said to be “at risk” to the development of resistance. An at-risk fungicide may bind to a very specific chemical within the fungus or disrupt one specific step required for the reaction. If the fungus has an alternate pathway to complete the reaction, can break down the fungicide, or prevents the chemical from acting in the fungus, then the fungus is resistant to that fungicide. It is generally accepted that there is a great deal of variation within populations of fungi, and a few individuals in the population are naturally resistant to certain types of chemicals. When the chemical is used, it kills almost all of the sensitive individuals in the population, but the survivors are those few individuals resistant to the action of the chemical. The survivors give rise to the next generation, most of which is resistant to the chemical.

High-risk (1 = low risk; 3 = high risk) chemicals should be used sparingly and in rotation with or mixed with chemicals with different modes of actions. Fungicide Resistance Action Committees (FRAC) developed a numbering system in which chemicals that have the same mode of action have the same FRAC group number (www.frac.info/frac/index.htm). When selecting chemicals for rotation or mixing, choose ones with different FRAC

group numbers (see below) to ensure that you are using ones with different modes of action.

Listed below are some of the commonly used fungicides. Not all fungicides are listed. Chemical, trade names, and availability change frequently. This is not a complete list. It may not be up to date since items change daily.

FRAC group	Class	Common name of active ingredient	Restricted-entry interval (REI)	Trade names (EPA Reg. No.)
1	Benzimidazole	Thiophanate methyl	12	3336 (1001-69) OHP 6672 (51036-329-59807) Fungo Flo (51036-329-59807) Systec 1998 (48234-12)
		Debacarb		Fungisol (7946-14)
2	Dicarboximide	Iprodione	12	Chipco 26GT (100-1138) Chipco 26019 (264-481) Iprodione (51036-361) OHP 26 (432-888-59807) Sextant (51036-361-59807)
		Vinclozolin	12	Curalan (7969-62-58185)
3	Imidazole	Triflumizole	12	Terraguard (400-433)
		Imazalil	24	Fungaflor (499-508)
	Pyrimidine	Fenarimol		Rubigan (62719-134)
	Piperazine	Triforine	12	Triforine (241-355)
		Fenamidone	12	FenStop (432-1389-59807)
	Triazole	Propiconazole	24	Banner MAXX (100-741) Propiconazole (51036-403) Spectator (62719-346-10404) Kestrel (66222-41-81943)
		Triadimefon	12	Strike (3125-436)
		Tebuconazole		Bayleton (432-1360) Tebuject (7946-24)
		Myclobutanil	24	Systhane (707-253) Rally (62719-410)
4	Acylanine	Mefenoxam	0	Subdue MAXX (100-796) Fenox (70252-11-48234)
		Metalaxyl	12	Subdue (100-619)
5	Piperidine	Piperalin	24	Pipron (67690-1)
7	Anilide (carboxamide)	Flutolanil	12	Contrast (45639-208-58185) ProStar (432-1477)
		Oxycarboxin	12	Plantvax (400-144)
11	Strobilurin	Azoxystrobin	4	Heritage (10182-408)
		Kresoxim-methyl	12	Cygnus (7969-124)
		Pyraclostrobin	12	Insignia (7969-184)
		Trifloxystrobin	12	Compass (432-1371)
12	Phenylpyrol	Fludioxonil	12	Medallion (100-769)

(continued on next page)

(continued from page 77)

FRAC group	Class	Common name of active ingredient	Restricted-entry interval (REI)	Trade names (EPA Reg. No.)
14	Aromatic hydrocarbon	PCNB	12	Revere (400-407-10404) Blocker (5481-211) Terraclor (400-399) Defend (5481-444-1001)
	Thiadiazole	Etridiazole	12	Truban (58185-7) Terrazole (400-416) Banrot (58185-10)
17	Hydroxyanilide	Fenhexamid	4	Decree (66330-35-67690)
19	Polyoxin	Polyoxin	4	Veranda (66330-56-459807) Endorse (66330-41-1001)
21	Qil	Cyazofamid		Segway (71512-13-279)
25	Glucopyranosyl antibiotic	Streptomycin		Streptomycin (66222-121)
28	Carbamate	Propamocarb	12	Banol (432-942) Previcur Flex
40	Cinnamic acid derivative	Dimethomorph	12	Stature (241-419-67690)
41	Tetracycline antibiotic	Oxytetracycline		Bacastat (74779-2) Mycoject (7946-18)
	Phthalimide	Captan	96	Captan (66330-29)
M	Chloronitrile	Chlorothalonil	48	Daconil (50534-9)
			12	Echo (60063-7)
			12	PathGuard (60063-7-499)
			48	Exotherm Termil (70-223)
			12	Concorde (72167-24-1812)
			12	Pegasus (72167-24-1812)
	Copper, complex	Copper sulfate	12	Camelot (1812-381)
			24	Phyton 27 (49538-3)
	Copper, fixed	Copper hydroxide	48	Kocide (352-656)
		Cupric hydroxide	48	Champion (55146-1)
	Dithiocarbamate	Mancozeb	24	Dithane (707-180) FORE (707-87) Junction (1812-360) Pentathlon (1818-251)
				Manganese + zinc
				24
				Ferbam
				24
				Ziram
				48
U	Phosphonate	Fosetyl-Al	12	Aliette (432-890)
	Phosphite	Phosphorus acid salts	4	Alude (71962-1-1001) ArborFos (7946-26)
				Potassium phosphite
NC		Potassium bicarbonate	4	Vital (42519-24)
				Armcarb (5905-541-AA)
				Milstop (70870-1-68539)
				Kaligreen (70231-1)
				Remedy (62719-70) Agricure (70870-1-1001)
		Sodium hypochlorite		Clorox (5813-55)
				ZeroTol (70299-1)
				TerraClean (70299-5)

FRAC group	Class	Common name of active ingredient	Restricted-entry interval (REI)	Trade names (EPA Reg. No.)
NC		Neem oil	4	Trilogy (70051-2) Triact (70051-2-59807)
		Paraffinic oil	4	JMS Stylet Oil 65564-1) Ultra-Fine Oil (862-23-499)
		Petroleum oil		PureSpray (69526-9)
		Potassium salts of fatty acids	12	M-Pede (62719-515)
		Sulfur	24	Kumulus (51036-352)
		Combined products		
4 + 12		Mefenoxam + fludioxonil	48	Hurricane (100-951)
11 + 7		Pyraclostrobin + boscalid		Pageant (7969-251)
M + M		Mancozeb + copper		Junction Fungicide (1812-360)
1 + M		Thiophanate methyl + chlorothalonil		Spectro 90(1001-72) ConSyst (48234-7)
1 + M		Thiophanate methyl + etridiazole		Banrot (58185-10) Zyban (58185-31)

Biological control agent	Type of organisms	Trade name (EPA Reg. No.)
<i>Agrobacterium radiobacter</i>	Bacteria	Galltrol A (strain 84) (40230-1) Norbac 84C (strain K84) (38087-2)
<i>Ampelomyces quisqualis</i>	Fungus	AG10 (55638-16)
<i>Bacillus subtilis</i>	Bacteria	Companion (GB03 strain) (71065-1) Serenade (69592-4) Rhapsody (QST 713 strain) (69592-10) Cease (QST 713 strain) (69592-19-68539)
<i>Candida oleophila</i>	Fungus (yeast)	Aspire (55638-29)
<i>Streptomyces lydicus</i>	Actinomycete (funguslike bacteria)	Actinovate (73314-1) Actino-Iron (73314-2)
<i>Streptomyces griseoviridis</i>	Actinomycete (funguslike bacteria)	Mycostop (64137-5)
<i>Trichoderma harzianum</i>	Fungus	PlantShield (68539-4)
<i>Trichoderma virens</i>	Fungus	SoilGard (70051-3)

CONTROL MEASURES FOR DISEASES OF SPECIFIC PLANTS

The pages noted below each disease name refer to text and photographs in *Diseases of Trees and Shrubs* by W. A. Sinclair, H. H. Lyon, and W. T. Johnson, 1987 edition, and *Diseases of Trees and Shrubs* by W. A. Sinclair and H. H. Lyon, 2005 edition, Cornell University Press (page numbers are listed as 1987 edition; 2005 edition).

Individual fact sheets with photographs of much of the information below can be found by going to the Penn State homepage (www.psu.edu) and typing the name of the plant followed by “diseases” into the search box. (Example of a keyword search: dogwood diseases.)

Trade names (product names) for the active ingredients noted below can be found in the tables on pages 77–79 of this manual.

Useful references include the disease compendium series available from the American Phytopathological Society (APS Press Customer Service, 3340 Pilot Knob Road, Saint Paul, MN 55121-2097; phone: 1-800-328-7560; fax: 1-651-454-0766; e-mail: aps@scisoc.org; Web site: www.shopapspress.org). APS disease compendia and CDs of photographs contained in the compendia are available for herbaceous perennials, pines, azalea and rhododendrons, roses, elm, flowering potted plants, chrysanthemums, palms, foliage plants, and many other plants.

Disease	Symptoms	Pathogen/cause	Management
AMELANCHIER (SHADBUSH, SERVICEBERRY)			
Fire blight (162; 376)	Infected flowers are killed and often remain attached throughout the season. The ends of twigs and branches become brown or black and may curl over into a shepherd's crook shape. Dead leaves may remain attached to the tree. Cankers formed the previous season may ooze a cloudy liquid during wet spring weather. Branches will be killed as slightly sunken cankers enlarge into larger branches and even into the main trunk.	<i>Erwinia amylovora</i>	During dormancy when the weather is dry, prune infected branches, cutting at least 4 inches below the base of the canker. Disinfect pruning tools frequently. Fertilize carefully to avoid promoting excessive succulent growth. Remove root suckers and water sprouts while they are small. Remove nearby unwanted plants that are susceptible to fire blight.
Rust (242–48; 260–68)	Brownish-orange spots up to ¼ inch in diameter form on leaves. These spores spread to and infect junipers.	<i>Gymnosporangium</i> spp.	Do not plant close to junipers. Remove unwanted junipers from the vicinity. Apply myclobutanil.
Witches' broom (20; 14)	Abnormal numbers of shoots develop along branches. Black fungal growth coats the undersides of leaves.	<i>Apiosporina</i>	No control is recommended.
ARBORVITAE			
Branchlet death (498; 520)	The oldest branchlets turn brown in autumn and fall off.	Normal browning	Branchlets rather than scale leaves are shed in autumn as a normal part of the plant's development.
Kabatina twig blight (138; 146)	Tips of one-year-old branches die and turn brown or ash gray. These remain on the shrub for many months. Larger branches can be invaded and girdled. On the dead tissue where it meets the still-living wood, small, black, pimplelike fungal fruiting structures form. Microscopic examination reveals oval, colorless spores. See “Phomopsis” below.	<i>Kabatina thujae</i>	Prune and destroy infected twigs and branches. Both Kabatina and Phomopsis twig blight can occur on the same plant. Apply mancozeb to protect the foliage.
Pestalotiopsis tip blight (128; 190)	Twig tips turn tan to brown in color and have black, pimplelike fungal fruiting structures dotting their surface.	<i>Pestalotiopsis funerea</i>	Protect plants from winter injury, drought, and other stresses. Apply copper to protect foliage.
Phomopsis twig blight (138; 146)	Tips of branches die and turn brown or ash gray. These remain on the shrub for many months. Larger branches can be invaded and girdled. On the dead tissue where it meets the still-living wood, small, black, pimplelike fungal fruiting structures form. Microscopic examination reveals both oval and long, threadlike colorless spores. See “Kabatina” above.	<i>Phomopsis juniperovora</i>	Prune and destroy infected twigs and branches. Both Kabatina and Phomopsis twig blight can occur on the same plant. Apply thiophanate methyl when new growth is present.

Disease	Symptoms	Pathogen/cause	Management
ASH			
Anthracnose (106; 98)	Young unfolding leaves are distorted and develop greenish-brown to dark-brown spots at their tips, along their margins, and between the veins. When fully expanded leaves are attacked, light-brown to tan blotches form. Severely infected leaves fall prematurely. Infected young twigs are girdled and killed. Disease severity is greatest on the lower branches. Fungal fruiting structures (acervuli) form in the infected tissues and are only slightly darker in color than the spots. A magnifying glass is required to find the acervuli in the spots.	<i>Gloeosporium aridum</i>	Remove and destroy infected twigs and branches during dormancy. Rake and remove fallen leaves in the autumn. Apply chlorothalonil, mancozeb, or thiophanate methyl + mancozeb as the young leaves and twigs are forming to protect them against initial infections. Continued applications are required until the weather becomes dry and daily temperatures average above 65°F.
Decline (446; 398)	Tree growth slows. Tufts of numerous branches form. Branch dieback progresses until much of the tree is dead.	Exposed site; heavy, poorly drained soils; drought; canker-causing fungi, viruses, nematodes, and mycoplasma-like organisms combine to weaken and kill the tree	Protect the tree from as many stresses as possible.
Ganoderma root rot (334; 348–50)	Branches dieback as a root rot develops. A very distinctive shelflike fungus grows on the wood annually singly or in overlapping clusters. These shelves are brown to reddish brown on top with a cream to white margin and may become 14 inches across. The upper surface may appear to have been varnished.	<i>Ganoderma lucidum</i>	The appearance of the fungus on the tree is the last sign that the tree is severely diseased. Remove the tree immediately if it is in a location where falling limbs or the falling tree poses a threat to life or property.
Laetiporus root rot (346; 310)	The bark is slightly depressed and cracked in areas on trees with dying limbs. Infected trees are very prone to wind breakage. Massive clusters of bright, sulfur-yellow to salmon to bright-orange, shelflike fruiting structures that turn white with age initially form in the summer or autumn on the wood of the tree but fall off during the winter. The underside of the fruiting structure has tiny pores in which the spores are formed. New shelves form on the wood the following summer and autumn. Fruiting occurs long after most of the damage has been done.	<i>Laetiporus sulfureus</i> (formerly <i>Polyporus sulfureus</i>)	Remove the tree at the first sign of infection since it poses a very serious threat to life and property.
Rust (252; 270)	In the spring along the East Coast, yellow-orange spots form on the leaves of white and green ash. Leaves become distorted as orange fungal fruiting structures form on the underside of leaves and on petioles. Cankers form on twigs, and trees can be defoliated prematurely. The spores formed on ash blow to and infect <i>Spartina</i> (cordgrass) in salt marshes where the fungus overwinters.	<i>Puccinia sparangioides</i>	Apply chlorothalonil or mancozeb in the spring to protect young leaves and twigs of trees usually found with the disease. Trees usually free of the disease should not be sprayed.
Yellows (394; 390, 398)	Twig and trunk growth slows to less than half of the growth rate before infection. Bud break is 1 to 2 weeks earlier than normal. Foliage appears to be in tufts because of the very short internodes. Witches' brooms may form. Leaves may be yellow and smaller than normal. Scattered branches die during the winter. Water sprouts form along branches or at ground level. Early fall coloration is a common symptom. Highly susceptible trees die 1 to 3 years after infection.	Phytoplasma	Leafhoppers and spittlebugs carry the pathogen. Remove infected trees.

Disease	Symptoms	Pathogen/cause	Management
AZALEA AND RHODODENDRON			
Botryosphaeria canker (172–74; 120–22)	Rough, sunken, dark-brown areas form around wounds or natural openings in the bark. The wood of a recently killed branch is lighter brown than the pith. Dead bark falls off the cankered area. Leaves on affected branches wilt as affected branches die. Chocolate-brown cankers enlarge along the branch more quickly than around its circumference. Tiny black fungal fruiting structures that pepper the dead bark are most easily seen on the light tan bark.	<i>Botryosphaeria dothidea</i>	Irrigate plants to prevent drought stress, which predisposes the plants to this canker. Prune infected branches, cutting back to where growth will resume. Do not leave large stubs of nongrowing tissue. Disinfest the pruning shears frequently. No chemicals adequately control this disease. Rhododendron hybrids considered to have some resistance include Boursault, Cunningham's White, English Roseum, Lebar's Red, Roseum Elegans, and Roseum 2.
Botrytis blight (60; 72)	Small, water-soaked lesions develop on petals. Gray fungal growth covers infected petals.	<i>Botrytis cinerea</i>	Space plants to ensure good air circulation and to avoid excessively high humidity. Remove fading flowers and yellowing leaves. Apply <i>Streptomyces</i> , <i>Bacillus subtilis</i> , <i>Trichoderma</i> , chlorothalonil, copper, copper sulfate, cupric hydroxide, iprodione, fludioxanil, mancozeb, mancozeb + thiophanate methyl, polyoxin, or thiophanate methyl to protect healthy tissue.
Cercospora leaf spot (88; 34)	Circular to irregular brown spots up to ½ inch in diameter form on leaves, especially lower leaves. Spots may become tan in the center and may have a yellow halo. Dark-brown, pimplelike fungal fruiting structures form within the spots. Infected leaves may fall.	<i>Pseudocercospora handellii</i>	Inspect new plants and do not use if found to be infected. Rake and destroy fallen leaves. Avoid overhead irrigation. Apply chlorothalonil, myclobutanil, cupric hydroxide, mancozeb + thiophanate methyl, or triadimefon to protect leaves before infection in the spring.
Cylindrocladium blight (294; 220)	Leaves turn brown to black and fall in 3 to 4 days. Stems have brown spots on which white masses of spores later form. Or roots die and plants wilt without having leaf spots form. Plants die rapidly.	<i>Cylindrocladium scoparium</i>	Rake and destroy fallen leaves. Use clean, disinfested tools. Remove severely infected plants. Apply thiophanate methyl as a soil drench (may be toxic to some cultivars), trifloxystrobin, or triflumizole.
Leaf and flower gall (26; 250)	Young leaves and flowers become swollen, fleshy, and pale green. These become white due to the formation of spores by the fungus on the surface. Later, the galls become hard and brown. Infection occurs in the spring. The new spores formed on the surface of the galls are dispersed but do not cause more galls to form during that same season. They remain dormant until the following spring.	<i>Exobasidium vaccinii</i>	Remove and destroy all galls before they become white with new spores. If many plants had the disease in previous years and galls were too numerous to pick, apply mancozeb to protect new foliage and flowers as they emerge. Applications can cease when the leaves reach their full size.
Ovulinia petal blight (58; 70)	Pale-white to rust-colored spots form on petals. Spots enlarge rapidly. Petals become slimy and fall apart easily.	<i>Ovulinia azalea</i>	Remove crop debris. Water in a manner that keeps plant surfaces dry. Space plants to ensure good air circulation. Apply thiophanate methyl, chlorothalonil, mancozeb, mancozeb + thiophanate methyl, triadimefon, triforine, or myclobutanil as blossoms open. Chlorothalonil is phytotoxic to some cultivars.

Disease	Symptoms	Pathogen/cause	Management
Phytophthora root rot and top dieback (284–90; 358, 364)	Plants are stunted and wilted. Leaves yellow, and the entire plant eventually dies. Roots with few feeder roots die. Stem wood at the soil level has red-brown discoloration. In the top dieback phase, leaves have dark-brown spots. Shoots die from the tips back as dark-brown cankers form. No obvious fungal fruiting structures are formed. Compare these symptoms to those of botryosphaeria described above because these diseases are readily confused.	<i>Phytophthora</i> spp.	Purchase disease-free plants. Especially inspect southern-grown, containerized material before planting. Use clean, disinfested tools. Avoid overhead watering. Following a diagnosis confirming that the plant is infected, remove infected plants. To protect healthy plants, apply mefenoxam, etridiazole, etridiazole + thiophanate methyl, fosetyl-Al, metalaxyl, phosphates, potassium salts of phosphorus acid, cyazofamid, or propamocarb. Fungicide applications to infected plants merely delay eventual death.
Powdery mildew (16; 8–10)	Faint yellow areas form on expanded leaves. White fungal growth forms on the yellow areas of some cultivars while only small dead spots with no fungal growth occur on other cultivars.	<i>Erysiphe polygoni</i> or <i>Microsphaera penicillata</i>	Apply <i>Trichoderma</i> , <i>Bacillus subtilis</i> , azoxystrobin, chlorothalonil, cupric hydroxide, triflumizole, mancozeb + thiophanate methyl, myclobutanil, polyoxin, paraffinic oil, or triadimefon.
Rhizoctonia web blight (94; 256)	Small tan to black spots form on leaves and expand to engulf the entire leaf. Leaves fall. Webbing may develop. Small plants may die.	<i>Rhizoctonia solani</i>	Maintain good air circulation. Avoid late afternoon watering. Apply <i>Bacillus subtilis</i> , triflumizole, thiophanate methyl, chlorothalonil, fludioxonil, polyoxin, or iprodione.

BEECH

Bark disease (440–42; 184)	Circular to horizontal elliptic cankers form on the bark. Cracks form in the cankered bark. As large areas of bark are affected, the tree is girdled and killed. White woolly specks observed on the bark in August are woolly beech scales. The fungus that invades after scale feeding forms red, pimplelike fruiting structures in the cankers.	<i>Cryptococcus</i> (woolly beech scale) attacks the tree and opens wounds invaded by the fungus <i>Nectria</i>	Control the woolly beech scale. There is no control of the fungus.
Bleeding canker (286; 356–58)	Large cankers form on the major roots and trunk and may extend several feet up the trunk. The fungus enters wounds and succulent roots. Well-defined cankers have reddish-brown margins. Reddish-brown sap oozes from the cankers. Eventually, new leaves remain small and yellow and branches begin to die.	<i>Phytophthora</i> spp.	Remove the infected tree and do not replace it until the soil has been fumigated and aerated thoroughly.
Laetiporus root rot (346; 310)	The bark is slightly depressed and cracked in areas on trees with dying limbs. Infected trees are very prone to wind breakage. Massive clusters of bright, sulfur-yellow to salmon to bright-orange, shelflike fruiting structures that turn white with age initially form in the summer or autumn on the wood of the tree but fall off during the winter. The underside of the fruiting structure has tiny pores in which the spores are formed. New shelves form on the wood the following summer and autumn. Fruiting occurs long after most of the damage has been done.	<i>Laetiporus sulfureus</i> (formerly <i>Polyporus sulfureus</i>)	Remove the tree at the first sign of infection since it poses a very serious threat to life and property.

Disease	Symptoms	Pathogen/cause	Management
BOSTON IVY (PARTHENOCISSUS)			
Leaf spot or black rot (80; 40)	Angular, reddish to gray-brown spots enlarge and turn brown at the margins with tiny, black fungal fruiting bodies in the spots. Dieback occurs if the plant is severely infected.	<i>Guignardia bidwelli</i> f. sp. <i>parthenocissi</i>	Avoid overhead irrigation. Apply thiophanate methyl before or soon after the plants have moisture on their leaves for 48 hours.
BOXWOOD			
Decline	Stunted growth and dieback occur. Young foliage turns grayish green or bronze and finally straw colored. Old leaves fall prematurely. Middle or top branches die. Sunken cankers form at the soil line or on branches in the crotches where dead leaves accumulate. Wood under the sunken canker is blackened.	Attack by various fungi and nematodes adds to damage from winter injury and stress on plants, especially those in poorly drained sites	Protect plants from winter injury and other stresses. Prune dead branches well below cankered areas. Remove dead leaves accumulated among the branches.
Leaf burn (476; 492)	Leaf tips and margins yellow and redden as leaves fall prematurely.	Water stress and low temperature	Protect shrubs from drought and drying winds in the autumn and winter.
Leaf spot	Straw-yellow leaves are dotted with small, black fungal fruiting structures.	<i>Macrophoma candollei</i>	Only leaves weakened by winter injury are infected. Protect plants from wind, salt spray, and salt runoff.
Nematodes (298–302; 430–32)	Growth is stunted, leaves have a bronzed appearance, and the shrub is in decline. Small roots have small brown dead areas which enlarge to engulf the entire root ends.	<i>Pratylenchus</i>	There are no adequate controls once the plant is infected. If a plant is removed, do not replace it with a nematode-susceptible plant unless the site is thoroughly fumigated and aerated first.
CATALPA			
Leaf spot (90, 102–24; 18, 74, 84, 114)	Brown to black spots form on leaves. These spots may drop out or leaves may fall prematurely.	Many different fungi can cause spotting	No control is recommended since little damage occurs.
Powdery mildew (16; 8–10)	White fungal growth develops on the upper surface of the lower leaves.	<i>Microsphaera</i> or <i>Phyllactinia</i>	No control is recommended since little damage occurs.
Verticillium wilt (374; 242)	Purplish to bluish-brown streaks are found under the bark in the sapwood of wilted branches. Wilting often develops on branches on one side of the tree.	<i>Verticillium</i>	Trees may die within a year or may survive to wilt to some extent every year. There are no effective controls. Do not replace a tree killed by verticillium wilt with another catalpa or other species susceptible to the disease.
CHERRY			
Black knot (152; 152)	Dark-brown to black, hard swellings form on twigs and branches. At first these galls are small but continue to enlarge each year, becoming very rough. Each spring, galls are covered with dark, olive-green, feltlike growth. Branches may be girdled and die.	<i>Apiosporina morbosa</i>	Prune and destroy galls, cutting several inches below the gall whenever they are found but especially during dormancy. Remove unwanted <i>Prunus</i> species from the area. If the trunk or a large branch is affected, cut out the gall and also remove about 1 inch of wood around the gall. Apply mancozeb + copper hydroxide just as green tissue is observed and again just before bloom.

Disease	Symptoms	Pathogen/cause	Management
Brown rot (126; 76)	Flowers collapse and brown quickly. Small cankers form on twigs and gum oozes out. Ripening fruits brown and shrivel as they become covered with tan to gray masses of spores. While many fruits fall, some shriveled mummies are left on the tree.	<i>Monilinia fructicola</i>	Apply chlorothalonil, cupric hydroxide, triforine, propiconazole, or ziram when blossoms first open and again at 70 to 90 percent bloom.
Leaf spot (66; 80)	Circular, purple to reddish-brown spots up to 1/8 inch in diameter form on the leaf early in the summer and more spots develop as the season progresses. Spots may fall away, leaving a shot-hole appearance. Infected leaves yellow and fall prematurely.	<i>Blumeriella jaapii</i>	Apply propiconazole, myclobutanil or mancozeb + thiophanate methyl as leaves emerge in the spring.
Leucostoma canker (198; 170)	Branch dieback and multiple perennial cankers occur on infected trees. A gummy substance accumulates in the inner bark and erupts through cracks or lenticels in the bark. The gum becomes a blackened crust around the canker. Trees with freeze damage and those under drought stress are most susceptible.	<i>Leucostoma cincta</i> or <i>L. persoonii</i>	Infection can occur at any time of the year. When the tree is growing, it walls off the fungus. When tree growth slows or stops, the fungus continues invading. Prune cankered limbs and promote tree vigor.
Necrotic ring spot (408–10; 416)	Leafing is delayed in the spring on individual branches or the entire tree. Leaves are smaller than normal and fewer in number. Expanding leaves have light green spots up to 1/4 inch in diameter and dark ring and line patterns. Leaf margins are wavy and blades are rough. Spots on the leaf die and fall out. Bark splitting and branch dieback occur on severely affected plants.	Necrotic ring spot virus	This virus can be transmitted mechanically, through grafting, through seed, and in pollen. Destroy infected trees. Plums and other stone fruits are also susceptible.

CHESTNUT

Blight (186–88; 160)	Slightly sunken or slightly swollen cankers on branches or the trunk are yellow-brown and oval or irregular in shape. As the stems are girdled, the leaves yellow and brown but remain attached to the branch. Water sprouts may develop below the canker. During wet weather, yellowish masses of spores ooze from orange pimplelike fruiting structures that pepper the surface of the canker.	<i>Cryphonectria parasitica</i> (formerly <i>Endothia parasitica</i>)	American and European chestnuts are susceptible. Chinese and Japanese chestnuts are not immune but have some resistance. Remove infected trees.
Leaf spot	Small, circular, yellow to brown spots have concentric rings within them. Spots may drop out and leave a shot hole, or leaves may fall prematurely.	<i>Marssonina ochroleuca</i>	No control is recommended.
Twig canker (Chinese and Japanese chestnuts)	Cankers on any part of the tree girdle and kill the tissue.	<i>Cryptodiaporthe castanea</i>	Prune infected wood.

COTONEASTER

Botryosphaeria canker (172–76; 120, 126–28)	Leaves on affected branches wilt and die. Branches die back and become covered with dark brown to black, pimplelike fungal fruiting structures. Wood under the bark is dark brown.	<i>Botryosphaeria</i>	Trees most susceptible are those under drought stress. Therefore, irrigate to prevent drought stress. Prune infected branches.
Fire blight (162–64; 376)	Infected flowers are killed and often remain attached throughout the season. The ends of twigs and branches become brown or black and may curl over into a shepherd's crook shape. Dead leaves may remain attached to the tree. Cankers formed the previous season may ooze a cloudy liquid during wet spring weather. Branches will be killed as slightly sunken cankers enlarge into larger branches and even into the main trunk.	<i>Erwinia amylovora</i>	During dormancy when the weather is dry, prune infected branches, cutting at least 4 inches below the base of the canker. Disinfest pruning tools frequently. Fertilize carefully to avoid promoting excessive succulent growth. Remove root suckers and water sprouts while they are small. Remove nearby unwanted plants that are susceptible to fire blight.

Fire blight-resistant plants: *Cotoneaster anoenus*, *C. adpressus*, *C. canadensis*, *C. dammeri* var. *radicans*, *C. horizontalis*, *C. microphyllus*, *C. praecox*, and *C. zabelii*

Disease	Symptoms	Pathogen/cause	Management
CRABAPPLE			
Botryosphaeria canker (172–76; 120, 126–28)	Leaves on affected branches wilt and die. Branches die back and become covered with dark-brown to black, pimplelike fungal fruiting structures. Wood under the bark is dark brown.	<i>Botryosphaeria</i>	Trees most susceptible are those under drought stress. Therefore, irrigate to prevent drought stress. Prune infected branches.
Fire blight (162–64; 376)	Infected flowers are killed and often remain attached throughout the season. The ends of twigs and branches become brown or black and may curl into a shepherd's crook shape. Dead leaves may remain attached to the tree. Cankers formed the previous season may ooze a cloudy liquid during wet spring weather. Branches will be killed as slightly sunken cankers enlarge into larger branches and even into the main trunk.	<i>Erwinia amylovora</i>	During dormancy when the weather is dry, prune infected branches, cutting at least 4 inches below the base of the canker. Disinfect pruning tools frequently. Fertilize carefully to avoid promoting excessive succulent growth. Remove root suckers and water sprouts while they are small. Grow resistant cultivars (see list below). Remove nearby unwanted plants that are susceptible to fire blight.
Fire blight-resistant crabapples: 'Adams', 'Callaway', 'David', 'Dolgo', 'Harvest Gold', 'Indian Summer', 'Jewelberry', 'Liset', 'Profusion', 'Red Baron', 'Selkirk', and 'Sentinel'			
Scab (96; 86)	Dull, olive-green, velvety fungal growth develops on the surface of leaves and petioles in the spring. Leaves yellow and fall prematurely, giving the tree a thin, bare appearance by mid-season. Infected fruit have circular, rough spots on their surface.	<i>Venturia inaequalis</i>	Grow resistant cultivars (see list below). Rake and destroy fallen leaves and fruit. Apply propiconazole + chlorothalonil as flower buds begin to show color (early pink) and again 3 weeks later.
Scab-resistant crabapples: 'Adams', 'Baskatong', 'Brandywine', 'Callaway', 'David', 'Dolgo', 'Donald Wyman', 'Malusfloribunda', 'Henry Kohankie', 'Henningi', 'Jewelberry', 'Ormiston Roy', 'Professor Sprenger', <i>Malus seiboldi</i> var. zum cultivar <i>Calocarpa</i> , 'Silver Moon', 'Sugartyme', <i>Malus tschonoski</i> , 'Weeping Candy Apple', 'White Angel', and 'White Cascade' have been observed in many locations to have only slight to moderate scab infections.			
Cedar-apple rust (242–48; 260–68) or Japanese apple rust	Bright-yellow or yellow-orange spots form on leaves. On the upper surface of the leaf spot, small, black fungal fruiting structures form. Later, clusters of cup-shaped structures with fringed edges can be observed on the underside of the infected leaves.	<i>Gymnosporangium juniperi-virginianae</i> <i>Gymnosporangium yamadae</i>	Remove unwanted junipers growing near crabapples. Do not plant junipers close to crabapples. Remove the galls from juniper branches during dormancy. Where the disease seldom occurs or few leaves are infected, no control is necessary. Where disease is frequent and severe, apply chlorothalonil, mycolbutanil, fenarimol, propiconazole, triadimefon, or mancozeb first when crabapple flower bud tissue can be seen and at petal fall.
Frogeye leafspot (176; 126)	Small distinct spots with purple margins form soon after the leaves unfold. Old spots become gray with a concentric pattern within them. Leaves yellow and fall prematurely.	<i>Botryosphaeria</i>	Prune dead twigs and branches and remove them from the vicinity of the tree.

Disease	Symptoms	Pathogen/cause	Management
DOGWOOD			
Anthracnose (122–24; 18, 106) and Decline (404)	Brown spots up to ¼-inch in diameter go entirely through the leaf and have reddish-brown halos. Tiny, dark-brown fungal fruiting structures dot the brown areas. Small, reddish-brown spots without brown centers may pepper portions of the leaf or extend along veins. Also, large, brown blotches of dead tissue may occur on leaf tips, along the margin of leaves, or between the veins. Leaves on branch tips may be completely blighted and remain attached over the winter. Reddish-brown dead spots occur on the flower bracts. Lower twigs and branches die. Small, raised, pimplelike fruiting structures form on the dead twigs. Water sprouts form along the trunk of severely affected trees. The entire tree may be killed over a period of years.	<i>Discula destructiva</i>	Prune and destroy dead twigs and branches during dormancy and when observed during the growing season. Protect trees from drought stress, winter injury, and dogwood borer attack. Rake and destroy fallen leaves. Apply propiconazole, azoxystrobin, myclobutanil, thiophanate methyl + mancozeb, chlorothalonil, or mancozeb, or during bud break to protect new flowers, twigs, and foliage. Kousa dogwood (<i>C. kousa</i>) and hybrids of kousa and native dogwood (<i>C. florida</i>) are resistant to anthracnose and decline and should be used to replace dying trees.
Leaf and flower blight (60; 72)	Irregular, brown, wrinkled patches form on flower bracts and leaves in the spring. Patches of gray mold grow on the patches if the weather remains very humid.	<i>Botrytis cinerea</i>	This disease occurs only if weather conditions are very wet and humid in the spring. Warm, dry weather will curtail the disease.
Crown canker (284; 354)	Leaves are smaller than normal, light green, and exhibit premature fall leaf coloration. Twigs and large branches die as a canker forms at the base of the tree. The canker slowly girdles the tree. During this time, the tree flowers and fruits profusely but eventually dies.	<i>Phytophthora cactorum</i>	Remove the infected tree and do not replace it with another woody ornamental until the soil has been fumigated and aerated. Apply cyazofamid or mefenoxam to nearby dogwoods to protect them from invasion.
Powdery mildew (14–16; 8–12)	White fungal growth develops on the surface of leaves late in the summer and during the autumn.	<i>Erysiphe pulchra</i> or <i>Phyllactinia guttata</i>	Apply <i>Bacillus subtilis</i> , <i>Trichoderma</i> , azoxystrobin, myclobutanil, chlorothalonil, potassium bicarbonate, polyoxin, or triadimefon as soon as symptoms are seen. <i>Cornus kousa</i> , <i>C. sericea</i> , <i>C. mas</i> , <i>C. alternifolia</i> , <i>C. alba</i> , and <i>C. controversa</i> are much more resistant than <i>Cornus florida</i> . The following <i>C. florida</i> cultivars are resistant: ‘Jean’s Appalachian Snow’, ‘Kay’s Appalachian Mist’, ‘Karen’s Appalachian Blush’, and ‘Appalachian Joy’.
Septoria leaf spot (74; 24)	Angular gray to brown spots with yellow or dark purple halos form on leaves. Spots can be up to ¼ inch in diameter. Small dark brown fruiting structures of the fungus are visible within the brown spots.	<i>Septoria cornicola</i>	Apply chlorothalonil to protect new leaves during bud break.
Spot anthracnose (18)	Reddish-purple spots on flower bracts are up to 1/10 inch in diameter. Leaf spots are circular to angular, dark-purple areas less than 1/32 inch in diameter and often drop out, leaving shot holes. Spotting can occur on twigs and fruit also.	<i>Elsinöe corni</i>	See “Anthrachnose” above.

Disease	Symptoms	Pathogen/cause	Management
DOUGLAS-FIR			
Rhabdocline needlecast (40; 58)	During March through May, yellow spots form on the previous year's needles. These enlarge and become reddish-brown patches on an otherwise green needle. These needles then fall.	<i>Rhabdocline pseudotsugae</i> and <i>R. weirii</i>	Place plants in locations where good air circulation is available. Maintain good weed control so that air circulation is not impeded. When approximately 10 percent of the buds have broken in the spring, apply chlorothalonil. Repeat the application 1 week later and again 3 weeks after bud break. If spring is cold and new shoots mature slowly, apply a fourth spray 2 to 3 weeks after the third spray.
Swiss needlecast (40; 58)	From March through June, the previous year's needles gradually brown and fall. Rows of tiny, black fungal fruiting structures line the midrib on the underside of the needles. A magnifying glass is needed to see individual structures.	<i>Phaeocryptopus</i>	Place plants in locations where good air circulation is available. Maintain good weed control so that air circulation is not impeded. When new shoots are 1.5 inches long, apply chlorothalonil or azoxystrobin. Repeat the application 3 weeks later.
Twig blight (136; 130)	A very few twig tips curl downward, turn dark brown, and die.	<i>Diplodia</i>	Prune and destroy blighted tips.
ELM			
Black leaf spot (108; 96)	Small, black, slightly raised, rough spots form on leaves. Leaves yellow and fall prematurely.	<i>Stegophora ulmea</i> (formerly <i>Gnomonia ulmea</i>)	No control is recommended for trees in the landscape.
Botryodiplodia canker (182; 132)	Cankers form on twigs and branches. The junction of cankered and healthy wood is sharply defined under the bark where reddish-brown, infected wood meets white, healthy wood. Leaves on infected branches turn bright yellow and fall without wilting. (Compare to Dutch elm disease and phloem necrosis below.) In the autumn, fungal fruiting structures roughen the bark of infected twigs.	<i>Botryodiplodia</i>	Irrigate to prevent drought stress. Prune infected branches well below the canker. Disinfect pruning tools frequently.
Dutch elm disease (366; 240)	Leaves on one or more branches wilt, yellow, and fall prematurely. Progressively more branches exhibit symptoms. Outer layers of sapwood of affected branches have brown streaks.	<i>Ophiostoma ulmi</i>	See details below. Grow resistant cultivars.

Management of Dutch elm disease: Remove severely infected trees promptly. Peel the bark off the stump to below the soil line. Promptly burn or bury all wood greater than 0.5 inch in diameter. Do not stockpile it for later burning unless it is first tarped and fumigated promptly to kill bark beetles. Midway between elms within 50 feet of the infected elm, trench 2 feet deep to cut root grafts, or drill 2-inch diameter holes 2 feet deep, 6 to 8 inches apart in a line between the infected elm and elms within 50 feet of infected elms. Mix 1 part sodium methyl dithiocarbamate and 4 parts water and pour 1 cup into each hole. Plug the holes with a chunk of sod. This fumigant will kill root grafts.

If less than 5 percent of the crown of a tree exhibits symptoms, find the lowest point of vascular streaking and prune the branch at least 12 feet below that point. Inject benzimidazole or propiconazole fungicide. Maintain good elm bark beetle control.

Treating unwanted elms with cacodylic acid (an herbicide) has been found to kill elms and make them very attractive to elm bark beetles, which carry the fungus, but brood production in those trees is greatly suppressed. Thus, the number of infested elm bark beetles is reduced in the area.

Dutch elm disease-resistant cultivars: 'Accolade', 'Cathedral', 'Discovery', 'Dynasty', 'Frontier', 'Homestead', 'Independence', 'Jefferson', 'Morton Glossy', 'Morton Plainsman', 'Morton Stalwart', 'New Harmony', 'New Horizon', 'Ohio', 'Pathfinder', 'Patriot', 'Pioneer', 'Princeton', 'Prospector', 'Regal', 'Sapporo Autumn Gold', 'Urban', and 'Valley Forge'

Disease	Symptoms	Pathogen/cause	Management
Ganoderma root rot (332; 348–50)	Very distinctive shelflike fruiting structures form annually on the wood singly or in overlapping clusters. They are brown to reddish brown on top with a cream to white margin. Shelves may become 14 inches across. The upper surface may appear to have been varnished. Branches and eventually the entire tree die as the root rotting progresses.	<i>Ganoderma lucidum</i>	A tree with fungal fruiting structures on the trunk, butt, or roots should be removed promptly if it is in a location where property damage may occur or where people or pets could be struck by falling limbs or the falling tree.
Inonotus root rot (328; 344)	Root and butt rot may cause trees to topple before any obvious symptoms are noted. Infected trees often have branch dieback and fewer than normal leaves that are yellowed. Although the root rot begins well out on the root system, the fungus eventually reaches the butt of the tree where it forms large, tough, irregularly shaped, light-brown to dark-brown shelves at or just above the soil line. With age, these become very rough and dark brown to black. Cutting the shelf reveals a reddish-brown center. The underside of the shelf is brown with millions of tiny pores in which the spores are formed.	<i>Inonotus dryadeus</i> (formerly <i>Polyporus dryadeus</i>)	A sure sign of severe damage to the tree is the presence of the fruiting structures. Infected trees should be removed immediately.
Laetiporus root rot (346; 310)	Massive clusters of bright sulfur-yellow to salmon to bright-orange, shelflike fruiting structures that turn white with age initially form in the summer or autumn on the wood of the tree but fall off during the winter. The underside of the fruiting structure has tiny pores in which the spores are formed. New shelves form on the wood the following summer and autumn. The bark where the fruiting structure forms is slightly depressed and cracked.	<i>Laetiporus sulfureus</i> (formerly <i>Polyporus sulfureus</i>)	Fruiting structures form long after most of the damage has been done. Infected trees are very prone to wind breakage even before the fungus begins to form fruiting structures and should be removed at the first sign of infection.
Leaf scorch (386; 388)	Early to midsummer, leaves on a few branches have a marginal leaf burn or scorch. Symptoms increase on the leaves later in the summer. The line marking the boundary between dead and living tissue is wavy and has a definite yellow halo. Leaves usually fall prematurely. More branches become involved in following years.	<i>Xylella fastidiosa</i>	Leafhoppers and spittle bugs carry the bacteria from tree to tree. Infected trees are very attractive to elm bark beetles, which may be carrying the Dutch elm disease fungus.
Elm yellows (elm phloem necrosis) (388; 396)	Leaves yellow over the entire crown of the tree and fall prematurely in summer. Epinasty may occur (leaves droop but are not limp, as in a wilt). Trees die within 1–2 years. Roots are killed early in disease development. The inner bark (phloem) and the outer most layer of xylem (water-conducting tissue) is yellow or butterscotch in color and may have an oil of wintergreen or maple syrup odor if held close to the nose immediately after cutting. If a piece of the discolored bark is placed in a tightly sealed jar, the smell will intensify.	Phytoplasmas	White-banded leafhoppers (<i>Scaphoideus</i>) feeding on the phloem of elms move the phytoplasmas from tree to tree. Allygus leafhopper and others may also be involved. Apply insecticide to suppress leafhopper activity. Remove infected trees. Homestead elm is reported to be resistant to elm yellows and Dutch elm disease.
Wetwood (slime flux; 382; 384)	Foul-smelling liquid oozing from branch stubs, pruning cuts, or cracks in the bark runs down the trunk and leaves gray streaks. Bark and turf where the ooze lands may be killed. Affected wood within the tree has a water-soaked appearance but is rarely rotted.	Many bacteria	Wetwood does no apparent damage to the tree unless the tree comes under some other severe stress. Protect the tree from stresses such as soil compaction, excavation, or drought. Avoid wounding the tree in any way. Do not insert pipes to relieve pressure.

Disease	Symptoms	Pathogen/cause	Management
ENGLISH IVY (HEDERA)			
Bacterial leaf spot (158; 372)	Circular, dark-brown to black spots with yellow halos develop on leaves. Leaves yellow, die, and fall.	<i>Xanthomonas campestris</i> pv. <i>hederae</i>	Purchase plants free of the disease. Discard infected plants. Water in a manner that keeps the surface of the leaves dry. Apply cupric hydroxide, mancozeb + copper, potassium salts of phosphorus acid, or fosetyl-Al to protect leaves.
Fungal leaf spot (114)	Large, irregularly shaped, tan to brown spots have numerous, tiny dark-brown dots (fruiting structures) within them.	<i>Colletotrichum trichellum</i>	Purchase plants free of the disease. Discard infected plants. Water in a manner that keeps the surface of the leaves dry. Apply pyraclostrobin + boscalid, azoxystrobin, polyoxin, or copper.
EUONYMUS			
Anthrachnose (124; 114)	Small spots pepper leaves of evergreen euonymus. An orange-brown, slightly raised stem canker may develop and cause branch dieback.	<i>Glomerella cingulata</i> (asexual stage is <i>Colletotrichum gloeosporiodes</i>)	Avoid overhead watering in the nursery and landscape. Inspect containerized plants and do not use those already infected. Apply chlorothalonil, cupric hydroxide, mancozeb, or thiophanate methyl + mancozeb, polyoxin, or azoxystrobin to protect healthy leaves.
Crown gall (156; 382)	Galls ¼ inch to several inches in diameter form on stems or roots. These are white at first and firm like cauliflower but become hard and dark brown with age.	<i>Agrobacterium tumefaciens</i> carrying a gall-causing plasmid	Purchase gall-free plants. Never plant galled material. Plants not severely affected should be cared for well so that they are not under other stresses. Severely affected plants should be removed. Do not replace the plant with gall-susceptible woody or herbaceous plants. Dip cuttings in <i>Agrobacterium radiobacter</i> .
FORSYTHIA			
Gall (146; 148, 382)	Knobby galls form along branches.	Unknown; crown gall, the fungus <i>Phomopsis</i> , and genetic abnormality have been blamed for this disease but none has been conclusively proven to be the cause	Prune infected branches. Disinfest the pruning shears thoroughly after use.
Twig blight	The ends of lower branches, especially those near the ground, die. Black nodules of fungal tissue are found inside the stems when split open. Young nodules of fungus in the pith are white at first.	<i>Sclerotinia</i>	Avoid overhead watering in the spring. Prune infected branches. Thin the shrub to ensure good air circulation. Apply thiophanate methyl + flutolanil.
HACKBERRY			
Witches' broom (120; 14)	Many short twigs develop close together from a swelling on a branch. The tree may be covered with witches' brooms.	<i>Sphaerotheca phytophila</i> (a powdery mildew) and an eryophyid mite (<i>Eriophyes celtis</i>)	No control recommended.

Disease	Symptoms	Pathogen/cause	Management
HAWTHORN			
Fire blight (162–64; 376)	Flower clusters are killed and turn dark brown to black. Dead leaves and aborted flower parts remain on the tree. Long, slightly sunken cankers are seen where the dead wood meets the live wood. In the spring, slime may ooze from the canker if the weather is warm and wet. No fungal fruiting structures are found in the canker.	<i>Erwinia amylovora</i>	During dormancy when the weather is dry, prune infected branches, cutting at least 4 inches below the base of the canker. Disinfect pruning tools frequently. Use fertilization practices that do not promote excessive succulent growth. Remove root suckers and water sprouts while they are small. Remove unwanted plants that are susceptible to the disease from near cultivated plants.
Fire blight-resistant plants: <i>Crataegus arnoldiana</i> , <i>C. coccinea</i> , <i>C. crus-galli</i> , <i>C. douglasii</i> , <i>C. phaenopyrum</i> , <i>C. prunifolia</i> , <i>C. punctata</i> Ohio Pioneer, and <i>C. viridis</i> Winter King			
Cedar-hawthorn rust (246–48; 260–68)	Orange-yellow spots form on leaves. Severely affected leaves fall prematurely. Green fruit is deformed.	<i>Gymnosporangium globosum</i>	Plant resistant hawthorns including cockspur thorn, yellow fruited thorn, <i>Crataegus intricata</i> , and <i>Crataegus pruinosa</i> . Apply chlorothalonil, propiconazole, fenerimol, flutolanil, mancozeb + thiophanate methyl, or triadimefon azoxystrobin, or myclobutanil at 10-day intervals beginning just as flower bud break occurs. Do not plant close to junipers.
Cedar-quince rust (246–48; 260–68)	Petioles, twigs, and thorns swell and become distorted. Fruit is covered with spore horns during the summer. Orange-yellow spots form on leaves, which, if severely affected, fall prematurely.	<i>Gymnosporangium clavipes</i>	Apply chlorothalonil, mancozeb + thiophanate methyl, azoxystrobin, myclobutanil, tridimefon, propiconazole, fenerimol, or flutolanil, at 10-day intervals beginning just as flower bud break occurs. Do not plant close to junipers.
Leaf blight and fruit rot (126; 76)	Leaves wilt, turn brown, and die in the spring. Flower clusters die. Fruits turn brown, mummify, and fall.	<i>Monilinia johnsonii</i>	Remove and destroy fallen mummified fruits before bud break occurs.
Leaf spot (64; 78)	Many small, reddish-brown to gray leaf spots develop, sometimes with dark-brown borders. Spots may be so numerous that they merge. Infected leaves yellow quickly and fall by August. On twigs, slightly raised, brown, irregular spots form. English hawthorn (<i>Crataegus oxycantha</i>) and ‘Pauls Scarlet’ (<i>Crataegus oxycantha pauli</i>) are very susceptible.	<i>Diplocarpon mespili</i> (<i>Entomosporium</i> , asexual stage)	Rake and destroy fallen leaves. Apply chlorothalonil, azoxystrobin, myclobutanil, mancozeb, copper hydroxide, or mancozeb + thiophanate methyl during bud break and at 10-day intervals during wet weather. Two or three applications may be sufficient. Cease spraying if the weather dries.
HEMLOCK			
Cytospora canker (194; 166)	Slightly sunken cankers girdle and kill branches.	<i>Valsa</i> (<i>Cytospora</i>)	Prune infected branches.
Fabrella needle blight	Needles in the lower part of the tree turn brown and fall in late summer, leaving bare twigs. Fungal fruiting structures appear as small dots on the underside of the needle and are white at first but then darken, lining either side of the main vein.	<i>Fabrella tsugae</i>	No control recommended. Generally, little damage occurs unless the tree is under other stresses such as drought or insect attack.
Rust (258; 276, 284)	Current-season growth is slightly swollen and curled. Orange-yellow spores coat the infected tissue. Infected plant parts die in the summer. Orange-yellow spores develop on poplar leaves where the fungus overwinters.	<i>Melampsora</i>	No control is recommended for this fungus, which overwinters on poplar and then spreads to hemlock and back to poplar.

Disease	Symptoms	Pathogen/cause	Management
HICKORY			
Leaf spot (108; 104)	Irregular, reddish-brown spots on the upper leaf surface form while brown spots occur on the lower leaf surface. In severe cases, leaves may fall prematurely.	<i>Gnomonia caryae</i>	No control is recommended since the disease occurs late in the season and little damage results. However, raking and destroying leaves in the fall can reduce the amount of inoculum near the trees.
HOLLY			
Leaf scorch (242)	Circular to irregular, tan spots appear in early spring or summer. Tiny, black fungal fruiting structures pepper the spot surface as a result of attack by a secondary fungus.	Young leaves formed during cool, damp weather are damaged easily if exposed to hot, dry, windy weather	No control is recommended.
Nematodes (298; 430)	Yellowing, stunting, and twig dieback occur. The root system is small and has dead areas, as well as galls in some cases.	<i>Criconemella</i> , <i>Meloidogyne</i> , <i>Pratylenchus</i> , or <i>Tylenchorhynchus</i>	An analysis of soil and roots must be done to confirm that nematodes are actually causing the symptoms. Care for plants well so that they are not under stress from other factors. If the shrub is replaced, first fumigate and thoroughly aerate the soil.
Phytophthora root rot	Leaves yellow and brown spots develop. Branches and eventually the entire plant die.	<i>Phytophthora cinnamomi</i>	Remove the infected plant. Do not replace it with a woody ornamental unless the planting site is first fumigated and aerated thoroughly. Protect surrounding plants with mefenoxam, cyazofamid, etridiazole, or fosetyl-Al.
Spine spot	Pinhead-sized or larger spots frequently surrounded by a purple halo appear on leaves in late winter and early spring.	Ovipositing by certain insects	No control is recommended.
Tar spot (54; 66)	Small, yellow spots form on leaves and turn reddish brown with a small, yellow halo later in the summer. In the autumn, a flat black, cushion-shaped fungal structure forms beneath the leaf surface.	<i>Rhytisma prini</i>	No control is recommended.
Thielaviopsis or black root rot (294; 222)	Plants are stunted and have branch dieback. Roots are blackened.	<i>Thielaviopsis</i>	Inspect the roots of containerized hollies before planting. Do not use those with blackened roots. Apply thiophanate methyl, tri-flumizole, or thiophanate methyl + etridiazole as a soil drench to protect healthy roots.
HONEYSUCKLE			
Powdery mildew (16–18; 8)	White fungal growth develops on the upper surface of lower leaves.	<i>Microsphaera</i>	If severe, apply <i>Bacillus subtilis</i> , <i>Trichoderma</i> , polyoxin, or myclobutanil.
HORSE CHESTNUT			
Leaf blotch (76, 80; 40)	Small irregular, reddish-brown spots and large blotches with yellow halos form in late June or early July. Most infected leaves brown and fall prematurely. Tiny, black fruiting structures are found in the dead areas.	<i>Guignardia aesculi</i>	Apply mancozeb to protect the foliage of highly valuable trees in early summer. Trees not highly valued should not be treated.

Disease	Symptoms	Pathogen/cause	Management
HYDRANGEA			
Botrytis blight (60; 72)	During wet weather, white to gray fungal growth covers flower clusters. This frequently happens after a frost has damaged flowers.	<i>Botrytis cinerea</i>	Remove infected flowers. Protect flowers with <i>Streptomyces</i> , <i>Bacillus subtilis</i> , <i>Trichoderma</i> , mancozeb, copper, polyoxin, or chlorothalonil.
Leaf spot (122–24; 30–32)	Brown spots form along leaf margins. If the disease is severe, leaves and flowers are killed.	<i>Phyllosticta hydrangeae</i> , <i>Colletotrichum</i> , or <i>Cercospora</i>	Protect new foliage with mancozeb, copper, polyoxin, or chlorothalonil.
Powdery mildew (16; 10)	White fungal growth develops on the upper surface of lower leaves.	<i>Erysiphe polygoni</i>	Apply <i>Bacillus subtilis</i> , <i>Trichoderma</i> , thiophanate methyl, triadimefon, piperalin, myclobutanil, azoxystrobin, chlorothalonil, sulfur, polyoxin, or fenarimol to protect leaves.
Rust (260; 276)	Spores that form on hemlock needles blow to hydrangea leaves. A spore-forming structure develops on the underside of the leaf and results in tiny blisterlike protrusions that release orange-yellow spores. In late summer, reddish-brown spores (teliospores) form on the top and bottom leaf surfaces. These spores give rise to another spore type that blows to and infects hemlocks.	<i>Pucciniastrum hydrangeae</i>	No control is recommended.
JUNIPER			
Cedar-apple rust (240–48; 260–68)	Smooth, round galls on twigs are up to golf ball size. Their surface may be dimpled like a golf ball.	<i>Gymnosporangium juniperi-virginianae</i>	Prune and destroy galls before the spore horns develop. In the nursery, apply azoxystrobin, mancozeb, triadimefon, or mancozeb + thiophanate methyl in the summer.
Cedar-quince rust (240–48; 260–68)	Young leaves and twigs have bright-orange spots that look like paint splatters in the spring. These spots darken and become dull orange to rust colored. Slight twig swellings are not obvious except in the spring when their surface is orange with spores. The bark on infected twigs flakes away, growth slows, and twigs die back.	<i>Gymnosporangium clavipes</i>	Prune and destroy infected twigs before the spore horns develop. In the nursery, apply triadimefon, mancozeb, or mancozeb + azoxystrobin, thiophanate methyl in the summer.
Cercospora blight (86; 32)	In the summer, needles become bronzed, tan, and eventually gray. The needles of the inner and lower branches are affected first. The disease progresses upward on the shrub and outward toward the branch tips. This differs from twig blights which start at branch tips. Dark fungal fruiting structures break through the surface of infected needles. Microscopic examination of the spores reveals dark, multicelled spores that are longer than they are wide. Affected branches thin and fall, giving the shrub an open, bare appearance.	<i>Cercospora sequoiae</i> var. <i>juniperi</i>	The fungus overwinters on the plant, spores are present all year, and infection can occur whenever temperatures are mild and moisture is on the needles. Removal of the plant is better than attempting to control this disease with fungicides. However, copper hydroxide, azoxystrobin, triadimefon, mancozeb, or myclobutanil can be used.
Kabatina twig blight (138; 146)	Tips of branches die and turn brown or ash gray. These remain on the shrub for many months. Larger branches can be invaded and girdled. On the dead tissue where it meets the still-living wood, small, black, pimplelike fungal fruiting structures form. Microscopic examination reveals oval, colorless spores. See “Phomopsis” below.	<i>Kabatina juniperi</i>	Prune and destroy infected twigs and branches. It is possible for both kabatina and phomopsis twig blight to occur on the same plant. If only <i>Kabatina</i> is present, apply mancozeb. Otherwise, apply mancozeb + thiophanate methyl whenever new growth is present on the shrub.

Disease	Symptoms	Pathogen/cause	Management
JUNIPER (continued)			
Phomopsis twig blight (138; 146)	Tips of branches die and turn brown or ash gray. These remain on the shrub for many months. Larger branches can be invaded and girdled. On the dead tissue where it meets the still-living wood, small, black, pimplelike fungal fruiting structures form. Microscopic examination reveals both oval and long, threadlike colorless spores. See "Kabatina" above.	<i>Phomopsis juniperovora</i>	Prune and destroy infected twigs and branches. It is possible for both Kabatina and Phomopsis twig blight to occur on the same plant. If only <i>Phomopsis</i> is present, apply, azoxystrobin, thiophanate methyl. Otherwise, apply mancozeb thiophanate + mancozeb whenever new growth is present on the shrub.
LEUCOTHOE			
Cylindrocladium leaf spot (294; 220)	Dark spots form on leaves. Lesions on stems can girdle and kill them.	<i>Cylindrocladium</i>	Avoid overhead irrigation. Apply triflumizole as a drenching spray.
Cylindrocladium root rot (294; 220)	Plants are stunted. Leaves yellow and wilt as branches die. Many dark-brown to black lesions form on roots, enlarge, and girdle roots. Longitudinal cracks may develop in the stem at the soil line.	<i>Cylindrocladium</i>	Avoid overhead irrigation. Apply polyoxin or triflumizole.
LILAC			
Ascochyta blight (130; 38)	In the spring, the current year's shoots and flower stalks are girdled, wilted, and brown. The base of the dead area is tan to gray and shriveled. In wet weather, dark gray pimplelike fungal fruiting structures dot the dead tissue. In summer and autumn, olive green round leaf spots turn tan and have indefinite edges. Fungal fruiting structures dot the upper surface of the spots.	<i>Ascochyta syringae</i>	Prune infected tissue. Avoid overhead irrigation. Apply thiophanate methyl, thiophanate methyl + mancozeb, or chlorothalonil to protect healthy shoots.
Bacterial blight (160; 368)	Leaves turn completely brown to black and remain attached to the branch. Shoots are girdled and killed. Flower buds are blackened while flower clusters become limp and brown. See "Shoot Blight" below.	<i>Pseudomonas syringae</i>	Avoid overhead watering in the spring. Prune infected branches, cutting well below the diseased tissue. Disinfest the pruning shears between cuts. Apply mancozeb + copper to protect new growth.
Powdery mildew (16; 8)	Dry white fungal growth develops on the surface of leaves. Leaves become distorted.	<i>Microsphaera syringae</i>	Apply paraffinic oil as soon as mildew is observed. Reapply the material if mildew reappears. Or apply <i>Bacillus subtilis</i> , <i>Trichoderma</i> , thiophanate methyl + mancozeb, triadimefon, kresoxim methyl, chlorothalonil, propiconazole, myclobutanil, or triforine.
Shoot blight (358, 360)	Shoots are killed extensively, up to 4 to 5 feet, and turn very black. Root sprouts at the base of the plant are killed and blackened. See "Bacterial Blight" above	<i>Phytophthora cactorum</i>	Remove the infected plant; do not replace it with plants susceptible to <i>Phytophthora</i> . Avoid overhead watering of healthy plants.
Witches' brooms (396; 394)	Short, thin twigs and branches originating from one area of the stem form dense clusters. Leaves may be distorted, small, and yellow. Twigs forming the brooms are abnormally upright and often retain green leaves too long in the autumn and die back in winter.	Phytoplasmas	Prune affected branches. Remove severely infected plants.

Disease	Symptoms	Pathogen/cause	Management
MAPLE			
Anthracnose (104)	Norway maple: narrow, purple to brown streaks occur along the leaf veins. Sugar maple: large, irregular, brown or red-brown areas develop along and between the veins similar to injury due to drought and heat stress. Small, brown fruiting structures of the fungus are found near the affected leaf veins. Under very wet spring conditions, some defoliation can occur.	<i>Discula (Gloeosporium)</i>	Prune dead twigs and branches. Rake and destroy fallen leaves. Usually, little damage occurs and no treatment is necessary. In a nursery situation, apply mancozeb or mancozeb + thiophanate methyl at bud break and at 7- to 10-day intervals until the weather dries and the daily average temperature is above 65°F.
Bacterial leaf scorch (red maple) (384–86; 388)	Leaf margins on localized, individual branches brown in mid- to late July. The light-brown area is separated from green tissue by a dark reddish-brown band and a narrow but distinct yellow halo. Leaves may fall in August.	<i>Xylella fastidiosa</i>	Leafhoppers and spittle bugs carry the bacteria from tree to tree. Promote plant vigor by protecting the tree from stresses.
Bleeding canker (286; 354)	Reddish-brown cankers develop in the inner bark of the main trunk and branches. The bark over the canker becomes sunken, and reddish-brown sap oozes out. Leaves wilt and branches die.	<i>Phytophthora cactorum</i>	Remove the infected tree and do not replace it with a woody ornamental until the soil has been fumigated and aerated thoroughly.
Decline (444; 460)	Tree growth slows. Branch dieback progresses until much of the tree is dead.	Depending on the site, combinations of poor soil aeration, poor soil drainage, deicing salt damage, high temperatures at the site, drought, excavation damage, soil compaction, paving close to trees, verticillium wilt, and armillaria root rot weaken and kill the tree	Protect the tree from stresses, particularly insect defoliation.
Fomes root rot (346; 308)	A fungal fruiting structure that is hard, gray topped, hoof shaped, and 6 to 8 inches across and enlarges perennially. The underside of the “hoof” is white with tiny pores in which the spores are formed. Heart rot and dying limbs may be apparent.	<i>Fomes fomentarius</i>	A tree with fungal fruiting structures on the trunk should be removed promptly if it is in a location where property damage may occur or where people or pets could be struck by falling limbs or the falling tree.
Ganoderma root rot (332; 346–48)	Very distinctive shelflike fruiting structures form annually on the wood singly or in overlapping clusters. They are brown to reddish brown on top with a cream to white margin, and may reach 14 inches across. The upper surface may appear to have been varnished. Branches and eventually the entire tree die as the root rotting progresses.	<i>Ganoderma lucidum</i>	A tree with fungal fruiting structures on the trunk, butt, or roots should be removed promptly if it is in a location where property damage may occur or where people or pets could be struck by falling limbs or the falling tree.
Laetiporus root rot (346; 310)	Massive clusters of bright sulfur-yellow to salmon to bright-orange, shelflike fruiting structures that turn white with age initially form in the summer or autumn on the wood of the tree but fall off during the winter. The underside of the fruiting structure has tiny pores in which the spores are formed. New shelves form on the wood the following summer and autumn. The bark where the fruiting structure forms is slightly depressed and cracked.	<i>Laetiporus sulfureus</i> (formerly <i>Polyporus sulfureus</i>)	Fruiting structures form long after most of the damage has been done. Infected trees are very prone to wind breakage even before the fungus begins to form fruiting structures and should be removed at the first sign of infection.
Leaf spot (76; 92)	Leaf spots up to ¼ inch in diameter with a pronounced purple border are round or irregular in shape. Tiny, black fungal fruiting structures dot the upper surface of the spots.	<i>Phyllosticta minima</i>	See anthracnose control above.
Powdery mildew (8–10)	White fungal growth develops on the upper surface of leaves in the late summer and autumn.	<i>Phyllactinia</i>	No control is necessary since the disease begins too late to cause significant damage.

Disease	Symptoms	Pathogen/cause	Management
MAPLE (continued)			
Tar spot (54; 66)	Oval to irregularly shaped, shiny, black spots up to ½ inch in diameter form on the leaves of silver or red maples.	<i>Rhytisma acerinum</i> or <i>R. punctatum</i>	No control measures are necessary.
Verticillium wilt (374; 242–44)	Early symptoms of verticillium wilt include heavy seed production, leaves that are smaller than normal, and browning of the margins of leaves. Frequently, the foliage on only one side of a tree wilts. The wood under the bark of wilt-ing branches is discolored with green to black streaks. The smallest branches may not exhibit the discoloration.	<i>Verticillium</i>	Do not replant susceptible species where a specimen was killed by <i>Verticillium</i> . When a tree exhibits mild symptoms, prune out affected limbs and water to maintain tree vigor. Some trees recover. Do not fertilize heavily.
MOUNTAIN ASH			
Cytospora canker (198; 172)	Trunks and larger branches have brown, sunken cankers, circular or irregular in shape, which gradually enlarge and girdle the wood. Black, pimplelike fruiting structures form on infected bark. Yellow threads of spores ooze out of the fruiting structures during wet weather.	<i>Cytospora</i>	Prune infected limbs well below the canker. Disinfest the pruning tools thoroughly between cuts. Remove severely infected trees.
Fire blight (162–64; 376)	Flower clusters are killed and turn dark brown to black. Dead leaves and aborted flower parts remain on the tree. Long, slightly sunken cankers are seen where the dead wood meets the live wood. In the spring, slime may ooze from the canker if the weather is warm and wet. No fungal fruiting structures are found in the canker. Flower clusters are killed and turn dark brown to black.	<i>Erwinia amylovora</i>	During dormancy when the weather is dry, prune infected branches, cutting at least 4 inches below the base of the canker. Disinfest pruning tools frequently. Use fertilization practices that do not promote excessive succulent growth. Remove root suckers and water sprouts while they are small. Remove unwanted plants that are susceptible to the disease from near cultivated plants. Apply copper hydroxide or copper hydroxide + mancozeb. <i>Sorbus aucuparia</i> and <i>S. intermedia</i> are resistant.
Leaf spot (78; 22)	Round to irregular, brown spots form on leaflets. Tiny, black fruiting structures form within older spots.	<i>Phyllosticta</i>	No control is recommended.
MOUNTAIN LAUREL			
Leaf spot (88; 34)	Large, tan to brown spots on leaves have a dark line on their perimeter and a purple halo. Dark-brown, pimplelike fruiting structures are scattered within the spot.	<i>Pseudocercospora kalmiae</i>	Avoid overhead irrigation. Apply myclobutanil, chlorothalonil, or triadimefon.
OAK			
Anthraxnose (110; 100)	During wet weather, young leaves are blighted as bud break occurs or large dead areas form between the leaf veins primarily on lower branches. Winter twig dieback may occur. Slightly raised, brown dots (fungal fruiting structures) form on the lower surface of leaves and on dead twigs. Often, these can be seen without a magnifying glass. However, magnification helps greatly in finding these small structures.	<i>Apiognomonia</i>	Only highly valued trees should be treated with a fungicide to protect new twigs and leaves as they form. Otherwise, prune and destroy dead twigs and branches during dormancy. Apply chlorothalonil, azoxystrobin, propiconazole, copper sulfate, copper hydroxide, myclobutanil, or mancozeb.

Disease	Symptoms	Pathogen/cause	Management
Armillaria root rot (308; 330)	Branches die back. A fleshy, firm, honey-colored mushroom forms annually in the autumn in groups of a few to 100 or more in a cluster at the tree base. The cap of the mushroom is 1.5 to 6 inches in diameter with a slightly depressed center and may have brown, scalelike spots. Although the cap is usually dry, it may be slimy after a rain. Its stem is 0.5 to 1 inch thick and may be 2 to 6 inches long. The spores are formed on flat, plate-like structures (gills) on the underside of the cap. A white fan of fungal growth is often found just under the bark at the base of the infected tree. Dark-brown rhizomorphs (very coarse shoestring-like threads) may be found under the bark or on the surface of the roots or trunk.	<i>Armillaria</i>	Remove infected trees. Protect healthy trees in the area from stresses, especially those that cause defoliation, such as insect feeding (gypsy moth larval feeding or leaf rollers).
Bacterial leaf scorch (386; 388)	Browning of the oldest leaves along their margins begins in mid to late summer on one branch or a few branches on inner and lower portions of the tree. A wavy, reddish-brown band sometimes develops between the brown and green tissue of the leaf. The browning of leaves progresses to include more leaves toward the ends of branches. Branches and eventually entire trees die.	<i>Xylella fastidiosa</i>	Leafhoppers and spittle bugs carry the bacteria from tree to tree. See information on this disease under to "Common Plant Diseases" section of this manual. Promote plant vigor by protecting the tree from stresses. Oxytetracycline injection will suppress symptoms each year the tree is injected but does not cure the tree.
Bacterial wetwood or slime flux (382; 384)	Dark streaks of sap, usually foul smelling, ooze from holes or cracks in the bark. The heartwood is discolored dark brown. Pin oaks are especially prone to wetwood.	Various bacteria can be involved	Avoid wounding the bark of affected trees. Care for the tree as normal, minimizing any stresses.
Ganoderma root rot (332–34; 348)	A butt rot may take several years to kill the tree but makes the tree very susceptible to windthrow. A distinctive shelflike fruiting structure forms singly on the wood at or near the soil line. It is brown to reddish brown on top with a cream to white margin. The brown portion appears to have been varnished. The shelf grows perennially for 5 to 10 years and may reach 8 to 12 inches across. The underside of the shelf is light colored with tiny pores in which the spores are formed. The underside turns brown where scratched and forms an interesting drawing surface, thus the common name "artist's conk." Infected trees slow in growth rate and have dying branches with small, yellowed leaves.	<i>Ganoderma applanatum</i> (formerly <i>Fomes applanatus</i>)	Although it may require several years for the tree to die, an infected tree poses a hazard. A tree with fungal fruiting structures on it should be removed promptly if it is in a location where property damage may occur or where people or pets could be struck by falling limbs or the falling tree.
Inonotus root rot (328; 316)	A root and butt rot develops. Trees may topple before any obvious symptoms are noted. Infected trees often have branch dieback and fewer than normal leaves that are yellowed. Although the root rot begins well out on the root system, the fungus eventually reaches the butt of the tree where it forms large, tough, irregularly shaped, light- to dark-brown shelves at or just above the soil line. With age, these become very rough and dark brown to black. Cutting the shelf reveals a reddish-brown center. The underside of the shelf is brown with tiny pores in which the spores are formed. A sure sign of severe damage to the tree is the presence of the fruiting structures.	<i>Inonotus dryadeus</i> (formerly <i>Polyporus dryadeus</i>)	Infected trees should be removed immediately.

Disease	Symptoms	Pathogen/cause	Management
OAK (continued)			
Laetiporus root rot (346; 310)	Massive clusters of bright sulfur-yellow to salmon to bright-orange, shelflike fruiting structures that turn white with age initially form in the summer or autumn on the wood of the tree but fall off during the winter. The underside of the fruiting structure has tiny pores in which the spores are formed. New shelves form on the wood the following summer and autumn. The bark where the fruiting structure forms is slightly depressed and cracked.	<i>Laetiporus sulfureus</i> (formerly <i>Polyporus sulfureus</i>)	Fruiting structures form long after most of the damage has been done. Infected trees are very prone to wind breakage even before the fungus begins to form fruiting structures and should be removed at the first sign of infection.
Leaf spot (44)	In mid- to late summer, irregular, dark-brown spots form between the leaf veins and enlarge up to $\frac{3}{8}$ inch in diameter and become reddish brown, often with a yellow halo. Trees with iron chlorosis and those under other stresses are most severely affected.	<i>Tubakia</i> (formerly <i>Actinopelte</i>)	Little damage results from this disease, which does not cause defoliation. No control action is recommended for landscape situations. Mancozeb or propiconazole can be applied in the nursery beginning at bud break.
Oak leaf blister (22; 4)	Spots $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter turn light green as young leaves expand. Leaf cells in the spots multiply more than surrounding cells, and a raised blisterlike buckling of the leaf results. As the spots age, their upper surface becomes covered with a buff white coating of fungal growth that later turns brown. The leaves usually do not fall prematurely.	<i>Taphrina caerulescens</i>	Fungicide application in the landscape is not necessary because the leaves are seldom severely spotted and do not fall prematurely. Although infections may be extensive some years, little damage actually results. In the nursery, chlorothalonil or mancozeb must be applied late in dormancy prior to bud break to prevent spotting. Once bud break has occurred and symptoms are visible, it is too late to spray.
Powdery mildew (14; 8–12)	White fungal growth develops on the surface of leaves in the autumn.	<i>Microsphaera</i>	This disease develops so late in the year that no significant damage occurs. No control is recommended. Where trees are being readied for fall sale, apply triadimefon, polyoxin, azoxystrobin, or myclobutanil.
Oak wilt (238)	Most oaks but especially red oaks are susceptible. White oaks tend to be resistant. Leaves at the top of the tree turn brown along the tips and margins, wilt, and soon begin to fall while there is still some green color left in them. This damage progresses down the tree. Twigs and branches die. Brown streaks often observed in the outer sapwood are sometimes difficult to find. Trees usually die within a year after infection.	<i>Ceratocystis fagacearum</i>	Remove infected trees as soon as the diagnosis is made. Do not stack the wood since insects in it may leave and carry the fungus to neighboring trees. Cut root grafts first and then inject mildly infected tree and neighboring oaks with propiconazole. This will not eliminate the fungus from root systems but will inhibit the fungus in twigs and branches.

Disease	Symptoms	Pathogen/cause	Management
PACHYSANDRA			
Volutella blight	Brown to tan spots on the leaves are small at first but enlarge and may cover the entire leaf. Concentric line patterns form within the brown spots as leaves yellow and fall. Infected stems become dark brown to black in color and die. Under moist conditions, salmon to pink masses of fungal spores form on the surface of dead stems. Large patches of plants are killed.	<i>Pseudonectria pachysandricola</i> (<i>Volutella</i>)	Inspect transplants carefully and discard infected material. Avoid planting in areas of heavy shade or areas where moisture will be retained on leaves for prolonged periods. In established beds, remove diseased plants and thin the bed. Remove fallen leaves and other debris that inhibits good air circulation. Protect plants from winter injury and de-icing salt runoff. Control oyster-shell and euonymus scales and mites. Fertilize plants moderately to prevent nutrient deficiencies. Avoid using sprinkler irrigation but protect plants from drought stress. Apply copper hydroxide, chlorothalonil, mancozeb, or thiofanate methyl + mancozeb to protect plants when the weather is wet.
PIERIS			
Phytophthora root rot (209; 364)	Plants are stunted and then wilt, yellow, and die. Roots with few feeder roots die. Stem wood at the soil level has red-brown discoloration. No obvious fungal fruiting structures are formed.	<i>Phytophthora</i>	Purchase disease-free plants. Especially inspect southern-grown, containerized material before planting. Use clean, disinfested tools. Following a positive diagnosis, remove infected plants. Avoid overhead watering. Apply etridiazole, fosetyl-Al, phosphates, cyazofamid, or mefenoxam to protect healthy plants.
PINE			
Cyclaneusma needlecast (38; 54)	Needles on Scots and Austrian pines yellow and have dark-brown bands from September through December the year after infection or from April through June, 2 years after infection. The brown bars become filled with a tan fungal fruiting structure, which opens wide under very moist conditions.	<i>Cyclaneusma minus</i>	Space plants and control weeds to ensure good air circulation around the tree. Apply chlorothalonil first in mid-March and again in early May, mid-June, mid-August, and mid-October to protect the needles since they can be attacked any time the temperature is above 32°F and water is on the needle.
Diplodia tip blight (136; 130)	Shoot tips are attacked in the spring and a canker forms at the base of the new shoot. Resin oozes from the canker. This often occurs on scattered branches low on the tree at first. Close examination of the dead and dying tips reveals that the tissue was killed before the needles reached full size. Lower branches are killed in succeeding years. Old cones and dead needles persist on the tree and have small, dark-brown to black, pimple-like fruiting structures peppering their surface.	<i>Diplodia sapinae</i> (formerly <i>Sphaeropsis</i>)	Do not plant young, healthy two- and three-needled pines near older, infected pines. Remove infected twigs to reduce the amount of fungus in the tree. Apply azoxystrobin, thiophanate methyl, or copper salts beginning as the buds swell in the spring and repeat application until the needles reach full size. Spraying at other times is not effective. Do not apply high-nitrogen fertilizer.

Disease	Symptoms	Pathogen/cause	Management
PINE (continued)			
Ploioderma needlecast (34; 48)	From March through May the year following infection, red-brown spots develop on needles. Tips of needles girdled by spots die while needle bases remain green and needles remain attached to twig. Black fungal fruiting structures that look like lines in the dead area of the needle form. Needles are cast in May through June the year after infection.	<i>Ploioderma lethale</i>	Space plants and control weeds to ensure good air circulation around the tree. Apply chlorothalonil or mancozeb three times at 3-week intervals beginning in late May.
Lophodermium needlecast (32; 46)	From March through May the year following infection, needles on lower branches turn completely brown and fall. Black fungal fruiting structures that look like lines in the dead area of the needle form on the cast needles.	<i>Lophodermium</i>	Space plants and control weeds to ensure good air circulation around the tree. Apply chlorothalonil, azoxystrobin, or mancozeb three times beginning in mid-July and at 3-week intervals. However, if early summer is warm, begin in mid-June.
Needle rust (268; 290)	Two- and three-needled pines develop small, cream-colored, baglike pustules on the needles. These rupture and release orange spores that blow to and infect goldenrod and asters where the fungus overwinters. Pines are infected the following summer by spores from asters and goldenrod.	<i>Coleosporium asterum</i>	Little damage occurs, and no control measures are recommended.
Pine-pine gall rust (282; 300, 304)	Many round galls form on the branches and enlarge up to several inches in diameter. Approximately 15 months after infection, masses of yellow spores erupt from the galls and infect new pine shoots.	<i>Endocronartium harknessii</i>	Inspect plants very carefully and prune all galls. Inspect all newly purchased seedlings carefully for galls. Destroy infected seedlings. Apply mancozeb as new needles emerge and again 2 weeks later.
Pine-oak gall rust (274; 296)	A few galls, which may swell to 10 inches in diameter, form on two- and three-needled pines. Masses of yellow-orange spores erupt from the galls about a year after infection and blow to red oaks. Small areas of yellow-orange spores develop on the underside of oak leaves in the summer. These spores reinfect oak. Small, brown, hairlike fungal structures, where the fungus overwinters, develop on the underside of oak leaves late in the growing season.	<i>Cronartium quercuum</i>	Inspect plants very carefully and prune all galls. Do not establish a two- and three-needled pine nursery close to or within a red oak stand. Inspect all newly purchased seedlings carefully for galls. Destroy infected seedlings.
Root rot (370; 228)	Trees, particularly white pines, are stunted before any other symptoms appear. Infected trees decline, yellow, wilt, and die. Dead needles remain attached. Resin oozes from a girdling canker at the soil line or several inches above the soil. Wood beneath the bark where resin is oozing is chocolate brown to black.	<i>Verticicladiella procera</i>	Trees most susceptible are ones growing on poor sites for pines. Remove infected trees and do not replace them with pine.
White pine blister rust (272; 294)	White pines develop swollen cankers on the trunk or branches. Resin flows from the cankers. Powdery, yellow to cream-colored spores erupt from the cankers in May through July, two to three seasons after infection. Branches and entire trees are girdled and die. Spores formed on the pine infect the leaves of currants and gooseberries (<i>Ribes</i>). Spores formed on currants and gooseberries infect pines through the needle. The fungus then grows into twigs, branches, and the main trunk.	<i>Cronartium ribicola</i>	Destroy currants and gooseberries in and around nurseries. Purchase and plant only rust-free plants. Inspect pines frequently and prune out any infected branches, cutting 12 inches below the canker.

Disease	Symptoms	Pathogen/cause	Management
POPLAR			
Cryptodiaporthe canker (184; 154)	At first, a few twigs are killed. The fungus spreads rapidly to cause many variously shaped cankers and kill large branches as it does so. Perennial canker formation leads to leaf yellowing, premature defoliation, and water sprout formation. Green-brown material filled with spores oozes out of the canker during wet weather and dries to a brown color. When the tree walls off the canker, the bark covering the canker may crack, fall away, and thereby expose inner wood to decay fungi. Trees most susceptible are those under drought or other stress.	<i>Cryptodiaporthe populea</i>	Irrigate to prevent drought stress in the late summer and autumn. Remove infected trees.
Cytospora canker (200; 168)	Twigs and larger branches die. Brown, circular, sunken cankers form on the bark. During wet weather, yellowish threads of spores ooze out of fruiting structures in the canker. Lombardy poplar is very susceptible.	<i>Cytospora</i>	Remove infected branches cutting well below the canker. Remove severely infected trees.
Rust (256–58; 286)	Small, yellowish-orange areas of powdery spores form on the underside of leaves. These spores spread to the alternate host, hemlock.	<i>Melampsora</i>	No control is recommended since little damage occurs.
Scab and shoot blight (100; 90)	Branch tips and young leaves blacken and die rapidly. Olive-green spores of the fungus develop on the surface of dead and dying tissue. Small trees are most susceptible.	<i>Venturia tremulae</i>	Remove severely infected trees.
PRIVET			
Gall (146; 148)	Knobby galls 6 inches in length and 1½ inches in diameter occur on stems of common privet.	<i>Phomopsis</i>	Prune infected stems.
Twig blight and canker (122–24; 114)	Common or European and Lodenese privet twigs die. Cankers have pinkish fungal fruiting structures. Affected bark splits and plants die when girdled.	<i>Glomerella cingulata</i>	Plant resistant cultivars such as 'Amure', 'California', 'Ibota', or 'Regal'.
PYRACANTHA			
Fire blight (162; 376)	Twigs, branches, and leaders on shrubs wilt and blacken, especially during flowering. Affected twigs and branches may bend over into the shape of a shepherd's crook. Blackened flower parts remain attached to the plant. Cream-colored liquid may ooze out of the cankers and run down the trunk and branches in the spring if conditions are very wet. No fungal fruiting structures are found in the cankers.	<i>Erwinia amylovora</i>	Do not purchase or plant infected material. Remove severely infected plants. During dormancy when the weather is dry, prune infected branches, cutting at least 4 inches below the base of the canker. Disinfect pruning tools frequently. Fire blight-resistant plants include 'Mojave', 'Navaho', 'Teton', 'Yunan', and 'Shawnee'.
Scab (98; 88)	Velvety, olive green spots can form on all plant parts. Leaves and fruit fall prematurely.	<i>Spilocaea pyracanthae</i> (<i>Fusicladium</i>)	Plant resistant cultivars such as 'Bella', 'Duval', 'Flava', 'Firey Cascade', 'Government Red', 'Prostrata', 'Rutgers Shawnee', and 'Santa Cruz Prostrata'. Avoid using sprinkler irrigation. Apply chlorothalonil, mancozeb, mancozeb + thiophanate methyl, myclobutanil, or thiophanate methyl in the spring and at regular intervals until the weather dries.

Disease	Symptoms	Pathogen/cause	Management
REDBUD			
Dieback and canker (172; 120)	Leaves wilt and die as branches are slowly killed. Small, sunken cankers slowly increase in size. The wood beneath the canker is discolored. Trees cankered near the base will die.	<i>Botryosphaeria</i>	Prune infected branches well below the canker. Remove severely infected trees. Protect trees from drought stress and winter injury.
ROSE			
Anthraxnose (122–24; 18)	Dark-purple to black spots are bordered by a narrow, dull-brown band. Centers of spots turn gray and fall out. Spots similar to leaf spots form on canes.	<i>Sphaceloma rosarum</i>	Maintain good sanitation. Black spot control procedures (below) also control anthracnose.
Black spot (66; 80)	Brown to black round spots with feathery edges form on leaves. Leaves yellow and fall. Small, purplish spots form on canes.	<i>Diplocarpon rosae</i>	Remove infected canes. Remove and destroy fallen leaves. Water in a manner that keeps foliage surfaces dry. Apply one of the following to protect new foliage: neem oil, chlorothalonil, mancozeb, thiophanate methyl, thiophanate methyl + mancozeb, azoxystrobin, myclobutanil, triforine or ziram. Triadimefon can stunt some cultivars.
Botrytis blight (60; 72)	Small, water-soaked lesions form on petals. Gray fungal growth covers infected petals. Stubs left after harvest become infected. The fungus then moves down to girdle the cane.	<i>Botrytis cinerea</i>	Space plants to ensure good air circulation. Remove fading flowers and yellowing leaves. Apply <i>Streptomyces</i> , <i>Bacillus subtilis</i> , <i>Trichoderma</i> , chlorothalonil, fludioxonil, or iprodione to protect healthy tissue.
Cankers (82, 294; 36, 176)	Reddish-brown spots on canes turn light to dark brown and become covered with tiny, black dots (fungal fruiting structures). Cankers girdle and kill the cane.	<i>Coniothyrium fuckelii</i> , <i>Cryptosporella umbrina</i> , <i>Coniothyrium wernsdorfiae</i> , <i>Cylindrocladium scoparium</i>	Do not plant stock with cankers. Remove infected canes, making the cut immediately above a bud. Apply a fungicide (see black spot) after pruning. Sterilize the shears with bromine disinfectant between cuts. Maintain even soil moisture and moderate fertilization.
Crown gall (156; 382)	Small white to cream-colored galls that form on stems may enlarge to 6 inches in diameter. Galls can form on roots or stems.	<i>Agrobacterium tumefaciens</i>	Do not plant infected material. Apply <i>Agrobacterium radiobacter</i> to protect healthy plants at transplant.
Downy mildew (12; 352)	Purplish-brown spots form on leaves during cool, damp spring weather. Leaves yellow and fall. Small spots or long, purplish areas may form on and kill twigs.	<i>Peronospora sparsa</i>	Water in a manner that keeps leaf surfaces dry. Apply mancozeb, azoxystrobin, potassium salts of phosphorus acid, or mancozeb + thiophanate methyl.
Powdery mildew (16; 10)	Spots on leaves, stems, and flower parts expand and become covered with white fungal growth. Small dead spots form on some cultivars.	<i>Sphaerotheca pannosa</i>	Apply <i>Bacillus subtilis</i> , <i>Trichoderma</i> , azoxystrobin, myclobutanil, potassium bicarbonate, kresoxim methyl, chlorothalonil, triflumizole, piperidin, fenarimol, sulfur, polyoxin, triadimefon, triforine, or ziram. Triadimefon can stunt many cultivars.
Rose rosette (418)	Leaves are distorted and often bright red. Canes are excessively thorny and mature very slowly. Plants may branch excessively (witches' broom).	Thought to be caused by a virus vectored by eriophyid mites	Destroy infected plants. Eliminate multiflora roses in a 100-foot radius of desired roses.

Disease	Symptoms	Pathogen/cause	Management
Rust (238; 258)	Lower leaves and cane tissue in the spring and summer have masses of orange powdery spores. Black spores form on the leaves and other parts in autumn.	<i>Phragmidium</i>	Infected plants should be immediately destroyed since this disease is not common in the U.S. and poses a serious threat to roses. Bury infected plant material or seal in a plastic bag and send it to a landfill. Only roses are susceptible. The fungus will die quickly if no roses are available for infection.
Viruses (410, 414; 408, 412, 416, 418, 422)	Leaves may exhibit mosaic, mottling, yellow line, or ring patterns. Veins may turn yellow.	Rose mosaic, mottle, yellow mosaic, ring pattern, or streak virus; tobacco streak; rose rosette, rose wilt, spring dwarf, or color break virus; strawberry latent ring spot	Destroy infected plants. Plant only healthy, virus-free plants. Maintain good insect and mite control.

SPRUCE

Cytospora canker (196; 168)	Sunken dead areas of bark and underlying wood form on the lower branches of the trees girdling small branches in 1 or 2 years and large branches after several years. Resin flows out of the cankers and may drip down on lower branches. Scattered lower branches die. Branch death progresses up the tree.	<i>Leucostoma kunzei</i> (<i>Cytospora</i>)	Since the fungus readily infects wounded tissue but remains latent in the tree without causing symptoms until the tree is drought stressed, fungicide sprays can not be effectively timed to prevent this disease. Select the planting site carefully, avoiding drought prone sites. Anticipate the future needs of the mature tree and consider whether the site has the potential to supply the water required of a specimen 50 to 60 feet tall. Prune infected branches. Blue, white, red, black, Engelmann, and Norway spruces are all susceptible to this disease.
Needle rust (266; 288)	Year-old needles are cast after turning rust colored in the spring. Blue spruce is very susceptible, as are black, Engelmann, red, Sitka, and white spruces.	<i>Chrysomyxa weirii</i>	Notify the Bureau of Plant Industry immediately to obtain a positive diagnosis. Destroy infected trees. To protect trees not yet affected, apply chlorothalonil first when 10 percent of the tree is in bud break, again 1 week later, and again 3 weeks after the first spray.
Rhizosphaera needlecast (42; 56)	Year-old needles turn lavender in color and have tiny, black fungal fruiting structures in rows on either side of the midvein on the underside of the needle. Large bare areas develop on the tree as needles fall.	<i>Rhizosphaera</i>	Space trees and provide good weed control to ensure free air circulation around the tree. Apply chlorothalonil when new shoots are 1½ inches long and again 3 weeks later to protect young needles from infections that occur in May through June. Some locations have an additional infection period in September and October. Blue and Engelmann spruce are highly susceptible. White spruce is somewhat susceptible. Norway spruce is relatively resistant.

Disease	Symptoms	Pathogen/cause	Management
SYCAMORE			
Anthraxnose (112; 102)	Dead twigs and branches have sunken cankers. Bud death followed by new bud formation and more bud death results in witches'-broom-like proliferation of branch ends as well as very crooked branching patterns. Black fungal fruiting structures are visible on the bark covering newly killed twigs early in the spring. Young shoots are killed. Leaves, especially on lower and inner branches, are blighted and fall early in the season only to be replaced by new leaves in mid-season. Tan, dead areas expand along leaf veins. Large, irregularly shaped areas are killed along the leaf margins and between the veins. Fungal fruiting structures can be found with a magnifying glass along the veins.	<i>Apiognomonia</i>	Prune and destroy dead twigs and branches during dormancy, cutting 3 to 4 inches below the canker. Plant resistant cultivars that have been vegetatively propagated from 'Bloodgood', 'Columbia', or 'Liberty' clones of London plane trees. If trees are of high value, benzimidazole can be injected in the autumn before the leaves have fallen, the next spring after the leaves emerge, and again in the autumn to obtain protection of new tissue for the following two to three springs. Or spray chlorothalonil, copper salts, cupric hydroxide, or mancozeb + thiophanate methyl in the spring at bud break and repeatedly until the weather dries and daily temperatures average above 65°F.
Bacterial leaf scorch (386; 386–88)	Oldest leaves brown along their margins and eventually between the veins beginning in mid to late summer on one branch or a few branches on inner and lower portions of the tree. A brown band sometimes develops between the brown and green tissue of the leaf. The browning of leaves progresses to include more leaves toward the ends of branches. Infected trees have delayed bud break in the spring and produce smaller-than-normal leaves.	<i>Xylella fastidiosa</i>	Leafhoppers and spittle bugs carry the bacteria from tree to tree. See the information on this disease in the "Common Plant Diseases" section. Promote plant vigor by protecting the tree from stresses. <i>X. fastidiosa</i> from elm does not infect sycamore or vice versa.
Canker stain (360; 234)	London plane and sycamore trees have sparse foliage, small leaves, and elongated sunken cankers on the trunk and larger branches. Beneath the cankers, the wood is stained bluish black or reddish brown. Viewed in cross section, the discolored wood is wedge shaped with the point of the wedge extending toward the center of the trunk or branch.	<i>Ceratocystis fimbriata</i> f. sp. <i>platani</i>	Since the fungus enters only through wounds, pruning tools, ropes, ladders, and other equipment must be disinfested immediately after use on a tree before proceeding to another tree. Do not use wound paints since brushes efficiently move spores from tree to tree. Sap-feeding beetles can also transmit the fungus.
Powdery mildew (16; 10)	Heavy white fungal growth develops on the upper surface of leaves in late summer and in the autumn. Leaf shape is very distorted.	<i>Microsphaera</i>	Little damage occurs to the tree itself other than deforming the leaf appearance. No control is recommended unless the tree is of very high value. Chlorothalonil, cupric hydroxide, mancozeb + thiophanate methyl, polyoxin, or triadimefon can be applied in late summer to protect leaves. Benzimidazole injection (described under anthracnose) gives some powdery mildew control.

Disease	Symptoms	Pathogen/cause	Management
TAXUS			
Dieback (128; 120, 144)	Needles on branches yellow as the branch dies.	Excessive soil moisture	Do not plant <i>Taxus</i> in poorly drained locations, especially in areas of heavy clay.
Edema (486; 502)	Bumps of scablike tissue form on the underside of needles.	Excessive soil moisture	See dieback above.
TULIPTREE, TULIP POPLAR			
Powdery mildew (16; 8)	White fungal growth forms on the upper surface of leaves.	<i>Erysiphe</i> or <i>Phyllactinia</i>	No control is recommended since little damage occurs.
Sooty mold (30; 16)	Black fungal growth covers the leaf surface where a shiny, sticky material has been deposited.	Sooty mold is not a pathogen; it merely grows on honeydew secreted by aphids higher up on the tree and drips onto lower leaves	Control aphids.
VIBURNUM			
Botryosphaeria canker (172–76, 180; 120, 126–28)	Leaves on affected branches wilt and die. Branches die back and become covered with dark-brown to black pimplelike fungal fruiting structures. Wood under the bark is dark brown.	<i>Botryosphaeria</i>	Plants most susceptible are those under drought stress. Therefore, irrigate to prevent drought stress. Prune infected branches.
Downy mildew (12; 352)	Angular spots limited in shape by the leaf veins form blotches that die and shrivel in the spring when the weather is wet. Severely affected leaves fall. Light-colored fungal growth sparsely covers the spots on the underside of the leaf.	<i>Plasmopara viburni</i>	Rake and destroy fallen leaves in the autumn. Avoid overhead irrigation in the spring. Apply azoxystrobin, polyoxin, or chlorothalonil + thiophanate methyl.
Powdery mildew (16; 10)	White fungal growth forms on the upper surface of leaves.	<i>Erysiphe</i> or <i>Phyllactinia</i>	No control is recommended since little damage occurs. If severe, apply <i>Bacillus subtilis</i> , <i>Trichoderma</i> , azoxystrobin, triadimefon, polyoxin, chlorothalonil or myclobutanil.
VINCA			
Blight	Branches and eventually the entire plant blackens at the base and dies.	<i>Phoma</i>	Avoid overhead irrigation. Apply thiophanate methyl + mancozeb or thiophanate methyl as a drenching spray.
WALNUT			
Anthracnose (118; 104)	Circular, brown spots with yellow halos form on the undersides of leaflets as the leaves reach full size. Leaflets yellow, brown, and fall prematurely, leaving trees very bare by August. Tiny, brown fungal fruiting structures form mostly along leaf veins on the undersides of leaves.	<i>Gnomonia leptostyla</i>	It is thought that little actual damage occurs to the tree since most of the growth has occurred before the leaves fall. However, repeated severe defoliation gradually weakens the tree. Fertilize the tree well to maintain good vigor.

Disease	Symptoms	Pathogen/cause	Management
WILLOW			
Crown gall (156; 382)	Rough galls form on stems at the soil line or on roots. If the galls engulf the stem or root, that tissue will be killed.	<i>Agrobacterium tumefaciens</i>	Remove severely affected trees. Do not replace them with herbaceous or woody plants susceptible to crown gall. Take cuttings only from healthy plants and dip them in <i>Agrobacterium radiobacter</i> .
Black canker	Black areas form on leaves and spread to engulf and kill larger woody twigs in the summer. If the weather is wet, pink spore masses form on blackened twig cankers. This disease often occurs on trees with blight. See below.	<i>Phyalospora miyabeana</i>	Do not plant highly susceptible cultivars in the landscape.
Blight or scab (102; 92)	Newly formed leaves and twigs are quickly browned in the spring during wet weather. Infected leaves fall. Olive-brown spores form on the surface of infected tissue.	<i>Venturia saliciperda</i>	Apply mancozeb, copper hydroxide, myclobutanil, or azoxystrobin to protect the foliage of highly valued trees.

PLANT DISEASE CLINIC SPECIMEN INFORMATION FORM

Department of Plant Pathology, The Pennsylvania State University, 220 Buckhout Lab., University Park, PA 16802

Please complete all sections of this form.

Lab Specimen No.: _____

Client Information

Name _____

Address _____

City, State, Zip _____ County _____

Phone _____ Fax _____ E-mail _____

Specimen Information

Plant _____ Variety _____ Date Collected _____

Describe the problem and explain what concerns you:

Plant Part Affected

- ☐ Leaves
- ☐ Roots
- ☐ Stems, branches
- ☐ Flowers

Symptoms

- ☐ Yellowing: _____ Interveinal _____ General _____ Marginal _____
- ☐ Browning: _____ Interveinal _____ General _____ Marginal _____
- ☐ Wilting
- ☐ Distortion
- ☐ Mottling
- ☐ Leaf spots
- ☐ Other: _____

Type of Planting

- ☐ Garden ☐ Nursery
- ☐ Yard ☐ Orchard
- ☐ Indoor/house ☐ Plantation
- ☐ Field ☐ Vineyard
- ☐ Forest ☐ Golf course
- ☐ Greenhouse
- ☐ Other: _____

Disease Distribution

- ☐ General ☐ High areas
- ☐ Scattered plants ☐ Low areas
- ☐ Dry areas ☐ Foundation
- ☐ Wet areas ☐ Next to drive or road
- ☐ Shaded areas ☐ Near vents/fans
- ☐ Sunny areas ☐ End of planting
- ☐ Other: _____

Soil Type

- ☐ Sandy
- ☐ Clay
- ☐ Loam

Soil Moisture

- ☐ Excessive
- ☐ Adequate
- ☐ Deficient

Drainage

- ☐ Good
- ☐ Moderate
- ☐ Poor

Terrain

- ☐ Sloped
- ☐ Level
- ☐ Low

When did the symptoms first appear? _____

Has the problem occurred previously? _____ When? _____

Additional Comments:

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

USING PESTICIDES SAFELY

If Pennsylvania growers are to produce a commercially acceptable and profitable product, they often rely on the use of pesticides. Most growers in the state practice integrated pest management (IPM) where pesticides play a vital role. Applicators must realize the legal and moral obligations when using pesticides. Furthermore, applicators who implement pesticide safety practices and take adequate precautions will greatly reduce the possibility of accidents and exposures.

GENERAL GUIDELINES FOR PESTICIDE SAFETY

Always read the label!

Only use pesticides when necessary. Before using any pesticide product, always read the label, as it is a legal document. The label provides information on which pests can be controlled, on which crops the pesticide product can be used, and the recommended rates and times of application. Any “off label” use is a violation of both federal and state laws. Correct use of pesticides is essential to protect human, animal, and plant health as well as to protect the environment. Additionally, proper use will ensure chemical residues on crops and animals do not exceed legal limits (tolerances).

- Before using any pesticide, read the label.
- Become familiar with current federal and state pesticide laws and regulations.
- Follow all safety precautions on the label.
- Wear protective clothing and use protective equipment (both are referred to as PPE) according to instructions on the pesticide label.

Minimum PPE requires long pants, long-sleeved shirt, socks, and shoes. In addition, chemically resistant gloves (nitrile, butyl, or neoprene) and unlined rubber boots should be worn.
- Be careful when handling pesticide materials to avoid spilling on skin or clothing.
- Never eat, drink, smoke, or use tobacco products while applying pesticides.
- When selecting pesticides, consider type of formulation and the application equipment required.
- Avoid drift to nontarget areas, which may endanger other plants or animals. Dusts drift more than sprays and airblast sprayers create more drift than boom sprayers.
- For record-keeping requirements, record the date, time, location, amount of each pesticide used, and any other required information within 24 hours of the application.
- Bathe or shower in hot, soapy water after applying pesticides.
- Wash clothing worn while applying pesticides separate from other laundry, in hot, soapy water. Contaminated clothing must be handled with the same precautions as the pesticide itself.

PESTICIDE TOXICITY

For all pesticides to be effective against the pests they are intended to control, they must be biologically active, or toxic. Because pesticides are toxic, they are also potentially hazardous to humans and animals. Any pesticide can be poisonous or toxic if absorbed in excessive amounts. Pesticides can cause skin or eye damage (topical effects) and can also induce allergic responses. However, if used according to label directions and with the proper personal protective equipment (PPE), pesticides can be used safely. For this reason, people who use pesticides or regularly come in contact with them must understand the relative toxicity and the potential health effects of the products they use. The risk of exposure to pesticides can be illustrated with the following simple equation:

$$\text{Hazard of Pesticide Use} = \text{Toxicity} \times \text{Actual Exposure}$$

Toxicity is a measure of the ability of a pesticide to cause injury, which is a property of the chemical itself. Pesticide toxicity is determined by exposing test animals to different dosages of the active ingredient. Tests are also done with each different formulation of the product (for example, liquids, dusts, and granulars). Pesticide toxicities are listed in milligrams of exposure to kilograms of animal body weight. By understanding the difference in toxicity levels of pesticides, a user can minimize the potential hazard by selecting the pesticide with the lowest toxicity that will control the pest.

Applicators may have little or no control over the availability of low-toxicity products or the toxicity of specific formulated products. However, exposure can be significantly reduced or nearly eliminated by using personal protective clothing and equipment. For example, over 90 percent of all pesticide exposure comes from dermal exposure, primarily to the hands and forearms. By wearing a pair of chemically resistant gloves, exposure can be reduced at least 90 percent. Therefore, by wearing the correct PPE, the hazard of pesticide use can be reduced to an insignificant level for the applicator.

Acute Toxicity and Acute Effects

Acute toxicity of a pesticide refers to the chemical's ability to cause injury to a person or animal from a single exposure, generally of short duration. The four routes of exposure are dermal (skin), inhalation (lungs), oral (mouth), and eyes. Acute toxicity is determined by examining the dermal toxicity, inhalation toxicity, and oral toxicity of test animals. In addition, eye and skin irritation is also examined.

Acute toxicity is usually expressed as LD₅₀ (lethal dose 50) or LC₅₀ (lethal concentration 50). This is the amount or concentration of a toxicant required to kill 50 percent of a test population of animals under a standard set of conditions. LD₅₀ values of pesticides are recorded in milligrams of pesticide per kilogram of body weight of the test animal (mg/kg), or in parts per million (ppm). LC₅₀ values of pesticides are recorded in milligrams of pesticide per volume of air or water (ppm). To put these units into perspective, 1 ppm is analogous to 1 inch in 16 miles or 1 minute in 2 years.

The LD₅₀ and LC₅₀ values are found in the product's Material Safety Data Sheet (MSDS), which is available from the supplier or product manufacturers when pesticide products are purchased. Most are also available from various online sources, including the manufacturer's Web site or through various search engines as listed on our Web site at www.pested.psu.edu/resources/web/labels. For many reasons, especially in an emergency situation, maintaining a file with copies of the label and MSDS for each pesticide product used is highly recommended.

The LD₅₀ and LC₅₀ values are useful in comparing the toxicity of different active ingredients as well as different formulations of the same active ingredient. The lower the LD₅₀ value of a pesticide, the less it takes to kill 50 percent of the test population, and therefore the greater the acute toxicity of the chemical. Pesticides with high LD₅₀ values are considered the least acutely toxic to humans when used according to the directions on the product label. It is important to keep in perspective that the LD₅₀ and LC₅₀ values are based on testing using concentrated forms of the active ingredient and not the end use form that applicators routinely work with on a regular basis.

Signal Words

Acute toxicities are the basis for assigning pesticides to a toxicity category and selecting the appropriate signal word for the product label. Pesticides that are classified as "highly toxic," on the basis of either oral, dermal, or inhalation toxicity, or in some cases environmental hazards, must have the signal words **DANGER** and **POISON** (in red letters) and a graphic of a skull and crossbones prominently displayed on the package label. **PELIGRO**, the Spanish word for danger, must also appear on the label of highly toxic chemicals. Acute oral LD₅₀ values for pesticide products in this group range from a trace amount to 50 mg/kg. An exposure of a few drops of a highly toxic material taken orally could be fatal to a 150-pound person.

Some pesticide products are labeled with the signal word **DANGER** without the skull and crossbones symbol. A **DANGER** signal word does not give any indication of the LD₅₀ value of the chemical. Instead, this signal word alerts the user of potentially more severe skin or eye effects from the product (caused by its irritant or corrosive properties).

Pesticide products considered "moderately toxic" must have the signal words **WARNING** and **AVISO** (Spanish) displayed on the label. Acute oral LD₅₀ values range from 50 to 500 mg/kg. An exposure of 1 teaspoon to 1 ounce could be fatal to a 150-pound person.

Pesticide products classified as either "slightly toxic or relatively nontoxic" are required to have the signal word **CAUTION** on the pesticide label. Acute oral LD₅₀ values are greater than 500 mg/kg.

Chronic Toxicity and Chronic Effects

Any harmful effects that occur from repeated small doses over a period of time are called chronic effects. The chronic toxicity of a pesticide is determined by observing symptoms of test animals that result from long-term exposure to the active ingredient

Some of the suspected chronic effects from exposure to certain pesticides include birth defects (teratogenesis); fetal toxicity (fetotoxic effects); production of tumors (oncogenesis), either benign (noncancerous) or malignant (cancerous/carcinogenesis); genetic changes (mutagenesis); blood disorders (hemotoxic effects); nerve disorders (neurotoxic effects); and reproductive effects. The chronic toxicity of a pesticide is more difficult to determine through laboratory analysis than is acute toxicity. The product's MSDS also contains information regarding chronic symptoms of pesticide exposure. However, as stated earlier, it is important to keep in perspective that the chronic toxicity information is based on testing using concentrated forms of the active ingredient and not the end use form that applicators routinely work with on a regular basis.

SYMPTOMS OF PESTICIDE POISONING

The symptoms of pesticide poisoning can range from a mild skin irritation to coma or even death. Different classes or families of chemicals cause different types of symptoms. Individuals also vary in their sensitivity to different levels of these chemicals. Some people may show no reaction to an exposure that may cause severe illness in others. Because of potential health concerns, pesticide users and handlers must recognize the common signs and symptoms of pesticide poisoning.

The effects, or symptoms, of pesticide poisoning can be broadly defined as either topical or systemic. Topical effects generally develop at the site of pesticide contact and are a result of either the pesticide's irritant properties (either the active and/or inert ingredient) or an allergic response by the victim. Dermatitis, or inflammation of the skin, is accepted as the most commonly reported topical effect associated with pesticide exposure. Symptoms of dermatitis range from reddening of the skin to blisters or rashes. Some individuals exhibit allergic reactions when using pesticides or when these materials are applied in or around their homes or places of work. Symptoms of allergic reactions range from reddening and itching of the skin and eyes to respiratory discomfort often resembling an asthmatic condition.

Systemic effects are quite different from topical effects. They often occur away from the original point of contact, as a result of the pesticide being absorbed into and distributed throughout the body. Systemic effects often include nausea, vomiting, fatigue, headache, and intestinal disorders.

Seeking prompt medical attention is important; however, the development of certain symptoms is not always the result of exposure to a pesticide. Common illnesses such as the flu, heat exhaustion or heat stroke, pneumonia, asthma, respiratory and intestinal infections, and even a hangover can cause symptoms similar to pesticide exposure. Carefully consider all possible causes of your symptoms.

Responding to Pesticide Poisoning Symptoms

Be alert for the early symptoms of pesticide poisoning. Responding immediately and appropriately when pesticide exposure is suspected will help minimize the effects of exposure and, in extreme cases, may save a life. If you are having symptoms but are unsure if they are pesticide related, at least notify someone in case your symptoms become worse. At this time, call the **National Poison Center at 1-800-222-1222** for guidance on the proper response to your symptoms. This number will direct your call to the nearest poison center, which is staffed on a 24-hour basis. Most pesticide labels also list an emergency contact number for the manufacturer of the product which can provide a direct link to medical personnel that are familiar with the potential health effects and necessary treatments in the event of an exposure.

If safe to do so, take the pesticide container to the telephone. (However, if the pesticide container is contaminated, write down the product name and percentage of active ingredients, and take that to the phone.) The product label provides medical personnel information such as active ingredients, an antidote, and an emergency contact number for the manufacturer of the product. If you must go to the hospital or doctor's office, take the entire container, including the label, with you. In order to avoid inhaling fumes or spilling the contents, make sure the container is tightly sealed and never put it in the enclosed passenger section of a vehicle.

If the Material Safety Data Sheet (MSDS) is available, take this with you also because it frequently contains additional information for medical personnel. In addition to posting emergency numbers or having them readily available by a telephone, keep these numbers in all service vehicles involved in transporting pesticides. Additional pesticide information can also be obtained by contacting the National Pesticide Information Center (NPIC) located at Oregon State University at 1-800-858-7378. The NPIC provides a variety of unbiased information about pesticides to anyone in the United States. (Medical professionals and government agencies can call NPIC at 1-800-858-7377.)

FIRST AID FOR PESTICIDE POISONING

Reviewed by J. Ward Donavon, Medical Director of Pinnacle Health Toxicology Center, Harrisburg Hospital

Immediate and appropriate action, such as providing first aid, may be necessary to prevent serious injury to a victim of pesticide poisoning. The situation can be a life-or-death matter. The product label should be one of the first sources of information in a pesticide exposure emergency, in addition to calling the National Poison Center (1-800-222-1222) and 911. **First aid is only the “first response” and is not a substitute for professional medical help.**

General First Aid Instructions

- Most important, be sure to protect yourself by wearing appropriate protective clothing and equipment if there is a likelihood of being directly exposed to a pesticide while administering first aid or removing the victim from an enclosed area.
- Have current labels and Material Safety Data Sheets (MSDS) available.
- Have emergency response telephone numbers readily available.
- Assemble a first aid kit with necessary supplies.
- Always have a source of clean water available. In an extreme emergency, even water from a farm pond, irrigation system, or watering trough could be used to dilute the pesticide.
- If oral or dermal exposure has occurred, the first objective is usually to dilute the pesticide and prevent absorption.
- If inhalation exposure occurs, first protect yourself, then get the victim to fresh air immediately.
- Never give anything orally to an unconscious person.
- Become familiar with the proper techniques of artificial respiration; it may be necessary if a person's breathing has stopped or become impaired.

Specific First Aid Instructions

If the victim IS NOT breathing:

First—Evaluate the surroundings of the victim. Protect yourself from pesticide exposure prior to and while giving assistance.

Second—Administer artificial respiration and call 911.

Third—Call National Poison Center (1-800-222-1222).

Fourth—Decontaminate the victim immediately; wash thoroughly and quickly. Speed is essential.

If the victim IS breathing:

First—Evaluate the surroundings of the victim. Protect yourself from pesticide exposure prior to and while giving assistance.

Second—Decontaminate the victim immediately; wash thoroughly and quickly. Speed is essential.

Third—Call 911 if the victim has ill effects from the exposure.

Fourth—Call the National Poison Center (1-800-222-1222).

If the pesticide has been spilled on the skin or clothing, remove any contaminated clothing immediately and thoroughly wash the skin with soap and water. Avoid harsh scrubbing, as this enhances pesticide absorption. Rinse the affected area with water, wash again, and rinse. Gently dry the affected area and wrap it in a loose cloth or blanket, if necessary. If chemical burns of the skin have occurred, cover the area loosely with a clean, soft cloth. Avoid the use of ointments, greases, powders, and other medications unless instructed by medical personnel.

Heavily contaminated clothing should be disposed of properly. If clothing is not heavily soiled, wash all contaminated clothing separately from any other laundry in hot water, at a high water level, and with a heavy duty liquid detergent. As an extra precaution, whoever is handling the contaminated clothing may want to wear chemically resistant gloves. After removing the clothes from the washing machine run the washer through a complete cycle with detergent and no clothes to remove pesticide residue before another wash. Store washed protective clothing separately from other clothes. Also, do not store protective clothing and equipment in pesticide storage areas.

If the pesticide has entered into the eyes, hold the eyelid open and immediately begin gently washing the eye with clean running water. Do not use chemicals or drugs in the eye wash water. Continue washing for 15 minutes. If only one eye is involved, avoid contaminating the other one. Flush under the eyelids with water to remove debris. Cover the eye with a clean piece of cloth and seek medical attention immediately. If contact lenses are worn, remove and discard the contacts, then wash the eyes as described above.

If the pesticide has been inhaled, get the victim to fresh air immediately. However, do not attempt to rescue someone who is in an enclosed area unless you are wearing appropriate protective equipment. Have the victim lie down and loosen their clothing. Keep the victim warm and quiet. If the victim is convulsing, watch their breathing and protect their head. Keep the chin up to keep air passages free for breathing. If breathing stops, administer artificial respiration and call 911. Call the National Poison Center (1-800-222-1222) after the victim is stabilized for further advice.

If the pesticide has been swallowed, contact the National Poison Center (1-800-222-1222) and provide them with the name and approximate amount of material that was ingested. Call 911 immediately if the victim has symptoms from the exposure. If the pesticide has entered the mouth but has not been swallowed, rinse the mouth with large amounts of water. **Inducing vomiting is rarely advised for any poisoning, including pesticide poisonings.**

If a petroleum product (kerosene, gasoline, oil, lighter fluid, EC pesticides) **has been swallowed**, call the National Poison Center (1-800-222-1222) and 911 immediately for further instruction.

If a corrosive poison (a strong acid or alkali) **has been swallowed**, dilute with water or milk immediately. Consult the National Poison Center (1-800-222-1222) and 911 immediately. The victim may experience severe pain and have extensive mouth and throat burns. Fortunately, most commonly used pesticides are not corrosive, but some household disinfectants and germicides fall into this category.

SAFE STORAGE OF PESTICIDES

- Read the label for specific storage instructions and precautions.
- Store pesticides in a clean, cool, dry, and well-ventilated building.
- Always lock the area to prevent entry by children, untrained persons, and vandals.
- Mark the storage facility with an appropriate warning sign.
- Maintain proper temperature control. For example, if emulsion-type materials freeze, the emulsion may be destroyed, resulting in loss of effectiveness and possible serious plant injury.
- To avoid the danger of cross-contamination, do not store herbicides with other pesticides.
- Keep dry materials above liquid materials.
- Do not store pesticides where food, water, feed, seeds, fertilizers, or personal protective clothing and equipment (such as respirators) can become contaminated.
- Store pesticides in their original containers. Never store pesticides in any food or drink containers.
- Do not remove the labels. Keep lids tightly closed.
- Check containers frequently for leaks.
- Clean up spilled chemicals promptly and properly. Dispose of broken or damaged containers and any pesticide waste in an approved and safe manner as directed on the product label.
- Keep an inventory of all chemicals. Mark each container with the year of purchase.
- Inform your local fire department of any chemicals (including fertilizers) stored in large quantity.

SAFE DISPOSAL OF PESTICIDES

- Read the pesticide label for specific disposal instructions.
- Avoid disposal problems by purchasing only the amount of material needed for one growing season. Do not stockpile.
- Use proper personal protective clothing and equipment when you dispose of pesticide wastes and containers.
- Mix only the amount of pesticide required for a particular application. If you mix too much, use the surplus by applying the material at the recommended rate to one of the crops listed on the label.
- Do not dump pesticides or pesticide rinsates on the ground or pour them down sinks, toilets, or other drains, including storm sewers.
- Pressure rinse or triple rinse empty pesticide containers with water and pour the rinse water into the spray tank. Drain 30 seconds each time.
- After rinsing metal, plastic, or glass containers, puncture, break, crush, or in some way render unusable. Recycle plastic containers through the Plastic Pesticide Container Recycling Program sponsored by the Pennsylvania Department of Agriculture (PDA). Additional information can be found at www.pested.psu.edu/pdaprog/ppcr or by contacting your regional PDA office. Disposal in a sanitary landfill is desirable if conducted in accordance with local regulations.
- If stated on the label and permitted by local ordinances, combustible containers can be burned. However, do not burn pes-

ticide containers near residential areas or where the smoke can contact humans. Avoid exposure to the smoke; it may contain toxic vapors. Bury the ashes since they also may be toxic.

- Send large metal drums to a reconditioning company.
- Before disposing of pesticide concentrates, check with PDA's CHEMSWEEP Program, which provides disposal options for unwanted and outdated pesticide concentrates free of charge. Additional information can be found at www.pested.psu.edu/pdaprog/chemsweep or by contacting your regional PDA office.
- Do not reuse empty pesticide containers for any purpose.
- Clean up thoroughly after handling and disposing of pesticides.

REGULATIONS GOVERNING PESTICIDES

Applicator Certification Requirements

Certification as a commercial or public applicator is required if:

- A pesticide application is being made to a property not owned or rented by the applicator or their employer
- Restricted-use pesticides or fumigants are being applied on a property rented or owned by the applicator, but they are not applied for the production of an agricultural crop
- Pesticides are being applied to apartments of four or more units, golf courses, parks, playgrounds/athletic fields, swimming pools for other than single-family residences, education/research institutions, and schools, including public and private day care centers with seven or more children

Certification as a private applicator is required if:

- An applicator intends to purchase and/or apply restricted-use pesticides for the purpose of producing an agricultural commodity on land that is owned or rented by that person or his/her employer

Additional information regarding applicator certification requirements can be found at www.pested.psu.edu/applicators/certification/cert_brochure.

Current Status of Restricted-Use Pesticides in Pennsylvania

Under the authority of the amended Pennsylvania Pesticide Control Act of 1973 and the amended Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), applicators who apply restricted-use pesticides (RUP) in the production of an agricultural crop must be certified as a private applicator or must work under the direct supervision of a certified applicator. Furthermore, only certified applicators can purchase restricted-use pesticides. The pesticide dealer is required by law to record the name, address, and certification number of the purchaser of RUPs, as well as the identity of the product, amount sold, and date of purchase. Commercial and public pesticide applicators must be certified to use any pesticide, not just restricted-use pesticide products.

The official list of Pennsylvania's RUPs includes all pesticide products designated as restricted-use by the U.S. Environmental Protection Agency, and, in the interest of the public health and welfare of the citizens of the Commonwealth, any other product designated for restricted-use by the Secretary of Agriculture, Commonwealth of Pennsylvania. If a pesticide is restricted-use it will be clearly marked on the label.

Worker Protection Standard for Agricultural Pesticides

In 1992, the U.S. Environmental Protection Agency (EPA) revised its Worker Protection Standard (WPS), which addresses the protection of agricultural workers from pesticide exposure (40 CFR Part 170). The WPS includes requirements designed to reduce the risks of illness or injury to agricultural workers and pesticide handlers from occupational or accidental exposure to pesticides in the production of agricultural plants on farms and in nurseries, greenhouses, and forests. This regulation applies only when employees are performing tasks during the production of an agricultural crop.

The WPS expands the scope of prior worker protection regulations to identify two types of agricultural employees:

- Pesticide handlers—those who handle agricultural pesticides (mix, load, apply, clean or repair contaminated equipment, act as flaggers, etc.)
- Agricultural workers—those who perform tasks related to the cultivation and harvesting of plants on farms or in greenhouses, nurseries, or forests where pesticides are used

The WPS holds growers/employers responsible for compliance. The regulations expand requirements for the employer to make sure that employees are provided with the following:

- Warnings about pesticide applications
- Clean and properly maintained personal protective equipment (PPE), which employers must ensure is used
- Restrictions on reentry by personnel to treated areas (all pesticides used on farms and in forests, nurseries, and greenhouses have specific restricted-entry intervals (REIs) that are listed on the label under the “Agricultural Use Requirements” section)

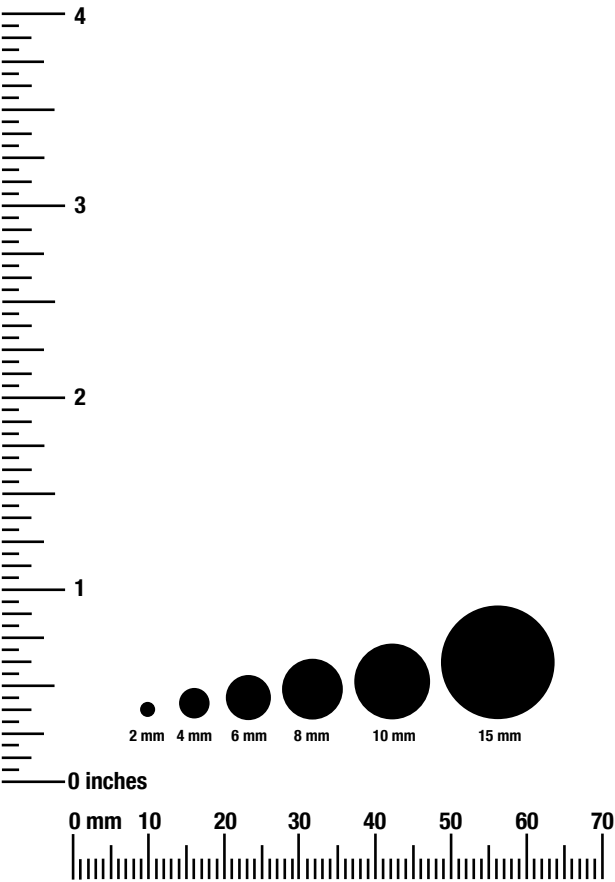
- Decontamination facilities
- Pesticide safety training and information
- Notification of pesticide applications and information about the pesticide(s) used
- Maintain contact with handlers when applying highly toxic pesticides
- Emergency assistance when required
- A pesticide safety poster placed in an area where it can be seen easily by all workers
- Information about pesticide label safety for pesticide handlers and early entry workers
- A centrally located listing of recent pesticide applications on the premises

Under WPS, labels now include statements specifying personal protective equipment, restricted-entry intervals (REIs), and (on some pesticide labels) a requirement to provide both oral warnings and posting of treated areas.

EPA developed these regulations with the non-English-speaking worker specifically in mind. Safety warnings, information, and training must be given in “a manner the worker can understand.”

The Pesticide Safety Fact Sheet *EPA Worker Protection Standard for Agricultural Pesticides* describes these requirements in some detail. It is available from the Publications Distribution Center, The Pennsylvania State University, 112 Agricultural Administration Building, University Park, PA 16802; phone 814-865-6713 or online at www.pested.psu.edu/resources/facts.

Measurements for Accurate Diagnosis



POISON CONTROL CENTERS

1-800-222-1222

Calling the toll-free National Poison Center hotline above will connect you to the nearest poison center. Pennsylvania residents are served by the Pittsburgh Poison Center and the Poison Control Center in Philadelphia.