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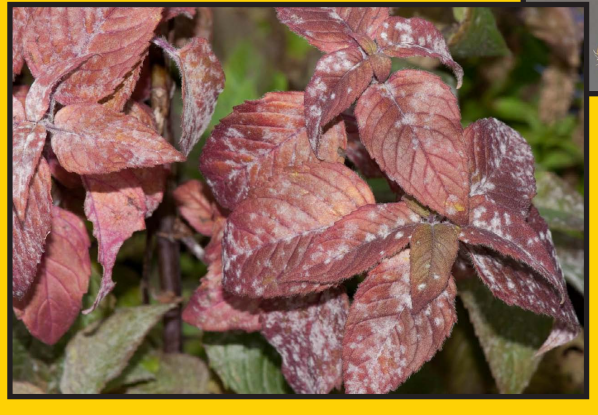
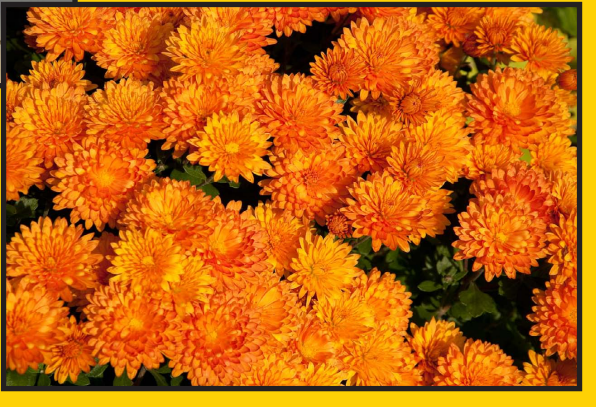
Bulletin 359 Revised 2012

Total Plant Management of Herbaceous Perennials

With an emphasis on plant nutrition, managing growth, and breaking the cycle of weeds, insects and diseases through Integrated Pest Management (IPM)





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This publication is a joint effort of the University of Maryland, Virginia Tech and Cornell University and their specialists in various environmental fields

Integrated Pest Management for Commercial Horticulture
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Preface

Herbaceous perennial plant use in residential and commercial landscapes has increased dramatically in the past 25 years. Consequently, demand has increased for nursery and greenhouse produced herbaceous perennials. Customers often request large plants in high quanitites and of the highest quality. The challenge for growers and managers is to produce and maintain high quality by managing fertility, irrigating correctly, controlling weeds, and preventing insects and diseases from destroying the beauty of the plants.

This manual is designed for use by herbaceous perennial growers, greenhouse and nursery managers, and Extension educators involved with the floriculture industry. Our goal with this manual is to help growers and landscape managers produce and maintain the highest quality plants with minimal loss. This publication is based on the extensive experience of Maryland growers, independent Total Plant Management and Integrated Pest Management (TPM/ IPM) scouts, and faculty and specialists of the University of Maryland Extension, Virginia Tech and Cornell University. It is our intent that this manual serve as a valuable tool for improved management of herbaceous perennial crops. We have created charts for easy access to information and text for more in-depth information on key subjects.

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Integrated Pest Management Of Herbaceous Perennials

Stanton A. Gill, Extension Specialist, IPM and Entomology
Karen Rane, Extension Specilaist, Plant Pathology

Introduction

The goal of most programs for managing herbaceous perennial plant pests should be to maintain pests below an economically damaging level, that is, a level acceptable to most customers. Keeping nursery and landscape plants pest-free by regularly scheduled preventative cover sprays is neither effective nor economical, nor is it an environmentally sound method of controlling insects, mites, and diseases. The best method of controlling pests is a Total Plant Management/Integrated Pest Management (TPM/IPM) program which involves regular monitoring and identification of problems, pests, and beneficial organisms.

When Using IPM

- Identify pest problems early
- Isolate or destroy pest-prone plants before the problem spreads
- Develop a treatment threshold
- Use beneficial organisms where practical
- Spot treat with pesticides, which may include insect growth regulators (IGRs), reduced risk pesticides, and/or biopesticides that have the least impact on beneficial organisms.

New chemicals with minimal impact on beneficial organisms are constantly being registered for use in nurseries. Growers and managers who suppress pests by maximizing the use of naturally existing beneficial organisms and by using environmentally friendly pesticides take a positive approach toward pest control.

When you must use chemicals to control plant-feeding pests, several ways to reduce potentially adverse effects on beneficial organisms are:

1. Treat only the plants or portions of plants requiring treatment.
2. Apply pesticides at the time they will be most effective. Do not apply chemicals to pests in a stage of their life cycle when they are relatively immune to pesticides. For example, do not spray an insect pest when the majority of the population is in the egg or pupa stage.
3. Select pesticides least disruptive to the beneficial organisms that may be present in the growing area.

Monitoring

Monitoring is the backbone of any IPM program. Knowing if pests are present, along with knowing their location, the size of their population, and, in many cases, their life stage, provides a basis for making wise pest-management decisions. This information offers many growers great peace of mind and eliminates much of the uncertainty.

Monitor on a routine basis, usually weekly. Successful monitoring usually requires one or more employees, whose job descriptions outline such responsibilities, or private IPM consultants. Using a private scout, if

one is available, offers advantages. The grower receives an independent view of plant health, and plants are monitored regularly by a professional who is not distracted by other duties.

Recordkeeping

It is important to record scouting results systematically each week. Develop a data sheet for keeping track of weekly pest levels. Include information on crop cultivar, crop stage, sticky card counts for each pest species, and counts from foliar inspections for each pest (See Appendix B for sample forms). Record the time required for scouting, pesticide applications, or other pest management tactics, and use these records to determine the costs of your pest management program. These records are also useful for determining if pest levels are declining; compare these records with your spray records to determine the best pesticide and the best method and time of application.

It is critical to have a plan that is routine, organized, and timely for communicating scouting results to the person responsible for pest-management decisions. Follow up to ensure any necessary control measure was made and to determine if the control was or is being achieved.

Thresholds

Use your scouting records to determine your own thresholds for a pest. Thresholds can change as the crop grows. At important times for each crop, note the number of pests recorded on sticky cards or during foliar inspections and whether the amount of damage is significant. Note whether a control tactic was applied and if the finished crop was acceptable to you and your customers.

Chapter 2
Biological Control For Insects, Mites And Diseases

Stanton A. Gill, Extension Specialist, IPM and Entomology
Karen Rane, Extension Specilaist, Plant Pathology

Introduction

Biological control involves controlling insects, mites, and diseases by using their natural enemies. The natural enemies are predators, parasites, insect pathogens, and antagonistic fungi. Some of these beneficial organisms may already exist in your nursery and landscape, while others will have to be introduced.

A certain number of resident beneficial organisms are commonly found around nursery plants, especially if you avoid cover sprays. Routine use of insecticides usually eliminates predaceous insects and mites. In addition to immediately killing natural enemies present at the time of spraying (contact toxicity), many pesticides leave residues on foliage that kill predators or parasites that migrate in after spraying (residual toxicity). With an IPM approach and close monitoring you can spot treat problem plants and avoid cover sprays that will kill or repel beneficial organisms.

Predators

Arthropod (having jointed legs and exoskeletons) predators of insects and mites are generally very active with long legs that enable the predators to move quickly. Winged forms of predators are usually good fliers, enabling them to move from plant to plant searching for prey. In most cases, predators are larger than the animals they eat. Many predators are generalists and feed on several species of insects.

Parasites

Parasites live in or on another organism. The parasite not only benefits from the host but also often kills it. A host that harbors a parasite is said to be parasitized. Adult parasites are generally smaller and more active than adult predators.

Releasing Beneficial Organisms

Relatively little has been published about release rates of commercially available beneficial organisms for controlling pests on herbaceous perennial plants.

To increase the likelihood that beneficial organism releases will be successful, take the following steps:

1. Detect pests early while their populations are low.
2. Accurately identify a pest you want to control and determine what the life stage is for the majority. Keep in mind that the pest might produce multiple generations per season, requiring multiple beneficial organism releases.
3. Record plants on which the pest is active and the time of year. Use this information in future seasons to determine the best predator or parasite to release and on which plant to concentrate the release.
4. Release the appropriate beneficial organism when the pest is in its most vulnerable life stages. For example, predators of thrips such as *Amblyseius* (=*Neoseiulus*) *cucumeris* are most effective when feeding on young thrips larvae. When releasing *A. cucumeris* it is important to start the release when the thrips population is low. Under proper conditions many predators and parasites are effective in keeping pest populations below damaging thresholds. Release beneficials before pest populations build up or poor levels of control will result. If you must use pesticides, select materials least disruptive to the

beneficial organisms (Table 3.1). Avoid spraying broad-spectrum, persistent residual pesticides, or use them as spot treatments on infested plants.

Effectively releasing natural enemies requires that the IPM scout or grower search for background information. Collect as much information as you can about the major pests you are trying to control and ask your state Extension office to recommend suitable biological control organisms. For IPM scouts and growers using the internet, check state university websites.

Beneficial organism releases fail for several reasons. The most common causes of failure are wrong species released, incorrect timing of release, poor heath of beneficial organisms at time of release, or application of a residual pesticide too close to time of release. Keep in mind that beneficial organisms need to be released shortly after their arrival at the nursery or landscape. Before release, examine them under magnification to make sure they are active. Obtain beneficial organisms from a quality supplier.

Beneficial Pathogens For Insect And Mite Control

Beneficial, mutualistic pathogens of insect and mite pests include bacteria, fungi, and nematodes. Most pathogens enter insects or mites through the insect exoskeleton or in food the insect ingests. *Bacillus thuringiensis* 'kurstaki' (Btk) and *B. thuringiensis* var. serotype H14 (=Bti) are two naturally occurring bacteria that are commercially available. *Bacillus thuringiensis* is used to control young caterpillar larvae that feed on herbaceous plants. Bti is used to control the young stages of fungus gnat larvae and some root maggot larvae.

Beauveria bassiana is a fungus (sold as Naturalis-0 and BotaniGard) that can be used to control soft-bodied arthropods such as whiteflies, some aphid species, and some thrips. Apply this fungus using a sprayer that produces a fine mist; the fungus spores must make direct contact with the pest. Humidity levels must be above 35 percent for effective infection. Repeated applications are often necessary.

Entomopathogenic nematodes are beneficial parasites that attack insect larvae. Nematodes enter the larvae through the mouth, anus, or breathing tubes (spiracles). Once inside, the nematodes release bacteria that kills the host. Entomopathogenic nematodes work best in moist areas such as a plant's root zone. Try nematodes on pests such as root maggots, fungus gnat larvae, and black vine weevil larvae.

Chapter 3
Biopesticides And Reduced Risk Pesticides

Stanton A. Gill, Extension Specialist, IPM and Entomology

Introduction

Biopesticides are types of pesticides derived from natural materials such as animals, plants, bacteria, fungi, and certain minerals. Examples include entomopathogenic nematodes used for fungus gnat control and potassium bicarbonate which kills powdery mildew.

Why Growers Should Use Biopesticides?

Biopesticides are usually inherently less toxic than conventional pesticides. At most nurseries and greenhouses, workers are constantly entering the growing area to water, move plant material, fertilize, and perform other plant maintenance chores. Most pesticides have a required re-entry interval (REI) that restricts employees from entering a greenhouse or nursery unless they wear the Personnel Protective Equipment (PPE) specified on the pesticide label. Putting on PPE adds time and additional expense to the nursery or greenhouse operation. Biopesticides generally have REIs that last only 4 to 12 hours.

Some biopesticides, such as entomopathogenic nematodes, have no REI. Growers who select effective biopesticides with minimal or no REI for controlling insects or diseases will save in labor time. Not needing PPE equipment makes the selection of biopesticides highly attractive. Biopesticides also make sense for use in residential and commercial landscapes because of the increasing demand for least-toxic pest control methods that are part of an Integrated Pest Management (IPM) approach. Re-entry intervals are not presently used in landscape settings.

An additional benefit of biopesticides is that disposing of them is less restrictive than disposing of more toxic compounds. Because biopesticides often decompose quickly, humans and the environment are less exposed to them than to conventional pesticides. Also, the pollution conventional pesticides cause is largely avoided. Disposal of old pesticides, which currently creates problems for landscape managers and greenhouse and nursery growers, is likely to present an even bigger and more expensive problem in the near future.

Biological control has been used in only a limited manner in the nursery, greenhouse, and landscape industries. Biopesticides can help managers transition to using beneficial organisms. Biopesticides generally affect only the target pest and closely related organisms in contrast to broad-spectrum, conventional pesticides. Many biopesticides can be combined with biological releases to control insect or mite pests. Biopesticides used to control fungi often have to be pre-incorporated into substrate or inoculated early in the growth stages of a plant.

Future Trend Of Biopesticides

Because biopesticides generally pose fewer risks to the environment and to workers than conventional chemicals, the federal Environment Protection Agency (EPA) generally requires less data for registering biopesticides compared to the process for conventional chemicals. Registering conventional pesticides usually takes at least three years, while registering for biopesticides averages less than one year. Chemical companies, aware of the cost savings, are working on several new biopesticides which should be registered

during the next decade. Companies submitting a new pesticide for registration must submit a variety of data about its composition, toxicity, and degradation to the environment before the EPA approves it for use.

Biopesticides Fall Into Three Main Categories

Microbial Pesticides:
Microbial pesticides consist of microorganisms, including bacterium, fungus, and virus, as the active ingredient. Some microbials control plant pathogens, usually on a preventative basis, and some control insects and mites. In some cases the microbial insecticide may have specific targets, such as *Bacillus thuringiensis* Serotype 14 (Bti) which controls fungus gnat larvae and mosquito larvae. In other cases such as the fungus, *Beauveria bassiana*, the microbial controls several species of insects including whitefly, aphids, and some caterpillars. The most widely known microbial pesticide, *Bacillus thuringiensis* (Bt), is used to control a variety of early-stage caterpillars.

Reduced Risk Pesticides:
Starting in 1993, EPA has expedited the registration of conventional pesticides shown to be effective and compatible with IPM; the pesticides must also exhibit characteristics such as very low toxicity to humans and nontarget organisms including fish and birds, low risk of groundwater contamination or runoff, and low potential for pesticide resistance. EPA refers to materials meeting these criteria as "reduced risk." The "reduced risk" designation applies only to certain uses of a particular pesticide which may not apply to all label uses for that product. Reduced risk products/uses must be registered with EPA and labels will bear EPA registration numbers. Manufacturers, however, are not permitted to label materials as "reduced risk."

Floramite (EPA #400-481) miticide and Endeavor (100-613) insecticide are two reduced risk pesticides labeled for use on ornamentals. Fenpyroximate (Akari 5SC) from SePro Company is a reduced risk miticide. Tebufenozide (Confirm), from Dow AgroSciences, is an insect growth regulator (IGR) for caterpillars and is another reduced risk pesticide for ornamentals. Some insecticides such as spinosad (Conserve) are considered reduced risk for application only to certain nonornamentals. Conserve is not presently classed as a reduced risk pesticide. Other reduced risk pesticides for use on ornamentals include the fungicide Heritage (10182-408) for turf and Subdue GR (100-794), Subdue 2X WSP (100-795), Subdue Maxx (100-796) and Compass (100-920) for ornamentals. Minimum risk pesticides, products exempted from EPA registration (and carrying no EPA registration number), contain only active ingredients outlined in FIFRA 40 CFR 152.25(g) ("the 25b list") and inert ingredients now listed on Federal Register Notice 59 FR 49400 ("the 4A list").

Biochemical Pesticides:
Biochemical pesticides are naturally occurring substances that control pests. A material such as insecticidal soap which is composed of fatty acids, alcohol, and water, is a good example of a biochemical. Empower, a garlic extract, is an insect repellant that can be used to flush cryptic insects such as thrips from tight, hard-to-penetrate areas on plants. This biochemical is often used in combination with a contact material that kills the thrips once they are in the open. Because it can be difficult to tell if a substance meets the criteria for classification as a biochemical pesticide, EPA set up in 1994 the Biopesticide and Pollution Prevention Division within the office of Pesticide Programs.

Living organisms, which are not regulated by EPA, include entomopathogenic nematodes, beneficial mites, and insects.

Table 3.1 Biopesticides, Reduced Risk Pesticides And Their Uses

Chemical Name	Trade Name/ Common Name	Application Method	Type of Biopesticide	Re-Entry Interval (hours)	Pest and Usage
Azadirachtin (NEEM)	Azatin XL	Soil drench for controlling soil-borne insect larvae	Biological	4	Works best on immature insects. Interferes with insect's ability to molt. Feeding deterrent and repellent for some insects. Apply a drench to moderately moist soils.
	Aza-Direct Neemix	For use as a drench or as a foliar spray			
	Ornazin	Foliar spray application		12	
Bacillus thuringiensis	*Bacillus thuringiensis* subsp. *kurstaki* (BioBit HP Dipel EF Dipel Pro DF Javelin WG) *Bacillus thuringiensis* subsp. *aizawai*	Foliar spray application	Microbial	4	Labeled for all greenhouse ornamentals and herbs. Works only on small, early instar caterpillars. Apply at egg hatch. Must be ingested to be effective so thorough coverage is essential.
	Bacillus thuringinensis var. *israeliensis* (= serotype H-14) Gnatrol WDG	Soil drench application	Microbial	4	Labeled for all herbs, greenhouse ornamentals, and interiorscapes. Apply to young (early instar) fungus gnat larvae - does not kill adults. Can apply Gnatrol in irrigation systems. Organic certification.
Beauveria bassiana	BotaniGard ES or WP Naturalis T&O	Apply to foliage at 3 to 5 day intervals. Acts by contact: spores must attach to cuticle of target insect to be effective.	Microbial	4	Labeled for all herbs, greenhouse ornamentals, and interiorscapes. Treat before high insect populations develop. Repeated sprays are usually necessary. It takes 3 to 7 days for insects to die.

Table 3.1 Biopesticides, Reduced Risk Pesticides And Their Uses (continued)

Chemical Name	Trade Name/ Common Name	Application Method	Type of Biopesticide	Re-Entry Interval (hours)	Pest and Usage
Bifenazate	Floramite	Foliar application	Reduced risk pesticde	12	Labeled for all greenhouse ornamentals and interiorscapes. Spider mite control for 21 to 28 days. Also has ovicidal control. Minimal impact on beneficial mites.
Buprofezin	Talus 40 SC Talus 70 DF	Foliar application	Insect growth regulator	12	Labeled for all greenhouse ornamentals for whiteflies, mealybugs, scales and leafhoppers.
Capsaicin	Hot pepper wax	Foliar application	Botanical	4	A feeding deterrent and repellent for some insects. Requires repeat applications.
Diflubenzuron	Adept	Soil drench or coarse spray	Insect growth regulator	12	Labeled for most greenhouse ornamentals and interiorscapes. For fungus gnat and shore fly larvae. Do not apply to hibiscus or Reiger begonia.
Etoxazole	Tetra-San	Foliar application	Mite growth regulator	12	Labeled for all greenhouse ornamentals and interiorscapes for spider mites and shore flies. Controls egg and nymph stages; will not kill adult mites. Transovarial (treated adults will not produce viable eggs).

Table 3.1 Biopesticides, Reduced Risk Pesticides And Their Uses (continued)

Chemical Name	Trade Name/ Common Name	Application Method	Type of Biopesticide	Re-Entry Interval (hours)	Pest and Usage
Fenpyroximate	Akari 5SC	Foliar application	Reduced risk pesticide	12	Labeled for all greenhouse ornamentals for 21- to 24-day mite control. Immediate cessation of feeding and egg laying. Minimal impact on beneficial mites.
Horticultural oil	All Seasons Horticultural Spray Oil concentrate (mineral oil) Golden Pest Spray Oil (soybean oil) JMS Stylet oil PureSpray Green (petroleum oil) Saf-T-Side oil SuffOil-X (paraffinic oil) Summit Year Round Spray Oil (mineral oil) UltraFine Oil Ultra-Pure Oil (Petroleum oil)	Apply to foliage and make direct contact with insect	Biochemical	4	Labeled for most greenhouse ornamentals, herbs, and interiorscapes. See label for specific crops. Must make contact with insect or mite. No residual control. Do not use Ultrafine Oil on maidenhair ferns. Blooms of chrysanthemums and geranium may show injury at higher rates. Saf -T-Side is only labeled for fuchsia, glads, iris, lily, mums, and vines. The only perennials on the JMS oil label are mums and mints.

Table 3.1 Biopesticides, Reduced Risk Pesticides And Their Uses (continued)

Chemical Name	Trade Name/ Common Name	Application Method	Type of Biopesticide	Re-Entry Interval (hours)	Pest and Usage
Insecticidal soap (Potassium salts of fatty acids)	Bonide Insectidal Soap Concern Insecticidal Soap DES-X M-Pede Natural Guard Insecticidal Soap	Foliar application Do not use on open blooms, transplants, or root cuttings.	Biochemical	4	Labeled for most greenhouse ornamentals, herbs, and interiorscapes. Compatible with biological control agents. Must contact insect or mite. No residual control. Do not apply when temperatures exceed 90 °F. Do not treat blooms, transplants, or root cuttings.
Kinoprene	Enstar II	Foliar application. Drench for root mealybug.	Juvenile hormone analogue	4	For mums, fern, geranium, dianthus, ivy, hydrangea, lantana, lily and coleus. May damage blooms under certain conditions.
Metarhizium anisopliae strain F52	Met52	Granular	Bioinsecticide	4	For black vine weevil control. Most active above 60 °F.
Nematodes, Beneficial	*Heterorhabditis bacteriophora* (Hb): HETERO-MASK; J-3 Max *Steinernema feltiae* (Sc): Nemasys, ScanMask, Ecomen, Nemashield	Soil drench application. Experimental use also as foliar application in high humidity greenhouses.	Biological	0	For control of black vine weevil larvae, caterpillars, and fungus gnat larvae in containers. Apply solution to moist substrate. Works best in soil at temperatures between 50 and 85 °F.
Novaluron	Pedestal	Foliar spray	Insect growth regulator	12	Labeled for most greenhouse ornamentals.
Paecilomyces fumosoroseus strain FE9901	NoFly	Foliar spray	Mycoinsecticide	4	Compatible with beneficial insects such as *Encarsia formosa* and *Eretmocerus eremicus*.

Table 3.1 Biopesticides, Reduced Risk Pesticides And Their Uses (continued)

Chemical Name	Trade Name/ Common Name	Application Method	Type of Biopesticide	Re-Entry Interval (hours)	Pest and Usage
Pyrethrin	Pyreth-It 1100 Pyrethrum TR Pyganic	Foliar application	Biochemical	4	Apply directly to insects or mites. No residual control.
Pyrethrin + Piperonyl butoxide	Pyrenone (EC) Prentox Pyronyl Crop Spray Pyreth-It (Prescription Treatment Brand)	Foliar application	Pyrethroid	12	Labeled for all greenhouse ornamentals and herbs except cyclamen and nasturtium. A botanical insecticide plus a synergist to flush insects out of hiding and into contact with spray residues. Apply when foliage is dry.
Pyrethrin + Rotenone	Pyrellin	Foliar, in irrigation systems	Botanical mix	12	Labeled for all greenhouse ornamentals and herbs. Organic certification. For aphids, loopers, mites, plant bugs, thrips, and whiteflies.
Spinosad (*Saccharopolyspora spinosa*)	Conserve Entrust	Foliar application	Reduced risk pesticide	4	For gall midges, leafminers, mites, shoreflies, thrips, sawfly larvae and caterpillars. Registered for use on organically produced ornamental and culinary herbs for caterpillars and thrips.
Tebufenozide	Confirm	Foliar application	Reduced risk pesticide	4	Insect growth regulator for caterpillar control in mint and some vegetables.

Chapter 4
Key Insects, Diseases, And Cultural Problems By Crop

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Terms And Abbreviations

Diseases:

Root rots:
P=*Pythium* R=*Rhizoctonia* T=Black root rot (*Thielaviopsis*)

Viruses:
INSV=Impatiens necrotic spot virus
CMV=Cucumber mosaic virus ToRSV=Tomato ring spot virus
POTY=Potato virus group of aphid-transmitted varieties

pH:
The pH ranges listed are the best for growing a respective species in the landscape. With few exceptions, most growers of herbaceous perennials make no attempt to tailor the pH of the substrate to each species of herbaceous perennial. The goal is to have a pH of 6.3 to 6.7 for soil-based substrates and a pH of 5.7 to 6.2 for organic-based or soilless substrates.

Salt Index
Maintain soluble salt levels of 1.0 to 2.0 mmhos/cm during the spring through fall growing season. The soluble salt level can drop to 1.0 mmhos/cm for overwintering herbaceous perennials. Maintain higher fertility levels for rooted cuttings being held in heated greenhouses.

Table 4.1 Key Problems On Herbaceous Perennials

Plant	Major Pests (Insect, mites, arthropods, and mollusca)	Major Diseases	Cultural Requirements
Acanthus spp. Bear's breeches	Slugs, snails	Root knot nematode	Propagation: root cuttings or division in spring; seed. Full sun to part shade. Dry substrate. pH: 6.0–7.0 Zones: 6–10. Susceptible to root rots in moist soil.
Achillea spp. Yarrow	Twospotted spider mites	Powdery mildew	Propagation: basal cuttings in spring or early summer; division in spring or fall; seed. Full sun. Moist, well-drained substrate. pH: 6.5–7.0. Zones: 3–9.
Aconitum spp. Monkshood	Twospotted spider mites	Virus (INSV)	Propagation: division late fall or early spring; seed sown in fall as soon as ripe. Full sun to part shade. Moist substrate. pH: 5.0–6.0. Zones: 3–7. Plant sap is poisonous.
Agapanthus spp. African lily	Slugs, snails	Blight, root rots (P, R)	Propagation: division in fall; seed. Part shade. Moist substrate, let dry out as plant goes dormant. Zone: not hardy above zone 7. 'Headbourne' hybrids most hardy.
Ajania pacifica Gold and silver mum	Aphids	Root rot (R)	Propagation: terminal cuttings in spring or summer. Full sun. Dry substrate. pH: 5.5–6.5. Zones: 5–9. Excellent drainage needed for winter survival.
Alcea rosea Hollyhock	Aphids, thrips, twospotted spider mites	Rust	Propagation: division; seed in spring. Full sun. Moist substrate. pH: 6.0–7.0. Zones: 2–10. Do not germinate too early or plants will stretch.

Table 4.1 Key Problems On Herbaceous Perennials (continued)

Plant	Major Pests (Insect, mites, arthropods, and mollusca)	Major Diseases	Cultural Requirements
Anchusa azurea Alkanet		Root knot nematode	Propagation: root cuttings in early spring; seed. Full sun. Dry, well drained substrate. pH: 6.0–7.0. Zones: 3–8. Susceptible to root rots in wet substrates.
Anemone x *hybrida* Japanese anemone	Aphids, black blister beetles	Viruses (INSV, ToRSV) root knot nematode, foliar nematode	Propagation: June division for tuberous/ rhizomatous species; fall division for autumn-flowering forms; root cuttings for fibrous-rooted forms; seed. Full sun to part shade. Moist substrate. pH: 5.0–6.5. Zones: 4–8. Protect from sun in hottest part of day in summer.
Aquilegia spp. Columbine	Leafminers (*Phytomyza*), aphids, spider mites, grasshoppers, whiteflies	Botrytis blight, powdery mildew, leaf spots, root rots (T, R), foliar nematode	Propagation: seed; divisions with care. Part shade. Moist substrate. pH: 5.5–7.0. Zones: 3–9. Comes readily from seed, but short-lived.
Argyranthemum spp. Daisy	Aphids, chrysanthemum lace bugs	Crown gall, downy mildew, Rust	Propagation: root cuttings. Full sun. Well drained substrate. pH: 5.8–6.2. Zones: 7–11.
Asclepias tuberosa Butterfly weed	Thrips, monarch caterpillars, aphids, whiteflies, serpentine leafminers	Leaf spots (*Cercospora*, *Phyllosticta*); virus (CMV); ozone damage	Propagation: root cuttings; seeds germinate best in hot weather. Full sun. Dry substrate. pH: 6.0–7.0. Zones: 4–9. Pot early to establish.
Astilbe spp. Astilbe	Aphids, black vine weevils, whiteflies, tarnished plant bugs	Foliar nematode, root knot nematode, root rot (R), web blight (R), root rot (T)	Propagation: division in spring or fall; grow from seed for species. Full sun to part shade. Moist substate. Zones: 4–9. Plants produced from seed can take 30–31 months to flower freely. Avoid excess fertilizer.

Table 4.1 Key Problems On Herbaceous Perennials (continued)

Plant	Major Pests (Insect, mites, arthropods, and mollusca)	Major Diseases	Cultural Requirements
Bellis perennis English daisy	Aphids	Leaf spots, root rot (R)	Propagation: division; seed. Full sun to part shade. Moist substrate. Zones: 3–10. Variable resistance to hot summers.
Buddleia spp. Butterfly bush	Twospotted spider mites, whiteflies		Propagation: tip cuttings. Full sun. Dry, well drained substrate. Zones: 5–10.
Campanula carpatica Carpathian harebell	Aphids, spider mites, thrips, slugs, snails	*Botrytis*, root rot (R), root knot nematode	Propagation: division; terminal stem cuttings; root cuttings; seed for all but double-flowered cultivars; sow seed in spring, seeds need cool temperatures to germinate. Full sun to part shade. Moderately moist substrate, avoid overwatering. pH: 5.0–6.0. Zones: 3–8. Does not tolerate night temperatures consistently above 70 °F.
Centaurea spp. Cornflower	Aphids, twospotted spider mites		Propagation: division; seed. Full sun to part shade. Dry substrate. pH: 5.0–6.0. Zones: 3–8. Responds well to regular fertilization.
Cimicifuga simplex Bugbane		Virus (CMV), root knot nematode, leaf spots	Propagation: division; seed. Part shade. Moist substrate. Zones: 3–8. Needs a moist, shady location to do well or will be stunted.
Clematis spp. Clematis	Blister beetles, tarnished plant bugs, cyclamen mites, whiteflies, twospotted spider mites	Leaf spot, dieback/canker	Full sun to part shade. Moist substrate. pH: 6.0–7.0. Zone: 3–7, depending on species. Keep roots cool and shaded.

Table 4.1 Key Problems On Herbaceous Perennials (continued)

Plant	Major Pests (Insect, mites, arthropods, and mollusca)	Major Diseases	Cultural Requirements
Coreopsis grandiflora Tickseed	Aphids, cucumber beetles, plant bugs, leafminers, thrips, leafhoppers	Root rot (R), root knot nematode, downy mildew, rust, virus(CMV)	Propagation: division in spring or fall; seed. Full sun. Irrigate frequently. pH: 5.0–6.0. Zones: 4–9. Deadheading necessary to achieve full bloom.
Coreopsis verticillata Threadleaf coreopsis	Coreopsis leaf beetles, leafhoppers	Root rot (R), rust, root knot nematode, downy mildew	Propagation: tip cuttings; division. Full sun. Moist, well drained substrate. pH: 5.0–6.0. Zones: 5–9. Irrigate frequently. Deadhead to encourage second fall bloom.
Cosmos atrosanguineus Chocolate cosmos	Aphids, aster leafhoppers, plant bugs, European corn borers, twospotted spider mites	Root rots (P, R)	Propagation: seed or division of tuberous roots; tip cuttings before flower buds form. Full sun. Well drained substrate. Zones: 8 or warmer. Tubers can be dug in fall and overwintered in loose peat.
Delphinium spp. Delphinium	Aphids, twospotted spider mites, cyclamen mites, thrips, slugs, snails	Root rots (P, R), powdery mildew, leaf spots (fungal and bacterial)	Propagation: basal cuttings in spring. Light: full sun. Well drained, especially crown or basal portion of plant. pH: 6.0–7.0. Zones: 3–10. Needs cool daytime temperatures to excel.
Dendranthema spp. Chrysanthemum	Aphids, mites, thrips	Root rots (P, R), leaf spots (fungal and bacterial), powdery mildew, virus (INSV and others), white mold (*Sclerotinia*)	Propagation: division; tip cuttings. Full sun. Moist, well drained substrate. pH: 5.5–6.5. Zones: 5–9. Deer will feed on mums.
Dianthus spp. Pinks	Aphids, cutworms, twospotted spider mites, fungus gnat larvae in stems and roots, thrips	Anthracnose, root rots (P, R, T), rust, leaf spots	Propagation: terminal cuttings; seed. Full sun. Well drained substate. pH: 6.0–7.0. Zones: 3–9. Keep crown and roots cool.

Table 4.1 Key Problems On Herbaceous Perennials (continued)

Plant	Major Pests (Insect, mites, arthropods, and mollusca)	Major Diseases	Cultural Requirements
Digitalis spp. Foxglove	Thrips, aphids, twospotted spider mites		Propagation: seed. *Digitalis purpurea* takes a minimum of 2 years to bloom; perennial forms also take several seasons to bloom. Part shade, but tolerates some sun. Well drained, must be well watered to bloom at maximum. Zones: 3–8.
Echinacea spp. Coneflower	Japanese beetles, fourlined plant bugs, aphids, mites	Virus (CMV), leaf spots (fungal and bacterial)	Propagation: division; seed. Full sun. Well drained substrate. Zones: 3–8. White-flowered cultivars more sensitive to overwatering.
Echinops spp. Globe thistle	Aphids, fourlined plant bugs	Root rots (R, P)	Propagation: division; root cuttings; seed. Full sun. Well drained subsrate. Zones: 3–10. Tolerates very dry soils.
Gaillardia aristata Blanket flower	Twospotted spider mites, thrips, aphids, aster leafhoppers, plant bugs	Powdery mildew, root rots (P, R), bacterial leaf spot	Propagation: division; root cuttings; seed. Full sun. Well drained, but needs frequent irrigation on hot, sunny days. pH: 6.0–7.0. Zones: 2–10. Large leaf surface makes plant prone to wilting in hot weather.
Geranium spp. Cranesbill	Plant bugs, fungus gnat larvae, whiteflies	Leaf spots (bacterial and fungal), downy mildew, root rots (T, P), foliar nematodes	Propagation: division; root cuttings for *G. sanguineum*. Full sun to part shade. Moist, well drained. pH: 6.0–7.0. Zones: 4–8. Plants get leggy with shade.
Geum spp. Avens	Black vine weevils, leafminers, twospotted spider mites, spittle bugs	Downy mildew, root rot (R)	Propagation: division; seed. Full sun to part shade. Slightly moist, well drained. pH: 6.0–7.0. Zones: 4–7. Short lived and often sparse number of blooms.

Table 4.1 Key Problems On Herbaceous Perennials (continued)

Plant	Major Pests (Insect, mites, arthropods, and mollusca)	Major Diseases	Cultural Requirements
Gypsophilia spp. Baby's breath	Leafhoppers		Propagation: seed; terminal cuttings; division. Full sun. Well drained substrate. pH: 6.0–7.0. Zones: 3–9. High pH, alkaline substrate essential to well-being of plant.
Helianthus spp. Perennial sunflower	Aphids, plant bugs, grasshoppers, corn borers	Leaf spots, powdery mildew, rusts, downy mildew	Propagation: division, after flowering; cuttings; seed. Full sun. Dry, well drained substrate. Zones: 6–9. Needs full sun to produce sturdy plants.
Helleborus orientalis Lenten rose	Aphids	Root rot (P), leaf spot (fungal)	Propagation: seed; dig seedlings in spring or fall. Part shade to shade. Well drained, keep on dry side. pH: 6.0–7.0. Zones: 4–9. Does not take well to moving.
Hemerocallis spp. & cvs. Daylilies	Aphids, grasshoppers, cutworms, thrips, especially *Frankliniella hemerocallis* (daylily thrips), slugs, snails	Daylily leaf streak (*Aureobasidium*)	Propagation: division. Full sun to part shade. Well drained. pH: 6.0–7.0. Zones: 3–10. Tolerant of wide range of growing conditions.
Heuchera sanguinea Coral bells	Fungus gnat larvae boring into stems, twospotted spider mites, black vine weevils, fourlined plant bugs	*Botrytis*, foliar nematode	Propagation: division; seed (seedlings rot easily). Full sun to part shade. Dry substrate. pH: 5.0–6.0. Zones: 3–8. Susceptible to sunburn.
Hibiscus spp. Hibiscus	Whiteflies, aphids, caterpillars, mealybugs, thrips, twospotted spider mites, sawflies, flea beetles	Bacterial blight, leaf spot, rusts	Propagation: seed; tip cuttings. Full sun. Well drained and moist substrate. Zones: 6–9. Plants slow to emerge in spring.

Table 4.1 Key Problems On Herbaceous Perennials (continued)

Plant	Major Pests (Insect, mites, arthropods, and mollusca)	Major Diseases	Cultural Requirements
Hosta spp. & cvs. Plantain lily, Funkia, Hosta	Aphids, grasshoppers, thrips, black vine weevils, slugs, snails, fungus gnat larvae	Root rot (P), leaf blight, root knot nematode, foliar nematode. Note: nutrient deficiencies may resemble leaf blight, especially on large cultivars	Propagation: division, some tissue culture being performed. Part shade to shade. Moist, well drained substrate. Zones: 3–9. Excessively wet soil leads to problems with fungus gnat larvae.
Hypericum spp. St. John's-wort	Aphids, caterpillars	Leaf spots (fungal and bacterial), foliar nematode	Propagation: cuttings; division. Full sun to part shade. Well drained substrate. pH: 5.5–7.0. Zones: 5–9.
Iris spp. Iris	Iris borers, aphids, bulb mites, thrips, slugs, snails	Bacterial soft rot of rhizome, leaf spot, rust, root rot (R), foliar nematode, rust	Propagation: division. Full sun to part shade. Moist substrate. pH: 6.0–7.0. Zones: 3–10. Plant rhizomes at soil line, slightly exposed.
Lamium spp. Dead nettle	Thrips, spider mites, slugs, snails	Wilt (*Phytophthora*), blight (*Myrothecium*), virus (INSV)	Propagation: tip cuttings, which rot easily in hot weather. Part shade to shade. Moist substrate. Zones: 3–8. Spreads rapidly.
Lavandula augustifolia Lavender	Twospotted spider mites	Root rots (P, R), wilt (*Phytophthora*), leafspot (bacterial)	Propagation: tip cuttings; cuttings of nonflowering shoots with part of heel of older wood in fall or spring; division. Full sun. Well drained substrate. pH: 5.5–6.0. Zones: 5–9. Plants rot easily if media poorly drained.
Liatris spp. Blazing star		Root knot nematode	Propagation: division of tuberous roots; seed. Full sun. Dry, well drained substate. pH: 4.5–6.0. Zones: 3–9. Rabbits feed on shoots.

Table 4.1 Key Problems On Herbaceous Perennials (continued)

Plant	Major Pests (Insect, mites, arthropods, and mollusca)	Major Diseases	Cultural Requirements
Ligularia stenocephala Narrow-spiked ligularia		Root knot nematode, foliar nematode	Propagation: division in early spring or middle fall; seed. Afternoon shade. Moist substrate. Zones: 5–8. Tends to wilt on hot days; not winter hardy below zone 7.
Lobelia cardinalis Cardinal flower	Fungus gnat larvae, thrips, slugs, snails	Viruses (INSV, CMV), root rot (P)	Propagation: division; seed. Full sun to full shade. Moist substrate. pH: 6.0–7.0. Zones: 4–8. Leaves scorch in full sun. Plant short-lived. Basal foliage can rot when covered during winter. Great for hummingbirds.
Lychnis x *arkwrightii* spp. Champion	Aphids, whiteflies	Leaf spots, crown rot, root rot (P)	Propagation: division; stem cuttings. Full sun. Well drained substrate. Zone: 3–9. Interesting dark bronze foliage.
Lysimachia spp. Loosestrife	Aphids		Propagation: division; seed. Full sun to part shade. Moist substrate. pH: 5.0–7.0. Zones: 4–8. Most *Lysimachia* are invasive.
Malva spp. Mallow	Thrips, whiteflies (silverleaf, banded winged, greenhouse), Japanese beetle adults, spider mites	Root rot (R), rust	Propagation: terminal cuttings in spring; seed; division. Full sun. Moist substrate. Zones: 4–8. Flowers very showy.
Monarda spp. Bee balm	Aphids, leafminers, thrips, spider mites, whiteflies	Powdery mildew, root rot (R)	Propagation: division; tip cuttings Full sun to part shade. Moist substrate. pH: 6.0–7.0. Zones: 4–9. Avoid overhead watering, especially in late afternoon or evening.

Table 4.1 Key Problems On Herbaceous Perennials (continued)

Plant	Major Pests (Insect, mites, arthropods, and mollusca)	Major Diseases	Cultural Requirements
Myosotis spp. Forget-me-not	Aphids, spider mites, flea beetles	Root rot (R), powdery mildew	Propagation: division in fall; seed. Full sun to full shade. Moist substrate. pH: 6.0–7.0. Zones: 3–8. *M. scorpiodes* will grow in water.
Nepeta spp. Nepeta		Powdery mildew, rust	Propagation: cuttings; division. Full sun, but afternoon shade needed in hot weather. Dry, well drained substrate. Zones: 3–10.
Oenothera speciosa Primrose	Slugs, fungus gnat larvae, leafhoppers	Virus (CMV)	Propagation: division in summer; seed. Full sun. Well drained substate. Zones: 4–8. Most are lovely evening-blooming plants.
Paeonia spp. & cvs. Peony	Aphids, Japanese beetle adults, thrips	Root knot nematode, foliar nematode, leaf spots	Propagation: division. Full sun. Well drained substrate. pH: 6.0–7.0. Zones: 2–10. Susceptible to edema and bud blast from improper climate or culture.
Papaver spp. Poppy	Plant bugs, aphids, aster leafhoppers, thrips	Root rot (R), wilt, leaf spots, foliar nematodes	Propagation: division; root cuttings in fall. Full sun. Well drained substrate. pH: 6.0–7.0. Zones: 2–7. Does not transplant easily.
Penstemon spp. Bearded tongue	Aphids	Powdery mildew	Propagation: division; terminal cuttings in early to late summer. Full sun. Well drained substrate. pH: 5.5–7.0. Zones: 2–8.
Phlox paniculata Garden phlox	Leafhoppers, corn earworms, plant bugs, twospotted spider mites, fungus gnat larvae	Leaf spots (fungal), virus (POTY, others), powdery mildew	Propagation: stem cuttings; division; root cuttings. Full sun. Well drained. pH: 5.0–6.0. Zones: 4–8. Avoid overhead watering to reduce leaf spot problems.

Table 4.1 Key Problems On Herbaceous Perennials (continued)

Plant	Major Pests (Insect, mites, arthropods, and mollusca)	Major Diseases	Cultural Requirements
Physostegia virginiana Obedient plant	Corn borers, *Lygus* bugs, harlequin bugs	Rust (*Pucinnia*), crown rots, leaf spots	Propagation: stem cuttings; division, seed. Full sun to part shade. Well drained substrate. pH: 5.0–7.0. Zones: 2–9. White-flowered form less invasive than pink-flowered form.
Platycodon grandiflorus Balloonflower	Aphids, thrips, whiteflies, leafminers	Leaf spot, web blight (R)	Propagation: tip cuttings; division; seed. Full sun to part shade. Dry, well drained. Zones: 3–8. Pot before August 1 so plants get established before winter.
Pulmonaria spp. Lung wort	Aphids, slugs, snails	Powdery mildew, root rot (R), virus (ToRSV), root knot nematode	Propagation: division after flowering. Part shade to shade. Moist substrate. Zones: 3–10.
Rudbeckia fulgida Orange coneflower	Grasshoppers, whiteflies, aphids, thrips, plant bugs, corn borers, leafhoppers	Root rot (P), leaf spots	Propagation: division; terminal cuttings; seed. Full sun. Well-drained soil, evenly moist, not drought tolerant. pH: 5.5–7.0. Zones: 3–9.
Salvia spp. Salvia	Aphids, caterpillars, leafhoppers, plant bugs, whiteflies	Root rot (P, R), powdery mildew, leafspots (minor), root knot nematode	Propagation: division; terminal cuttings; seed depending on species. Full sun. Well drained pH: 6.0–7.0. Zones: 5–10, depending on species.
Scabiosa spp. Pincushion flower	Fungus gnat larvae, slugs, mites, snails	Powdery mildew, root knot nematode	Propagation: seed. Full sun. Well drained substrate. Zones: 3–7.
Sedum spectabile Showy stonecrop	Aphids, fungus gnat larvae in stems, black vine weevils	Root rots (R, P), powdery mildew, wilt (*Phytophthora*)	Propagation: division; terminal cuttings. Full sun to part shade. Well drained substrate. Zones: 4–10.
Senecio spp. Senecio	Aphids, cutworms, aster leafhoppers, twospotted spider mites, leafminers, whiteflies	Leaf spots, powdery mildew, virus (INSV), downy mildew	Propagation: seed, division. Full sun. Well drained substrate. Zones: 5–9.

Table 4.1 Key Problems On Herbaceous Perennials (continued)

Plant	Major Pests (Insect, mites, arthropods, and mollusca)	Major Diseases	Cultural Requirements
Solidago spp. Goldenrod	Aphids, spider mites, gall flies	Powdery mildew, rust	Propagation: division; stem cuttings for hybrids; seed for species. Full sun. Well drained substrate. Zones: 5–9.
Stachys byzantina Lamb's-ears	Aphids, cyclamen mites	Root rot (R), southern blight, root knot nematode	Propagation: division; terminal cuttings; seed. Full sun to part shade. Well drained substrate. pH: 6.0–7.0. Zones: 4–8. Many species and cultivars "melt out" in hot weather; *S. byzantina* 'Countess Helene von Stein' does not.
*Symphyotrichum** *novi-belgii* New York aster (*formerly Aster)	Leafhoppers, spittlebugs	Powdery mildew, rust, leaf spots (*Septoria*, others), root rot (R)	Propagation: division; tip cuttings. Full sun. Dry substrate. pH: 6.0–7.0. Zones: 4–9. Excess fertilization promotes lanky growth.
Thymus spp. Thyme	Root mealybugs	Root rot (R), *Botrytis*, southern blight	Propagation: division; stem cuttings. Full sun. Dry and well drained substrate or will rot. Can melt down in summer. Zones: 5–10.
Tiarella cordifolia Allegheny foam flower	Aphids, black vine weevils	Root rot (T), bacterial leaf spot	Propagation: division because slow to root out; seed. Part shade. Moist, well drained substrate. pH: 6.0–7.0. Zones: 3–8. Grown as much for its many different forms of foliage as for its flowers.
Tradescantia spp. Spiderwort	Spider mites, thrips		Propagation: division. Full sun. Well drained substrate. Zones: 4–9. Blooms reduced by shade and wet soil.

Table 4.1 Key Problems On Herbaceous Perennials (continued)

Plant	Major Pests (Insect, mites, arthropods, and mollusca)	Major Diseases	Cultural Requirements
Tricyrtis spp. Toad lily	Spider mites	Viruses (INSV, CMV, ToRSU), foliar nematodes	Propagation: division; seed for species. Part shade to shade. Moist substrate. pH: 6.0–7.0. Zones: 5–9. Unusual flowers, orchid-like.
Verbena spp. Verbena	Tarnished plant bugs, verbena leafminers, whiteflies, thrips, twospotted spider mites	Root rots (R, P)	Propagation: root cuttings in spring. Full sun. Well drained substrate. Zones: 8–10. Grow in masses for best effect.
Veronica longifolia Long-leaf Veronica	Aphids, thrips, plant bugs	Root rot (P), leaf spots, downy mildew, root knot nematode	Propagation: division in spring; seed. Full sun to part shade. Well drained. pH: 6.0–7.0. Zones: 4–8. Staking required if placed in shade and fertilized heavily.
Viola spp. Violet	Aphids, fritillary butterfly larvae, aster leafhoppers, twospotted spider mites, cutworms, slugs, snails	Root rots (P, T), leaf spots, downy mildew, blight (*Myrothecium*)	Propagation: division; cuttings; seed. Full sun to part shade. Moist substrate. Zones: 6–9. Can be invasive. Cross pollinates readily. Keep colors far apart.
Yucca spp. Yucca	Yucca plant bugs, yucca weevils	Bacterial blight (*Erwinia*), leaf spots (fungal)	Propagation: division; root cuttings; seed. Full sun. Dry, well drained substrate. Zones: 4–10.

Table 4.2 Key Problems On Herbaceous Perennial Grasses

Plant	Major Pests (Insect, mites, arthropods, and mollusca)	Major diseases	Cultural Requirements
Calamagrotis spp. Feather reed grass		Crown rust, anthracnose	Propagation: division. Full sun, part shade. Well drained substrate. pH: 6.0–7.0. Zones: 6–9. Very upright character.
Miscanthus sinensis Maiden grass	Miscanthus mealybugs	Miscanthus blight (*Stagonospora*), root rot (R)	Propagation: division. Full sun. Well drained substrate. pH: 6.0–7.0. Zones: 6–9. A clump grower. Can be invasive if let go to seed. Late season interest.
Miscanthus sinensis 'strictus' Porcupine grass		Colletotricum leaf spot, root rot (R)	Propagation: division. Full sun. Well drained substrate. pH: 6.0–7.0. Zones: 6–9. Good upright, nonfloppy character.
Miscanthus sinensis 'Zebrinus' Zebra grass	Miscanthus mealybugs	Leaf spot, anthracnose, root rot (R)	Propagation: division. Full sun. Well drained substrate. pH: 6.0–7.0. Zones: 6–9. Floppy when mature. Best not to fertilize.
Panicum spp. Switch grass		Leaf spot, root rot (R)	Propagation: division. Full sun. Well drained. pH: 6.0–7.0. Zones: 6–9. Many cultivars have striking foliage color.

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Chapter 5
Monitoring Techniques For Insects, Mites And Other Arthropods

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Introduction

Following are key pests that our Total Plant Management/Integrated Pest Management program has identified in Maryland (Tables 5.1 and 5.2). The greenhouse environment is one of the best-suited areas to use biological control in the production cycle of herbaceous perennial plants. Included in the tables are the best methods of monitoring pests, pests' identification features, and potential biological control agents.

Table 5.1 Monitoring Pests In The Greenhouse

Pest	Best monitoring method	Indentification features	Potential biological control
APHIDS (general)	Sticky cards (yellow) will indicate aphid migration into greenhouse in spring, summer, and fall. Important to inspect plant foliage weekly. Presence of cast skins and/or honeydew is a good indicator.	Species differs in size, color, location on plant, and crop preference. Most aphids are 1–4 mm in size, pear-shaped and soft bodied with 2 cornicles (tailpipes) at rear of abdomen. Legs and antennae typically long and slender. Winged forms on cards; wingless forms on plants.	Green lacewings (*Chrysoperla carnea* and *Chrysoperla rufilabris*), Aphid midge (*Aphidoletes aphidomyza*), Parasitic wasp (*Aphidius colemani*) Entomopathogenic fungus: *Beauveria bassiana* (Naturalis-O and BotaniGard)
APHIDS Chrysanthemum aphid (*Macrosiphoniella sanborni*)	Found only on chrysanthemum species.	Shiny; color varies from reddish to blackish-brown. Cornicles are short, stout, and black. No indentation between antennae as with green peach aphid.	See aphid section above
APHIDS Green peach aphid (*Myzus persicae*) May cause plant damage through disease transmission as well as from feeding	Inspect plant foliage weekly. Pests found on wide range of perennials. Prefer new growth.	Color ranges from light green, light yellow, green, gray-green, pink to reddish. Pronounced indentation between antennae. Cornicles are long, thin, and slightly swollen in the middle. Tip of cornicles are dark and slightly flared.	See aphid section above

Table 5.1 Monitoring Pests In The Greenhouse (continued)

Pest	Best monitoring method	Indentification features	Potential biological control
APHIDS Melon aphid (*Aphis gossypii*)	Found on wide range of perennials.	Color varies from light yellow to dark green. No indentation between antennae as with green peach aphid. Distinct cornicles always dark in color for entire length.	See aphid section above
CATERPILLARS (general)	Several species feed on greenhouse crops. Most adult butterflies and moths overwinter outdoors and migrate into greenhouses. Moth migration is greatest in fall. Regular monitoring of adult flight activity alerts growers to look for eggs on foliage or stems.	Most have appendages, called prolegs, on abdomen. All have mouthparts for chewing foliage and stems or boring into stems.	Microscreening over vents and greenhouse openings excludes migrating adult moths and butterflies. Several species of moths and butterflies are susceptible to *Bacillus thuringiensis kurstaki* (Bt), which is sold under various brand names, in early caterpillar stages.
FUNGUS GNATS *Bradysia* spp.	Sticky cards will capture adults. Lay potato slices (1" by 1") on soil surfaces. Larvae will migrate to potato disk surface facing soil.	Adults are small, humpbacked flies with long legs, beaded antennae, and a single pair of wings with characteristic forked vein near wing tips. Larvae are opaque to white with black head capsule.	Entomopathogenic nematodes, including *Steinernema feltiae* and *S. carpocapsae*, control larval stages. *Bacillus thuringiensis* var. serotype H14 (Gnatrol) control larvae. Several insect growth regulators, including dimilin (Adept), S-kinoprene (Enstar II), and Neem (Azatin, Neemazad) control larvae.
LEAFHOPPERS	Sticky cards will capture adults. In outdoor beds, use sweep nets to capture adults.	Small, slender insects that disperse rapidly when disturbed. Both adults and nymphs run sideways and are good jumpers. Most are wedge-shaped and vary in color: shades of green, yellow, brown, or mottled.	Microscreening on greenhouses excludes leafhoppers that migrate into greenhouses. Outdoors, control may not be necessary on most crops. On plants susceptible to viruses transmitted by leafhoppers, apply systemic insecticide to kill feeding leafhoppers.

Table 5.1 Monitoring Pests In The Greenhouse (continued)

Pest	Best monitoring method	Indentification features	Potential biological control
MITES: Twospotted spider mites *Tetranychus urticae*	Pests tend to build up under hot conditions. Examine plants in warmest section of greenhouse for early infestations. Look for stippling of foliage. In heavy infestations look for webbing on stems, flowers, and upper leaves.	Larvae are pale green with 6 legs. Protonymphs and deutonymphs are pale green to brown with 8 legs. Adults have 2 large black spots on each side and 8 legs. Size is minute.	The predacious mite, *Phytoseiulus persimilis*, is an effective control. *N. californicus* also used for control.
THRIPS Flower thrips (*Franklinielllla tritici*) Onion thrips (*Thrips tabaci*) Western flower thrips (WFT) (*Frankliniella occidentalis*)	Adults congregate in open flowers and can be easily tapped out of flowers. Blowing in flowers also drives them out. Many of these thrips species, especially WFTs, are found in tight, hidden parts of the plant; others such as flower thrips feed on open leaf surfaces. Feeding thrips deposit minute black circular fecal spots on leaf surfaces. Yellow sticky cards capture thrips, but blue sticky cards are particularly attractive to western flower thrips.	Adults are small, generally 1–2 mm in length. Bodies of adults are tubular, with narrow, pointed, fringed wings. Two larval stages feed on plant parts above ground. Prepupal and pupal stages occur in soil. Mount adult species on microscope slide for identification.	Microscreening over vents and greenhouse openings can exclude migrating adult thrips. Predacious mites, *Amblyseius* (= *Neoseiulus*) *cucumeris* and *Iphiseius* (= *Amblyseius*) *degenerans*, are used for controlling first instar thrips larvae. Minute pirate bugs, *Orius* sp., feed on larvae and adults. Entomopathogenic fungus, *Beauveria bassiana*, infests thrips; direct fine mist spray onto pests.
WHITEFLIES Banded-winged whitefly (BWWF) (*Trialeurodes abulitnoea*) Greenhouse whitefly (GHWF) (*Trialeurodes vaporariorum*) Silverleaf whitefly (SLWF) (*Bemisia argentifolia*)	Use yellow sticky cards to monitor for adults. Place sticky cards near intake vents and doors to detect inward-migrating adults. Plant inspection should detect immature stages on under-surface of foliage .	Adults are short in length (1–2 mm), white, and flylike. Eggs are tiny, spindle-shaped, and laid on undersides of leaf surfaces. SLWF eggs start out white but turn amber-brown. GHWF eggs start white and turn to gray with time. Crawlers and other nymphal stages are oval, flattened, and translucent.	Release *Encarsia formosa* early in crop cycle to suppress greenhouse whiteflies before population builds up. Suppress silverleaf whitefly using *Eretmocerus eremicus*. An entomopathogenic fungus, *Beauveria bassiana* (Naturalis-O, BotaniGard), is effective against nymph stages of SLWF and GHWF.

Table 5.2 Monitoring Insects In Outdoor Production Areas

Pest name and Plant Host(s)	Pest description	Monitoring techniques	Non-chemical control strategies
APHIDS Chrysanthemum aphid *Macrosiphoniella sanborni* Green peach aphid *Myzus persicae* Melon aphid A*phis gossypi* **Plant Hosts:** Chrysanthemum aphid - only on chrysanthemums. Green peach and melon aphids found on a wide range of herbaceous perennials.	Adults may be winged or wingless. Adults vary from 1.25–2.5 mm. Bodies are pear-shaped with 2 tube-like cornicles (tailpipes) on abdomen. Chrysanthemum aphid is black with small, stout cornicles. Green peach aphid is light to dark green or pink with red eyes. Three dark lines run down the back. Conspicuous rectangular dent between antennae. Melon aphid is yellow to dark green with black head and thorax. Cornicles are dark the whole length.	Examine new growth by flipping leaves over and looking on undersides. Cast skins may be evident. Honeydew and sooty mold may appear on foliage. Activity of ants on plants often indicates honeydew and aphid activity. Aphids sucking fluids from buds and leaf veins cause stunting, deformation, discoloration, and leaf death.	A number of predators and parasites often control aphids if cover sprays are avoided. Entomopathogenic fungi such as *Beauveria bassiana* may be effective in humidities above 35%. Horticultural oils, neem products, insect growth regulators, and insecticidal soaps control aphids with minimal impact on beneficial organisms.
CATERPILLAR Iris borer *Macronoctua onusta* **Plant Hosts:** Japanese, German, and blueflag iris, and *Iris pseudocorus*	Adults rarely seen, but are mottled brown with yellow-brown hind wings. Larvae are pale yellowish-pink with brown heads. Female lays up to 1000 eggs, singly or in clusters of 2–5 on old foliage in late summer, early fall.	Eggs hatch in spring when new fans are 4–6" long. Look for early foliar feeding, leaf bleeding. Hold damaged leaves up to sun to see caterpillar silhouette. Tiny caterpillars feed inside new foliage, causing leaves to bleed sap and look ragged. Narrow water-soaked slits appear. Larvae move into rhizome and feed internally. Slimy frass found if leaves and rhizomes are opened.	Remove all old foliage from area in fall. If find borers in foliage in early spring, crush larvae in the leaf with your fingers or apply a systemic insecticide.Apply entomopathogenic nematodes to soil to kill larvae in rhizomes in July and August.

Table 5.2 Monitoring Insects In Outdoor Production Areas (continued)

Pest name and Plant Host(s)	Pest description	Monitoring techniques	Non-chemical control strategies
LACE BUG Chrysanthemum lace bug *Corythucha marmorata* **Plant Host(s):** *Chrysanthemum* spp.	Adults are 2.5–3 mm long and 1.5 mm wide, dark, with hood-like head covering and netted, lacy, wings with dark markings. Wings are folded flat over abdomen. Legs and antennae are light brown. Nymphs found almost exclusively on undersides of leaves and are colorless at hatch but soon turn dark and spiny. There are 5 nymphal instars before the adult stage.	Look for early stippling injury on foliage, black (tar-like) fecal spots and lace bugs on underside of foliage. Adults and nymphs cause injury as they feed with piercing, sucking mouthparts. Pests extract liquid contents of leaf tissue through undersurface. Upper surface of infested leaves turn stippled or blanched. Severe infestations: leaves turn white and may dry up.	Remove foliage if infestation is small and on isolated plants.
LEAFMINERS *Liriomyza trifolii* (Has no official common name) **Plant Host(s):** Infests many floral and vegetable crops, particularly species within Asteraceae. Damages asters, *Dahlia* spp., gerbera daisies, chrysanthemum, baby's breath	Tiny flies in insect family Agromyzidae are most common leafminer pests of herbaceous plants. Adult flies are small (2.5 mm long) and dark with yellowish body markings. In propagation house, they are attracted to yellow sticky cards. Eggs are tiny and whitish and deposited in leaf. Legless larvae feed between leaf surfaces and grow to about 2 mm.	Closely monitor plants for leafminer. Look for the characteristic leaf punctures and early leafminer damage which can enable removal of infested leaves and prevent a more serious problem. Use yellow sticky cards to monitor adult activity. If adults are detected on cards, examine plants near card. Egg-laying adults feed from small leaf punctures they make and sometimes lay egg within puncture. Puncture leaves white speck. Numerous specks grow unsightly. Larvae (maggots) feed on inside of leaf; larvae tunnel through leaf and produce meandering whitish mines giving these pests the name, serpentine leafminer. Mines grow wider each time maggot molts to next instar.	Repeated applications of a systemic insecticide may be necessary. Pick off leaves. *Diglyphus* spp. (*D. isaea*, *D. intermedius*, and *D. begini*) are commercially available wasps that parasitize late second and third instar leafminer larvae. *Dacnusa sibirica* is another leafminer parasitoid.

Table 5.2 Monitoring Insects In Outdoor Production Areas (continued)

Pest name and Plant Host(s)	Pest description	Monitoring techniques	Non-chemical control strategies
MITES: Twospotted spider mite *Tetranychus urticae* **Plant Host(s):** Wide range of herbaceous perennial species. Certain perennials such as coreopsis, rock rose (*Helianthenum nummularium*), salvia, yarrow, and crocosmia are especially susceptible.	Adults have oval bodies, about 0.05 mm long, with 8 legs. Generally greenish-yellow with black spot on each side of body during growing season. Overwintering females are red. Eggs are white to yellow and round. Multiple generations per year.	Populations flourish in hot, dry weather. Examine undersides of foliage for pests. Conduct tap test with white paper placed under foliage. Adults overwinter at base of plant; no eggs used for overwintering. Damaged foliage appears stippled. In heavy infestations leaves turn yellow and die. Some plants are susceptible to spider mite toxins; low populations can cause plants to die. In heavy infestations webbing may be present.	Use horticultural oils or mite insect growth regulator such as Hexygon that will preserve any beneficial organisms. During hot, dry weather when populations are high consider using a residual miticide. Spray water directly on underside of leaves where mites are present.
PLANT BUG Fourlined plant bug *Poecilocapsus lineatus* **Plant Host(s):** Attacks more than 250 herbaceous perennial species. Common on phlox, rudbeckia, foxglove, mints, echinacea	Adults are yellow with 4 black stripes down back. Nymphs are smaller with longitudinal black and yellow stripes confined to developing wing buds. One spring generation per year outdoors. Eggs overwinter in shoots.	Found in May and June in Maryland. Look for fresh, yellow stippling injury on foliage. Feeding generally stops in June. Plant leaves develop yellow stipples that turn necrotic brown to black. Feeding injury on newly expanding foliage may distort new growth. In large infestations, spots coalesce and cause leaves to turn brown. Many plants outgrow damage.	Consider using systemic insecticide for densely foliaged plants. Horticultural oil or insecticidal soap can be timed to make contact with nymphs. Repeated applications may be necessary.

Table 5.2 Monitoring Insects In Outdoor Production Areas (continued)

Pest name and Plant Host(s)	Pest description	Monitoring techniques	Non-chemical control strategies
PLANT BUG Tarnished plant bug *Lygus lineolaris* **Plant Host(s):** Attacks wide range of herbaceous plants including asters, chrysanthemums, goldenrod, and phlox	Adults are 6 mm long, oval, and pale yellow with a few black markings, or reddish brown to black. Have characteristic white triangle between shoulders. Antennae are relatively long. Nymphs are yellowish green. Older nymphs have 4 black spots on thorax and one on abdomen.	Look for distorted foliage or small yellow spots that progress to brown. May find nymphs on stems and leaves. Adults are very active and fly freely. May invade nurseries near agricultural crops such as alfalfa, when crop is cut. Use needle-like mouthparts to extract plant juices. Feeding causes terminal growth to be yellowish or distorted. Flowers from damaged plants sometimes fail to open on one side or flowers abort.	Keep weed populations down around growing areas. Weed hosts include fleabane, goldenrod, vetch, dock, and dogfennel.
SLUGS AND SNAILS Belong to the Phylum Mollusca, Class Gastropoda, Order Sytlomatophora. Although not related to insects, they cause major damage to many species of herbaceous perennials. **Plant Host(s):** Wide range of herbaceous perennials, especially iris, hosta, lilies, narcissus, and chrysanthemum. Some hostas show "resistance" to slug feeding. Also feed on decaying plant matter.	Both have unsegmented bodies and antennae. Body region in contact with ground is muscle—the gliding foot —which produces silvery, slimy substance that coats surfaces which is nearly always associated with their feeding damage. Most are nocturnal feeders. Snails have external shell. Slugs have no external shell; instead, have protective mantle on dorsal side. Adults may live many years.	Slime trails are a good indication these mollusks are present. If slime trails are not apparent, yet snails or slugs are suspected, water infested area in late afternoon. Place board or upside down pot on or beneath bench and check each day. Look for irregularly shaped holes with smooth edges on leaves closest to ground. Can chew off succulent plant parts and growing tips close to ground. Seedlings are usually killed. Most damage occurs during cool, rainy weather.	Can withstand submersion in water for about 2 hours, then they drown. Need adequate moisture to survive because of limited protection against water loss. Absorb water directly through skin or drink from puddles. Generally avoid areas with strong air currents which can dry them out.

Table 5.2 Monitoring Insects In Outdoor Production Areas (continued)

Pest name and Plant Host(s)	Pest description	Monitoring techniques	Non-chemical control strategies
THRIPS Daylily thrips *Frankliniella hymenocallis* **Plant Host(s):** Mainly damages daylily but also found damaging iris	Adults are slender, tubular-shaped insects that are 1.5 mm long. Wings have fringes of hairs. Larvae are white to yellow.	After new spring shoots appear look for foliar damage. Pull leaf sheaths apart to find larvae and adults. Thrips use single mandible to pierce plant tissue creating wounds on foliage of silver to white patches, which eventually join. New growth is often distorted and twisted.	Repeat applications of insecticides may be necessary. Determine this by pulling foliage apart and examining for presence of live thrips. Three applications5–7 days apart is advisable.
WEEVIL Black vine weevil *Otiorhynchis sulcatus* **Plant Host(s):** Several perennial species including astilbe, sedum, hosta, daylily, lily of the valley, bergenia, phlox, physostegia, Christmas fern, toad lily	Larvae are white, c-shaped, legless, with brown heads. Adults are 3/8" long and black with faint yellow flecks. One generation per year.	Look for notching of foliage in June. Adults feed at night. To trap adults, use pit-fall traps as well as boards, burlap, and other objects placed on the ground. Check during day. Look for larvae on roots of wilted plants or plants with notched foliage. Adults cause marginal leaf notching. Larvae feed on roots, girdling plants.	Use entomopathogenic nematodes such as *Heterorhabditis bacteriophora* or *Steinernema carpocapsae* to control larvae in container-grown plants.
WHITEFLIES Greenhouse whitefly (GHWF)*Trialeurodes vaporariorum* **Plant Host(s):** Wide range of perennials. Certain species, (e.g. *Calceolaria*, *Dahlia, Dicentra, Hibiscus, Malva, Lavandula, Lupinus, Salvia, Polystrichum, Rudbeckia*, and *Verbena*) are more susceptible.	Adults are highly mobile, 1–2 mm long, and snow white. Color comes from wax secreted from insect's abdomen. Eggs are small and spindle-shaped and usually laid on undersides of leaves. Crawler and nymphal stages are oval, greatly flattened, and somewhat translucent. The 4th instar pupa, which is used for identification, is the largest nymphal stage, with eyespots obvious near one end of body.	In greenhouses use yellow sticky cards to monitor adults' flight activity. Damaged foliage appears chlorotic. In heavy infestations leaves turn yellow and die; honeydew excretions cause shiny, sticky leaves. Honeydew serves as substrate for growth of grayish-black sooty mold fungus, which detracts from plant's aesthetic value.	Use horticultural oils, insecticidal soaps, or (in greenhouses) insect growth regulators that will preserve any beneficial organisms. Identify and treat hotspots early before populations build and spread. Because whiteflies often first build up on old foliage, remove and destroy it.

Table 5.2 Monitoring Insects In Outdoor Production Areas (continued)

Pest name and Plant Host(s)	Pest description	Monitoring techniques	Non-chemical control strategies
WHITEFLIES Silverleaf whitefly (SLWF) *Bemisia argentifolia* **Plant Host(s):** Wide range of perennials. Certain species, (e.g. *Calceolaria*, *Dahlia, Dicentra, Hibiscus, Malva, Lavandula, Lupinus, Salvia, Polystrichum, Rudbeckia*, and *Verbena*) are more susceptible.	Pupal stage found on leaf undersides. Pupa rounded or dome-shaped and not fringed with hairs on the edges. Adults are yellowish and fold wings at 45˚ angle, tightly to body. Crawler and nymphal stages of most species are oval, greatly flattened, and somewhat translucent. The 4 nymphal stages are identified by their relative size. 4th instar pupa, which is used for identification, is largest nymphal stage, usually with eyespots obvious near one end of body.	In greenhouses use yellow sticky cards to monitor adults' flight activity. Damaged foliage appears chlorotic. In heavy infestations leaves turn yellow and die; honeydew excretions cause shiny, sticky leaves. Honeydew serves as substrate for growth of grayish-black sooty mold fungus, which detracts from plant's aesthetic value.	Use horticultural oils, insecticidal soaps, or (in greenhouses) insect growth regulators that will preserve any beneficial organisms. Identify and treat hotspots early before populations build and spread. Because whiteflies often first build up on old foliage, remove and destroy it.

Chapter 6
Pesticide Application Equipment: Selection And Calibration

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Introduction

Proper application of pesticides is essential for achieving the desired control. Applying pesticides is an unpopular and time-consuming task. You must use the correct application equipment and no one type of sprayer can do all tasks. Calibrate the equipment to ensure that the proper amount of chemical reaches the target. Reaching the target does not happen automatically; the operator influences the success or failure of the task. Actually, the operator must time the spraying and accurately proportion the chemical over the target area, being careful to direct the spray in a manner that achieves good coverage of the entire plant.

A couple of factors are important in pesticide application. First, droplet size needs to match the target pest. Flying insects need small droplets that stay in the air. Second, if the target pest is inside a canopy, then the canopy air volume must be replaced by the pesticide spray air volume in order to deliver the pesticide to the foliage inside the canopy. Sprayer capability must match required droplet size.

While spraying is a principal means of controlling insects and diseases, growers must identify and eliminate the source of the insect or disease problem to reduce the frequency of sprayings. Weeds or grasses near the greenhouse may harbor the insects or disease carriers. A compost or discard pile of non-composted plants located near the inlet vents can be a source of insects or disease. Sites that might harbor pests that can move into the greenhouse must be kept clean. Insect screening, if properly used, can help to reduce the quantity of insects entering the greenhouse. Rotating the classes of chemicals used will help delay the development of resistance to chemical control.

Droplet Size Versus The Pest

One of the primary differences among the several different types of sprayers available is the size of the droplet each produces. Your ultimate goal is to reach the target with pesticide (Table 6.1). Reaching the smallest insects, mites, and disease organisms requires complete coverage with tiny droplets or a good wetting to the point of runoff. For good coverage a contact insecticide or fungicide must come in direct contact with the target; a systemic pesticide must be absorbed by the plant. Weeds are killed by herbicides that are absorbed by foliage; large droplets supply adequate coverage of the plant for absorption to take place and reduce the chances of the herbicide drifting onto the desired crop.

Table 6.1 Optimum Spray Drop Sizes For Various Targets

Source: Adapted from Matthews 1979

Target	(in microns)
Flying insects	10 to 50
Insects on foliage	30 to 50
Diseases on foliage	40 to 100
Growing medium and weeds	250 to 500 (avoids spray drift)

There is a relationship between droplet size and the number of droplets per unit area (Table 6.2). A great number of small droplets give better coverage than a few large droplets. To reach a small target (insect or mite), therefore, use small droplets; the more droplets that fill a given area, the more likely the target is to make contact with a droplet. Note that 1 square inch equals 6.45 square centimeters; 19,099 drops per square centimeter equals 123,189 drops per square inch.

The mathematical relationship between the diameter of a droplet and its volume is a cubic one. A 100-micron droplet reduced to a 50-micron size results in eight 50-micron droplets. In other words, the volume of one 100-micron droplet equals the volume of eight 50-micron droplets. A 100-micron droplet reduced to 10-micron droplets results in 1,005 10-micron-size droplets. Although a small insect may walk around a 100-micron droplet on a leaf, 1,005 10-micron droplets will cover the leaf, which makes the insect unable to avoid them. The same holds true for diseases, mites, and slugs: the increased coverage makes it hard to avoid the chemical.

Table 6.2 Theoretical Spray Coverage

Applying one liter per hectare with various spray drop sizes.

Drop Diameter (microns)	Number of Drops Per Square Centimeter
10	19,099
20	2,387
50	153
100	19
200	2.4
400	0.3
1,000	0.02

Types Of Sprayers

The three primary types of sprayers used in greenhouses are:

1 Hydraulic or high-volume hydraulic
2 Targeted low volume
3 Fog or ultralow volume

Each sprayer has a purpose; a greenhouse operation will require two or more sprayer types for various tasks. Main differences among sprayers are quantity of water used, operating pressure, and droplet size produced.

Hydraulic

A hydraulic or high-volume sprayer uses a high flow rate of water to wet the foliage to the point of runoff. This sprayer uses standard rates of chemicals and large volumes of water. The droplets coming from the sprayer are generally more than 100 microns in size. The sprayer applies herbicides in large droplets of 200 to 400 microns at a low pressure of 15 to 60 pounds per square inch (psi) to avoid drift. Insecticides and fungicides are applied at higher pressures— more than 60 psi—to achieve droplets of 100 microns or less in diameter. The lower-volume greenhouse sprayers use 500 psi and 2 to 4 gallons per minute (gpm) flows to wet to runoff.

The quantity of water to use depends on the specific sprayer and nozzle, the spraying technique of the operator, and the size of the crop. Calibrating the sprayer according to the operator and the crop is essential for mixing the correct amount of spray mix. Ten thousand square feet of crop early in its growth may require 15 to 20 gallons of water. As the crop reaches maturity and has more foliage, achieving good coverage may require 30 to 50 gallons of water.

The hydraulic sprayer can do a good job of covering foliage. The operator can see the spray on the foliage and know whether or not the target has been hit. The larger flow of water provides force to move foliage aside for penetrating the canopy and stirring the leaves. By using a low application rate the operator can hold the spray nozzle onto a target long enough to achieve penetration without excessive wetting.

Low Volume

The targeted low-volume sprayer may be hydraulic, air assisted, electrostatic air assisted, or rotary. The object of using this type of sprayer is to use small droplets and a low quantity of water to carry the chemical to the crop.

The *low-volume hydraulic sprayer* utilizes high pressures between 1,000 and 3,000 psi to break the droplets into roughly 50-micron size or smaller; however, these sprayers use less water and produce a mist that is too fine to show a wetting pattern. There is no wet-to-runoff pattern to observe. The operator aims the sprayer at the target and sprays until the air volume under the foliage is filled with spray. The operator is responsible for obtaining full coverage. A concentrated chemical mix (chemical plus water) can be used because less water will be applied.

The calibration process is more difficult for low-volume sprayers because the spray does not wet the foliage as visibly as the high-volume hydraulic sprayer does. Special water-sensitive paper that indicates coverage is available (from some sprayer or chemical suppliers). The paper changes color when droplets of water land on it. Attach pieces of this paper to plants in various places before spraying and examine the paper afterward to observe how well the spray droplets were distributed during calibration or normal spraying. The calibration process also helps to determine the amount of water needed to cover a given area. Calibration is still very important for spray mix preparation to avoid costly waste. Calibration information may also be useful in determining legal amounts of chemical to use with a measured amount of water for covering a given area. It may be necessary to consult the chemical producer to learn what are the allowable mixing ratios.

Air-assisted low-volume sprayers use air as the primary carrier of the chemical. High-speed air strikes the stream of liquid chemical or chemical and water being injected into the sprayer and breaks the stream into small droplets. The air then carries the liquid to the plants. The speed at which the sprayer moves past the foliage determines the penetration of air into the foliage to deliver the chemical. Slow movement may be necessary to allow the air mass created by the sprayer to penetrate into thick foliage, pushing the air in the foliage out the other side. The sprayer air volume must displace the air volume under the foliage.

Electrostatic sprayers produce fine droplets in the 30- to 60-micron size, which are electrically charged and then air-blasted into the crop foliage. The negatively charged particles are attracted to any surface and can provide coverage that is as good as the coverage from a high-volume sprayer.

A sprayer with a *spinning or rotary disk* is used to impact and break a stream of water into droplets that are 60 to 80 microns in diameter. A variety of sizes are available for greenhouse use.

Fog Or Ultra-Low Volume

The fogger uses little water (2 liters per 10,000 square feet) and produces fine droplets less than 25 microns in diameter. When you distribute pesticides in very small droplets as a fog your rate of application is reduced. Some chemicals are not labeled for reduced rates and some formulations are not intended to be used in ultralow-volume sprayers. Clogging will occur with some chemicals; special carriers are needed with some pesticides.

Mechanical cold foggers operate between 1,000 and 3,000 psi to force the mixture of chemical and a small amount of water through the nozzle. Thirty-micron droplets drop out of the air fairly quickly, but 5-micron droplets float in air currents for hours. These sprayers use no chemical additives.

Thermal foggers use a pulsing jet engine to produce a highly visible fog that can stay suspended in the air for up to 6 hours. Inside the thermal fogger, a gasoline and air mixture explodes in an enclosed resonator. The explosion rushes out as a jet stream. A chemical solution is injected into the jet stream and is blown apart into very small 0.5- to 30-micron particles. A carrier solution added to the mix causes a visible fog, eliminates the evaporation of droplets, and ensures uniform particle sizes.

An *aerosol micro-particle generator sprayer* is available. It uses an oilless air compressor to produce high-pressure air. The air flows through a special nozzle to produce superfine fog particles of 0.5 to 10 microns in diameter. These particles can stay suspended for up to 6 hours. No special carrier solution is required. One commercial company packages a pure technical active ingredient in a container that emits the material as a fog. You open an aerosol can or cans and set them down in the greenhouse, starting at the point farthest from the exit and walking toward the exit. The company claims 40 percent of the material reaches the undersides of foliage.

Some sprayers have a fan to move the air around the greenhouse; if not, use the HAF (horizontal airflow fans) to distribute the fog throughout the building.

Calibration

Proper use of the sprayer involves following a procedure that measures the amount of water or spray used to cover a given area or volume at a known rate of operator travel speed. Calibration, which tells you the amount of liquid that was applied to a known unit area, enables you to prepare chemical spray mixes properly.

For a hydraulic sprayer fill the sprayer with water, spray a known area of the greenhouse crop, and then record the time required for spraying. The goal is to spray the water to achieve uniform coverage. Next, measure the water required to refill your sprayer. Calculate the spray rate by dividing the gallons used by the area covered. Adjust the rate by adjusting the nozzle or your walking rate.

If a nozzle wears out or an operator rushes and does a poor job of coverage, the amount of spray used should alert the owner or operator to a problem. The operator's movement is critical to applying the correct amount of spray.

Measuring the output of a nozzle will verify its rate of flow. The manufacturer can provide information about the discharge rate (gallons per minute) of each nozzle at several pressures. A good quality sprayer should have a pressure gauge to enable you to know if the sprayer is operating properly (on all sprayers moving liquid at pressure). Set and/or record the pressure of liquid going to the nozzle. Catch the discharge of the nozzle in a container for a measured period of time. Measure the amount of liquid collected.

Calculate the flow through the nozzle in gallons per minute using the measured volume and time. Compare this value to the manufacturer's discharge rate for the pressure observed. If you follow the procedure fairly accurately, the measured discharge rate should approximate the rate presented in the manufacturer's data. Small differences may be caused by wear.

You can calibrate a low-volume sprayer in a similar manner. Carefully direct the low-volume sprayer into the foliage to exchange the air under the foliage with the air containing the pesticide. Practice and calibration help the operator to establish the amount of water and chemical to use for large jobs.

Wear chemical-resistant personal protective equipment (PPE) during the calibration and during the spraying—the operator needs to experience the same environment during calibration as during actual spray application. Protective equipment is a must during pesticide application.

Canopy Air Volume Replacement For Penetration

In addition to the topics covered above, the successful application of pesticides means adequate penetration into the foliage of the plant to deposit the pesticide onto the foliage of the plant. This means that the air volume of the canopy must be replaced by air containing the pesticide. The sprayer must force a large volume of air into the canopy. The applicator must travel slowly enough to allow the necessary air volume to be moved into the canopy.

Perhaps in a greenhouse situation, but more likely in a nursery operation where larger plants are grown in-ground or in large containers, dense crops must be sprayed to kill pests inside the plant foliage. An airblast sprayer may be required in order to penetrate the foliage and canopy air volume to deliver the pesticide to plant foliage. This is a fourth type of sprayer. A fan moves a high volume of air in which the pesticide is injected. Air is used instead of water (hydraulic sprayer) to deliver the pesticide.

Coverage is tested using paper strips, with a water soluble detection coating, that are hung in the canopy. Spray droplets that wet the paper leave a mark Observe to see if spray in passing through the canopy and to see the density of marks on the detection paper. Adjust speed of travel, slower to get more penetration and greater density of marks.

Reference

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Chapter 7
Insecticide And Miticide Classes

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Introduction

Fungicides and insecticides are tools used by growers to manage diseases, insects, and mites. Generally these products do not eliminate the problems; rather they manage disease and insect problems to acceptable levels. The biological world is designed to change and adapt to overcome any block to its survival so fungicides, miticides and insecticides must be used correctly to manage pest problems and to delay the development of resistance to chemicals.

Two Organizations Dedicated To Reducing Pest Resistance (IRAC and FRAC)

The Insecticide Resistance Action Committee (IRAC) was founded in 1984 as a specialized technical group to help prevent or delay the development of resistance in insect and mite pests. The Fungicide Resistance Action Committee (FRAC) started at an industry seminar in Brussels in 1981 and originated from a course on fungicide resistance in 1980. The purpose of FRAC is to provide fungicide resistance management guidelines to prolong the effectiveness of "at risk" fungicides and to limit crop losses should resistance occur.

Resistance Defined

Resistance to insecticides, miticides and fungicides is defined 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 recommendations for that pest species." (IRAC).

Rotating: Ways To Delay Resistance Development

The assumption is that rotations of compounds from different modes of action (MoA) classes remain the most viable resistance management technique. Most insecticides and miticides affect insects and mites in specific ways. IRAC currently classifies insecticides and miticides into 28 different modes of action. The following chart identifies those insecticides and miticides used in greenhouses, nurseries and landscapes by their modes of action (Table 7.1). Timing for chemical class rotation is slightly different for insects and mites compared to disease control. To delay the onset of resistance to pesticides, it is usually recommended to rotate from one pesticide to another one that has a different mode of action after one to two insect or mite generations. This chart may be used to identify the mode of action of a pesticide and to determine other pesticides with different modes of action that may be used in a pesticide rotation plan.

Table 7.1 Mode Of Action (MoA) Classification Of Insecticides And Miticides Used In Greenhouses Used In Maryland Greenhouse Operations

(Note: IRAC created 28 groups. Groups that do not have any chemicals registered for use in greenhouses, nurseries and landscapes are not inlcuded.)

Group	Main Group and Primary Site of Action	Chemical Class	Active Ingredient (Trade Name)
1A	Acetylcholine - Nerve action	Carbamates	Methiocarb (Mesurol)
1B	Esterase inhibitors – nerve action	Organophosphates	Acephate (Orthene TT&O 97, 1300 Orthene TR) Chlorpyrifos (DuraGuard ME) Chlorpyrifos + cyfluthrin (*Duraplex TR) Dichlorvos (Fulex DDVP Fumigator) Fenpropathrin + acephate (*Tame/Orthene TR) Naled (Dibrom 8 Emulsive)
2A	GABA-gated chloride channel antagonists	Cyclodiene organochlorines	Endosulfan (Thiodan 50 WP)
3A	Sodium channel modulators	Pyrethroids Pyrethrins	Bifenthrin (Talstar, Attain, Menace GC) Cyfluthrin (Decathlon20WP) Cyfluthrin + imidacloprid (*Discus) chlorpyrifos + cyfluthrin (*Duraplex TR) Llambda-cyhalothrin (Scimitar GC) Fenpropathrin (Tame) Fenpropathrin + acephate (*Tame/Orthene TR) Tau-fluvalinate (Mavrik Aquaflow) Permethrin (Astro, Fulex Permethrin Fumigator) Pyrethrin + piperonyl butoxide (Pyrethrum TR, Pyrenone, Pyreth-It)

Table 7.1 Mode Of Action (MoA) Classification Of Insecticides And Miticides Used In Greenhouses Used In Maryland Greenhouse Operations (continued)

Group	Main Group and Primary Site of Action	Chemical Class	Active Ingredient (Trade Name)
4A	Nicotine acetylcholine receptor disruptors- nerve action	Neonicotinoids	Acetamiprid (TriStar) Clothianidin (Celero) Cyfluthrin + imidacloprid (*Discus) Imidacloprid (Marathon, Benefit 60WP) Dinotefuran (Safari) Thiamethoxam (Flagship)
4B		Nictoine	Nicotine alkaloid (Fulex Nicotine Fumigator)
5	Nicotine acetylcholine receptor agonists – nerve action	Spinosyns	Spinosad (Conserve SC, Entrust)
6	Chloride channel activators	Avermectins	Abamectin (Avid 0.15EC, Flora-Mek 0.15EC, Lucid)
7A	Juvenile hormone mimics	Juvenile hormone analogues	Kinoprene (Enstar II)
7B		Fenoxycarb	Fenoxycarb (Preclude, Precision Accu-Pack)
7C		Pyriproxyfen	Pyriproxyfen (Distance)
9B	Selective feeding blockers	Pymetrozine	Pymetrozine (Endeavor)
9C		Flonicamid	Flonicamid (Aria)
10A	Mite growth and embryogenesis inhibitors	Clofentezine	Clofentezine (Ovation)
		Hexythiazox	Hexythiazox (Hexygon DF)
10B		Etoxazole	Etoxazole (TetraSan)
11A1	Microbial disruptors of insect midgut membranes	*B.t.* var *israelensis*	*B.t.* var *israelensis* (Gnatrol)
11B2		*B.t.* var *kurstaki*	*B.t.* var *kurstaki* (Dipel, Biobit HP, Deliver, Thuricide)
12B	Inhibitors of oxidative phosphorylation, disruptors of ATP formation	Organotin miticides	Fenbutatin oxide (ProMite)
13	Uncoupler of oxidative phosphorylation via disruption of H proton gradient	Chlorfenapyr	Chlorfenapyr (Pylon)
15	Inhibitors of chitin biosynthesis, type 0, Lepidopteran	Benzoylureas	Diflubenzuron (Adept, Dimilin SC) Novaluron (Pedestal)
16	Chitin synthesis inhibitor	Buprofezin	Buprofezin (Talus)

Table 7.1 Mode Of Action (MoA) Classification Of Insecticides And Miticides Used In Greenhouses Used In Maryland Greenhouse Operations (continued)

Group	Main Group and Primary Site of Action	Chemical Class	Active Ingredient (Trade Name)
17	Molting disruptor	Cyromazine	Cyromazine (Citation)
20B	Mitochondial electron transport inhibitors	Acequinocyl	Acequinocyl (Shuttle)
21A	Site 1 Mitochondrial electron transport inhibitors	METI acaricides	Fenpyroximate (Akari) Pyridaben (Sanmite)
21B		Rotenone	Pyrethrin and rotenone (*Pyrellin EC)
23	Inhibitors of lipid synthesis	Tetronic and tetramic acid derivatives	Spiromesifen (Judo) Spirotetramat (Kontos)
Unclassified: listed but not classified by IRAC	Compounds of unknown mode of action	*Beauveria bassiana*– fungus	*Beauveria bassiana (*Botani-Gard, Naturalis, Mycotrol O)
		Bifenazate	Bifenazate (Floramite)
		Pyridalyl	Pyridalyl (Overture)
		Azadirachtin	Azadirachtin (Azatin, Ornazin, Aza-Direct, Ornazin, Neemix 4.5)
		Dicofol	Difocol (Kelthane 50 WSP)
Insecticides used in greenhouse not classified by IRAC	Desiccation of membrane disruptors	Oil	Neem oil (Triact)
			Paraffinic oil (SunSpray Ultra-Fine Oil, JMS Stylet Oil)
			Petroleum oil (PureSpray Green, Saf-T-Side, SuffOil-X, Ultra-Pure Oil)
			Soybean oil (Golden Pest Spray Oil)
		Insecticidal Soap	Potassium salts of fatty acids (Insecticidal Soap 49.52, M-Pede)

Chapter 8
Insecticide And Miticide Recommendations For Herbaceous Perennials

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The following tables in this chapter list those insecticides currently labeled for the most commonly found insect pests of greenhouses (Tables 8.1 to 8.19). The trade names are those most readily available for use on commercial ornamental plants in Maryland. (**Note:** This list may not include all brands sold, nor does it imply any preference whatsoever).

Formulation Key:
WSP - Water soluble packets
G - Granule
WP - Wettable powder
SG - Soluble granular
EC/ES - Emulsifiable concentrate/Emulsifiable suspension
F - Flowable
WDP - Water dispersible granular

NC = Not classified
IGR = Insect growth regulator
** = Restricted use

DISCLAIMER

The USER is always responsible for the effects of pesticide residues, as well as for problems that could arise from drift or movement of the pesticides to the property of others. Use pesticides only according to the directions on the label. Follow all directions, precautions, and restrictions that are listed. Do not use pesticides on plants or sites that are not listed on the label.

The pesticide rates in this publication are recommended only if they are registered with the Environmental Protection Agency and your state department of agriculture. If a registration is changed or cancelled, any rates listed here are no longer recommended. Before you apply any pesticide, fungicide or herbicide, check with your Extension agent for the latest information.

Trade names are used only to give specific information. This publication does not endorse nor guarantee any product and does not recommend one product instead of another that might be similar.

Table 8.1 Insecticides For Aphid Control

Refer to disclaimer statement on page 47.

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Abamectin	Abamectin E-Pro 0.15 EC	6	Avermectin	12	G		L	Do not apply through any type of irrigation system. Do not use on chrysanthemums, ferns, roses, or Shasta daisies. For aphid suppression. See label about resistance management issues.
	Avid 0.15EC				G		L	
	Ardent 0.15 EC				G		L	
	Flora-Mek 0.15 EC				G		L	
	Minx				G		L	
	Quali-Pro Abamectin 0.15 EC				G		L	
	Timectin 0.15EC T&O				G		L	
Acephate	Avatar	1B	Organophos-phate	24	G	N	L	Do not treat certain chrysanthemums and those with open blooms.
	Acephate 90 WDG				G	N	L	
	Acephate 90 SP				G	N	L	
	Acephate 97Up				G	N	L	
	Orthene TT&O				G	N		
Acetamiprid	TriStar 70 WSP	4A	Neonicotinoid	12	G	N		Do not irrigate overhead for at least 6 hrs after application. See label for tank mixing suggestions.
	Tri Star 30 SG				G	N		
Azadirachtin	Azatin XL	NC	Botanical	4	G	N	L	IGR, repellant, anti-feedant. Controls immatures and pupae on contact or by ingestion. Do not use with Bordeaux mixture, triphenyltin hydroxide, lime sulfur, Rayplex iron or other highly alkaline materials. +Azatrol: May reduce waxy bloom on certain plants.
	Aza-Direct			4	G	N	L	
	Azatrol+			4	G	N	L	
	Neemix 4.5			12	G	N		
	Neemazad 1.0% EC			12	G	N		

Table 8.1 Insecticides For Aphid Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Beauveria bassiana	BotaniGard ES	NC	Biological	4	G	N	L^	Contact insecticide. Do not tank mix with fungicides. Can use ultra-low volume equipment and chemigation but not thermal foggers. *Mycotrol has organic certification. ^Commercial site.
	BotaniGard 22 WP				G	N	L^	
	Mycotrol O (WP)*				G	N		
	Naturalis L (JW-1 strain)				G	N	L	
	Naturalis H&G				G	N	L	
Bifenthrin	Attain Greenhouse	3A	Pyrethroid	12	G		L	Apply when foliage is dry. Do not apply through any irrigation system.
	Attain TR				G			Apply when foliage is dry,
	Menace GC 7.9% Flowable (F)**				G	N	L	Preventative and curative topical drench. Wait 30 days to reapply.
	Menace 7.9% Flowable (F)						L	Do not apply through any irrigation system.
	Onyx Insecticide						L	Do not apply more than once per 7 days. A surfactant or horticultural oil may increase effectiveness.
	Onyx Pro**					N	L	
	Talstar P (Professional) (F)				G		L	Need thorough coverage. Do not apply more than once per seven days. Can tank mix with IGRs and other products.
	Talstar Nursery				G	N		
	Talstar Select**				G	N	L	Need thorough coverage. Do not apply through any irrigation system.
	Up-Star SC (F)**				G	N	L	
	Wisdom F				G	N	L	

Table 8.1 Insecticides For Aphid Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Carbaryl	Carbaryl 4L	1A	Carbamate	12			L	Do not apply to wet foliage or during high humidity periods. Do not use on Boston ivy, Virginia creeper, or maidenhair fern.
	Sevin 80 WSP					N	L	
Chlorpyrifos	DuraGuard ME**	1B	Organophospate	24	G	N		Direct spray to open blooms may cause petal drop.
Chlorpyrifos + Cyfluthrin	Duraplex TR (WP)**	1B 3A	Organophos-phate Pyrethroid	24	G			Micro total release insecticide. Apply when foliage is dry.
Clothianidan	Celero 16 WSG	4A	Neonicotinoid	12	G	N		See label for plant restrictions.
Cyfluthrin	Decathlon 20 WP	3A	Pyrethroid	12	G	N	L	Do not apply through any type of irrigation system. Good coverage is necessary.
	Discus					N		Spray, drench, soil injection. Can apply through irrigation systems.
Dinotefuran	Safari 2G	4A	Neonicotinoid	12	G	N	L	Only apply to moist soil media. Do not apply to dry or saturated media.
	Safari 20 SG				G	N	L	
Fenoxycarb	Prescription Treatment Preclude TR	7B	Fenoxycarb	12	G			Micro-release. Do not use more than every seven days.
Fenpropathrin	Tame 2.4 EC	3A	Pyrethroid	24	G	N	L	Do not use in greenhouses less than 500 ft^2. Can tank mix with Orthene TT&O spray - see label.
Fenpropathrin Acephate	Prescription Treatment Tame/Orthene TR	3A 1B	Pyrethroid and Organophos-phate	24	G			Do not use in greenhouses <900 ft^2. Must store cans at room temperature for 24 hrs before use.

Table 8.1 Insecticides For Aphid Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Flonicamid	Aria	9C	Pyridinecarbox-amide	12	G	N	L	Insects stop feeding within 30 minutes, but may remain on plants up to 5 days. Treat when insects appear; has residual control. Effectiveness against green peach aphid varies due to resistance. Apply with a pyrethroid for knockdown of heavy infestations.
Imidacloprid	Benefit 60WP	4A	Neonicotinoid	12	G	N		Systemic foliar spray or applied to soil media. Do not treat saturated soils.
	Imida E-Pro 1% G				G	N		Systemic applied to the soil media. Do not treat saturated soils.
	Imida E-Pro 60 WSP				G	N		
	Lada 2F				G	N	L	Systemic foliar spray or to soil media. Do not treat saturated soils.
	Mallet 2F						L	
	Mantra 2F				G	N		
	Mantra 1G				G	N		Systemic; applied to the soil media.
	Marathon 1% G				G	N		Systemic; soil treatment only. Do not use more than once every 16 weeks. Media with 30 to 50% or more bark content may confer a shorter period of protection.
	Marathon 60 WP				G	N		
	Quali-Pro Imidacloprid 1G Nursery & Greenhouse				G	N		
	Quali-Pro Imidacloprid 2F Nursery & Greenhouse Insecticide				G	N		

Table 8.1 Insecticides For Aphid Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Insecticidal soap	Bonide Insecticidal Soap	NC	Potassium salts of fatty acids	12	G	N	L	Complete coverage is essential. Can use with biological control agents. Do not use on new transplants, unrooted cuttings, or drought stressed plant material or under hot, humid, or overcast conditions. See label for plant cautions. Caution if pH of final solution is < 8.0.
	DES-X				G	N	L	
	M-Pede				G	N	L	
	Natural Guard Insecticidal Soap				G			
Kinoprene	Enstar II (F)	7A	Juvenile hormone analogue	4	G			IGR. May cause some damage to blooms under certain conditions.
Lambda-cyhalothrin	Scimitar GC (EC)	3A	Pyrethroid	24	G	N	L	A spreader-sticker is recommended. Do not apply through irrigation system.
	Scimitar CS						L	
	Quali-Pro lambda GC-O**				G	N	L	
Methiocarb	Mesurol 75WP**	1A	Carbamate	24	G	N		Do not apply with foliar fertilizers. Efficacy may be reduced when pH of spray solution is > 7. Do not apply more than twice per year per crop.
Naled	Dibrom 8E	1B	Organophos-phate	***	G			Fumigant action. Can corrode metals. Do not over treat or apply directly to plants. May injure Dutchman's pipe. Do not apply above > 90°F. *** REI and WPS ventilation requirements met.

Table 8.1 Insecticides For Aphid Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Neem oil	Triact 70	NC	Botanical	4	G	N	L	For immatures and adults. Do not apply to wilted or stressed plants, or new transplants prior to root establishment. Caution if applying to hibiscus flowers.
Nicotine	Fulex Nicotine Fumigator**	4B	Nicotine smoke	***	G			***Meet WPS vent. criteria
Oil, Horticultural - paraffinic hydrocarbon oils; petroleum oil, soybean oil, vegetable oil	Golden Pest Spray Oil (soybean oil)	NC	Oil	4	G		L	Need complete covereage. Do not apply to plants under stress. Avoid spraying in greenhouses under overcast conditions. Do not exceed label rates or apply more often than recommended. Effectiveness is reduced below 50 °F. Do not use within 2 weeks of sulfur or within 7 days of Captan. Do not apply through any type of irrigation system.
	PureSpray Green (petroleum oil)				G	N	L	
	Saf-T-Side (petroleum oil)						L	
	SuffOil-X (paraffinic oil)				G	N	L	
	Summit Year Round Spray Oil (mineral oil)						L	
	Ultra-fine Spray Oil (paraffinic oil)				G	N	L	
	Ultra-Pure Oil (Petroleum oil)				G	N		
Paecilomyces fumosoroseus strain FE9901	NoFly WP	NC	Entomopathogenic fungus	4	G	N		Spores are sensitive to high temperatures, drought and ultraviolet.
Permethrin	Astro 3.2EC	3A	Pyrethroid	12	G		L	Application to blooms may cause browning of petals.
	Perm-Up 3.2EC**				G	N	L	
	Tenkoz Permethrin 3.2EC**				G	N	L	

Table 8.1 Insecticides For Aphid Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Pymetrozine	Endeavor	9B	Pyridine	12	G	N	L	Insects will remain on plants for 2-4 days following the application. The insect will stop feeding but will take a couple of days to die.
Pyrethrin + Piperonyl butoxide	Pyrenone Crop Spray	3A	Pyrethroid	12	G	N	L	A botanical insecticide plus a synergist to flush insects out of hiding and into contact with spray residues. Can be used up to and including the day of harvest. Apply when foliage is dry.
	Prentox Pyronyl Crop Spray				G	N	L	
	Pyreth-It (Prescription Treatment Brand)				G	N	L	
Pyriproxyfen	Distance	7C	Pyridine	12	G	N	L	IGR for control of immature insects only. Apply no more than two times per cropping cycle or no more than two times per six months. Do not apply to coral bells, gardenia, ghost plant, or salvia.
Tau-fluvalinate	Mavrik Aquaflow	3A	Pyrethroid	12	G	N	L	Effectiveness against green peach aphid varies due to resistance.
Thiamethoxam	Flagship 25 WG	4A	Neonicotinoid	24	G	N		Foliar and soil applications, but soil applications work as a preventative measure or where population is low.
	Flagship 0.22G				G	N		

Table 8.2 Insecticides For Black Vine Weevil Control

Refer to disclaimer statement on page 47.

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Acephate	Avatar	1B	Organophosphate	24	G	N	L	Do not treat certain chrysanthemums and those with open blooms.
	Acephate 90 WDG				G	N	L	
	Acephate 90 SP				G	N	L	
	Acephate 97Up				G	N	L	
	Orthene TT&O				G	N		
Azadirachtin	Aza-Direct EC	18B	Botanical	4	G	N	L	IGR. Repellant, anti-feedant. Controls immatures and pupae on contact or by ingestion. Use within 8 hours. Reduce irrigation pH if pH exceeds 7.0. Do not use with Bordeaux mixture, lime sulfur, triphenyltin hydroxide, Rayplex iron or other highly alkaline materials. *Has organic certification. +Azatrol may reduce the waxy bloom on certain ornamental plants.
	Azatin XL EC				G	N	L	
	Azatrol*+				G	N	L	
	Ornazin 3% EC*			12	G	N		
	Neemix 4.5 (EC)				G	N		
Beauveria bassiana GHA strain	BotaniGard ES	NC	Entomopathogenic fungus	4	G	N	L^	Contact insecticide. Can use with ultra-low volume equipment and chemigation but not with thermal foggers. Can use as pre-plant dips for cuttings. Do not tank mix with fungicides. ^Commercial landscape.
	BotaniGard 22 WP				G	N	L^	
	Naturalis L (JW-1 strain)				G	N	L	

Table 8.2 Insecticides For Black Vine Weevil Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Bifenthrin	Attain Greenhouse	3A	Pyrethroid	12	G		L	Do not apply through any kind of irrigation system.
	Menace 7.9% F						L	Adult control only. Do not apply through any irrigation system.
	Menace GC 7.9% F**				G	N	L	Adult and larvae control. Preventative and curative topical drench. Wait 30 days between applications.
	Onyx Insecticide						L	Adult and larvae control. Do not apply more than once per 7 days.
	OnyxPro**					N	L	
	Talstar P Professional F				G		L	Talstar P: adult control; Talstar Nursery: adult and larvae control. Thorough coverage is important. Do not apply more often than once per seven days. Can tank mix with IGRs and other products.
	Talstar Nursery				G	N		
	Up-Star SC F**				G	N	L	For control of adults and larvae. Do not use through irrigation system.
	Wisdom F				G	N	L	
Chlorpyrifos	DuraGuard ME**	1B	Organophos-phate	24	G	N		For laravae control. Do not mix with alkaline materials (e.g. Bordeaux and lime). May cause petal drop.
	Dursban 50W					N		For adult control.
Cyfluthrin	Discus	3A	Pyrethroid	12		N		Do not apply through irrigation system. For larvae.

Table 8.2 Insecticides For Black Vine Weevil Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Dinotefuran	Safari 20 SG	4A	Neonicotinoid	12	G	N	L	For larvae and adults. Only apply to moist soil media. Do not apply to dry or saturated media.
	Safari 2G				G	N	L	
Fenpropathrin	Tame 2.4 EC	3A	Pyrethroid	24	G	N	L	Can tank mix with Orthene. For adults.
Imidacloprid	Benefit 60 WP	4A	Neonicotinoid	12	G	N		Systemic; foliar spray or soil treatment. Do not treat saturated soils. For larvae control.
	Imida E-Pro 1% G				G	N		Systemic; soil treatment only. Do not apply to saturated soils. For larvae control.
	Imida E-Pro 60 WSP				G	N		
	Lada 2F				G	N	L	Systemic; foliar spray or to the soil media. Do not treat saturated soils. For larvae control.
	Mallet 2F						L	
	Mantra 2F				G	N		
	Mantra 1G				G	N		Systemic; applied to the soil media. For larvae control.
	Marathon 1% G				G	N		Systemic; soil treatment only. Use only once every 16 weeks. Media with >30 % bark may reduce protection period. For larvae control.
	Marathon 60 WP				G	N		
	Merit 2.5 G						L	
	Merit 75 WP						L	
	Merit 75WSP						L	
	Merit 2F						L	Systemic; applied as foliar spray or to the soil media. Do not apply to saturated soils. For larvae control.
	Quali-Pro Imidacloprid 1G Nursery & Greenhouse				G	N		
	Quali-Pro Imidacloprid 2F Nursery & Greenhouse Insecticide				G	N		

Table 8.2 Insecticides For Black Vine Weevil Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Lambda-cyhalothrin	Scimitar GC (EC)	3A	Pyrethroid	24	G	N	L	For control of adults and larvae. A spreader-sticker is recommended. Do not apply through any type of irrigation system.
	Scimitar CS						L	
	Quali-Pro lambda GC-O**				G	N	L	
	Demand CS						L	
Metarhiziium anisopliae strain F52	Met52	NC	Entomopatho-genic fungus	4	G	N		Apply to moist substrate and keep moist for best performance. Do not mix fungicides in growing substrate.
Nematodes, beneficial (= Entomo-pathogenic)	*Steinernema feltiae* Entonem NemaShield Nemasys ScanMask *Heterorhabditis bacteriophora* Heteromask Larvanem *S. carpocapsae* EcoMask	NC	Biological	0				Biological control. Insect-parasitic nematodes releases symbiotic bacteria while feeding that kill the pest. Use as a preventive or curative control. Apply to moist growing media as soon as possible after potting. Works best at temperatures from 50 – 85 °F. See label for details and tank mix cautions.
Permethrin	Astro 3.2EC**	3A	Pyrethroid	12	G		L	For control of adults. Direct application to blooms may cause browning of petals. Marginal leaf burn may occur on salvia.
	Perm-Up 3.2EC**				G	N	L	
	Tenkoz Permethrin 3.2EC**				G	N	L	
Pyrethrin	Pyganic Crop Protection EC 5.0	3A	Botanical	12	G	N	L	Organic certification. Can be used with hydroponic systems.
	Pyganic PRO				G	N	L	

Table 8.2 Insecticides For Black Vine Weevil Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Pyrethrin + Piperonyl butoxide	Pyrenone Crop Spray	3A	Pyrethroid	12	G	N	L	A botanical insecticide plus a synergist to flush insects out of hiding and into contact with spray residues. Can be used up to and including the day of harvest. See label for details. Apply when foliage is dry.
Tau-Fluvalinate	Mavrik Aquaflow	3A	Pyrethroid	12	G	N	L	Can also be used as a dip for cuttings.
Thiamethoxam	Flagship 25 WG	4A	Neonicotinoid	24	G	N		For adult control. Foliar and soil applications, but soil applications work as a preventative measure or where population is low.

Table 8.3 Insecticides For Caterpillar Control

Refer to disclaimer statement on page 47.

Note: You will obtain the most effective control when you apply materials to early instar larvae, especially when using *Bacillus thuringiensis*, Azadirachtin, and *Saccharopolyspora spinosa*.

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Acetamiprid	TriStar 70 WSP	4A	Neonicotinoid	12	G	N		Do not irrigate overhead for at least 6 hrs after application. See label for tank mixing suggestions.
	TriStar 30SG				G	N		
Azadirachtin	Aza-Direct EC	18B	Botanical	4	G	N	L	IGR. Repellant, anti-feedant. Controls immatures and pupae on contact or by ingestion. Use within 8 hours. Reduce pH of irrigation water if the pH exceeds 7.0. *Do not use with Bordeaux mixture, lime sulfur, triphenyltin hydroxide, Rayplex iron or other highly alkaline materials. +Azatrol may reduce the waxy bloom on certain ornamental plants.
	Azatin XL EC				G	N	L	
	Azatrol*+				G	N	L	
	Ornazin 3% EC*			12	G	N		
	Neemix 4.5 (EC)				G	N		
Bacillus thuringiensis Atzawai strain	Agree WG	11 B2	Biological	4		N	L	Only controls small caterpillars. Must be ingested to be effective so thorough coverage is essential.
Bacillus thuringiensis Kurstaki strain	Biobit XL	11 B2	Biological	4			L	Same as above.
	Condor				G	N	L	
	Crymax WDG				G	N		
	Deliver				G	N	L	
	Dipel ES				G			
	Foray XG						L	
	Javelin WG				G	N	L	

Table 8.3 Insecticides For Caterpillar Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Beauveria bassiana GHA strain	BotaniGard ES	NC	Entomopatho-genic fungus	4	G	N	L^	Contact insecticide. Can use with ultra-low volume equipment and chemigation but not with thermal foggers. Can use as a pre-plant dip for cuttings. Do not tank mix with fungicides. *Mycotrol has organic certification. ^Commercial landscape.
	BotaniGard 22 WP				G	N	L^	
	Mycotrol O (WP)*				G	N		
	Naturalis L (JW-1 strain)				G	N	L	
Bifenthrin	Attain Greenhouse	3A	Pyrethroid	12	G		L	Do not apply through any kind of irrigation system.
	Attain TR				G			Apply when foliage is dry.
	Menace 7.9% F						L	Do not apply through any irrigation system.
	Menace GC 7.9% F**				G	N	L	Preventative and curative topical drench. Wait 30 days between applications.
	Onyx Insecticide						L	Do not apply more often than once per seven days.
	OnyxPro**					N	L	
	Talstar P Professional F				G		L	Thorough coverage is important. Do not apply more often than once per seven days. Can tank mix with IGRs and other products.
	Talstar Nursery				G	N		
	Up-Star SC F**				G	N	L	Do not use through any irrigation system.
	Wisdom F				G	N	L	

Table 8.3 Insecticides For Caterpillar Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Carbaryl	Carbaryl 4L	1A	Carbamate	12			L	Do not use more than 6x/year. Do not apply to wet foliage or during high humidity periods. Get good coverage on upper and lower leaf surfaces. Do not use on Virginia creeper or maidenhair fern.
	Sevin SL					N	L	
	Sevin 80 WSP					N	L	
Chlorpyrifos	DuraGuard ME**	1B	Organophos-phate	24	G	N		Do not mix with alkaline materials (e.g. Bordeaux and lime). Treatment to open blooms may cause petal drop.
Chlorpyrifos Cyfluthrin	Duraplex TR (WP)**	1B 3A	Organophos-phate Pyrethroid	24	G			Apply when foliage is dry.
Cyfluthrin	Decathlon 20 WP	3A	Pyrethroid	12	G	N	L	Do not apply through irrigation system. Need to get good coverage.
	Discus					N		Spray, drench, soil injection. Can be applied through irrigation systems.
Diflubenzuron	Adept	15	Benzoylurea	12	G			IGR for army-worms. Do not apply to pots on capillary mats. Do not reuse treated potting media. Do not use on hibiscus.
	Dimilin 25 W**						L	
Dinotefuran	Safari 20 SG	4A	Neonicotinoid	12	G	N	L	Only apply to moist soil media. Do not apply to dry or saturated media.
	Safari 2G				G	N	L	
Fenoxycarb7B	Preclude TR		Fenoxycarb	12	G			Micro-release IGR. Apply when foliage is dry. Do not use more than once every 7 days.

Table 8.3 Insecticides For Caterpillar Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Fenpropathrin	Tame 2.4 EC	3A	Pyrethroid	24	G	N	L	For armyworms. Can tank mix with Orthene.
Fenpropathrin Acephate	Tame/Orthene TR	3A 1B	Pyrethroid Organophos-phate	24	G			Do not use in greenhouses < 900 ft^2 or apply within 48 hrs of a previous application. Store cans at room temperature for 24 hrs before application. Apply when foliage is dry.
Imidacloprid	Benefit 60 WP	4A	Neonicotinoid	12	G	N		Systemic; foliar spray or soil treatment. Do not treat saturated soils.
	Imida E-Pro 1% G				G	N		Systemic; soil treatment only. Do not apply to saturated soils.
	Imida E-Pro 60 WSP				G	N		
	Lada 2F				G	N	L	Systemic; foliar spray or to the soil media. Do not treat saturated soils.
	Mallet 2F						L	
	Mantra 2F				G	N		
	Mantra 1G				G	N		Systemic; applied to the soil media.
	Marathon 1% G				G	N		Systemic; soil treatment only. Do not use more than once every 16 weeks. Media with >30 % bark may reduce protection period.
	Marathon 60 WP				G	N		
	Quali-Pro Imidacloprid 1G Nursery & Greenhouse				G	N		Systemic; applied as foliar spray or to the soil media. Do not apply to saturated soils.
	Quali-Pro Imidacloprid 2F Nursery & Greenhouse Insecticide				G	N		

Table 8.3 Insecticides For Caterpillar Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Insecticidal soap	Bonide Insectidal Soap	NC	Potassium salts of fatty acids	12	G	N	L	Contact insecticide so complete coverage is essential. Do not use on new transplants, unrooted cuttings, or plant material stressed by drought or under hot, humid or overcast conditions. Caution if using on Euphorbia. Caution if the pH of the final solution is lowered below 8.0. Do not use on bleeding heart or lily. Compatible with biological control agents.
	DES-X				G	N	L	
	M-Pede				G	N	L	
	Natural Guard Insecticidal Soap				G			
Lambda-cyhalothrin	Scimitar GC (EC)	3A	Pyrethroid	24	G	N	L	A spreader-sticker is recommended. Do not apply through any type of irrigation system.
	Scimitar CS						L	
	Quali-Pro lambda GC-O**				G	N	L	
Novaluron	Pedestal	15	Benzoylurea	12	G	N		IGR; controls immatures (not adults). Do not apply more than twice a year.
Permethrin	Astro 3.2EC**	3A	Pyrethroid	12	G		L	Direct application to blooms may cause browning of petals. Marginal leaf burn may occur on salvia.
	Perm-Up 3.2EC**				G	N	L	
	Tenkoz Permethrin 3.2EC**				G	N	L	
Pyrethrin	Pyganic Crop Protection EC 5.0	3A	Botanical	12	G	N	L	Organic certification. Can be used with hydroponic systems.
	Pyganic PRO				G	N	L	

Table 8.3 Insecticides For Caterpillar Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Pyrethrin + Piperonyl butoxide	Pyrenone Crop Spray	3A	Pyrethroid	12	G	N	L	A botanical insecticide plus a synergist to flush insects out of hiding and into contact with spray residues. Can be used up to and including the day of harvest. See label for details. Apply when foliage is dry.
	Pyreth-It				G	N	L	
Pyridalyl	Overture 35 WP	NC	Pyridine	12	G			Strong translaminar activity. Do not tank mix with fertilizers. Do not apply through any type of irrigation system. Do not apply more than 3 times per cropping cycle.
Spinosad	Conserve SC (EC)	5	Biological	4	G	N	L	Minimum impact upon beneficials. No more than two consecutive applications.
	Entrust				G	N	L	Registered for use on organically produced ornamental and culinary herbs.
Tau-Fluvalinate	Mavrik Aquaflow	3A	Pyrethroid	12	G	N	L	Can also be used as a dip for cuttings.
Thiamethoxam	Flagship 25 WG	4A	Neonicotinoid	24	G	N		Foliar and soil applications, but soil applications work as a preventative measure or where population is low.
	Flagship 0.22G				G	N		

Table 8.4 Nematicides For Foliar Nematode Control

Refer to disclaimer statement on page 47.

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Chlorophenyl	Pylon	13	Pyrrole	12	G			Translaminar activity; may be applied twice consecutively, but no more than three times within a season. Apply prior to bloom or avoid blooms where possible. Do not apply to salvia.

Table 8.5a Insecticides For Fungus Gnat Larvae Control

Refer to disclaimer statement on page 47.

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Acetamiprid	TriStar 70 WSP	4A	Neonicotinoid	12	G	N		Do not irrigate overhead for at least 6 hrs after application. See label for tank mixing suggestions.
	Tri Star 30 SG				G	N		
Azadirachtin	Azatin XL	NC	Biological	4	G	N	L	IGR. Repellant, anti-feedant. Controls larvae and pupae by contact or ingestion. Do not use with Bordeaux mixture, lime sulfur, triphenyltin hydroxide, Rayplex iron or other highly alkaline materials. Use within 8 hrs. Reduce irrigation water pH if >7.0. +Azatrol may reduce waxy bloom on certain ornamental plants.
	Aza-Direct				G	N	L	
	Azatrol+				G	N	L	
Bacillus thuringiensis	Gnatrol	11 A1	Biological	4	G	N	L	Only controls immatures. Drench or chemigation. Do not apply with fertilizers or fungicides with chlorine or copper or to plants under stress.
	Gnatrol WDG				G	N	L	
Beauveria bassiana	Naturalis L (JW-1 strain) (WP)	NC	Biological	4	G	N	L	Contact insecticide. Do not tank mix with fungicides. Can use with ultra-low volume equipment and chemigation but not with thermal foggers. Can use as pre-plant dip for cuttings.
	Naturalis H&G				G	N	L	

Table 8.5a Insecticides For Fungus Gnat Larvae Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Bifenthrin	Attain Greenhouse	3A	Pyrethroid	12	G		L	Apply to dry foliage. Do not apply through any irrigation system.
	Attain TR				G			Micro total release insecticide. Apply when foliage is dry.
	Menace GC 7.9% Flowable (F)**				G	N	L	Preventative and curative topical drench. Wait 30 days between applications.
	Menace 7.9% Flowable (F)						L	Do not apply through any irrigation system.
	Onyx Pro**					N	L	Apply only once per seven days. A surfactant or hort. oil may increase effectiveness.
	Talstar P (Professional) (F)**				G		L	Need thorough coverage. Do not use through any irrigation system.
	Talstar Nursery				G	N		
	Up-Star SC (F)**				G	N	L	
	Wisdom F				G	N	L	
Chlorfenapyr	Pylon	13	Pyrrole	12	G			Translaminar. Use ≤ 3 times per season. Avoid blooms if possible.
Cyfluthrin	Decathlon 20 WP	3A	Pyrethroid	12	G	N	L	Good coverage needed. Do not apply through any irrigation system.
	Discus					N		Spray, drench, soil injection. Can apply through irrigation systems.
Cyromozine	Citation	17	Triazine	12	G	N	L	IGR. Do not apply through any irrigation system.

Table 8.5a Insecticides For Fungus Gnat Larvae Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Diflubenzuron	Adept	15	Benzoylurea	12	G			IGR. Spray or drench. Do not re-use treated media. Do not treat hibiscus or pots on capillary mats.
	Dimilin SC (WP)**						L	
Dinotefuran	Safari 20 SG	4A	Neonicotinoid	12	G	N	L	Only apply to moist soil media. Do not apply to dry or saturated media.
	Safari 2G				G	N	L	
Imidacloprid	Benefit 60WP	4A	Neonicotinoid	12	G	N		Systemic; apply as foliar spray or to the soil media. Do not apply to saturated soils.
	Imida E-Pro 1% G				G	N		Systemic; applied to the soil media. Do not apply to saturated soils.
	Imida E-Pro 60 WSP				G	N		
	Lada 2F				G	N	L	Systemic; applied as foliar spray or to soil media. Do not treat saturated soils.
	Mallet 2F						L	
	Mantra 2F				G	N		
	Mantra 1G				G	N		Systemic; applied to the soil media.
	Marathon 60WP				G	N		Systemic; soil treatment. No adult control. Use only once every 16 weeks. Residual activity to apply before egg-laying of pest. Bark content > 30% may reduce protection period.
	Quali-Pro Imidacloprid 1G Nursery & Greenhouse				G	N		Systemic; applied as foliar spray or to the soil media. Do not apply to saturated soils. Do not apply to ferns.
	Quali-Pro Imidicloprid 2F Nursery & Greenhouse Insecticide				G	N		

Table 8.5a Insecticides For Fungus Gnat Larvae Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Kinoprene	Enstar II (F)	7A	Juvenile hormone analogue	4	G			IGR. May cause some damage to blooms under certain conditions.
Nematodes, beneficial (= Entomo-pathogenic)	*Steinernema feltiae* Entonem NemaShield Nemasys ScanMask	NC		0				Biological control. Insect-parasitic nematodes release symbiotic bacteria while feeding that kill the pest. Use as a preventive or curative control. Apply to moist growing media as soon as possible after potting. Works best at temperatures from 50 – 85 °F. See label for details and tank mix cautions.
Pyriproxyfen	Distance	7C	Pyridine	12	G	N	L	IGR for control of immature insects only. Apply no more than two times per cropping cycle or no more than two times per six months. Do not apply to coral bells, gardenia, ghost plant, or salvia.

Table 8.5b Insecticides For Fungus Gnat Adult Control

Refer to disclaimer statement on page 47.

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Acephate	1300 Orthene TR	1B	Organophos-phate	24	G			Total release cans.
Bifenthrin	Attain Greenhouse	3A	Pyrethroid	12	G		L	Microemulsion. Apply to dry foliage. Do not apply through any irrigation system.
	Attain TR				G			Micro total release. Apply when foliage is dry.
	Menace GC 7.9% Flowable (F)				G	N	L	Preventative and curative topical drench. Wait 30 days between uses.
	Menance 7.9% Flowable (F)						L	Do not use in any irrigation system.
	Talstar P (Professional) (F)				G		L	Thorough coverage needed. Apply only once per seven days. Can tank mix with IGRs and other products
	Talstar Nursery				G	N		
	Up-Star SC (F)**				G	N	L	Do not apply through any irrigation system.
	Wisdom F				G	N	L	
Chlorpyrifos	DuraGuard ME**	1B	Organophospate	24	G	N		Do not mix with alkaline materials (e.g. Bordeaux and lime). May cause petal drop.
Chlorpyrifos + Cyfluthrin	Duraplex TR (WP)**	1B 3A	Organophos-phate Pyrethroid	24	G			Micro total release insecticide. Apply when foliage is dry.
Cyfluthrin	Decathlon 20 WP	3A	Pyrethroid	12	G	N	L	Do not apply through any type of irrigation system.
Fenpropathrin + Acephate	Prescription Treatment Tame/Orthene TR	3A 1B	Pyrethroid Organophos-phate	24	G			Do not use in greenhouses < 900 ft^2. Store cans at room temperature 24 hrs before use.

Table 8.5b Insecticides For Fungus Gnat Adult Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Oil, Horticultural (paraffinic hydrocarbon oils; petroleum oil, soybean oil, vegetable oil)	Golden Pest Spray Oil (soybean oil)	NC	Oil	4	G		L	Complete covereage needed. Do not apply if plants are under stress. Do not apply during periods of prolonged high temperatures combined with high humidity. Avoid spraying in greenhouses under overcast conditions. Effectiveness at temperatures below 50 °F is reduced. Do not use within 2 weeks of sulfur or within 7 days of captan. Do not apply through any irrigation system. #Mums and mints are only perennials on label.
	JMS Stylet Oil (Paraffinic oil)#				G	N	L	
	Organic JMS Stylet Oil# (Paraffinic oil)				G	N	L	
	PureSpray Green (Petroleum oil)				G	N	L	
	Saf-T-Side (Petroleum oil)						L	
	SuffOil-X (paraffinic oil)				G	N	L	
	Summit Year Round Spray Oil (Mineral oil)						L	
	Ultra-fine Spray Oil (Paraffinic oil)				G	N	L	
	Ultra-Pure Oil (Petroleum oil)				G	N		
Permethrin	Astro 3.2 EC	3A	Pyrethroid	12	G		L	Avoid spraying chrysanthemum blooms. Marginal leaf burn noticed on salvia. May cause petal browning.
	Perm-Up 3.2 EC**				G	N	L	
	Tenkoz Permethrin 3.2EC**				G	N	L	
Pyrethrin + Piperonyl butoxide	Pyrenone Crop Spray	3A	Pyrethroid	12	G	N	L	Has a synergist to flush insects out into contact with spray residues. Can use up to and including day of harvest. Apply when foliage is dry.
	Prentox Pyronyl Crop Spray				G	N	L	
	Pyreth-It (Prescription Treatment Brand)				G	N	L	

Table 8.6 Insecticides For Japanese Beetle Control

Refer to disclaimer statement on page 47.

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Acephate	Avatar	1B	Organophosphate	24	G	N	L	Do not treat certain chrysanthemums and those with open blooms.
	Acephate 90 WDG				G	N	L	
	Acephate 90 SP				G	N	L	
	Acephate 97Up				G	N	L	
	Orthene TT&O				G	N		
Azadirachtin	Aza-Direct EC	18B	Botanical	4	G	N	L	IGR. Repellant, anti-feedant. Controls immatures and pupae on contact or by ingestion. Use within 8 hours. Reduce irrigation pH if it exceeds 7.0. Do not use with Bordeaux mixture, lime sulfur, triphenyltin hydroxide, Rayplex iron or other highly alkaline materials. *Has organic certification. +Azatrol may reduce the waxy bloom on certain ornamental plants.
	Azatin XL EC				G	N	L	
	Azatrol*+				G	N	L	
	Ornazin 3% EC*			12	G	N		
Beauveria bassiana GHA strain	BotaniGard ES	NC	Entomopathogenic fungus	4	G	N	L^	Contact insecticide. Can use with ultra-low volume equipment and chemigation but not with thermal foggers. Can use as a pre-plant dip for cuttings. Do not tank mix with fungicides. ^Commercial landscape.
	BotaniGard 22 WP				G	N	L^	
	Naturalis L (JW-1 strain)				G	N	L	

Table 8.6 Insecticides For Japanese Beetle Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Bifenthrin	Attain Greenhouse	3A	Pyrethroid	12	G		L	Do not apply through any kind of irrigation system.
	Menace 7.9% F						L	Do not apply through any irrigation system.
	Menace GC 7.9% F**				G	N	L	Preventative and curative topical drench. Wait 30 days between applications.
	Onyx Insecticide						L	Do not apply more often than once per seven days.
	OnyxPro**					N	L	
	Talstar P Professional F				G		L	Thorough coverage is important. Do not apply more often than once per seven days. Can tank mix with IGRs and other products.
	Talstar Nursery				G	N		
	Up-Star SC F**				G	N	L	Do not use through any irrigation system.
	Wisdom F				G	N	L	
Carbaryl	Carbaryl 4L	1A	Carbamate	12			L	Do not apply to wet foliage or during periods of high humidity. Do not use on Boston ivy or Virginia creeper. Do not use more than 6x/year. Obtain thorough coverage of both leaf surfaces.
	Sevin SL					N	L	
	Sevin 80 WSP					N	L	
Chlorantra-niliprole	Acelepryn	28	Diamide	4			L	Apply no more than once per 7 days.
Chlorpyrifos	DuraGuard ME**	1B	Organophos-phate	24	G	N		Do not mix with alkaline materials (e.g. Bordeaux and lime). Treatment open blooms may cause petal drop.
	Dursban 50W					N		

Table 8.6 Insecticides For Japanese Beetle Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Cyfluthrin	Discus	3A	Pyrethroid	12		N		Do not apply through irrigation system.
Dinotefuran	Safari 20 SG	4A	Neonicotinoid	12	G	N	L	Only apply to moist soil media. Do not apply to dry or saturated media.
	Safari 2G				G	N	L	
Fenpropathrin	Tame 2.4 EC	3A	Pyrethroid	24	G	N	L	Can tank mix with Orthene.
Insecticidal Soap	M-Pede	NC	Potassium salts of fatty acids	12	G	N	L	Contact insecticide; Need complete coverage. Do not treat new transplants, unrooted cuttings, or stressed plants. Avoid spraying in greenhouses under overcast conditions. Caution if final solution pH is <8.0. Caution on *Euphorbia*. Do not use on bleeding heart or lily or on chrysanthemum after bloom. Can use with biological control.
Imidacloprid	Benefit 60 WP	4A	Neonicotinoid	12	G	N		Systemic; foliar spray or soil treatment. Do not treat saturated soils.
	Imida E-Pro 1% G				G	N		Systemic; soil treatment only. Do not apply to saturated soils.
	Imida E-Pro 60 WSP				G	N		
	Lada 2F				G	N	L	Systemic; foliar spray or to the soil media. Do not treat saturated soils.
	Mallet 2F						L	
	Mantra 2F				G	N		
	Mantra 1G				G	N		Systemic; applied to the soil media.

Table 8.6 Insecticides For Japanese Beetle Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Imidacloprid (continued)	Marathon 1% G	4A	Neonicotinoid	12	G	N		Systemic; soil treatment only. Use only once every 16 weeks. Media with >30 % bark may reduce protection period.
	Marathon 60 WP				G	N		
	Merit 2.5G						L	
	Merit 75WP						L	
	Merit 75 WSP						L	
	Merit 2						L	Systemic; applied as foliar spray or to the soil media. Do not apply to saturated soils.
	Quali-Pro Imidacloprid 1G Nursery & Greenhouse				G	N		
	Quali-Pro Imidacloprid 2F Nursery & Greenhouse Insecticide				G	N		
Lambda-cyhalothrin	Scimitar GC (EC)	3A	Pyrethroid	24	G	N	L	A spreader-sticker is recommended. Do not apply through any type of irrigation system.
	Scimitar CS						L	
	Quali-Pro lambda GC-O**				G	N	L	
	Demand CS						L	
Nematodes, beneficial (= Entomo-pathogenic)	*Heterorhabditis bacteriophora* Heteromask Larvanem NemaSeek	NC		0				Grub control. Insect-parasitic nematodes releases symbiotic bacteria while feeding that kill the pest. Use as a preventive or curative control. Apply to moist growing media quickly after potting. Works best at 50 – 85 °F.
Permethrin	Astro 3.2EC**	3A	Pyrethroid	12	G		L	May cause browning of petals. Marginal leaf burn may occur on salvia.
	Perm-Up 3.2EC**				G	N	L	
	Tenkoz Permethrin 3.2EC**				G	N	L	

Table 8.6 Insecticides For Japanese Beetle Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Pyrethrin	Pyganic Crop Protection EC 5.0	3A	Botanical	12	G	N	L	Organic certification. Can be used with hydroponic systems.
	Pyganic PRO				G	N	L	
Pyrethrin + Piperonyl butoxide	Pyrenone Crop Spray	3A	Pyrethroid	12	G	N	L	A botanical insecticide plus a synergist to flush insects out of hiding and into contact with spray residues. Can be used up to and including the day of harvest. See label for details. Apply when foliage is dry.
Thiamethoxam	Flagship 25 WG	4A	Neonicotinoid	24	G	N		Foliar and soil applications, but soil applications work as a preventative measure or where population is low.

Table 8.7 Insecticides For Lace Bug and Plant Bug Control

Refer to disclaimer statement on page 47.

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Acetamiprid	TriStar 30 SG	4A	Neonicotinoid	12	G	N		Do not irrigate overhead for at least 6 hrs after application. See label for tank mixing suggestions.
Acephate	Avatar	1B	Organophos-phate	24	G	N	L	Do not treat certain chrysanthemums and those with open blooms.
	Acephate 90 WDG				G	N	L	
	Acephate 90 SP				G	N	L	
	Acephate 97Up				G	N	L	
	Orthene TT&O				G	N		
Azadirachtin	Aza-Direct EC	18B	Botanical	4	G	N	L	IGR. Repellant, anti-feedant. Use within 8 hours. Reduce irrigation pH if > 7.0. Do not use with Bordeaux mixture, lime sulfur, triphenyltin hydroxide, Rayplex iron or other highly alkaline materials. *Has organic certification. +Azatrol may reduce the waxy bloom on certain ornamental plants.
	Azatrol*+				G	N	L	
Beauveria bassiana GHA strain	BotaniGard ES	NC	Entomopatho-genic fungus	4	G	N	L^	Naturalis L is for *Lgyus* sp bug control. Contact insecticide. Can use with ultra-low volume equipment and chemigation but not with thermal foggers. Do not tank mix with fungicides. ^Commercial site.
	BotaniGard 22 WP				G	N	L^	
	Naturalis L (JW-1 strain)				G	N	L	

Table 8.7 Insecticides For Lace Bug and Plant Bug Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Bifenthrin	Attain Greenhouse	3A	Pyrethroid	12	G		L	Do not apply through any kind of irrigation system.
	Menace 7.9% F						L	Do not apply through any irrigation system.
	Menace GC 7.9% F**				G	N	L	Preventative and curative topical drench. Wait 30 days between applications.
	Onyx Insecticide						L	Do not apply more often than once per seven days.
	OnyxPro**					N	L	
	Talstar P Professional F				G		L	Thorough coverage is important. Do not apply more often than once per seven days. Can tank mix with IGRs and other products.
	Up-Star SC F**				G	N	L	Do not use through any irrigation system.
	Wisdom F				G	N	L	
Carbaryl	Carbaryl 4L	1A	Carbamate	12			L	Do not apply to wet foliage or during periods of high humidity. Do not use on Boston ivy or Virginia creeper. Do not use more than 6x/year. Obtain thorough coverage of both leaf surfaces.
	Sevin SL					N	L	
	Sevin 80 WSP					N	L	
Chlorpyrifos	Dursban 50W**	1B	Organophospate	24		N		Do not mix with alkaline materials (e.g. Bordeaux and lime). Do not apply through irrigation system.
Cyfluthrin	Discus	3A	Pyrethroid	12		N		Do not apply through irrigation system.
	Decathlon 20 WP				G	N	L	

Table 8.7 Insecticides For Lace Bug and Plant Bug Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Dinotefuran (only for lace bug control)	Safari 20 SG	4A	Neonicotinoid	12	G	N	L	Only apply to moist soil media. Do not apply to dry or saturated media.
	Safari 2G				G	N	L	
Fenpropathrin (only for lace bug control)	Tame 2.4 EC	3A	Pyrethroid	24	G	N	L	Can tank mix with Orthene.
Insecticidal Soap	M-Pede	NC	Potassium salts of fatty acids	12	G	N	L	Contact insecticide; Need complete coverage. Do not treat new transplants, unrooted cuttings, or stressed plant. Avoid spraying in greenhouses under overcast conditions. Caution if final solution pH is <8.0. Caution on *Euphorbia*. Do not use on bleeding heart or lily or on chrysanthemum after bloom. Can use with biological control.
Imidacloprid (only for lace bug control)	Benefit 60 WP	4A	Neonicotinoid	12	G	N		Systemic; foliar spray or soil treatment. Do not treat saturated soils.
	Imida E-Pro 1% G				G	N		Systemic; soil treatment only. Do not apply to saturated soils.
	Imida E-Pro 60 WSP				G	N		
	Lada 2F				G	N	L	Systemic; foliar spray or to the soil media. Do not treat saturated soils.
	Mallet 2F						L	
	Mantra 2F				G	N		
	Mantra 1G				G	N		Systemic; applied to the soil media.

Table 8.7 Insecticides For Lace Bug and Plant Bug Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Imidacloprid (continued) (only for lace bug control)	Marathon 1% G	4A	Neonicotinoid	12	G	N		Systemic; soil treatment only. Use only once every 16 weeks. Media with >30 % bark may reduce protection period.
	Marathon 60 WP				G	N		
	Merit 2.5G						L	
	Merit 75WP						L	
	Merit 75 WSP						L	
	Merit 2						L	Systemic; applied as foliar spray or to the soil media. Do not apply to saturated soils.
	Quali-Pro Imidacloprid 1G Nursery & Greenhouse				G	N		
	Quali-Pro Imidacloprid 2F Nursery & Greenhouse Insecticide				G	N		
Lambda-cyhalothrin	Scimitar GC (EC)	3A	Pyrethroid	24	G	N	L	A spreader-sticker is recommended. Do not apply through any type of irrigation system.
	Scimitar CS						L	
	Quali-Pro lambda GC-O**				G	N	L	
	Demand CS						L	
Oil, Horticultural (paraffinic hydrocarbon oils; petroleum oil, soybean oil, vegetable oil)	Golden Pest Spray Oil (soy-bean oil)	NC	Oil	4	G		L	Need complete covereage. Do not treat stressed plants or in greenhouses under overcast conditions. Do not exceed label rates or apply more often than recommended. Effectiveness is reduced below 50 °F. Do not apply through irrigation system. See label for cautions if using with certain other products and for restrictions and mixing cautions.
	Saf-T-Side (petroleum oil)						L	
	SuffOil-X (paraffinic oil)						L	
	Ultra-fine Spray Oil (paraffinic oil)				G	N	L	
	Ultra-Pure Oil (petroleum oil)				G	N		

Table 8.7 Insecticides For Lace Bug and Plant Bug Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Permethrin	Astro 3.2EC**	3A	Pyrethroid	12	G		L	May cause browning of petals. Marginal leaf burn may occur on salvia.
	Perm-Up 3.2EC**				G	N	L	
Pyrethrin	Pyganic Crop Protection EC 5.0	3A	Botanical	12	G	N	L	Organic certification. Can be used with hydroponic systems.
	Pyganic PRO				G	N	L	
Pyrethrin + Piperonyl butoxide	Pyrenone Crop Spray	3A	Pyrethroid	12	G	N	L	A botanical insecticide plus a synergist to flush insects out of hiding and into contact with spray residues. Can be used up to and including the day of harvest. See label for details. Apply when foliage is dry.
Tau-Fluvalinate	Mavrik Aquaflow	3A	Pyrethroid	12	G	N	L	For *Lygus* sp. plant bugs. Can also be used as a dip for cuttings.
Thiamethoxam	Flagship 25 WG	4A	Neonicotinoid	24	G	N		Foliar and soil applications, but soil applications work as a preventative measure or where population is low.

Table 8.8 Insecticides For Leafminer Control

Refer to disclaimer statement on page 47.

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Abamectin	Abamectin E-Pro 0.15 EC	6	Avermectin	12	G		L	Do not apply through any type of irrigation system. Do not use on chrysanthemums, ferns, roses, or Shasta daisies. For aphid suppression only. See label about resistance management.
	Avid 0.15EC				G		L	
	Ardent 0.15 EC				G		L	
	Lucid 2F				G		L	
	Minx				G		L	
	Quali-Pro Abamectin 0.15 EC				G		L	
	Timectin 0.15EC T&O				G		L	
Acephate	Orthene 75 S	1B	Organophos-phate	24	G	N	L	Do not apply to certain mum cultivars or to ones with open blooms.
Acetamiprid	TriStar 70 WSP	4A	Neonicotinoid	12	G	N		Do not irrigate overhead for at least 6 hrs after application. See label for tank mixing suggestions.
	TriStar 30 SG				G	N		
Azadirachtin	Azatin XL	NC	Botanical	4	G	N	L	IGR, anti-feedant, repellant. Use within 8 hrs. Controls larvae and pupae by contact or ingestion. Do not use with Bordeaux mixture, triphe-nyltin hydroxide, lime sulfur, Rayplex iron or other highly alkaline materials. Reduce irrigation water pH if it > 7.0. See specific plants on label. +Azatrol: The waxy bloom on certain ornamental plants may be reduced after an application.
	Azatrol+				G	N	L	
	Aza-Direct				G	N	L	
	Ornazin 3% EC			12	G	N		
	Neemix 4.5			12	G	N		
	Neemazad 1.0% EC			12	G	N		

Table 8.8 Insecticides For Leafminer Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Bifenthrin	Attain Greenhouse	3A	Pyrethroid	12	G		L	Microemulsion. Do not apply through any kind of irrigation system. Micro total release insecticide. Apply when foliage is dry.
	Menace GC 7.9% Flowable (F)**				G	N	L	Preventative and curative topical drench. Wait 30 days between applications.
	Onyx Insecticide						L	Repeat applications should be limited to no more than once per seven days
	Onyx Pro**					N	L	Do not apply more than once per seven days. Addition of a surfactant or horticultural oil may increase effectiveness.
	Talstar P (Professional) (F)				G		L	Thorough coverage needed. Do not apply more often than once per seven days. May be tank mixed with IGRs and other products.
	Talstar Nursery				G	N		
	Up-Star SC (F)**				G	N	L	Thorough coverage is important. Do not use through any irrigation system.
	Wisdom F				G	N	L	
Carbaryl	Carbaryl 4L	1A	Carbamate	12			L	Do not apply to wet foliage or during periods of high humidity. Do not use on Boston ivy or Virginia creeper. Do not use more than 6x/year. Obtain thorough coverage of both leaf surfaces.

Table 8.8 Insecticides For Leafminer Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Cyfluthrin	Decathlon 20 WP	3A	Pyrethroid	12	G	N	L	Do not apply through any type of irrigation system. Good coverage is necessary.
	Discus					N		Spray, drench, soil injection. Can be applied through irrigation systems.
Cyromozine	Citation	17	Triazine	12	G	N	L	IGR; will not kill adult insects. Rotate with insecticides that have different modes of action.
Diflubenzuron	Adept	15	Benzoylurea	12	G			IGR; spray or soil drench. Do not apply to pots grown on capillary mats. Do not reuse treated potting media. Do not apply to hibiscus.
	Dimilin 25 W**						L	
Dinotefuran	Safari 2 G	4A	Neonicotinoid	12	G	N	L	Only apply to moist soil media. Do not apply to dry or saturated media
	Safari 20 SG				G	N	L	
Fenoxycarb	Prescription Treatment Preclude TR	7B	Fenoxycarb	12	G			Micro-release IGR. Apply when foliage is dry. Do not use more often than every seven days.
Fenpropathrin	Tame 2.4 EC	3A	Pyrethroid	24	G	N	L	Do not use in greenhouses < 500 ft^2. Can be tank mixed with Orthene TT&O WSP spray.
Fenpropathrin + Acephate	Prescription Treatment Tame/Orthene TR	3A 1B	Pyrethroid Organophos-phate	24	G			Do not use in greenhouses <900 ft^2. Store cans at room temperature for 24 hrs before application.

Table 8.8 Insecticides For Leafminer Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Fenpyroximate	Akari 5 SC	2	Pyrazole	12	G	N		Good coverage needed. Do not apply more than 48 fl. oz. per crop cycle or growing season. Use at least two different chemicals with two different modes of action between treatments.
Imidacloprid	Benefit 60WP	4A	Neonicotinoid	12	G	N		Systemic; apply as foliar spray or to the soil media. Do not apply to saturated soils.
	Imida E-Pro 1% G				G	N		Systemic; applied to the soil media. Do not apply to saturated soils.
	Imida E-Pro 60 WSP				G	N		
	Lada 2F				G	N	L	Systemic; applied as foliar spray or to soil media. Do not treat saturated soils.
	Mallet 2F						L	
	Mantra 2F				G	N		
	Mantra 1G				G	N		Systemic; applied to the soil media.
	Marathon 1% G				G	N		Systemic; soil treatment only. Use only 1x/ 16 weeks. Residual activity so can apply before egg-laying of pests. Media bark content > 30% may reduce protection period.
	Marathon 60WP				G	N		
	Merit 75 WP						L	
	Merit 75 WSP						L	
	Quali-Pro Imidacloprid 1G Nursery & Greenhouse				G	N		Systemic; applied as foliar spray or to the soil media. Do not apply to saturated soils. Do not apply to ferns.
	Quali-Pro Imidicloprid 2F Nursery & Greenhouse Insecticide				G	N		

Table 8.8 Insecticides For Leafminer Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Insecticidal soap	Bonide Insectidal Soap	NC	Potassium salts of fatty acids	12	G	N	L	Contact insecticide; complete coverage is essential. Do not use on new transplants, unrooted cuttings, or plant material stressed by drought or under hot, humid conditions. Avoid spraying in greenhouses under overcast conditions. Caution if using on *Euphorbia*. Caution if the pH of the final solution is below 8.0. Do not use on bleeding heart or lily. Do not apply to chrysanthemum after bloom. Compatible with biological control agents.
	DES-X				G	N	L	
	M-Pede				G	N	L	
	Natural Guard Insecticidal Soap				G			
Lambda-cyhalothrin	Lambda-Cy EC**	3A	Pyrethroid	24	G	N	L	For adults only. A spreader-sticker is recommended. Do not apply through any type of irrigation system
	Scimitar GC (EC)**				G	N	L	
	Scimitar CS						L	
	Quali-Pro lambda GC-O***				G	N	L	
Novaluron	Pedestal	15	Benzoylurea	12	G	N		IGR; controls immatures (not adults). Do not apply more than twice a year.

Table 8.8 Insecticides For Leafminer Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Oil, Horticultural (paraffinic hydrocarbon oils; petroleum oil, soybean oil, vegetable oil)	Golden Pest Spray Oil (soybean oil)	NC	Oil	4	G		L	Need complete covereage. Do not apply if plants are under any stress or during periods of prolonged high temperatures combined with high relative humidity. Avoid spraying in greenhouses under overcast conditions. Do not exceed label rates or apply more often than recommended. Effectiveness at temperatures below 50 °F is reduced. Do not use within 2 weeks of sulfur or within 7 days of Captan. Do not apply through any irrigation system. See label for cautions if using with/ before/following application of certain products and for use restrictions and mixing cautions. #Mums and mints are only perennials on label.
	JMS Stylet Oil# (paraffinic oil)				G	N	L	
	Organic JMS Stylet Oil# (paraffinic oil)				G	N	L	
	PureSpray Green (petroleum oil)				G	N	L	
	Saf-T-Side (petroleum oil)						L	
	SuffOil-X (paraffinic oil)						L	
	Summit Year Round Spray Oil (mineral oil)				G	N	L	
	Ultra-fine Spray Oil (paraffinic oil)				G	N	L	
	Ultra-Pure Oil (petroleum oil)				G	N		
Permethrin	Astro 3.2EC	3A	Pyrethroid	12	G		L	Avoid spraying chrysanthemum blooms. Marginal leaf burn has been noticed on salvia. Application to blooms may cause petal browning.
	Perm-Up 3.2EC**				G	N	L	
	Pounce 25 WP					N		
	Tenkoz Permethrin 3.2EC**				G	N	L	

Table 8.8 Insecticides For Leafminer Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Pyrethrin + Piperonyl butoxide	Pyrenone Crop Spray	3A	Pyrethroid	12	G	N	L	A botanical insecticide plus a synergist to flush insects out of hiding and into contact with spray residues. Can be used up to and including the day of harvest. See label for details. Apply when foliage is dry.
	Prentox Pyronyl Crop Spray				G	N	L	
	Pyreth-It (Prescription Treatment Brand)				G	N	L	
Pyriproxyfen	Distance	7C	Pyridine	12	G	N	L	IGR for spotted tentiform leafminer only. Apply no more than two times per cropping cycle or no more than two times per six months. Do not apply to coral bells, gardenia, ghost plant, or salvia.
Spinosad	Conserve SC	5	Spinosyn	4	G	N	L	Minimum impact upon beneficials. Maximum of 2 consecutive applications.
	Entrust				G	N	L	
Tau-fluvalinate	Mavrik Aquaflow	3A	Pyrethroid	12	G	N	L	Do not apply more than 4 sprays per month. Can also be used as a dip for flower and foliage cuttings.
Thiamethoxam	Flagship 25 WG	4A	Neonicotinoid	24	G	N		Foliar and soil applications, but soil applications work as a preventative measure or where population is low.
	Flagship 0.22G				G	N		

Table 8.9 Insecticides For Mealybug Control

Refer to disclaimer statement on page 47.

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Acephate	Avatar	1B	Organophos-phate	24	G	N	L	Do not apply to certain chrysanthemums cultivars; avoid open blooms.
	Acephate 97 UP				G	N	L	
	Orthene TT&O				G	N		
	Orthene 1300 TR				G			
Acetamiprid	TriStar 30 SG	4A	Neonicotinoid	12	G	N		Do not irrigate overhead for at least 6 hrs after application. See label for tank mixing suggestions.
	TriStar 70 WSP				G	N		
Azadirachtin	Azatin XL	NC	Botanical	4	G	N	L	IGR, repellant, anti-feedant. Controls larvae and pupae by contact or ingestion. Do not use with Bordeaux mixture, triphenyltin hydroxide, lime sulfur, Rayplex iron or other highly alkaline materials. See specific plants on label. Use within 8 hours. Reduce irrigation water pH if it exceeds 7.0. +Azatrol: The waxy bloom on certain ornamental plants may be reduced.
	Azatrol+				G	N	L	
	Aza-Direct				G	N	L	
	Neemix 4.5			12	G	N		
	Neemazad 1.0% EC				G	N		

Table 8.9 Insecticides For Mealybug Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Beauveria bassiana	BotaniGard ES	NC	Biological	4	G	N	L^	Contact insecticide; insect-specific fungus. Do not tank mix with fungicides. Can use with ultra-low volume equipment and chemigation but not with thermal foggers. Can use as pre-plant dips for cuttings. Do not tank mix with fungicides. *Mycotrol - organic certification. ^Commercial.
	Mycotrol O (WP)*				G	N		
	Naturalis L (JW-1 strain)				G	N	L	
	Naturalis H&G				G	N	L	
Bifenthrin	Attain Greenhouse	3A	Pyrethroid	12	G		L	Microemulsion. Do not apply through any irrigation system. Apply when foliage is dry.
	Attain TR				G			Micro total release insecticide. Apply when foliage.
	Menace GC 7.9% Flowable (F)**				G	N	L	Preventative and curative topical drench. Wait 30 days between applications.
	Menace 7.9% Flowable (F)						L	Do not use through any irrigation system
	Onyx Insecticide						L	Repeat applications should be limited to no more than once per seven days.
	Onyx Pro**					N	L	Do not apply more often than once per seven days. A surfactant or horticultural oil may increase effectiveness.

Table 8.9 Insecticides For Mealybug Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Bifenthrin (continued)	Talstar P (Professional) (F)	3A	Pyrethroid	12	G		L	Thorough coverage is important. Apply only once per seven days. The addition of a surfactant or oil may improve mite control. May be tank mixed with IGRs and other products.
	Talstar Nursery				G	N		
	Up-Star SC **(F)				G	N	L	Thorough coverage is important. Do not use through any irrigation system.
	Wisdom F				G	N	L	
Buprofezin	Talus 40SC	16	Buprofezin	12	G	N	L	IGR; suppresses adult egg-laying as well as reduces egg viability. Not disruptive to beneficial insects and mites. Apply no more than two applications per season. Do not apply through any irrigation system.
	Talus 70 DF							
Carbaryl	Carbaryl 4L	1A	Carbamate	12			L	Do not use more than 6x/year. Obtain thorough coverage of both upper and lower leaf surface. Do not apply to wet foliage or during high humidity periods. Do not use on Boston ivy, or Virginia creeper.
	Sevin SL					N	L	
	Sevin 80 WSP					N	L	
Chlorpyrifos	DuraGuard ME**	1B	Organophospate	24	G	N		Do not mix with alkaline materials (e.g. Bordeaux and lime). Direct treatment to some open blooms may cause petal drop.

Table 8.9 Insecticides For Mealybug Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Chlorpyrifos + Cyfluthrin	Duraplex TR (WP)**	1B 3A	Organophos-phate Pyrethroid	24	G			Micro total release insecticide. Apply when foliage is dry.
Clothianidin	Celero 16 WSG		Neonicotinoid	12	G	N	L	See label for plant restrictions.
Cyfluthrin	Decathlon 20 WP		Pyrethroid	12	G	N	L	Good coverage is necessary. Do not apply Decathlon through any irrigation system. Spray, drench, soil injection.
	Discus					N		
Dinotefuran	Safari 2G	4A	Neonicotinoid	12	G	N	L	Only apply to moist soil media. Do not apply to dry or saturated media.
	Safari 20 SG				G	N	L	
Fenoxycarb	Prescription Treatment Preclude TR	7B	Fenoxycarb	12	G			Micro-release IGR. Apply when foliage is dry. Do not use more than every seven days.
Fenpropathrin	Tame 2.4 EC	3A	Pyrethroid	24	G	N	L	Do not use in greenhouses < 500 ft^2. Can tank mix with Orthene TT&O WSP spray.
Fenpropathrin + Acephate	Prescription Treatment Tame/Orthene TR	3A 1B	Pyrethroid Organophos-phate	24	G			Do not use in greenhouses < 900 ft^2. Store cans at room temperature for 24 hrs before use.
Flonicamid	Aria	9C	Pyridinecarbox-amide	12	G	N	L	Insects stop feeding within 30 minutes, but may remain on plants up to 5 days. Treat when insects appear; has excellent residual control. Apply with a pyrethroid for knockdown of heavy infestations.

Table 8.9 Insecticides For Mealybug Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Imidacloprid	Benefit 60WP	4A	Neonicotinoid	12	G	N		Systemic. Media with >30% bark may reduce protection period.
	Imida E-Pro 1% G				G	N		Systemic; applied as foliar spray or to the soil media. Do not apply to saturated soils.
	Imida E-Pro 60 WSP				G	N		Systemic; applied to the soil media. Do not apply to saturated soils.
	Lada 2F				G	N	L	Systemic; applied as foliar spray or to soil media. Do not apply to saturated soils or to ferns.
	Mallet 2F						L	
	Mantra 1G				G	N		Systemic; applied to the soil media.
	Mantra 2F				G	N		Systemic; applied as foliar spray or to the soil media. Do not apply to saturated soils.
	Marathon 1% G				G	N		Systemic; soil treatment only. Use no more than once every 16 weeks. Residual activity so can apply before egg-laying of target pests. Media with > 30% bark content may reduce protection period.
	Marathon 60WP				G	N		
	Merit 75 WP						L	
	Merit 75 WSP						L	
	Quali-Pro Imidacloprid 1G Nursery & Greenhouse				G	N		Systemic; applied as foliar spray or to the soil media. Do not apply to saturated soils. Do not apply to ferns.
	Quali-Pro Imidicloprid 2F Nursery & Greenhouse Insecticide				G	N		

Table 8.9 Insecticides For Mealybug Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Insecticidal soap	Bonide Insectidal Soap	NC	Potassium salts of fatty acids	12	G	N	L	Contact insecticide; Complete coverage needed. Do not use on new transplants, unrooted cuttings, or plant material stressed by drought or under hot, humid conditions. Avoid spraying in greenhouses under overcast conditions. Caution using on *Euphorbia*. Caution if pH of final solution is below 8.0. Do not use on bleeding heart, lily or chrysanthemum after bloom. Compatible with biological control.
	DES-X				G	N	L	
	M-Pede				G	N	L	
	Natural Guard Insecticidal Soap				G	N	L	
Kinoprene	Enstar II (F)	7A	Juvenile hormone analogue	4	G			IGR. May damage blooms under certain conditions.
Lambda-cyhalothrin	Lambda-Cy EC**	3A	Pyrethroid	24	G	N	L	A spreader-sticker is recommended. Do not apply through any type of irrigation system
	Scimitar GC (EC)**				G	N	L	
	Scimitar CS						L	
	Quali-Pro lambda GC-O**				G	N	L	
Naled	Dibrom 8E**	1B	Vapor	***	G			Fumigant action. Corrosive. Avoid over treatment and direct application to plants. May injure certain chrysanthemum varieties. Do not apply above 90 °F. *** REI and WPS ventilation requirements met.

Table 8.9 Insecticides For Mealybug Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Neem oil	Triact 70	NC	Botanical	4	G	N	L	Kills immature and adult insects. Do not apply to wilted or stressed plants, or to new transplants prior to root establishment. Caution if applying to flowers of hibiscus.
Oil, Horticultural (paraffinic hydrocarbon oils; petroleum oil, soybean oil, vegetable oil)	Golden Pest Spray Oil (soybean oil)	NC	Oil	4	G		L	Complete coverage is necessary. Do not apply if plants are under any kind of stress. Do not apply during periods of prolonged high temperatures combined with high relative humidity. Avoid spraying in greenhouses under overcast conditions. Do not exceed label rates or apply more often than recommended. Effectiveness at temperatures below 50 °F is reduced. Do not use within 2 weeks of sulfur or within 7 days of Captan. Do not apply through any irrigation system. See label for cautions if using with/ before/following application of certain products. #Mums and mints are only perennials on label.
	JMS Stylet Oil# (Paraffinic oil)				G	N	L	
	Organic JMS Stylet Oil# (Paraffinic oil)				G	N	L	
	PureSpray Green (petroleum oil)				G	N	L	
	Saf-T-Side (petroleum oil)						L	
	SuffOil-X (paraffinic oil)				G	N	L	
	Summit Year Round Spray Oil (mineral oil)						L	
	Ultra-fine Spray Oil (paraffinic oil)				G	N	L	
	Ultra-Pure Oil (Petroleum oil)				G	N		

Table 8.9 Insecticides For Mealybug Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Permethrin	Astro 3.2EC	3A	Pyrethroid	12	G		L	Avoid spraying chrysanthemum blooms. Marginal leaf burn has been noticed on salvia. Application to blooms may cause petal browning
	Perm-Up 3.2EC**				G	N	L	
	Tenkoz Permethrin 3.2EC**				G	N	L	
Pyrethrin + Piperonyl butoxide	Pyrenone Crop Spray	3A	Pyrethroid	12	G	N	L	A botanical insecticide and synergist to flush insects out and into contact with spray residues. Can use up to and including day of harvest. See label for details. Apply when foliage is dry.
	Pyreth-It (Prescription Treatment Brand)				G	N	L	
Pyriproxyfen	Distance	7C	Pyridine	12	G	N	L	IGR. Apply no more than 2 times per cropping cycle or no more than 2 times per 6 months. Do not apply to coral bells, gardenia, ghost plant, or salvia.
Spinosad	Conserve SC	5	Spinosyn	4	G	N	L	Minimum impact upon beneficials. Maximum of 2 consecutive applications.
	Entrust				G	N	L	
Tau-fluvalinate	Mavrik Aquaflow	3A	Pyrethroid	12	G	N	L	Do not apply more than 4 sprays per month. Can use as a dip for flower and foliage cuttings.
Thiamethoxam	Flagship 25 WG	4A	Neonicotinoid	24	G	N		Foliar and soil applications, but soil applications work as a preventative measure or where population is low.
	Flagship 0.22g				G	N		

Table 8.10 Miticides For Broad Mite Control

Refer to disclaimer statement on page 47.

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Abamectin	Abamectin E-Pro 0.15 EC	6	Avermectin	12	G		L	Do not apply through any type of irrigation system. Do not use on chrysanthemums, ferns, or shasta daisies. Repeat applications to new foliage may be necessary. See label about resistance management.
	Ardent 0.15 EC				G		L	
	Flora-Mek 0.15 EC				G		L	
	Lucid 2F				G		L	
	Minx				G		L	
	Tide Timectin 0.15EC T&O**				G		L	
Azadirachtin	Aza-Direct	NC	Botanical	4	G	N	L	IGR, repellant, anti-feedant. Controls larvae and pupae by contact or ingestion. Do not use with Bordeaux mixture, triphenyltin hydroxide, lime sulfur, Rayplex iron or other highly alkaline materials. See specific plants on label. Use within 8 hours. Reduce irrigation water pH if it exceeds 7.0. +Azatrol may reduce waxy bloom on certain ornamental plants.
	Azatrol+				G	N	L	
Beauveria bassiana ATCC 74040	Naturalis L (JW-1 strain)	NC	Biological	4	G	N	L	Entomopathogenic fungus. Contact insecticide. Do not tank mix with fungicides. Can use with ultra-low volume equipment and chemigation but not thermal foggers. Can use as pre-plant dip for cuttings.

Table 8.10 Miticides For Broad Mite Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Bifenthrin	Attain TR	3A	Pyrethroid	12	G			Micro total release insecticide. Apply when foliage is dry.
	Menace GC 7.9% **				G	N	L	Preventative and curative topical drench. Wait 30 days between applications.
	Onyx Insecticide						L	Micro total release insecticide. Apply when foliage is dry.
	Onyx Pro**					N	L	Do not apply more than once per seven days. A surfactant or horticultural oil may increase product effectiveness.
	Talstar P Professional				G		L	Thorough coverage is important. Do not apply more than once per seven days. A surfactant or oil may improve mite control. May be tank mixed with IGRs and other products.
	Talstar Select**				G	N	L	Thorough coverage is important. Do not apply through any irrigation system.
	Up-Star SC (F)**				G	N	L	
	Wisdom F**				G	N	L	
Chlorfenapyr	Pylon	13	Pyrrole	12	G			Controls larvae and nymphs. May be applied twice consecutively, but no more than three times within a season. Apply prior to bloom or avoid blooms where possible. Do not apply to salvia.

Table 8.10 Miticides For Broad Mite Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Chlorpyrifos + Cyfluthrin	Duraplex TR (WP)**	1B 3A	Organophos-phate Pyrethroid	24	G			Micro total release insecticide. Apply when foliage is dry.
Etoxazole	Beethoven TR	10B	Etoxazole	24	G			REI changes depending on ventilation (4 if ventilated with open windows or vents). If multi-tiered plant stock, apply at higher rate.
Fenpyroximate	Akari 5SC	2	Phenoxypyrazole	12	G	N		Good spray coverage needed. Do not apply more than 48 fl. oz. per crop cycle or per growing season. Use at least two different chemicals with two different modes of action between treatments.
Insecticidal soap	M-Pede	NC	Potassium salts of fatty acids	12	G	N	L	Contact insecticide; complete coverage is essential. Do not use on new transplants, unrooted cuttings, or plant material stressed by drought or under humid, hot conditions. Avoid spraying in greenhouses under overcast conditions. Caution treating *Euphorbia*. Caution if final solution pH is below 8.0. Do not use on bleeding heart, lily, or on chrysanthemum after bloom. Can use with biocontrol.

Table 8.10 Miticides For Broad Mite Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Lambda-cyhalothrin	Lambda-Cy EC**	3A	Pyrethroid	24	G	N	L	A spreader-sticker is recommended. Do not apply through any type of irrigation system.
	Quali-Pro Lambda GC-O**				G	N	L	
	Scimitar CS						L	
	Scimitar GC**				G	N	L	
Neem oil	Triact 70	NC	Botanical	4	G	N	L	Kills immatures and adults. Do not treat wilted or stressed plants or new transplants before root establishment. Caution treating hibiscus flowers.
Oil, Horticultural	JMS Stylet Oil (Paraffinic)#	NC	Oil	4	G	N	L	Complete coverage needed. Do not treat plants under stress, during periods of prolonged high temperatures and high humidity, or in greenhouses under overcast conditions. Do not exceed label rates or apply more often than recommended. Effectiveness is reduced below 50 °F. Do not use within 2 weeks of sulfur or within 7 days of Captan. Do not apply through any irrigation system. See label if using with/before/following certain other products. #Mums and mints are only perennials on label.
	Saf-T-Side (Petroleum)						L	

Table 8.10 Miticides For Broad Mite Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Pyridaben	Sanmite 75 WP	21A	Pyridazinone	12	G	N		Contact only. May be fatal if inhaled. Do not use in successive miticide applications. Do not apply this product through any irrigation system. Do not use fertilizers containing boron.
Spiromesifen	Forbid 4F	23	Tetronic Acid	12			L	Provides knockdown and residual control of all mite lifestages, including eggs and pupae. Do not apply this product through any type of irrigation system. See label for restrictions on use on specific plants/ cultivars.
	Judo				G	N		
Tau-fluvalinate	Mavrik Aquaflow	3A	Pyrethroid	12	G	N	L	Do not apply more than 4 sprays per month. Can also be used as a dip for flower and foliage cuttings.

Table 8.11 Miticides For Cyclamen Mite Control

Refer to disclaimer statement on page 47.

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Abamectin	Abamectin E-Pro 0.15 EC	6	Avermectin	12	G		L	Do not apply through any type of irrigation system. Do not use on chrysanthemums, ferns, or Shasta daisies. Repeat applications to new foliage may be necessary
	Ardent 0.15 EC				G		L	
	Flora-Mek 0.15 EC				G		L	
	Lucid 2F				G		L	
	Minx				G		L	
	Tide Timectin 0.15EC T&O**				G		L	
Azadirachtin	Aza-Direct	NC	Botanical	4	G	N	L	IGR, repellant, anti-feedant. Controls larvae and pupae by contact or ingestion. Do not use with Bordeaux mixture, triphenyltin hydroxide, lime sulfur, Rayplex iron or other highly alkaline materials. See specific plants on label. Use within 8 hours. Reduce irrigation water pH if it exceeds 7.0. +Azatrol: The waxy bloom on certain ornamental plants may be reduced.
	Azatrol+				G	N	L	
Beauveria bassiana ATCC 74040	Naturalis L (JW-1 strain)	NC	Biological	4	G	N	L	Entomopathogenic fungus. Contact insecticide; do not tank mix with fungicides. Can be used with ultra-low volume equipment and chemigation but not with thermal foggers. Can be used as pre-plant dips for cuttings.

Table 8.11 Miticides For Cyclamen Mite Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Bifenthrin	Attain TR	3A	Pyrethroid	12	G			Do not apply through irrigation system. Thorough coverage is important.
	Talstar P (Professional) F				G		L	
	Talstar Select**				G	N	L	
	Up-Star SC **				G	N	L	
Chlorfenapyr	Pylon	13	Pyrrole	12	G			Controls larvae and nymphs. May apply it twice consecutively, but no more than three times per season. Apply before bloom or avoid blooms if possible. Do not apply to salvia.
Chlorpyrifos + Cyfluthrin	Duraplex TR (WP)**	1B 3A	Organophos-phate Pyrethroid	24	G			Micro total release insecticide. Apply when foliage is dry.
Etoxazole	Beethoven TR	10B	Etoxazole	24	G			REI changes depending on ventilation (4 if ventilated with open windows or vents). If multi-tiered plant stock, apply at higher rate - see label
Fenpyroximate	Akari 5SC	2	Phenoxypyrazole	12	G	N		Good spray coverage needed. Do not apply more than 48 fl. oz. per crop cycle or per growing season. Allow at least two different chemicals with two different modes of action to be used between treatments.

Table 8.11 Miticides For Cyclamen Mite Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Neem oil	Triact 70		Botanical		G	N	L	Kills immatures and adults. Do not apply to wilted or stressed plants, or new transplants prior to root establishment. Caution if applying to hibiscus flowers.
Oil, Horticultural	JMS Stylet Oil (Paraffinic)#	NC	Oil	4	G	N	L	Completely cover pest with product to be effective. Do not apply if plants are under stress, during periods of prolonged high temperatures combined with high relative humidity, or in greenhouses under overcast conditions. Do not exceed label rates or apply more often than recommended. Effectiveness is reduced below 50 °F. Do not use within 2 weeks of sulfur or within 7 days of Captan. Do not apply through any irrigation system. See label for cautions if using with/ before/following application of other certain products. #Mums and mints are only perennials on label.
	Saf-T-Side (Petroleum)						L	

Table 8.11 Miticides For Cyclamen Mite Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Spiromesifen	Forbid 4F	23	Tetronic Acid	12			L	Provides knockdown and residual control of all mite life stages, including eggs and pupae. Do not apply this product through any type of irrigation system. See label for restrictions on use on specific plants/ cultivars.
	Judo				G	N		
Tau-fluvalinate	Mavrik Aquaflow	3A	Pyrethroid	12	G	N	L	Do not apply more than 4 sprays per month. Can also be used as a dip for flower and foliage cuttings.

Table 8.12 Miticides For Tetranychid (Spider) Mite Control

Refer to disclaimer statement on page 47.

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Abamectin	Abamectin E-Pro 0.15 EC	6	Avermectin	12	G		L	Do not apply through any type of irrigation system. Do not use on chrysanthemums, ferns, or Shasta daisies. Repeat applications to new foliage may be necessary.
	Avid 0.15EC				G		L	
	Ardent 0.15 EC				G		L	
	Flora-Mek 0.15 EC				G		L	
	Lucid 2F				G		L	
	Minx				G		L	
	Tide Timectin 0.15EC T&O**				G		L	
Acequinocyl	Shuttle 15 SC	20B	Naphthoquinone derivative	12	G	N	L	Apply as a foliar spray. Thorough coverage is important. Do not mix with strongly alkaline or acidic materials. Do not use product successively; use in rotation with other miticides with different modes of action.
Acephate	1300 Orthene TR	1B	Organophos-phate	24	G			Total release cans for greenhouse use only. Follow label precautions.
Azadirachtin	Aza-Direct	NC	Botanical	4	G	N	L	Repellant, anti-feedant, and IGR. Controls larvae and pupae on contact or by ingestion. Ensure good coverage to top and bottom of foliage. +Azatol: The waxy bloom on certain ornamental plants may be reduced after an application.
	Azatrol EC+				G	N	L	

Table 8.12 Miticides For Tetranychid (Spider) Mite Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Beauveria bassiana ATCC 74040	Naturalis L (JW-1 strain)	NC	Biological	4	G	N	L	Entomopathogenic fungus. Contact insecticide; do not tank mix with fungicides. Can use with ultra-low volume equipment and chemigation but not thermal foggers. Can use as pre-plant dip for cuttings.
Bifenthrin	Attain TR	3A	Pyrethroid	12	G			Micro total release insecticide. Apply when foliage is dry.
	Onyx Insecticide						L	
	Menace GC 7.9% (F) **				G	N	L	Preventative and curative topical drench. Wait 30 days between applications.
	Onyx Pro**					N	L	Do not apply more than once per seven days. Oil or a surfactant may increase product effectiveness.
	Talstar P Professional (F)				G		L	Thorough coverage is important. Do not apply more than once per seven days. A surfactant or oil may improve mite control. Can tank mix with IGRs and other products.
	Talstar Select**				G	N	L	Do not apply through any irrigation system. Thorough coverage is important.
	Up-Star SC (F)**				G	N	L	
	Wisdom F**				G	N	L	
Bifenazate	Floramite SC	UN	Bifenazate	4	G	N	L	See label about using for biological control program.

Table 8.12 Miticides For Tetranychid (Spider) Mite Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Chlorpyrifos	DuraGuard ME**	1B	Organophospate	24	G	N		Do not mix with alkaline materials (e.g. Bordeaux and lime). Direct treatment to some open blooms may cause petal drop.
Chlorpyrifos + Cyfluthrin	Duraplex TR (WP)**	1B 3A	Organophos-phate Pyrethroid	24	G			Micro total release insecticide. Apply when foliage is dry.
Chlorfenapyr	Pylon	13	Pyrrole	12	G			Controls larvae and nymphs. May be applied twice consecutively, but no more than three times within a season. Apply prior to bloom or avoid blooms where possible. Do not apply to salvia.
Clofentezine	Ovation SC	10A	Clofentezine	12	G	N		Most effective on eggs and early stages. Apply when mites first appear. If adults established, can use an adult miticides.
Etoxazole	Beethoven TR	10B	Etoxazole	24	G			Total release insecticide. REI varies (e.g. 4 if ventilated with open windows or vents). If multi-tiered plant stock, apply at higher rate.
	Tetrasan 5 WDG			12	G	N	L	Controls eggs and nymphs; treated adults will not produce viable eggs. Translaminar properties. Can use with contact adulticide.

Table 8.12 Miticides For Tetranychid (Spider) Mite Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Fenbutatin-oxide	ProMITE 50 WP**	12B	Organotin	48	G	N	L	Thorough coverage necessary. Product does best when daily temperatures average >70 °F. Do not use in sprayers that have any boron or chlorine residues. Apply to chrysanthemums pre-bloom. See label for cautions on ferns and other ornamentals.
Fenoxycarb	Prescription Treatment Brand Preclude TR	7B	Fenoxycarb	12	G			Juvenile hormone mimics. Micro-release IGR. Apply when foliage is dry.
Fenpropathrin	Tame 2.4 EC**	3A	Pyrethroid	24	G	N	L	Do not use in greenhouses <500 ft^2. Can tank mix with Orthene TT&O WSP.
Fenpyroximate	Akari 5SC	2	Phenoxypyrazole	12	G	N		Good spray coverage needed. Do not apply more than 48 fl. oz. per crop cycle or per growing season. Use at least two different chemicals with two different modes of action between treatments. A wetting agent can improve control. Do not apply through any irrigation system.
Hexythiazox	Hexygon DF	10A	Carboxamide	12	G	N	L	Controls eggs and immature stages. Will not kill adults, but treated adults will not produce viable eggs.

Table 8.12 Miticides For Tetranychid (Spider) Mite Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Insecticidal soap	M-Pede	NC	Potassium salts of fatty acids	12	G	N	L	Contact insecticide; complete coverage is essential. Do not treat unrooted cuttings, new transplants, or plant material stressed by drought or hot, humid, conditions. Avoid spraying in greenhouses when overcast. Caution treating *Euphorbia*. Caution if pH of final solution is below 8.0. Do not treat bleeding heart, or lily or apply to chrysanthemum after bloom.
Lambda-cyhalothrin	Lambda-Cy EC**	3A	Pyrethroid	24	G	N	L	A spreader-sticker is recommended. Do not apply through any type of irrigation system
	Scimitar CS						L	
	Scimitar GC**				G	N	L	
	Quali-Pro lambda GC-O**				G	N	L	
Methiocarb	Mesurol 75W**	1A	Carbamate	24	G	N		Do not apply in conjunction with foliar fertilizers. Effectiveness of product may be reduced when the spray solution has a pH greater than 7. Do not make more than 2 applications per year per crop.

Table 8.12 Miticides For Tetranychid (Spider) Mite Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Naled	Dibrom 8E**	1B	Organophos-phate	***	G			Good fumigant action. Corrosive. Avoid over treatment and direct application to plants. May injure certain chrysanthemum varieties and Dutchman's pipe. Do not apply when above 90 °F. *** REI and WPS ventilation requirements met.
Neem oil	Triact 70	NC	Botanical	4	G	N	L	Kills immature and adult mites. Do not apply to wilted or stressed plants, or to new transplants prior to root establishment. Caution if applying to hibiscus flowers.
Oil, Horticultural	JMS Stylet Oil# (Paraffinic)	NC	Oil	4	G	N	L	Complete coverage is necessary. Do not treat stressed plants. Do not use during periods of prolonged high temperatures and high humidity or in greenhouses when overcast. Effectiveness is reduced below 50 °F. Do not use within 2 weeks of sulfur or within 7 days of Captan. Do not apply through irrigation system. #Mums and mints are only perennials on label.
	Organic JMS Stylet Oil# (Paraffinic)				G	N	L	
	Prescription Treatment Ultra Pure Oil (Petroleum)				G	N		
	PureSpray Green (Petroleum)				G	N	L	
	Saf-T-Side (Petroleum)						L	
	Suffoil-X (Petroleum)				G	N	L	

Table 8.12 Miticides For Tetranychid (Spider) Mite Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Pyrethrins + Piperonyl butoxide	Pyrethrum TR	3A	Pyrethroid	12	G	N		A botanical insecticide plus a synergist to flush insects out of hiding and into contact with spray residues. Can be used up to and including the day of harvest. See label for details. Apply when foliage is dry.
Pyridaben	Sanmite 75 WP	21A	Pyridazinone	12	G	N		Contact only. May be fatal if inhaled. Do not use in successive miticide applications. Do not apply this product through any type of irrigation system. Do not use fertilizers containing boron.
Spinosad	Conserve SC (EC)	5	Biological	4	G	N	L	Minimum impact upon beneficials. Maximum of 2 consecutive applications.
Spiromesifen	Forbid 4F	23	Tetronic Acid	12			L	Provides knockdown and residual control of all mite life stages, including eggs and pupae. Do not apply this product through any type of irrigation system. See label for restrictions on use on specific plants/ cultivars.
	Judo				G	N		

Table 8.12 Miticides For Tetranychid (Spider) Mite Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Spirotetramat	Kontos	23	Tetramic acid derivative	24	G	N		Systemic. Spray adjuvants with spreading / penetrating characteristics may improve leaf uptake and systemic concentration of active ingredient.
Tau-fluvalinate	Mavrik Aquaflow	3A	Pyrethroid	12	G	N	L	Do not apply more than 4 sprays per month. Can also be used as a dip for flower and foliage cuttings.

Table 8.13 Insecticides For Soft Scale Control

Refer to disclaimer statement on page 47.

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Acephate	Acephate 97 Up	1B	Organophos-phate	24	G	N	L	Do not apply to certain chrysanthemums and those with open blooms. See label for specific scales.
	Acephate 90 WDG				G	N	L	
	Acephate 90 SP				G	N	L	
	Orthene TT&O 97				G	N	L	
	Orthene TT&O WSP				G	N	L	
	1300 Orthene TR				G			Total release cans for greenhouse use only. Follow label precautions.
Acetamiprid	TriStar 30 SG	4A	Neonicotinoid	12	G	N		Do not irrigate overhead for at least 6 hrs after application. See label for tank mixing suggestions.
Azadirachtin	Azatrol+	NC	Botanical	4	G	N	L	Repellant, anti-feedant, and IGR. Controls larvae and pupae on contact or by ingestion. Do not use with Bordeaux mixture, triphenyltin hydroxide, lime sulfur, Rayplex iron or other highly alkaline materials. Specific plants on label. Use within 8 hours. Reduce pH of irrigation water if the pH exceeds 7.0. +Azatrol: The waxy bloom on certain ornamental plants may be reduced after an application.
	Aza-Direct				G	N	L	
	Ornazin 3% EC				G	N		
	Neemix 4.5				G	N		
	Neemazad 1.0% EC				G	N		

Table 8.13 Insecticides For Soft Scale Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Bifenthrin	Attain TR	3A	Pyrethroid	12	G			Do not apply through any kind of irrigation system.
	Menace GC 7.9% Flowable (F)**				G	N	L	Preventative and curative topical drench. Wait 30 days between applications.
	Menance 7.9% Flowable (F)						L	Do not apply through any irrigation system.
	Onyx Insecticide						L	Limit applications to no more than once per 7 days.
	Talstar P (Professional) (F)				G		L	Do not apply more than once per 7 days. Can tank mix with IGRs and other products.
	Onyx Pro**					N	L	Apply no more than once per 7 days. Surfactant or horticultural oil may increase effectiveness.
	Up-Star SC** (F)				G	N	L	Thorough coverage is important. Do not use through any irrigation system.
	Wisdom F**				G	N	L	
Buprofezin	Talus 40 SC	16	Buprofezin	12	G	N	L	IGR; suppresses egg-laying and reduces egg viability. Does not disrupt beneficial insects and mites. Apply no more than twice per season. Do not apply through any irrigation system. Do not apply if a chitin synthesis inhibitor was used within 4 weeks.
	Talus 70 DF				G	N	L	

Table 8.13 Insecticides For Soft Scale Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Carbaryl	Carbaryl 4L	1A	Carbamate	12			L	Do not use on Boston ivy or Virginia creeper. Do not use more than 6x/year. Get thorough coverage of upper and lower leaf surface. Do not treat wet foliage or when high humidity. REI is 18 days for Carbaryl for ornamental cuttings.
	Sevin SL					N	L	
Chlorpyrifos	DuraGuard ME**	1B	Organophospate	24	G	N		Do not mix with alkaline materials (e.g. Bordeaux and lime). Direct treatment to some open blooms may cause petal drop.
Chlorpyrifos + Cyfluthrin	Duraplex TR (WP)**	1B 3A	Organophos-phate Pyrethroid	24	G			Micro total release insecticide. Apply when foliage is dry.
Cyfluthrin	Decathlon 20 WP	3A	Pyrethroid	12	G	N	L	Broad spectrum. Good coverage is necessary. Do not apply Decathlon 20 through any irrigation system. Spray, drench, soil injection. Can use Discus through an irrigation system.
	Discus N/G				G	N		
	Discus					N		
Dinotefuran	Safari 20 SG	4A	Neonicotinoid	12	G	N	L	Apply to moist media. Do not apply to dry or saturated media.
	Safari 2G				G	N	L	
Fenoxycarb	Prescription Treatment Preclude TR	7B	Fenoxycarb	12	G			Micro-release IGR. Apply to dry foliage. Do not use more than 1x/ 7 days.

Table 8.13 Insecticides For Soft Scale Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Fenpropathrin + Acephate	Prescription Treatment Tame/Orthene TR	3A 1B	Pyrethroid Organophos-phate	24	G			Do not use in greenhouses < 900 ft^2. Store cans at room temperature for 24 hrs before application. Apply when foliage is dry.
Flonicamid	Aria	9C	Pyridinecarbox-amide	12	G	N	L	Insects stop feeding within 30 minutes, but may remain on plants for up to 5 days. Treat when insects appear; has excellent residual control. Apply with a pyrethroid for knockdown of heavy infestations.
Imidacloprid	Benefit 60WP	4A	Neonicotinoid	12	G	N		Systemic. Media with >30% bark may reduce protection period.
	Imida E-Pro 1% G				G	N		Systemic; applied to soil media. Do not apply to saturated soils.
	Imida E-Pro 60 WSP				G	N		Systemic; applied as foliar Systemic; applied as foliar spray or to the soil media. Do not apply to saturated soils. Do not apply Mallet 2F to ferns.
	Lada 2F				G	N	L	
	Mallet 2F						L	
	Mantra 1G				G	N		Systemic; applied to the soil media.
	Mantra 2F				G	N		Systemic; applied as foliar spray or to the soil media. Do not apply to saturated soils.

Table 8.13 Insecticides For Soft Scale Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Imidacloprid (continued)	Marathon 1% G	4A	Neonicotinoid	12	G	N		Systemic; soil treatment only. Do not use more than once every 16 weeks. Residual activity so can apply before egg-laying of pests. Media with > 30 % bark content may reduce protection period.
	Marathon 60 WP				G	N		
	Merit 75 WP						L	
	Merit 75 WSP						L	
	Quali-Pro Imidacloprid 1G Nursery & Greenhouse				G	N		Systemic; applied as foliar spray or to the soil media. Do not apply to soils that are water logged or saturated or to ferns.
	Quali-Pro Imidicloprid 2F Nursery & Greenhouse Insecticide				G	N		
Kinoprene	Enstar II (F)	7A	Juvenile hormone analogue	4	G			IGR. May cause some damage to blooms under certain conditions.
Lambda-cyhalothrin	Lambda-Cy EC**	3A	Pyrethroid	24	G	N	L	For crawlers only. A spreader-sticker is recommended. Do not apply through any type of irrigation system.
	Scimitar GC (EC)**				G	N	L	
	Scimitar CS						L	
	Quali-Pro Lambda GC-O**				G	N	L	
Neem oil	Triact 70	NC	Botanical	4	G	N	L	Kills immatures and adults. Do not apply to wilted or stressed plants or to new transplants before root establishment. Caution if applying to hibiscus flowers.

Table 8.13 Insecticides For Soft Scale Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Oil, Horticultural (paraffinic hydrocarbon oils; petroleum oil, soybean oil, vegetable oil)	Golden Pest Spray Oil (soybean oil)	NC	Oil	4	G		L	Need complete coverage. Do not apply to plants under stress or during periods of prolonged high temperatures and high relative humidity. Avoid spraying in greenhouses when overcast. Effectiveness is reduced below 50 °F. Do not use within 2 weeks of sulfur or within 7 days of Captan. Do not apply through irrigation system. See label for use with other products. #Mums and mints are only perennials on label.
	JMS Stylet Oil# and Organic JMS Stylet Oil# (Paraffinic oil)				G	N	L	
	PureSpray Green (petroleum oil)				G	N	L	
	Saf-T-Side (petroleum oil)						L	
	SuffOil-X (paraffinic oil)				G	N	L	
	Ultra-Pure Oil (Petroleum oil)				G	N		
Pyriproxyfen	Distance	7C	Pyridine	12	G	N	L	IGR for control of immature insects only. Apply no more than two times per cropping cycle or no more than two times per six months. Do not apply to coral bells, gardenia, ghost plant, or salvia.
Thiamethoxam	Flagship 25 WG	4A	Neonicotinoid	24	G	N		Foliar and soil applications, but soil applications work as a preventative measure or where population is low.

Table 8.14 Insecticides For Armored Scale Control

Refer to disclaimer statement on page 47.

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Acephate	Acephate 90 WDG	1B	Organophos-phate	24	G	N	L	Apply in crawler stage. Do not apply to certain chrysanthemums and those with open blooms.
	Acephate 90 SP				G	N	L	
	Acephate 97 Up				G	N	L	
	Orthene TT&O 97 S				G	N		
	Orthene TT&O WSP				G	N		
	1300 Orthene TR				G			Total release cans. Follow label precautions.
Acetamiprid	TriStar 30 SG	4A	Neonicotinoid	12	G	N		Do not irrigate overhead for at least 6 hrs after application.
Azadirachtin	Aza-Direct	NC	Botanical	4	G	N	L	Repellant, anti-feedant, and IGR. Controls larvae and pupae on contact or by ingestion. +Azatrol: May reduce waxy bloom on certain ornamental plants.
	Azatrol+				G	N	L	
	Ornazin 3% EC				G	N		
Bifenthrin	Attain TR	3A	Pyrethroid	12	G			Apply when foliage is dry.
	Menace GC 7.9% Flowable (F)**				G	N	L	Apply to crawlers. Wait 30 days to reapply.
	Onyx Insecticide						L	Apply at the beginning of crawler activity for best control.
	Onyx Pro**					N	L	Apply to crawlers.
	Talstar P (Professional) (F)				G		L	Use on crawlers. Can tank mix with IGRs and other products.
	Talstar Select**				G	N	L	Use on crawlers. Do not use through irrigation system.

Table 8.14 Insecticides For Armored Scale Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Bifenthrin (continued)	Up-Star SC (F)**	3A	Pyrethroid	12	G	N	L	Use on crawler stage. Do not apply through irrigation system. Labeled for brown soft scale, California red scale, pine needle scale, and San jose scale.
	Wisdom F**				G	N	L	
Buprofezin	Talus40 SC	16	Buprofezin	12	G	N	L	IGR; Suppresses egg-laying and reduces egg viability. Not disruptive to beneficial mites and insects. Apply no more than twice a season. Do not use through any irrigation system. Do not apply within four weeks of another chitin synthesis inhibitor.
	Talus 70 DF				G	N	L	
Carbaryl	Drexel Carbaryl 4L	1A	Carbamate	12			L	For crawlers only. Do not use on Boston ivy or Virginia creeper. Do not use more than 6x/year. Obtain thorough coverage of leaf surfaces.
	Sevin SL					N	L	
Chlorpyrifos	DuraGuard ME**	1B	Organophospate	24	G	N		For crawlers only. Do not mix with alkaline materials (e.g. Bordeaux and lime). Direct treatment to some open blooms may cause petal drop.
Chlorpyrifos + Cyfluthrin	Duraplex TR (WP)**	1B 3A	Organophos-phate Pyrethroid	24	G			For crawlers only. Micro total release insecticide. Apply when foliage is dry.

Table 8.14 Insecticides For Armored Scale Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Cyfluthrin	Decathlon 20 WP	3A	Pyrethroid	12	G	N	L	Apply during crawler stage. Do not apply through any type of irrigation system. Good coverage is necessary. Spray, drench, soil injection. Can be applied through irrigation systems.
	Discus					N		
	Discus N/G				G	N		Suppression only. Apply during crawler stage.
Dinotefuran	Safari 20 SG	4A	Neonicotinoid	12	G	N	L	Only apply to moist soil media. Do not apply to dry or saturated media
	Safari 2G				G	N	L	
Fenoxycarb	Prescription Treatment Preclude TR	7B	Fenoxycarb	12	G			Micro-release IGR. Apply when foliage is dry. Do not use more often than every seven days. Not for use on any food crops.
Fenpropathrin + Acephate	Prescription Treatment Tame/Orthene TR	3A 1B	Pyrethroid Organophos-phate	24	G			Do not use in greenhouses < 900 ft^2. Cans must be stored at room temperature for 24 hrs before application.
Flonicamid	Aria	9C	Pyridinecarbox-amide	12	G	N	L	Insects stop feeding within 30 minutes, but may remain on plants for up to 5 days. Treat when insects appear; has excellent residual control. Apply with a pyrethroid for knockdown of heavy infestations.

Table 8.14 Insecticides For Armored Scale Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Imidacloprid	Benefit 60WP	4A	Neonicotinoid	12	G	N		Suppression only. Systemic; applied as foliar spray or to the soil media. Do not apply to saturated soils.
	Imida E Pro 2F				G	N		Systemic; applied to the soil media. Do not apply to saturated soils.
	Imida E Pro 60 WSP				G	N		Suppression only.
	Lada 2F				G	N	L	Suppression only. Systemic; applied as foliar spray or to soil media. Do not apply to saturated soils. Do not apply Mallet 2F to ferns.
	Mallet 2F						L	
	Mantra 2F				G	N		
	Mantra 1G				G	N		Suppression only. Systemic; applied to the soil media.
	Marathon 1% G				G	N		Suppression only. Systemic; soil treatment only. Use only once every 16 weeks. Residual activity so can use before egg-laying of pests. Media with >30 bark content may reduce protection period.
	Marathon 60WP				G	N		
	Merit 2F						L	
	Merit 75 WP						L	
	Merit 75 WSP						L	
	Quali-Pro Imidacloprid 1G Nursery & Greenhouse				G	N		Suppression only. Systemic; applied as foliar spray or to the soil media. Do not apply to saturated soils. Do not treat ferns.
Kinoprene	Enstar II (F)	7A	Juvenile hormone analogue	4	G			IGR. May cause some damage to blooms under certain conditions.

Table 8.14 Insecticides For Armored Scale Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Lambda-cyhalothrin	Lambda-Cy EC**	3A	Pyrethroid	24	G	N	L	Apply to crawler stage. A spreader-sticker is recommended. Do not apply through any type of irrigation system
	Scimitar CS						L	
	Scimitar GC**				G	N	L	
	Quali-Pro lambda GC-O**				G	N	L	
Neem oil	Triact 70	NC	Botanical	4	G	N	L	Kills immature and adult insects. Do not apply to wilted or stressed plants or to new transplants prior to root establishment. Caution if applying to hibiscus flowers.
Oil, Horticultural (paraffinic hydrocarbon oils; petroleum oil, soybean oil, vegetable oil)	Golden Pest Spray Oil (soybean oil)	NC	Oil	4	G		L	Apply at crawler stage.
	JMS Stylet Oil# (Paraffinic oil)				G	N	L	Completely cover target pest. Do not apply if plants are under stress. Do not apply during periods of prolonged high temperatures and high humidity. Avoid spraying in greenhouses under overcast conditions. Effectiveness is reduced below 50 °F. Do not use within 2 weeks of sulfur or within 7 days of Captan. Do not apply through any irrigation system. See label for compatibility with other products. #Mums and mints are only perennials on label.
	*Organic JMS Stylet Oil# (Paraffinic oil)				G	N	L	
	PureSpray Green (petroleum oil)				G	N	L	
	Saf-T-Side (petroleum oil)						L	
	SuffOil-X (paraffinic oil)				G	N	L	
	Ultra-Pure Oil (Petroleum oil)				G	N		

Table 8.14 Insecticides For Armored Scale Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Pyriproxyfen	Distance	7C	Pyridine	12	G	N	L	IGR for control of immature insects only. Apply no more than two times per cropping cycle or no more than two times per six months. Do not apply to coral bells, gardenia, ghost plant, or salvia.

Table 8.15 Insecticides For Shore Fly And Drain Moth Larvae Control

Refer to disclaimer statement on page 47.

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Azadirachtin	Azatrol EC*	NC	Botanical	4	G	N	L	Repellant, anti-feedant, and IGR. Controls larvae and pupae on contact or by ingestion. Do not use with Bordeaux mixture, triphenyltin hydroxide, lime sulfur, Rayplex iron or other highly alkaline materials. Specific plants on label. Use within 8 hrs. Reduce pH of irrigation water if pH exceeds 7.0. * Azatrol: The waxy bloom on certain ornamental plants may be reduced after an application.
	Azatin XL				G	N	L	
	Ornazin 3% EC				G	N		
Beauveria bassiana	Naturalis L (JW-1 strain)	NC	Biological	4	G	N	L	Entomopathogenic fungus. Contact insecticide; insect-specific fungus. Do not tank mix with fungicides. Can use with ultra-low volume equipment and chemigation but not with thermal foggers. Can use as pre-plant dips for cuttings.
	Naturalis H&G				G	N	L	
Chlorpyrifos	DuraGuard ME**	1B	Organophospate	24	G	N		Do not mix with alkaline materials (e.g. Bordeaux and lime). Direct treatment to some open blooms may cause petal drop.

Table 8.15 Insecticides For Shore Fly And Drain Moth Larvae Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Chlorpyrifos + Cyfluthrin	Duraplex TR (WP)**	1B 3A	Organophos-phate Pyrethroid	24	G			Micro total release insecticide to control immature larvae. Apply when foliage is dry.
Cyromazine	Citation	17	Cyromazine	12	G	N	L	IGR; will not kill adult insects. Rotate with insecticides that have different modes of action.
Diflubenzuron	Adept WSP	15	Benzoylurea	12	G			IGR; spray or soil drench. Do not apply to pots grown on capillary water mats. Do not reuse treated potting media. Do not apply to hibiscus.
	Dimilin SC (WP)				G			
Insecticidal soap	M-Pede	NC	Potassium salts of fatty acids	12	G	N	L	Contact insecticide; complete coverage is essential. Do not use on new transplants, unrooted cuttings, or plant material stressed by drought or under hot, humid conditions. Avoid spraying in greenhouses under overcast conditions. Caution if using on *Euphorbia*. Caution if the pH of the final solution is lowered below 8.0. Do not use on bleeding heart or lily. Do not apply to chrysanthemum after bloom. Compatible with biological control agents.

Table 8.15 Insecticides For Shore Fly And Drain Moth Larvae Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Nematodes, beneficial (= Entomo-pathogenic)	Millenium (*Steinernema carpocapsae*	NC	Biological	0	G	N	L	For larvae only. Nematode releases symbiotic bacteria while feeding that kill the pest. Preventive or curative control. Apply to moist substrate right after potting. Continuous agitation is essential. Works best from 50 to 85 °F. See label for details and tank mixing cautions.
Pyrethrins	Pyganic Crop Protection EC 5.0	3A	Botanical	12	G	N	L	Organic certification. Can use with hydroponic systems.
	Pyganic PRO				G	N	L	
Pyrethrins + Piperonyl butoxide	Pyrenone Crop Spray	3A	Pyrethroid	12	G	N	L	Botanical insecticide plus synergist to flush out insects into contact with spray residues. Can use up to and including the day of harvest. Apply when foliage is dry.
Pyriproxyfen	Distance	7C	Juvenile hormone mimic	12	G	N	L	IGR for larvae only; prevents egg laying. Apply no more than 2 times per crop cycle or no more than 2 times per 6 months. Do not apply to salvia.
Spinosad	Conserve SC (EC)	5	Biological	4	G	N	L	Minimum impact on beneficials. Maximum of 2 consecutive applications.
	Entrust				G	N	L	

Table 8.16 Insecticides For Shore Fly And Drain Moth Adult Control

Refer to disclaimer statement on page 47.

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Azadirachtin	Azatrol EC	NC	Botanical	4	G	N	L	Repellant, anti-feedant, and IGR. Controls larvae and pupae on contact or by ingestion. May reduce waxy bloom on certain plants. Do not use with highly alkaline materials (e.g. lime sulfur, Bordeaux mixture). Use within 8 hours. Reduce irrigation water pH if it exceeds 7.0.
Chlorpyrifos	DuraGuard ME**	1B	Organophospate	24	G	N		Do not mix with alkaline materials (e.g. Bordeaux and lime). Treating open blooms may cause petal drop.
Chlorpyrifos + Cyfluthrin	Duraplex TR**	1B 3A	Organophos-phate Pyrethroid	24	G			Micro total release insecticide. Apply when foliage is dry.
Insecticidal soap	M-Pede	NC	Potassium salts of fatty acids	12	G	N	L	Need complete coverage. Do not use on new trans-plants, unrooted cuttings, or plants stressed by drought or when humid and hot, or in greenhouses under overcast conditions. Caution on *Euphor-bia*. Caution if final solution pH is < 8.0. Do not use on bleeding heart, lily or chrysanthemum in bloom.

Table 8.16 Insecticides For Shore Fly And Drain Moth Adult Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Pyriproxyfen	Distance	7C	Pyridine	12	G	N	L	IGR for control of immature insects only. Apply no more than two times per cropping cycle or no more than two times per six months. Do not apply to coral bells, gardenia, ghost plant, or salvia.
Spinosad	Conserve SC (EC)	5	Biological	4	G	N	L	Minimum impact upon beneficials. Maximum of 2 consecutive applications.
	Entrust				G	N	L	

Table 8.17 Pesticides For Snail And Slug Control

Refer to disclaimer statement on page 47.

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Iron phosphate	Bonide Slug Magic	NC	Organic	0	G	N	L	Scatter bait granules in pots of plants being damaged or around pots on benches. Apply to moist but not saturated soil. Reapply as bait is consumed or every 2 weeks as needed.
	Sluggo				G	N	L	
	Spectracide Snail & Slug Killer Bait				G	N	L	
	Worry Free Lilly Miller Ferramol Slug & Snail Bait				G	N	L	
Iron phosphate + Spinosad	Bonide Bug & Slug Killer	NC	Organic	0	G	N	L	Scatter pellet bait granules on soil near or around plants and around perimeter of area. Do not apply more than 3 times in any 30 day period.
	Sluggo Plus				G	N	L	
Metaldehyde	Deadline Bullets	NC	Organic	12	G	N	L	Treat soil with bait granules/pellets. Do not apply directly to plants. Apply in early evening after watering. Do not rewater for 48 hrs. Maximum of 6 treatments per year.
	Deadline M-Ps				G	N	L	
	Metarex 4% Slug & Snail Bait				G	N		
Methiocarb	Mesurol 75W**	1A	Carbamate	24	G	N		Do not apply with foliar fertilizers or oils. Do not apply more than 2 times per year. Spray solution pH should be >7. Make applications at least 10 days apart.
	Mesurol Pro**				G	N		Irrigate before broadcasting bait over foliage, or treating soil around plants, under benches or around building foundations.

Table 8.18 Insecticdes For Thrips Control

Refer to disclaimer statement on page 47.

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Abamectin	Abamectin E-Pro 0.15 EC	6	Avermectin	12	G		L	Do not apply through any type of irrigation system. Do not use product on chrysanthemums, ferns or Shasta daisies.
	Avid 0.15EC				G		L	
	Ardent 0.15EC				G		L	
	Minx				G		L	
	Quali-Pro Abamectin 0.15 EC				G		L	
	Timectin 0.15EC T&O				G		L	
Acephate	Acephate 90 WDG	1B	Organophos-phate	24	G	N	L	Do not apply to certain chrysanthemums and those with open blooms.
	Acephate 90SP				G	N	L	
	Acephate 97Up				G	N	L	
	Orthene TT&O				G	N		
	Orthene 1300 TR				G			Total release cans. Follow label.
Acetamiprid	TriStar 70 WSP	4A	Neonicotinoid	12	G	N		Do not irrigate overhead for at least 6 hrs after application. See label for tank mixing suggestions.
	Tri Star 30 SG				G	N		
Azadirachtin	Azatin XL	NC	Botanical	4	G	N	L	Repellant, anti-feedant, and IGR. Controls larvae and pupae on contact or by ingestion. Do not use with highly alkaline products (e.g. lime sulfur, Bordeaux mixture), Specific plants on label. Use within 8 hours. Reduce irrigation water pH if >7.0. +Azatrol: May reduce waxy bloom on certain plants.
	Azatrol+				G	N	L	
	Aza-Direct				G	N	L	
	Ornazin 3% EC			12	G	N		
	Neemix 4.5				G	N		
	Neemazad 1.0% EC				G	N		

Table 8.18 Insecticdes For Thrips Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Beauveria bassiana	BotaniGard ES	NC	Biological	4	G	N	L^	Biological control: entomopathogenic fungus. Contact insecticide; insect-specific fungus. Do not tank mix with fungicides. Can be used with ultra-low volume equipment and chemigation but not with thermal foggers. Can be used as pre-plant dips for cuttings. Do not tank mix with fungicides. ^Commercial only. *Mycotrol: organic certification.
	BotaniGard 22 WP				G	N	L^	
	Mycotrol O (WP)*				G	N		
	Naturalis L (JW-1 strain)				G	N	L	
	Naturalis H&G				G	N	L	
Bifenthrin	Attain Greenhouse	3A	Pyrethroid	12	G		L	Micro total release insecticide. Do not apply through any kind of irrigation system. Apply when foliage is dry.
	Attain TR				G			Micro total release insecticide. Apply when foliage
	Menace GC 7.9% Flowable (F)**				G	N	L	Preventative and curative topical drench. Wait 30 days between applications.
	Menace 7.9% Flowable (F)						L	Do not use through any irrigation system.
	Onyx Insecticide						L	Repeat applications should be limited to no more than once per seven days.

Table 8.18 Insecticdes For Thrips Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Bifenthrin (continued)	Onyx Pro**	3A	Pyrethroid	12		N	L	Do not apply more often than once per seven days. The addition of a surfactant or horticultural oil may increase the effectiveness of this product.
	Talstar P (Professional) (F)				G		L	Thorough coverage is important. Do not apply more often than once per seven days. May be tank mixed with IGRs and other products.
	Talstar Nursery				G	N		
	Up-Star SC (F)**				G	N	L	Need thorough coverage. Do not apply through any irrigation system.
	Wisdom F**				G	N	L	
Carbaryl	Carbaryl 4L	1A	Carbamate	12			L	Do not use on Boston ivy or Virginia creeper. Do not use more than 6x/year. Obtain thorough coverage of both upper and lower leaf surface.
	Drexel Carbaryl 4L						L	
	Sevin SL					N	L	
	Sevin 80 WSP					N	L	
Chlorfenapyr	Pylon	13	Pyrrole	12	G			Controls larvae and nymphs – not eggs. May be applied twice consecutively, but no more than three times within a season. Apply prior to bloom or avoid blooms where possible. Do not apply to salvia.

Table 8.18 Insecticdes For Thrips Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Chlorpyrifos	DuraGuard ME**	1B	Organophospate	24	G	N		Do not mix with alkaline materials (e.g. Bordeaux and lime). Some varieties of azaleas, camellias, poinsettias, roses and variegated ivies have shown phytotoxicity. Do not use on herbs. Direct treatment to some open blooms may cause petal drop.
Chlorpyrifos + Cyfluthrin	Duraplex TR (WP)**	1B 3A	Organophos-phate Pyrethroid	24	G			Micro total release insecticide. Apply when foliage is dry.
Cyfluthrin	Decathlon 20 WP	3A	Pyrethroid	12	G	N	L	Good coverage needed. Do not apply through any irrigation system.
	Discus					N		Spray, drench, soil injection. Can be applied through irrigation systems.
Dichlorvos (DDVP)	Fulex Nicotine Fumigator**	4B	Nicotine smoke	***	G			Greenhouse temperatures must be between 70° and 90° F during application. Do not water on the day of application. Do not apply on rainy or windy days. See label for specifics. *** When WPS ventilation require-ments are met.
Dinotefuran	Safari 2G	4A	Neonicotinoid	12	G	N	L	Only apply to moist soil media. Do not apply to dry or saturated media.
	Safari 20 SG				G	N	L	

Table 8.18 Insecticdes For Thrips Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Fenoxycarb	Prescription Treatment Preclude TR	7B	Fenoxycarb	12	G			Micro-release IGR. Apply when foliage is dry. Do not use more often than every seven days.
Fenpropathrin	Tame 2.4 EC**	3A	Pyrethroid	24	G	N	L	Do not use in greenhouses less than 500 ft^2. Do not apply to chrysanthemums with open flowers. Can be tank mixed with Orthene TT&O WSP spray.
Fenpropathrin + Acephate	Prescription Treatment Tame/Orthene TR	3A 1B	Pyrethroid Organophos-phate	24	G			Do not use in greenhouses < 900 ft^2. Cans must be stored at room temperature for 24 hrs before application.
Flonicamid	Aria	9C	Pyridinecarbox-amide	12	G	N	L	Insects stop feeding within 30 minutes, but may remain on plants for up to 5 days. Treat when insects appear; has excellent residual control. Certain pansy cultivars have exhibited sensitivity. Apply with a pyrethroid for knockdown of heavy infestations.

Table 8.18 Insecticdes For Thrips Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Imidacloprid	Benefit 60WP	4A	Neonicotinoid	12	G	N		Systemic; applied as foliar spray or to the soil media. Do not apply to saturated soils.
	Imida E-Pro 1% G				G	N		Systemic; applied to the soil media. Do not apply to saturated soils.
	Imida E-Pro 60 WSP				G	N		
	Lada 2F				G	N	L	Systemic; applied as foliar spray or to the soil media. Do not apply to saturated soils. Do not apply to ferns.
	Majesty				G	N		
	Mallet 2F						L	
	Mantra 1G				G	N		Systemic; applied to the soil media.
	Mantra 2F				G	N		Systemic; applied as foliar spray or to the soil media. Do not apply to saturated soils.
	Marathon 1% G				G	N		Systemic; soil treatment only. Use no more than once every 16 weeks. Residual activity so can apply before egg-laying activity of target pests. Media with >30 bark content may reduce protection period.
	Marathon 60WP				G	N		
	Merit 75 WP						L	
	Merit 75 WSP						L	
	Quali-Pro Imidacloprid 1G Nursery & Greenhouse				G	N		Systemic; applied as foliar spray or to the soil media. Do not apply to saturated soils. Do not apply to ferns.
	Quali-Pro Imidicloprid 2F Nursery & Greenhouse Insecticide				G	N		

Table 8.18 Insecticdes For Thrips Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Insecticidal Soap	Bonide Insecticidal Soap	NC	Potassium salts of fatty acids	12	G	N	L	Contact insecticide; complete coverage needed. Do not use on new transplants, unrooted cuttings, or plant material stressed by drought or under humid, hot conditions. Avoid spraying in greenhouses under overcast conditions. Caution if final solution pH is below 8.0. Caution on *Euphorbia*. Do not use on bleeding heart or lily or on chrysanthemum after bloom. Can use with biological control.
	M-Pede				G	N	L	
Kinoprene	Enstar II (F)	7A	Juvenile hormone analogue	4	G			IGR. May damage blooms under certain conditions.
Lambda-cyhalothrin	Lambda-Cy EC**	3A	Pyrethroid	24	G	N	L	A spreader-sticker is recommended. Do not apply through any type of irrigation system
	Scimitar GC (EC)**				G	N	L	
	Scimitar CS						L	
	Quali-Pro lambda GC-O				G	N	L	
Methiocarb	Mesurol 75-W	1A	Carbamate	24	G	N		Do not make more than 2 applications per year per crop. Applications must be at least 10 days apart.

Table 8.18 Insecticdes For Thrips Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Nematodes, beneficial (= Entomo-pathogenic)	NemaShield (*Steinernema feltiae*)	NC	Biological	0	G	N	L	3,875/ft^2 suppresses thrips. Preventive or curative control. Apply to moist substrate after potting. Works best between 50 and 85 °F. Need continuous agitation. See label for tank mixing cautions.
	Nemasys (*Steinernema feltiae*)				G	N		
	ScanMask (*Steinernema feltiae*)				G		L	
Novaluron	Pedestal	15	Benzoylureas	12	G	N		IGR; controls immatures (not adults). Do not apply more than twice a year.
Oil, Horticultural (paraffinic hydrocarbon oils; petroleum oil, soybean oil, vegetable oil)	PureSpray Green (petroleum oil)	NC	Oil	4	G	N	L	Pest must be completely covered with product to be effective. Do not apply if plants are under any kind of stress. Do not apply during periods of prolonged high temperatures combined with high relative humidity. Avoid spraying in greenhouses under overcast conditions. Do not exceed label rates or apply more often than recommended. Effectiveness at temperatures below 50 °F is reduced Do not use within 2 weeks of sulfur or within 7 days of captan. Do not apply through any irrigation system.
	Summit Year Round Spray Oil (mineral oil)				G	N		
	Ultra-fine Spray Oil (par-affinic oil)				G	N	L	
	Ultra-Pure Oil (Petroleum oil)				G	N	L	

Table 8.18 Insecticdes For Thrips Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Paecilomyces fumosoroseus strain FE9901	NoFly WP	NC	Entomopatho-genic fungus	4	G	N		Controls all stages. Spores are sensitive to high tempera-tures, drought and ultraviolet.
Permethrin	Perm-Up 3.2 EC**	3A	Pyrethroid	12	G	N	L	Avoid spraying chrysanthemum blooms. Marginal leaf burn has been noticed on salvia. ay cause petal browning.
	Pounce 25 WP					N		
	Tenkoz Permethrin 3.2EC**				G	N	L	
Pyrethrin	Pyganic Crop Protection EC 5.0	3A	Botanical	12	G	N	L	Can use with hydroponic systems. Organic certification.
	Pyganic PRO				G	N	L	
Pyrethrins + Piperonyl butoxide	Pyrenone Crop Spray	3A	Pyrethroid	12	G	N	L	A botanical insecticide plus a synergist to flush insects out of hiding and into contact with spray residues. Apply when foliage is dry.
	Prentox Pyronyl Crop Spray				G	N	L	
	Pyreth-It (Prescription Treatment Brand)				G	N	L	
Pyridalyl	Overture 35WP	UN	Pyridine	12	G			Strong translaminar activity. Do not tank mix with fertilizers. Do not apply through any irrigation system. Do not apply more than 3 times per cropping cycle.
Spinosad	Conserve SC (EC)	5	Biological	4	G	N	L	Minimum impact on beneficials. Maximum of 2 consecutive applications.
	Entrust				G	N	L	
Tau-fluvalinate	Mavrik Aquaflow	3A	Pyrethroid	12	G	N	L	Do not apply more than 4 times per month. Can use as a dip for flower and foliage cuttings.

Table 8.19 Insecticides For Whitefly Nymph Control

Refer to disclaimer statement on page 47.

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Abamectin	Abamectin E-Pro 0.15 EC	6	Avermectin	12	G		L	Translaminar activitiy. Do not apply through any type of irrigation system. Do not use product on chrysanthemums, ferns or Shasta daisies. Repeat applications to new foliage may be necessary.
	Avid 0.15EC				G		L	
	Ardent 0.15 EC				G		L	
	Flora-Mek 0.15 EC				G		L	
	Lucid 2F				G		L	
	Minx				G		L	
	Quali-Pro Abamectin 0.15 EC				G		L	
	Timectin 0.15EC T&O				G		L	
Acephate	Avatar	1B	Organophos-phate	24	G	N	L	Do not apply to certain chrysanthemums and those with open blooms.
	Acephate 90 WDG				G	N	L	
	Acephate 97Up				G	N	L	
	Orthene TT&O 97				G	N	L	
	Orthene TT&O WSP				G	N	L	
	1300 Orthene TR				G			Total release cans for greenhouse use only. Follow label precautions.
Acetamiprid	TriStar 70 WSP	4A	Neonicotinoid	12	G	N		For immatures and adults. Tank mixing with a pyrethroid or surfactant may improve adult control. Do not irrigate overhead for at least 6 hrs after application. Adult whitefly control may improve when mixed with a pyrethroid.
	Tri Star 30 SG				G	N		

Table 8.19 Insecticides For Whitefly Nymph Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Azadirachtin	Azatin XL	NC	Botanical	4	G	N	L	Repellant, anti-feedant, and IGR. Controls larvae on contact or by ingestion. Good coverage to top and bottom of leaves needed. Do not use with highly alkaline materials (e.g. Bordeaux mixture, triphenyltin hydroxide, lime sulfur, Rayplex iron). Use within 8 hrs. Reduce irrigation water pH if it exceeds 7.0. +Azatrol: May reduce waxy bloom on certain plants. Caution if treating orchids - possible spotting of foliage and blooms. Ornazin is labeled for whitefly nymphs and pupae.
	Azatrol EC+				G	N	L	
	Aza-Direct				G	N	L	
	Ecozin Plus 1.2% ME				G	N	L	
	Ornazin 3% EC				G	N		
	Neemix 4.5				G	N		
Beauveria bassiana	BotaniGard ES	NC	Biological	4	G	N	L^	Biological control: entomopathogenic fungus. Contact insecticide; Do not tank mix with fungicides. Can use with ultra-low volume equipment and chemigation but not with thermal pulse foggers. Can use as pre-plant dip for cuttings. *Organic certification. ^Commercial site.
	BotaniGard 22 WP				G	N	L^	
	Mycotrol O (WP)*				G	N		
	Naturalis L (JW-1 strain)				G	N	L	

Table 8.19 Insecticides For Whitefly Nymph Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Bifenthrin	Attain TR	3A	Pyrethroid	12	G			Micro total release insecticide. Apply when foliage is dry.
	Menace GC 7.9% Flowable (F)**				G	N	L	Preventative and curative topical drench. Wait 30 days between applications.
	Talstar P (Professional) (F)				G		L	May be tank mixed with IGRs and other products.
	Talstar S Select**				G	N	L	Do not apply through any irrigation system.
	Up-Star SC (F)**				G	N	L	
	Wisdom F**				G	N	L	
Buprofezin	Talus 40SC	16	Buprofezin	12	G	N	L	IGR and suppresses adult egg-laying as well as reduces egg viability. Not disruptive to beneficial insects and mites. Apply no more than two applications per season. Do not apply this product through any type of irrigation system. Do not apply if a chitin synthesis inhibitor was used within 4 weeks.
	Talus 70DF				G	N	L	
Chlorpyrifos + Cyfluthrin	Duraplex TR (WP)**	1B 3A	Organophos-phate Pyrethroid	24	G			Micro total release insecticide. Apply when foliage is dry.
Clothianidan	Arena 50 WDG	4A	Neonicotinoid	12			L	See label for plant restrictions.
	Arena 0.25 G Insecticide						L	

Table 8.19 Insecticides For Whitefly Nymph Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Cyfluthrin	Decathlon 20 WP	3A	Pyrethroid	12	G	N	L	Do not apply through any type of irrigation system. Good coverage is necessary.
	Discus					N		Spray, drench, soil injection. Can be applied through irrigation systems.
	Discus N/G				G	N		
Diflubenzuron	Adept WSP	15	Benzoylurea	12	G			IGR; spray or soil drench. Do not apply to pots grown on capillary water mats. Do not reuse treated potting. Do not apply to hibiscus.
Dinotefuran	Safari 2G	4A	Neonicotinoid	12	G	N	L	Labeled for giant whitefly; greenhouse whitefly; silverleaf whitefly; sweet potato whitefly (B and Q Biotypes). Only apply to moist soil media. Do not apply to dry or saturated media.
	Safari 20 SG				G	N	L	
Fenpropathrin	Tame 2.4 EC**	3A	Pyrethroid	24	G	N	L	Do not use in greenhouses < 500 ft^2. Do not apply to chrysanthemums with open flowers. Can be tank mixed with Orthene TT&O WSP spray. Controls nymphs, pupae and adults.
Fenpropathrin + Acephate	Prescription Treatment Tame/Orthene TR	3A 1B	Pyrethroid Organophos-phate	24	G			Do not use in greenhouses < 900 ft^2. Store cans at room temperature for 24 hrs before application.

Table 8.19 Insecticides For Whitefly Nymph Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Fenoxycarb	Prescription Treatment Preclude TR	7B	Fenoxycarb	12	G			Micro-release IGR. Apply when foliage is dry. Do not use more often than every seven days.
Imidacloprid	Benefit 60WP	4A	Neonicotinoid	12	G	N		Systemic; applied as foliar spray or to the soil media. Do not apply to soils that are water logged or saturated.
	Imida E-Pro 60 WSP				G	N		Systemic applied to the soil media. Do not treat saturated soils.
	Lada 2F				G	N		Systemic; applied as foliar spray or to the soil media. Do not apply to soils that are water logged or saturated.
	Mallet 2F				G	N		
	Mantra 2F							
	Mantra 1G				G	N		Systemic; applied to the soil media.
	Marathon 1% G				G	N		Systemic; soil treatment only. Do not use more than once every 16 weeks. Media with >30 % bark may reduce protection period.
	Marathon 60 WP				G	N		Active ingredient in product has sufficient residual activity so can apply before egg-laying activity of target pests.
	Marathon II (F)				G	N		Labeled for ebb & flood applications.

Table 8.19 Insecticides For Whitefly Nymph Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Imidacloprid (continued)	Merit 75 WP	4A	Neonicotinoid	12			L	Systemic; soil treatment only. Not to be used more than once every 16 weeks. Media with >30 % bark may reduce protection period.
	Merit 75 WSP						L	
	Quali-Pro Imidacloprid 1G Nursery & Greenhouse				G	N		
	Quali-Pro Imidacloprid 2F Nursery & Greenhouse Insecticide				G	N		Systemic; applied as foliar spray or to the soil media. Do not apply to soils that are water logged or saturated. Do not apply to ferns.
Insecticidal soap	Bonide Insectidal Soap	NC	Potassium salts of fatty acids	12	G	N	L	Contact insecticide; complete coverage is essential. Do not use on new transplants, unrooted cuttings, or plant material stressed by drought or under hot, humid conditions. Avoid spraying in greenhouses under overcast conditions. Caution if using on *Euphorbia*. Caution if the pH of the final solution is lowered below 8.0. Do not use on bleeding heart or lily. Do not apply to chrysanthemum after bloom. Compatible with biological control agents. M-Pede adult application is for knockdown/ suppression.
	DES-X				G	N	L	
	M-Pede				G	N	L	

Table 8.19 Insecticides For Whitefly Nymph Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Kinoprene	Enstar II (F)	7A	Juvenile hormone analogue	4	G			IGR. May damage blooms under certain conditions.
Lambda-cyhalothrin	Lambda-Cy EC**	3A	Pyrethroid	24	G	N	L	A spreader-sticker is recommended. Do not apply through any type of irrigation system
	Scimitar GC (EC)**				G	N	L	
	Scimitar CS						L	
	Quali-Pro lambda GC-O**				G	N	L	
Naled	Dibrom 8E**	1B	Organophos-phate	***	G			For adults only. Avoid over treatment and direct application to plants. May injure some chrysanthemum varieties and Dutchmans pipe. Do not apply when temperature is > 90 °F. *** REI and WPS ventilation requirements met.
Neem oil	Triact 70	NC	Botanical	4	G	N	L	Do not apply to wilted or stressed plants, or to new transplants prior to root establishment. Caution if applying to hibiscus flowers.
Novaluron	Pedestal	15	Benzoylureas	12	G	N		IGR; only controls immatures. Do not apply more than twice a year. Do not make successive applications, use at least two other products between uses. Do not treat more than once per generation.

Table 8.19 Insecticides For Whitefly Nymph Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Oil, Horticultural (paraffinic hydrocarbon oils; petroleum oil, soybean oil, vegetable oil)	JMS Stylet Oil# (Paraffinic)	NC	Oil	4	G	N	L	Complete coverage needed. Do not apply if plants are under any kind of stress. Do not apply during periods of prolonged high temperatures combined with high relative humidity. Avoid spraying in greenhouses under overcast conditions. Do not exceed label rates or apply more often than recommended. Effectiveness at temperatures below 50 °F is reduced. Do not use within 2 weeks of sulfur or within 7 days of Captan. Do not apply through any irrigation system. #Mums and mints are only perennials on label.
	Organic JMS Stylet Oil# (Paraffinic)				G	N	L	
	Prescription Treatment Ultra-Pure Oil (Petroleum)				G	N		
	PureSpray Green (Petroleum)				G	N	L	
	Saf-T-Side (Petroleum)						L	
	Suffoil-X (Petroleum)				G	N	L	
Paecilomyces fumosoroseus strain FE9901	NoFly WP	NC	Entomopathogenic fungus	4	G	N		Compatible with beneficial insects such as *Encarsia formosa* and *Eretmocerus eremicus*. Spores are sensitive to high temperatures, drought and ultraviolet.
Permethrin	Astro 3.2 EC	3A	Pyrethroid	12	G		L	Avoid spraying chrysanthemum blooms. Marginal leaf burn has been noticed on salvia. May cause petal browning.
	Pounce 25 WP**					N		
	Tenkoz Permethrin 3.2EC**				G	N	L	

Table 8.19 Insecticides For Whitefly Nymph Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Pymetrozine	Endeavor	9B	Pyridine	12	G	N	L	Insects remain on plant for 2-4 days after application. Insects stop feeding but take a few days to die. Low toxicity to beneficial insect and mite populations.
Pyrethrin	Pyganic Crop Protection EC 5.0	3A	Botanical	12	G	N	L	Organic certification. Can be used with hydroponic systems.
	Pyganic PRO				G	N	L	
Pyrethrins + Piperonyl butoxide	Pyrenone Crop Spray	3A	Pyrethroid	12	G	N	L	A botanical insecticide plus a synergist to flush insects out of hiding and into contact with spray residues. Can be used up to and including the day of harvest. See label for details. Apply when foliage is dry.
	Prescription Treatment Brand Pyreth-It				G	N	L	
Pyridaben	Sanmite 75 WP	21A	Pyridazinone	12	G	N		Contact only. May be fatal if inhaled. Do not use in successive miticide applications. Do not apply this product through any type of irrigation system. Do not use with fertilizers containing boron. Treatment recommended at immature (nymph stages).

Table 8.19 Insecticides For Whitefly Nymph Control (continued)

Chemical Name	Trade Name	IRAC Code	Class	REI (hour)	Areas of Use			Comments
Pyriproxyfen	Distance	7C	Pyridine	12	G	N	L	IGR for control of immature insects only. Apply no more than two times per cropping cycle or no more than two times per six months. Do not apply to coral bells, gardenia, ghost plant, salvia.
Spiromesifen	Judo	23	Tetronic acid	12	G	N		Provides knockdown and residual control of all mite life stages, including eggs and pupae. Do not apply this product through any type of irrigation system. See label for restrictions on use on specific plants/ cultivars. Do not apply Judo more than four times per season.
Tau-fluvalinate	Mavrik Aquaflow	3A	Pyrethroid	12	G	N	L	Do not apply more than 4 sprays per month. Can also be used as a dip for flower and foliage cuttings.
Thiamethoxam	Flagship 25 WG	4A	Neonicotinoid	24	G	N		Foliar and soil applications, but soil applications work as a preventative measure or where population is low.
	Flagship 0.22G				G	N		

Chapter 9
Diagnosing Plant Diseases As Part Of A TCM/IPM Approach

Karen Rane, Extension Specilaist, Plant Pathology

Strategy For Successful Disease Diagnosis

Identify the Suspects (Causal Agents)

Biotic Agents. The science of plant pathology deals primarily with the following biotic, or living, plant pathogens: fungi, bacteria, phytoplasmas, viruses, viroids, nematodes, and parasitic higher plants. Biotic plant pathogens are usually highly host specific; they cause disease on only certain plant species or cultivars and are harmless to most other plants. They cause symptoms that appear gradually and get worse over time. These symptoms are usually distributed in a spotty, or nonuniform, pattern on the plant and around the site.

a) **Fungi.** Microscopic examination of symptomatic plant tissue is used to find and identify sclerotia, mycelium, mushrooms, powdery spores, pinpoint fungal fruiting bodies, and slimy spore masses exuding from fruiting bodies. Sometimes fungi must be isolated from diseased tissues and identified in culture. To select the proper fungicide, it is often necessary to know the specific fungus causing the disease. Most fungal plant pathogens are classified into three major groups. Many fungicides are most active on only one major group of fungi or on only certain fungi within one group.

(1) Oomycetes ("water molds"). Includes *Pythium*, *Phytophthora*, downy mildews.
(2) Ascomycetes and imperfect fungi. Includes *Botrytis*, *Fusarium*, *Verticillium*, powdery mildews, anthracnoses, scabs, and many others that cause wilts, blights, root rots, and leaf spots.
3) Basidiomycetes. Includes rusts, smuts, and mushrooms. *Rhizoctonia* and the Southern blight fungus (*Sclerotium rolfsii*) are also in this group.

b) **Bacteria.** Look for slime, bacterial ooze, distinctive malformations.

1. Crown gall makes corky, lumpy galls on roots and shoots.
2. A variety of bacteria causes blights and leaf spots, which often show a greasy, yellow, or translucent halo around spots.
3. Bacterial wilts. Often insects carry these bacteria into the crop. To identify, look for bacterial ooze streaming from the cut stem. Some bacterial wilts remain in the soil from crop to crop.
4. A type of bacteria called a phytoplasma causes aster yellows. Phytoplasma are carried into healthy plants by leafhopper insect vectors. Symptoms include distinctive leaf and flower malformations, stunting, and death. A wide variety of plants are susceptible: phlox, strawflowers, and asters and many other species in the Asteraceae family. Promptly remove and destroy symptomatic plants. Focus controls on the insect vector.

c) **Virus and Viroids.** These agents take control of the plant cell, forcing it to manufacture more virus or viroid and interrupting normal cell functions. Symptoms include rings, mosaic, stunting, abnormal colors, malformed or curled leaves and shoots, decline, wilting, and death. Viruses can be carried in infected plants by insects and nematodes or in plant sap. Lab tests are required to identify the specific virus.

d) **Nematodes.** The nematodes that cause plant disease are all colorless, microscopic roundworms. Nematodes damaging the roots produce symptoms such as failure to establish, decline, wilt, stunting, and galling of roots. Root knot nematode (*Meloidogyne*) and lesion nematode (*Pratylenchus*) are common on ornamentals. Test soil for nematodes; ideally, test soil before planting. The best time to test field soil is midsummer through fall. Soil taken in the winter is not useful for nematode testing. A few kinds of nematodes crawl into leaves and shoots and cause blight. The foliar nematode, *Aphelenchoides fragariae*, can infect many herbaceous perennials. The stem and bulb nematode, *Ditylenchus dipsaci*, can also infect many ornamentals. Test symptomatic plants for these nematodes.

e) **Parasitic higher plants include dodder, mistletoes, and witchweeds.** Dodder, the only common parasitic higher plant found in Maryland, looks like yellow or orange spaghetti. Mistletoe on oaks is usually not perceived as a pest.

Abiotic Agents. Examples of abiotic agents are heat, cold, drought, flooding, salt, chemicals, herbicides, and excessive or deficient fertilizer. Suspect an abiotic cause when the symptoms appear suddenly and affect a wide variety of plants. Often symptoms are uniformly distributed on the plants and on the site.

Know the Victim

When using IPM principles, your knowledge of each species or cultivar you grow is one of your strongest tools in preventing losses from diseases. Keep excellent records of damage each growing season. Consider eliminating disease-prone species. Determine each plant's specific requirements for optimum growth. Cultural factors such as soil pH, fertility, drainage, and light requirements are often key to preventing disease. Often symptoms are primarily caused by cultural or nutritional problems.

Look for Clues

a) **Symptoms.** Any alteration of the plant: wilt, galls, stunting, leaf spots, malformations.
b) **Signs.** The actual visible body of the causal agent. You must include signs in the sample submitted to experts (such as a diagnostic laboratory) for confirming your diagnosis. Examples of signs are spores, sclerotia, mycelium, mushrooms, rhizomorphs, bacterial ooze, and fungal fruiting bodies.

Develop a Tentative Diagnosis. Confirm the tentative diagnosis.

After making a tentative diagnosis, try to determine whether the diagnosis is correct or not.

Tools for making a diagnosis.

a) References and the grower's own knowledge. Compare the evidence collected to information about diseases or to personal knowledge.
b) Diagnostic Laboratories (University, Extension, State Department of Agriculture, commercial labs). Laboratory confirmation may be advisable in cases of possible lawsuits or when there

are several tentative and contending diagnoses.

c) Commercial testing labs analyze water and soil and perform specific tests. For disease diagnosis, the Agdia testing lab performs serological tests for a variety of viruses and some bacterial diseases at moderate cost. Agdia is especially useful for indexing propagating stock: Agdia, Inc., 30380 County Road 6, Elkhart, IN 46514 or visit on the web at www.Agdia.com.

d). Growers can perform certain serological tests on-site, using commercially available test kits that are quick to use. Test kits are currently available from Neogen Inc. for *Pythium*, *Rhizoctonia*, and *Phytophthora* (Phone 800-234-5333 for information). Agdia has a series of economical, rapid on-site tests for virus and bacterial diseases of ornamental crops.

Management Options

In some cases a grower can ignore a problem because it does no serious harm, e.g., when many leaf spots appear after rainy weather. If you simply cut back affected rows, plants will send up healthy shoots. *Botrytis* blight on flowers is almost impossible to control with fungicides outdoors; remove spotted flowers promptly.

In some cases cultural or chemical control is not possible: the plant cannot be saved and will die. Examples of this sad situation are plants infected by many of the vascular wilts such as *Fusarium* and *Verticillium*.

Some management action is appropriate

a) Analyze the disease cycle to determine the optimum time to intervene. Usually this is when infection is most likely to be happening. (e.g., during weather such as rain or heavy dew that promotes infection; during season or time when infectious spores are produced or insect vectors are present; or during susceptible crop stage.) For best disease control, apply a fungicide before or soon after infection.

b) Use disease-resistant plants or cultivars.

c). Adjust cultural factors for optimum plant vigor and to inhibit disease. Examples of cultural factors are:

1. Improve internal soil drainage to reduce root rots.
2. Use trickle irrigation to maintain uniform growth and to reduce leaf wetness and the diseases overhead irrigation can promote. Most fungal and bacterial diseases are promoted by leaf wetness; reduce or eliminate them by switching to trickle irrigation and increasing plant spacing to provide better air circulation around plants.
3. Select and apply fertilizers wisely. Excessive nitrogen can promote many leaf spots and blights. Inadequate fertilization can cause stress symptoms and poor flower quality.

d) Apply pesticides to prevent disease and control insect vectors. Check that the disease and the plant are on the pesticide label. Follow label rates. Because fungicides are usually used to prevent infection, check the disease cycle to see when the risk of infection is highest and apply at this time.

Chapter 10
Fungicides For Controlling Plant Diseases

Karen Rane, Extension Specilaist, Plant Pathology

DISCLAIMER

The following tables serve as guidelines only. The fungicides listed are recommended only if they are registered with the Environmental Protection Agency and your state department of agriculture. If a registration is changed or cancelled, any products listed here are no longer recommended. Before you apply any pesticide, fungicide or herbicide, check with your state Extension personnel for the latest information. The USER is responsible for using products that are registered for use on specific crops in their own state, and for using products according to label instructions.

If any information presented here is inconsistent with the product label, follow the label instructions. Always consult the product label for rates and crops listed. Presence of a product in these tables is not an endorsement, and absence of a labeled product from this list does not imply ineffectiveness.

Areas of Use

G = greenhouse
N = nursery
L = landscape

Bacterial Diseases

Bacteria are single-celled microorganisms that can multiply at a very rapid rate. Bacterial pathogens require films of water to enter plant tissues, and can be spread through splashing water or handling. Symptoms of bacterial diseases on herbaceous perennials include leaf spots, stem rots and galls. Leaf spots caused by bacteria are initially watersoaked or greasy in appearance, then turn dry and dark to light brown. In some cases, yellow "haloes" develop near the edges of the brown lesions. Bacterial soft rot of stems is usually associated with wounds from rough handling or insect feeding. Bacterial blight (caused by *Xanthomonas pelargonii*) causes leaf spots and blight in perennial cranesbill *Geranium* species. This plant can serve as a source of inoculum for infection of zonal and ivy geranium (*Pelargonium* x *hortorum*, *P. peltatum*), in which the same bacterial pathogen causes leaf spots, vascular wilt, and plant death. Crown gall, caused by *Agrobacterium tumefaciens*, produces swellings on roots and stems. The crown gall pathogen is soil-borne, and can survive in landscape beds for several years. Leafy gall, also called bacterial fasciation, is caused by *Rhodococcus fasciens*, and is spread through propagation of infected stock plants.

Management Strategies:

Keep foliage as dry as possible by managing irrigation and air circulation. If possible, avoid overhead irrigation. Destroy infected plants, being careful to avoid contact with other plants. Remove all plant debris and keep tools and benches free of unsterilized soil which may harbor soft rot bacteria. Commercial products are available to help reduce the spread of bacterial diseases, but they must be used along with a strict sanitation program for effective control.

Table 10.1 Products For Managing Bacterial Diseases

Refer to disclaimer statement on page 157.

Chemical Name	Code	Class	Trade Name	REI (hour)	Areas of Use		
Bacillus subtilis QST 713 strain	NC	Biopesticide	Cease	0	G	N	L
			Rhapsody				
Copper salts of fatty/rosin acids	M1	Inorganic	Camelot	12	G	N	L
Copper hydroxide	M1	Inorganic	Champ	24	G	N	L
			CuPro 2005 T/N/O				
			Nu-Cop 50DF				
Copper hydroxide + Mancozeb	M1 M3	Inorganic Dithiocarbamate	Junction	24	G	N	L
Copper sulfate pentahydrate	M1	Inorganic	Phyton 27	24	G	N	L

Gray Mold/Botrytis Blight

Gray mold, also called *Botrytis* blight, causes a range of symptoms, including spots and blights on leaves or petals, stem cankers, crown rot, wilting and damping-off. *Botrytis* infections may also cause discoloration and death of flower buds and premature loss of flowers. The fungus is spread primarily by the movement of spores in air currents and in splashing water. The fungus commonly invades wounded or senescent tissue, such as fallen flower petals or other fresh plant residues. *Botrytis* can also invade healthy tissue in contact with infected residues. Masses of fuzzy, grayish-brown spores on thin black stalks develop on infected plant tissues under cool, moist, humid, cloudy conditions. The presence of these spores is diagnostic for confirming *Botrytis* infections.

Management Strategies:

Sanitation is critical to *Botrytis* blight management. Even a small piece of infected debris can generate huge numbers of spores when environmental conditions are right, and these spores are easily dispersed in air currents. In greenhouse production, rogue out infected plants and clean up any plant debris on greenhouse benches or floors. Remove spent flowers whenever possible.

Botrytis spores require free moisture on plant surfaces to germinate and cause infection. Reduce leaf wetness periods, films of moisture and relative humidity to make conditions unfavorable for *Botrytis* blight development. In greenhouse production, heating and venting the greenhouse for a short time before sunset will help to reduce humidity and condensation (dew formation) on plant surfaces that commonly occurs at nightfall when warm humid air cools down. Use horizontal air flow systems or fans to circulate the air, which will help reduce humidity as well. In landscapes or nurseries, avoid overcrowding plants to promote air circulation around the foliage. Selective pruning of overhanging branches or crowded plants can help increase air movement in the landscape. If overhead irrigation is used, make sure watering occurs early enough in the day to allow plant surfaces to dry off before evening.

Fungicides are effective in managing *Botrytis* blight in greenhouse and nursery production, but they must be used in conjunction with cultural practices to obtain maximum disease control. Resistance management is an important consideration when choosing a fungicide for *Botrytis* control. Resistance to the benzimidazole fungicides is common in *Botrytis* populations, so these compounds are often ineffective in managing the disease. To miminize the chances of fungicide resistance, it is important to rotate applications of products from different fungicide groups.

Table 10.2 Fungicides For Managing Botrytis Blight

Refer to disclaimer statement on page 157.

Chemical Name	Code	Class	Trade Name	REI (hour)	Areas of Use		
Azoxystrobin	11	Strobilurin (QoI)	Heritage	4	G	N	L
Bacillus subtilis QST 713 strain	NC	Biopesticide	Cease	0	G	N	L
			Rhapsody		G	N	L
Chlorothalonil	M5	Chloronitrile	Daconil Ultrex	12	G	N	L
			Daconil Weather Stik 54F		G	N	L
			Echo 720 T+O		G	N	
			Echo Ultimate		G	N	
			Echo Zn T+O		G	N	
			Pegasus L		G	N	L
			PrimeraOne Chlorothalonil 720 SFT		G	N	L
			Quali-Pro Chlorothalonil 720 SFT		G	N	L
			Quali-Pro Chlorothalonil 500 Zn		G	N	L
			Quali-Pro Chlorothalonil DF		G	N	
			Exotherm Termil		G		
Chlorothalonil + Thiophanate methyl	M5 1	Chloronitrile Benzimidazole	Spectro 90 WDG	12	G	N	L
Copper hydroxide	M1	Inorganic	Champ	24	G	N	L
			CuPro 2005 T/N/O		G	N	L
			Nu-Cop 50 DF		G	N	
Copper hydroxide + Mancozeb	M1 M3	Inorganic Dithiocarbamate	Junction	24	G	N	L
Copper salts of fatty/ rosin acids	M1	Inorganic	Camelot	12	G	N	L
Copper sulfate pentahydrate	M1	Inorganic	Phyton 27	24	G	N	L
Dicloran	14	Aromatic hydrocarbon	Botran 75 W	12	G	N	
Fenhexamid	17	Hydroxyanilide	Decree	4	G	N	
Fludioxonil	12	Phenylpyrrole	Medallion	12	G	N	L
Fluxastrobin	11	Strobilurin (QoI)	Disarm O	12	G	N	
Iprodione	2	Dicarboxamide	Iprodione Pro	12	G		L
			OHP Chipco 26 GT-O		G	N	L
			OHP Chipco 26019 N/G		G	N	L
			Sextant		G	N	

Table 10.2 Fungicides For Managing Botrytis Blight (continued)

Chemical Name	Code	Class	Trade Name	REI (hour)	Areas of Use		
Iprodione + Thiophanate methyl	2 1	Dicarboximide Benzimidazole	26/36 Fungicide	12	G	N	L
Mancozeb	M3	Dithiocarbamate	Dithane 75 DF Rainshield T+O	24	G	N	(L)
			Fore 80 WP Rainshield T+O		G	N	L
			Pentathlon DF		G	N	
			Protect DF		G	N	L
Polyoxin D Zinc Salt	19	Polyoxin	Affirm WDG	4	G	N	L
			Veranda O		G	N	
Pyraclostrobin	11	Strobilurin (QoI)	Insignia	12	G	N	L
Pyraclostrobin + Boscalid	11 7	Strobilurin (QoI) Anilide	Pageant	12	G	N	L
Thiophanate methyl + Mancozeb	1 M3	Dithiocarbamate Benzimidazole	Zyban	12	G	N	L
Trifloxystrobin	11	Strobilurin (QoI)	Compass O 50 WDG	12	G	N	L

Downy Mildew

Downy mildews are fungus-like microorganisms similar to *Phytophthora* and *Pythium*. Symptoms of downy mildew include blotchy yellow or brown lesions on upper leaf surfaces, a general yellowing, leaf distortion and stunting. Leaf lesions caused by downy mildews are often angular in shape. These symptoms can be mistaken for other infectious or noninfectious problems. Check the undersides of affected leaves to look for the gray, brown or white fuzzy fungal growth typical of downy mildew infections. Some downy mildews can overwinter in infected plant debris, weeds or soil, while others move northward each year in air currents from southern overwintering sites. Cool temperatures and high humidity favor downy mildew infection.

Management Strategies:

Early detection is key for minimizing spread of downy mildew. Remove and destroy infected plants promptly. Space plants to promote air circulation and reduce leaf wetness to discourage downy mildew infection. Avoid overhead irrigation in cool weather. Fungicides can help manage downy mildew outbreaks in nursery and greenhouse production, but are rarely used in landscapes.

Table 10.3 Fungicides For Managing Downy Mildew

Refer to disclaimer statement on page 157.

Chemical Name	Code	Class	Trade Name	REI (hour)	Ares of Use		
Azoxystrobin	11	Strobilurin (QoI)	Heritage	4	G	N	L
Copper hydroxide	M1	Inorganic	Champ	24	G	N	L
			CuPro 2005 T/N/O		G	N	L
			Nu-Cop 3L		G	N	
Copper hydroxide + Mancozeb	M1 M3	Inorganic Dithiocarbamate	Junction	24	G	N	L
Copper salts of fatty/rosin acids	M1	Inorganic	Camelot	12	G	N	L
Copper sulfate pentahydrate	M1	Inorganic	Phyton 27	24	G	N	L
Fixed copper tannate	M1	Inorganic	Nu-Cop HB	24	G	N	L
Cyazofamid	21	Cyanoimidazole	Segway 34.5 EC	12	G	N	L
Dimethomorph	40	Cinnamic acid	Stature DM 50%	12	G	N	
Fenamidone	11	Imidazolinone	Fenstop	12	G		
Fludioxonil + Mefanoxam	12 4	Phenylpyrrole Phenylamide	Hurricane	48	G		
Fluopicolide	43	Acylpicolide	Adorn	12	G	N	L
Fluxastrobin	11	Strobilurin (QoI)	Disarm O	12	G	N	
Fosetyl-Al	33	Phosphonate	Aliette 80 WDG	12	G	N	L

*Nonresidential

Table 10.3 Fungicides For Managing Downy Mildew (continued)

Kresoxim methyl	11	Strobilurin (QoI)	Cygnus	12	G	N	L*
Chemical Name	**Code**	**Class**	**Trade Name**	**REI (hour)**	**Areas of Use**		
Mancozeb	M3	Dithiocarbamate	Dithane 75 DF Rainshield T+O	24	G	N	
			Fore 80 WP Rainshield T+O		G	N	L
			Lesco Mancozeb DG		G	N	L
			Pentathlon DF		G	N	
			Pentathlon LF		G	N	L
			Protect DF		G	N	L
Phosphorous acid-potassium salts	33	Phosphonate	KPhite	4	G	N	L
			Alude 45.8%		G	N	L
Polyoxin D Zinc Salt	19	Polyoxin	Affirm WDG	4	G	N	L
			Veranda O		G	N	
Pyraclostrobin	11	Strobilurin (QoI)	Insignia	12	G	N	L
Pyraclostrobin + Boscalid	11 7	Strobilurin (QoI) Anilide	Pageant	12	G	N	L
Thiophanate methyl + Mancozeb	1 M3	Benzimidazole Dithiocarbamate	Zyban	12	G	N	L
Trifloxystrobin	11	Strobilurin (QoI)	Compass O 50 WDG	12	G	N	L

Fungal Leaf Spots

There are many fungal pathogens that cause leaf spots on herbaceous perennials. Symptoms range from tiny discolored specks to larger blotches. The lesions may have red or purple margins depending on the host plant and pathogen involved. Most of these pathogens affect only one or a few plant species. Fungal leaf spot pathogens survive on infected plant debris and are spread from leaf to leaf and plant to plant by spores carried in air currents or splashing water. Prolonged leaf wetness usually favors disease development.

Management Strategies:

Inspect plants on a regular basis for fungal leaf spot symptoms and discard plants with severe leaf spot symptoms. Reduce humidity around plants in greenhouses and nurseries through increased plant spacing and use of fans to increase air movement. Avoid overhead irrigation in greenhouses, nurseries or landscapes to keep leaf wetness to a minimum.Use protectant fungicide sprays if disease continues to spread. Specific fungicides may not control all leaf spot fungi – check the label carefully for list of fungal pathogens.

Table 10.4 Fungicides For Managing Fungal Leaf Spots

Refer to disclaimer statement on page 157.

Chemical Name	Code	Class	Trade Name	REI (hour)	Areas of Use		
Azoxystrobin	11	Strobilurin (QoI)	Heritage	4	G	N	L
Bacillus subtilis QST 713 strain	NC	Biopesticide	Cease	0	G	N	L
			Rhapsody		G	N	L
Chlorothalonil	M5	Chloronitrile	Daconil 2787	48	G	N	L
			Daconil Ultrex	12	G	N	L
			Daconil Weather Stik 54F		G	N	L
			Echo 720 T+O		G	N	
			Echo Ultimate		G	N	
			Echo Zn T+O		G	N	
			Pegasus L		G	N	L
			Quali-Pro Chlorothalonil 500 Zn		G	N	L
			Quali-Pro Chlorothalonil 720 SFT		G	N	L
			Quali-Pro Chlorothalonil DF		G	N	
Chlorothalonil + Thiophanate methyl	M5 1	Chloronitrile Benzimidazole	Spectro 90 WDG	12	G	N	L
Copper hydroxide + Mancozeb	M1 M3	Inorganic Dithiocarbamate	Junction	24	G	N	L
Copper salts of fatty/ rosin acids	M1	Inorganic	Camelot	12	G	N	L
Copper sulfate pentahydrate	M1	Inorganic	Phyton 27	24	G	N	L
Fludioxonil	12	Phenylpyrrole	Medallion	12	G	N	L

Table 10.4 Fungicides For Managing Fungal Leaf Spots (continued)

Chemical Name	Code	Class	Trade Name	REI (hour)	Areas of Use		
Fluxastrobin	11	Strobilurin (QoI)	Disarm O	12	G	N	
Iprodione	2	Dicarboxamide	Iprodione Pro 2SE	12	G	N	L
			OHP Chipco 26 GT-O		G	N	L
			OHP Chipco 26019 N/G		G	N	L
			Sextant 23.3%		G	N	
Iprodione + Thiophanate methyl	1 2	Benzimidazole Dicarboximide	26/36 Fungicide	12	G	N	L
Kresoxim methyl	11	Strobilurin (QoI)	Cygnus	12	G	N	L
Mancozeb	M3	Dithiocarbamate	Dithane 75 DF Rainshield T+O	24	G	N	L
			Fore 80 WP Rainshield T+O		G	N	L
			Pentathlon DF		G	N	
			Pentathlon LF		G	N	L
			Protect DF		G	N	L
Myclobutanil	3	Dimethylation inhibitor	Eagle 20 EW	24	G	N	L
			Hoist		G	N	L
Polyoxin D Zinc Salt	19	Polyoxin	Affirm WDG	4	G	N	L
			Veranda O		G	N	
Propiconazole	3	Dimethylation inhibitor	Banner MAXX	12			L
Pyraclostrobin	11	Strobilurin (QoI)	Insignia	12	G	N	L
Pyraclostrobin + Boscalid	11 7	Strobilurin (QoI) Anilide	Pageant	12	G	N	L
Thiophanate methyl	1	Benzimidazole	Allban Flo 46.2% F	12	G	N	L
			Cleary's 3336 50% WP		G	N	L
			Fungo Flo 50		G	N	L
			OHP-6672 50W		G	N	L
			Quali-Pro TM 4.5 F		G	N	
			Quali-Pro TM 85 WDG		G	N	
			T-Bird 85		G	N	L
			T-Storm 50 WSB		G	N	L
Thiophanate methyl + Mancozeb	1 M3	Benzimidazole Dithiocarbamate	Zyban	12	G	N	L
Trifloxystrobin	11	Strobilurin (QoI)	Compass O 50 WDG	12	G	N	L

Fusarium Root And Stem Rot

Although less common than other root rot pathogens, *Fusarium* can cause root rot in herbaceous perennials, particularly in plants that are under stress from other environmental or cultural factors. Symptoms of *Fusarium* root rot are similar to other root rot diseases.

Management Strategies: As with other root rot diseases, good sanitation practices help to avoid introduction of *Fusarium* in a greenhouse. Maintain the vigor of perennials in greenhouses, nurseries and landscapes by using optimum cultural practices to help plants resist *Fusarium* root rot infection. While protectant fungicides can help manage *Fusarium* root rot in greenhouses and nurseries, they are less effective in landscapes and usually not warranted. Discard plants with severe root rot.

Table 10.5 Fungicides For Managing Fusarium Root Rot

Refer to disclaimer statement on page 157.

Chemical Name	Code	Class	Trade Name	REI (hour)	Areas of Use		
Azoxystrobin	11	Strobilurin (QoI)	Heritage	4	G	N	L
Etridiazole + Thiophanate methyl	14 1	Aromatic hydrocarbon Benzimidazole	Banrot 8G	12	G	N	L
			Banrot 40W	12	G	N	L
Fludioxonil	12	Phenylpyrrole	Medallion	12	G	N	L
Fludioxonil + Mefenoxam	12 4	Phenylpyrrole Phenylamide	Hurricane	48	G		
Fluxastrobin	11	Strobilurin (QoI)	Disarm O	12	G	N	
Iprodione	2	Dicarboxamide	Iprodione Pro 2SE	12	G	N	L
			OHP Chipco 26 GT-O		G	N	L
			OHP Chipco 26019 N/G		G	N	L
			Sextant 23.3%		G	N	
Pyraclostrobin	11	Strobilurin (QoI)	Insignia	12	G	N	L
Pyraclostrobin + Boscalid	11 7	Strobilurin (QoI) Anilide	Pageant	12	G	N	L

Table 10.5 Fungicides For Managing Fusarium Root Rot (continued)

Chemical Name	Code	Class	Trade Name	REI (hour)	Areas of Use		
Thiophanate methyl	1	Benzimidazole	Allban 50 WSB	12	G	N	L
			Allban Flo 46.2% F		G	N	L
			Cleary's 3336 F		G	N	L
			Cleary's 3336-WP 50%		G	N	L
			Cleary's 3336-G 2%		G	N	L
			Fungo Flo 50		G	N	L
			OHP-6672 50W		G	N	L
			Quali-Pro TM 4.5 F		G	N	
			Quali-Pro TM 85 WDG		G	N	
			T-Bird 85		G	N	L
			TM 4.5 T&O		G	N	L
			T-Storm 50 WSB		G	N	
			T-Storm Flowable		G	N	
Trichoderma harzianum KRL-AG2	NC	Biopesticide	Plant Shield HC 1.15%	0	G	N	L
			RootShield WP		G	N	L
			RootShield granules		G	N	L
Triflumazole	3	Dimethylation inhibitor	Terraguard 50W	12	G	N	
			Terraguard SC		G	N	

Powdery Mildew

Powdery mildew is characterized by the presence of whitish fungal growth on the surfaces of leaves and stems. Infection of young, expanding leaves or shoots can result in severe distortion. There are many different fungi in the powdery mildew group; some are quite host specific while others can infect a wide range of plants. The fungi obtain nutrients from host plants by penetrating the outermost layer of plant cells. Powdery mildew spores are easily detached from the hyphae on which they develop and are carried by air currents to surrounding plants. Unlike most fungal diseases, leaf wetness is not required for powdery mildew infection. Disease development is favored by high humidity resulting from dry, sunny days followed by cool, moist nights.

Management Strategies: Choose resistant cultivars when growing highly susceptible perennials such as *Phlox* and *Monarda*. Reduce humidity through increased plant spacing, increased air circulation and careful irrigation. Scout plants regularly to look for the first signs of powdery mildew, as this disease can spread very quickly throughout the crop. Fungicides may be necessary when conditions are favorable for disease. Avoid repeated use of a single fungicide or fungicides with the same mode of action to minimize the potential for development of resistance.

Table 10.6 Fungicides For Managing Powdery Mildew

Refer to disclaimer statement on page 157.

Chemical Name	Code	Class	Trade Name	REI (hour)	Areas of Use		
Azoxystrobin	11	Strobilurin (QoI)	Heritage	4	G	N	L
Bacillus subtilis QST 713 strain	NC	Biopesticide	Cease	0	G	N	L
			Rhapsody		G	N	L
Chlorothalonil	M5	Chloronitrile	Daconil 2787	48	G	N	L
			Daconil Ultrex	12	G	N	L
			Daconil Weather Stik 54F		G	N	L
			Echo 720 T+O		G	N	
			Echo Ultimate		G	N	
			Echo Zn T+O		G	N	
			Manicure 6FL		G	N	
			Pegasus L		G	N	L
			Quali-Pro Chlorothalonil 720 SFT		G	N	L
			Quali-Pro Chlorothalonil 500 Zn		G	N	L
			Quali-Pro Chlorothalonil DF	48	G	N	
			Thalonil 6L	12	G	N	
Chlorothalonil + Thiophanate methyl	M5 1	Inorganic Benzimidazole	Spectro 90 WDG	12	G	N	L
Copper hydroxide	M1	Inorganic	Champ	24	G	N	L
			CuPro 2005 T/N/O		G	N	L
			Nu-Cop 50 DF		G	N	L

Table 10.6 Fungicides For Managing Powdery Mildew (continued)

Chemical Name	Code	Class	Trade Name	REI (hour)	Areas of Use		
Copper hydroxide + Mancozeb	M1 M3	Inorganic Dithiocarbamate	Junction	24	G	N	L
Copper salts of fatty/rosin acids	M1	Inorganic	Camelot	12	G	N	L
Copper sulfate pentahydrate	M1	Inorganic	Phyton 27	24	G	N	L
Fluxastrobin	11	Strobilurin (QoI)	Disarm O	12	G	N	
Hydrogen dioxide	NC		ZeroTol	0	G	N	L
Kresoxim methyl	11	Strobilurin (QoI)	Cygnus	12	G	N	L*
Myclobutanil	3	Dimethylation inhibitor	Eagle 20 EW	24	G	N	L
			Hoist		G	N	L
Neem oil	NC		Triact 70	4	G	N	L
Piperalin	5	Amine	Pipron 84.4%L	12	G		
Polyoxin D Zinc Salt	19	Polyoxin	Affirm WDG	4	G	N	L
			Veranda O		G	N	
Potassium bicarbonate	NC		Armicarb O	4	G	N	L
			Kaligreen		G	N	L
			MilStop	1	G	N	L
Propiconazole	3	Demethylation inhibitor	Banner MAXX	12			L
Pyraclostrobin	11	Strobilurin (QoI)	Insignia	12	G	N	L
Pyraclostrobin + Boscalid	11 7	Strobilurin (QoI) Anilide	Pageant	12	G	N	L
Sulfur	M2	Inorganic	Microthiol Disperss	24	G	N	L

*Nonresidential

Table 10.6 Fungicides For Managing Powdery Mildew (continued)

Chemical Name	Code	Class	Trade Name	REI (hour)	Areas of Use		
Thiophanate methyl	1	Benzimidazole	Allban 50 WSB	12	G	N	L
			Allban Flo 46.2% F		G	N	L
			Cleary's 3336 F		G	N	L
			Cleary's 3336 WP 50%		G	N	L
			Fungo Flo 50		G	N	L
			OHP-6672 50W		G	N	L
			Quali-Pro TM 4.5 F		G	N	
			Quali-Pro TM 85 WDG		G	N	
			T-Bird 85		G	N	
Thiophanate methyl + Mancozeb	1 M3	Benzimidazole Dithiocarbamate	Zyban	12	G	N	L
Triadimefon	3	Dimethylation inhibitor	Strike 50 WDG	12	G	N	
Trichoderma harzianum KRL-AG2	NC	Biopesticide	Plant Shield HC 1.15%	0	G	N	L
Trifloxystrobin	11	Strobilurin (QoI)	Compass O 50 WDG	12	G	N	L
Triflumizole	3	Dimethylation inhibitor	Terraguard 50W	12	G	N	
			Terraguard SC		G	N	

Pythium And Phytophthora Root Rot And Blight

Pythium and *Phytophthora* are in the group of microorganisms called water molds. Both pathogens are soil inhabitants and produce spores that swim in films of water. Diseases caused by water molds are favored by poorly drained growing media and excessive moisture. Roots infected with water molds often show a dark, soft, wet rot. In some hosts, the pathogens can invade the lower stem as well, causing a black stem discoloration or crown rot. Symptoms can range from slight stunting and/or chlorosis of infected plants to wilting and plant death. *Pythium* is common in greenhouse and nursery production; *Phytophthora* is usually more aggressive in killing infected plants. *Phytophthora* can also cause blighting of foliage and stems above the soil line. *Pythium* root rot is favored by high soluble salts in the growing medium. Both pathogens can survive in surface water sources, such as ponds, and can be distributed through irrigation. Fungus gnats and shore flies can spread *Pythium* by carrying spores on their bodies or through their feeding activities.

Management Strategies: As with all root rot diseases, sanitation is important in minimizing disease. In greenhouse and nursery production, clean pots, tools and benches with a greenhouse disinfectant. Use a well-drained growing medium and monitor irrigation practices to avoid saturated conditions. Do not over fertilize and avoid high soluble salts levels in growing mix. If using pond water for irrigation, treat to reduce *Phytophthora* and *Pythium* prior to irrigation. Remove and discard plants with root rot symptoms. Raised beds can help improve drainage and reduce water mold diseases in landscapes with drainage problems. Fungicide drenches can help protect uninfected plants in nursery and greenhouse production. Most fungicides effective against *Pythium* root rots will also control *Phytophthora* root and crown rots. Many *Pythium* isolates and some *Phytophthora* isolates are insensitive to metalaxyl and mefenoxam (Subdue and Subdue MAXX), so always rotate with products having different modes of action for the best control of these diseases.

Table 10.7 Fungicides For Managing Phytophthora Foliar Blight

Refer to disclaimer statement on page 157.

Chemical Name	Code	Class	Trade Name	REI (hour)	Areas of Use		
Azoxystrobin	11	Strobilurin (QoI)	Heritage	4	G	N	L
Chlorothalonil	M5	Chloronitrile	Daconil Ultrex	12	G	N	L
			Daconil Weather Stik 54F		G	N	L
Chlorothalonil + Thiophanate methyl	M5 1	Chloronitrile Benzimidazole	Spectro 90 WDG	12	G	N	L
Copper hydroxide	M1	Inorganic	Champ	24	G	N	L
			CuPro 2005 T/N/O		G	N	L
			Nu-Cop 3L		G	N	L
Copper salts of fatty/ rosin acids	M1	Inorganic	Camelot	12	G	N	L
Copper sulfate pentahydrate	M1	Inorganic	Phyton 27	24	G	N	L
Cyazofamid	21	Cyanoimidazole	Segway 34.5 EC	12	G	N	L
Dimethomorph	40	Cinnamic acid	Stature DM 50%	12	G	N	
Fenamidone	11	Imidazolinone	Fenstop	12	G		

Table 10.7 Fungicides For Managing Phytophthora Foliar Blight (continued)

Chemical Name	Code	Class	Trade Name	REI (hour)	Areas of Use		
Fludioxonil + Mefanoxam	12 4	Phenylpyrrole Phenylamide	Hurricane	48	G		
Fluopicolide	43	Acylpicolide	Adorn	12	G	N	L
Fluxastrobin	11	Strobilurin (QoI)	Disarm O	12	G	N	L
Fosetyl-Al	33	Phosphonate	Aliette 80 WDG	12	G	N	L
Mancozeb	M3	Dithiocarbamate	Protect DF	24	G	N	L
Mefanoxam	4	Phenylamide	Subdue MAXX	48	G	N	L
Phosphorous acid - postassium salts	33	Phosphonate	KPhite Alude 45.8%	4	G	N	L
Pyraclostrobin	11	Strobilurin (QoI)	Insignia	12	G	N	L
Pyraclostrobin + Boscalid	11 7	Strobilurin (QoI) Anilide	Pageant	12	G	N	L
Trifloxystrobin	11	Strobilurin (QoI)	Compass O 50 WDG	12	G	N	L

Table 10.8 Fungicides For Managing Pythium And Phytophthora Root And Crown Rots

Refer to disclaimer statement on page 157.

Chemical Name	Code	Class	Trade Name	REI (hour)	Areas of Use		
Cyazofamid	21	Cyanoimidazole	Segway 34.5 EC	12	G	N	L
Dimethomorph	40	Cinnamic acid	Stature DM 50%	12	G	N	
Etridiazole	14	Aromatic hydrocarbon	Terrazole 35 WP	12	G	N	
			Terrazole L		G	N	
			Truban 25 EC		G	N	
			Truban 30 W		G	N	
Etridiazole + Thiophanate methyl	14 + 1	Aromatic hydrocarbon Benzimidazole	Banrot 8G	12	G	N	L
			Banrot 40W		G	N	L
Fenamidone	11	Imidazolinone	Fenstop	12	G		
Fludioxonil + Mefanoxam	12 + 4	Phenylpyrrole Phenylamide	Hurricane	48	G		
Fluopicolide	43	Acylpicolide	Adorn	12	G	N	L
Fluxastrobin	11	Strobilurin (QoI)	Disarm O	12	G	N	
Fosetyl-Al	33	Phosphonate	Aliette 80 WDG	12	G	N	L
Mefenoxam	4	Phenylamide	Quali-Pro Mefanoxam 2 AQ	48	G	N	L
			Subdue MAXX		G	N	L
Phosphorous acid	33	Phosphonate	KPhite	4	G	N	L
			Alude 45.8%		G	N	L
Propanocarb	28	Carbamate	Banol	24	G	N	
Pyraclostrobin	11	Strobilurin (QoI)	Insignia	12	G	N	L
Pyraclostrobin + Boscalid	11 + 7	Strobilurin (QoI) Anilide	Pageant	12	G	N	L
Trichoderma harzianum KRL-AG2		Biopesticide	Plant Shield HC 1.15%	0	G	N	L
			RootShield WP		G	N	L
			RootShield granules		G	N	L

Rhizoctonia Root And Crown Rot

Rhizoctonia root rot is common under a range of environmental conditions. Symptoms of *Rhizoctonia* root rot are similar to those caused by other root pathogens, but *Rhizoctonia* lesions on lower stems and roots are often drier and lighter in color than other root rots. The fungus tends to be most active in upper soil layers where the medium is drier. *Rhizoctonia* can also cause foliar blight when plants are crowded and humidity is high. *Rhizoctonia* is a common soil inhabitant, and can produce small sclerotia that can persist for several years in the soil. The primary means of introduction and spread in greenhouse production is the introduction of contaminated soil on greenhouse floors, pots, tools and plants.

Management Strategies: As with other root rot diseases, management is focused on sanitation and maintaining plant health by providing optimum growing conditions. Remove and discard plants with root rot symptoms. Fungicide drenches can help protect uninfected plants.

Table 10.9 Fungicides For Managing Rhizoctonia Root And Crown Rot

Refer to disclaimer statement on page 157.

Chemical Name	Code	Class	Trade Name	REI (hour)	Areas of Use		
Azoxystrobin	11	Strobilurin (QoI)	Heritage	4	G	N	L
Chlorothalonil	M5	Chloronitrile	Daconil Ultrex	12	G	N	L
			Daconil Weather Stik 54F		G	N	L
			Echo 720 T+O		G	N	
			Echo Ultimate		G	N	
			Echo Zn T+O		G	N	
			Pegasus L		G	N	L
			Quali-Pro Chlorothalonil 720 SFT		G	N	L
			Quali-Pro Chlorothalonil 500 Zn		G	N	L
			Quali-Pro Chlorothalonil DF		G	N	
Chlorothalonil + Thiophanate methyl	M5 1	Chloronitrile Benzimidazole	Spectro 90 WDG	12	G	N	L
Etridiazole + Thiophanate methyl	14 1	Aromatic hydrocarbon Benzimidazole	Banrot 8 G	12	G	N	L
			Banrot 40 W		G	N	L
Fludioxonil	12	Phenylpyrrole	Medallion	12	G	N	L
Fludioxonil + Mefanoxam	12 4	Phenylpyrrole Phenylamide	Hurricane	48	G		
Flutalonil	7	Carboximide	Contrast 70 WSP	12	G	N	
			ProStar 70 WDG		G	N	L
Fluxastrobin	11	Strobilurin (QoI)	DisarmO	12	G	N	

Table 10.9 Fungicides For Managing Rhizoctonia Root And Crown Rot (continued)

Chemical Name	Code	Class	Trade Name	REI (hour)	Areas of Use		
Iprodione	2	Dicarboxamide	Iprodione Pro	12	G	N	L
			OHP Chipco 26 GT-O		G	N	L
			OHP Chipco 26019 N/G		G	N	L
			Sextant		G	N	
Iprodione + Thiophanate methyl	2 1	Dicarboximide Benzimidazole	26/36 Fungicide	12	G	N	L
Pentachloro-nitrobenzene	14	Aromatic hydrocarbon	Terraclor 75 WP	12	G	N	L
			Terraclor 400		G	N	L
Polyoxin D Zinc Salt	19	Polyoxin	Affirm WDG	4	G	N	L
			Veranda O		G	N	
Pyraclostrobin	11	Strobilurin (QoI)	Insignia	12	G	N	L
Pyraclostrobin + Boscalid	11 7	Strobilurin (QoI) Anilide	Pageant	12	G	N	L
Thiophanate methyl	1	Benzimidazole	Allban Flo 46.2% F	12	G	N	L
			Cleary's 3336 F		G	N	L
			Cleary's 3336 G 2%		G	N	L
			Cleary's 3336 WP 50%		G	N	L
			Fungo Flo 50		G	N	L
			OHP-6672 50W		G	N	L
			Quali-Pro TM 4.5 F		G	N	
Trifloxystrobin	11	Strobilurin (QoI)	Compass O 50 WDG	12	G	N	L
Triflumizole	3	Dimethylation inhibitor	Terraguard 50W	12	G	N	
			Terraguard SC		G	N	

Rusts

Rust diseases are caused by a group of highly specialized fungi with complex life cycles. They are obligate parasites and must infect living plant tissue to grow and survive. Some rusts need two different host plants to complete their development, while others require only one host. The disease gets its name from the orange or brown spores produced by most of these fungi in at least one part of their life cycle. Spores develop in blister-like structures called pustules which often develop in concentric rings on the foliage. Rust diseases can be spread through the air via wind-blown spores or through the introduction of infected plants in the greenhouse. Rust spores can also spread plant to plant through splashing water. High humidity and long leaf wetness periods favor rust disease development. Hollyhock and daylily are among herbaceous perennials that can be infected.

Chrysanthemum white rust, caused by *Puccinia horiana* is a **federally regulated plant pathogen** and subject to quarantine restrictions. Incidents of suspected chrysanthemum white rust must be reported to state horticulture officials.

Management Strategies: Management of rust diseases starts with inspecting plants as they arrive. Careful scouting and rouging out of any symptomatic plants is a great way to avoid plant disease problems. Rust fungi can produce large quantities of spores in a relatively short period of time, so even a small number of infected plants can cause an epidemic. There are several effective fungicides for controlling rust diseases in greenhouse and nursery production, but these are preventative, and not curative. Fungicide treatment is no substitute for sanitation.

Table 10.10 Fungicides For Managing Rusts

Refer to disclaimer statement on page 157.

Chemical Name	Code	Class	Trade Name	REI (hour)	Areas of Use		
Azoxystrobin	11	Strobilurin (QoI)	Heritage	4	G	N	L
Chlorothalonil	M5	Chloronitrile	Daconil Ultrex	12	G	N	L
			Daconil Weather Stik 54F		G	N	L
			Echo 720 T+O		G	N	
			Echo Ultimate		G	N	
			Echo Zn T+O		G	N	
			Pegasus L		G	N	L
			Quali-Pro Chlorothalonil 720 SFT		G	N	L
			Quali-Pro Chloro-thalonil 500 Zn		G	N	L
			Quali-Pro Chlorothalonil DF		G	N	
Chlorothalonil + Thiophanate methyl	M5 1	Chloronitrile Benzimidazole	Spectro 90 WDG	12	G	N	L
Copper sulfate pentahydrate	M1	Inorganic	Phyton 27	24	G	N	L
Flutalonil	7	Carboximide	Contrast 70 WSP	12	G	N	
			ProStar WDG		G	N	
Fluxastrobin	11	Strobilurin (QoI)	Disarm O	12	G	N	

Table 10.10 Fungicides For Managing Rusts (continued)

Chemical Name	Code	Class	Trade Name	REI (hour)	Areas of Use		
Kresoxim methyl	11	Strobilurin (QoI)	Cygnus	12	G	N	L*
Mancozeb	M3	Dithiocarbamate	Dithane DF	24	G	N	L
			Dithane 75 DF Rainshield T+O		G	N	
			Fore 80 WP Rainshield T+O		G	N	L
			Pentathlon DF		G	N	
			Pentathlon LF		G	N	L
			Protect DF		G	N	L
Myclobutanil	3	Dimethylation inhibitor	Eagle 20 EW	24	G	N	L
			Hoist		G	N	L
Neem Oil	NC		Triact 70	4	G	N	L
Pyraclostrobin	11	Strobilurin (QoI)	Insignia	12	G	N	L
Pyraclostrobin + Boscalid	11 7	Strobilurin (QoI) Anilide	Pageant	12	G	N	L
Triadimefon	3	Dimethylation inhibitor	Strike 50 WDG		G	N	
Trifloxystrobin	11	Strobilurin (QoI)	Compass O 50 WDG	12	G	N	L
Triflumizole	3	Dimethylation inhibitor	Terraguard 50W	12	G	N	
			Terraguard SC		G	N	

*Nonresidential

Sclerotinia Blight And Crown Rot

Sclerotinia blight, also called white mold, can occur on a wide variety of herbaceous ornamentals as well as vegetables, field crops and weeds. Symptoms include crown rot, stem rot, and flower blight. The pathogen produces hard, black structures called sclerotia that are irregular in shape and about 1/8 to 1/4 inch in size. Sclerotia may appear on the plant or soil surface, or inside the stem of infected plants. Under conditions of high humidity, fluffy white fungal growth develops on infected plant parts as well, giving the disease the name "white mold". Sclerotia are very resistant to environmental extremes and can survive in soil and plant debris for several years. The disease is primarily spread through movement of sclerotia in soil or infected plants. Under certain environmental conditions, sclerotia can produce cup-like structures that release airborne spores.

Management Strategies: Sanitation is critical for managing *Sclerotinia* blight. Do not use unsterilized field soil in potting mixes. Discard infected plants promptly. Fungicide drenches can help protect plants from infection in containerized plants. In the landscape, avoid planting plants with *Sclerotinia* problems in areas known to have the disease.

Table 10.11 Fungicides For Managing Sclerotinia Blight And Crown Rot

Refer to disclaimer statement on page 157.

Chemical Name	Code	Class	Trade Name	REI (hour)	Areas of Use		
Pentachloro-nitrobenzene	14	Aromatic hydrocarbon	Terraclor 75 WP	12	G	N	L
			Terraclor 400		G	N	L
Pyraclostrobin	11	Strobilurin (QoI)	Insignia	12	G	N	L
Pyraclostrobin + Boscalid	11 7	Strobilurin (QoI) Anilide	Pageant	12	G	N	L
Thiophanate methyl	1	Benzimidazole	Allban 50 WSB	12	G	N	L
			Allban Flo 46.2% F		G	N	L
			Cleary's 3336 F		G	N	L
			Cleary's 3336-WP 50%		G	N	L
			Cleary's 3336-G 2%		G	N	L
			Fungo Flo 50		G	N	L
			OHP-6672 50W		G	N	L
			Quali-Pro TM 4.5 F		G	N	
			Quali-Pro TM 85 WDG		G	N	
			T-Bird 85		G	N	L
			T-Storm 50 WSB		G	N	L
			T-Storm Flowable		G	N	

Thielaviopsis Root Rot

This disease is also called black root rot due to the discrete black lesions present in infected roots. In severe cases, the root system is almost entirely black due to numerous dark, thick-walled spores produced by the fungus. The disease is most problematic in greenhouse and nursery production. Plants with *Thielaviopsis* root rot are often stunted and have chlorotic (yellowing) foliage. The pathogen has a wide host range, but common herbaceous perennials affected include *Digitalis*, *Gaillardia*, *Lupinus*, *Phlox*, and *Viola*. *Thielaviopsis* root rot is favored by high soil pH (6.5 and higher) and poor drainage.

Management Strategies: Keep the growing medium pH at 6 or below to reduce *Thielaviopsis* problems. As with all root rot diseases, sanitation is key to keeping the fungus out of the greenhouse and nursery. Discard diseased plants. Fungicides applied as a soil drench can help protect roots from *Thielaviopsis* infection in nursery and greenhouse production.

Table 10.12 Fungicides For Managing *Thielaviopsis* Root Rot

Refer to disclaimer statement on page 157.

Chemical Name	Code	Class	Trade Name	REI (hour)	Areas of Use		
Etridiazole + Thiophanate methyl	14 1	Aromatic hydrocarbon Benzimidazole	Banrot 8 G	12	G	N	L
			Banrot 40 W		G	N	L
Fludioxonil	12	Phenylpyrrole	Medallion	12	G	N	L
Fludioxonil + Mefanoxam	12 4	Phenylpyrrole Phenylpyrrole	Hurricane	48	G		
Thiophanate methyl	1	Benzimidazole	Allban Flo 46.2% F	12	G	N	L
			Cleary's 3336 50 WP		G	N	L
			Cleary's 3336 F		G	N	L
			Cleary's 3336 G 2%		G	N	L
			Fungo Flo 50		G	N	L
			OHP-6672 50W		G	N	L
			Quali-Pro TM 4.5 F		G	N	
			Quali-Pro TM 85 WDG		G	N	
			T-Bird 85		G	N	
Triflumizole	3	Dimethylation inhibitor	Terraguard 50W	12	G	N	
			Terraguard SC		G	N	

Virus Diseases

Viruses are sub-microscopic particles that can replicate within plant cells. Symptoms of virus infection are often quite striking and distinctive. Chlorotic mottling, ringspots and line patterns on the foliage or stems may occur. Stunting is commonly observed. Impatiens Necrotic Spot Virus (INSV) and Tomato Spotted Wilt Virus (TSWV) cause bleached white or reddish purple or brown spots on leaves and stems. These viruses are spread by western flower thrips feeding and primarily occur in greenhouse and nursery production. Hosta Virus X causes blotchy dark green and light green areas on infected hosta leaves, as well as stunting. Tobacco mosaic virus (TMV), tobacco rattle virus (TRV), and cucumber mosaic virus (CMV) have been found in herbaceous perennials as well. TMV is a very stable virus with a wide host range, and any practices that move infected plant sap (handling plants, taking cuttings, potting) can spread the virus easily throughout a crop.

Management Strategies: Inspect plants regularly for virus symptoms. Test symptomatic plants for virus diseases to have a definitive diagnosis of specific virus problems. Samples may be sent to a diagnostic laboratory or commercial virus-testing company, or may be tested in-house using commercially available virus test kits. Maintain strict weed control in nurseries and greenhouses. Destroy plants showing virus symptoms. Manage insect pests such as thrips and aphids to reduce the spread of virus diseases in the greenhouse and nursery.

Phytoplasma Diseases

Phytoplasmas are microorganisms similar to bacteria but without cell walls. Aster yellows is the most important disease of herbaceous perennials caused by this group of plant pathogens. The aster yellows phytoplasma can infect a large number of plant species. Herbaceous perennial hosts include coneflower, aster and chrysanthemum. Symptoms of aster yellows include stunting of plants, leaf yellowing and abnormal flower development. A characteristic symptom of this disease is the replacement of normal flower petals with green, leaf-like structures. Phytoplasmas are spread through propagation of infected plants (divisions or cuttings) and by leafhoppers. Phytoplasma infections are systemic, and infected plants cannot be cured. Symptomatic plants should be destroyed. Manage weeds in nurseries and greenhouses to eliminate potential sources of the pathogen.

Fungal Vascular Wilt Diseases

Vascular wilt fungal pathogens (certain *Fusarium* subspecies and *Verticillium* sp.) infect the water-conducting tissue of host plants, causing stunting, wilt and eventual plant death. Plants that may be infected include chrysanthemum, dianthus and coreopsis. Symptoms are those of extreme water stress, because the fungi block water transport through the stem, and include stunting, wilting, dieback and eventual plant death. The water-conducting tissue (xylem) of plants of infected plants will often show a reddish or brown discoloration. Species of *Fusarium* that cause vascular wilt diseases are host specific, but *Verticillium* can infect a large number of different plants. Both fungal pathogens are spread through propagation of infected stock plants, and the fungi can also persist in soil and infect plants through roots. Once plants are infected, there is no cure. Fungicides are generally not effective in preventing vascular wilt diseases. Discard plants with vascular wilt symptoms and choose resistant varieties or species to plant in landscapes where vascular wilt diseases have been confirmed.

Nematodes

Nematodes are microscopic roundworms that are common inhabitants of the environment. Most are saprophytic bacteria or fungal feeders, but a few species will cause plant disease. Foliar nematodes survive in infected plant debris and move in films of water to infect leaves. Hosta, Japanese anemone, hellebores and ferns are among the most common hosts. Symptoms include angular yellow or brown lesions or streaks, leaf distortion and leaf blight. Infected areas are bordered by leaf veins. Lesions caused by foliar nematodes can resemble those of downy mildew, but there will be no fungal growth on the undersides of foliar

nematode lesions. Once infection occurs, it is very difficult to control foliar nematode problems. Sanitation is very important – discard symptomatic plants and all fallen leaf debris. Infected plants will survive in the landscape, showing symptoms year after year. This can be a serious problem in nurseries, however. See page 66 for chemical options for reducing foliar nematode populations in commercial production.

Root knot nematodes feed in roots of a wide variety of plant hosts, causing small swellings or galls on fine roots. Aboveground symptoms include stunting, poor color and lack of plant vigor – symptoms of an impaired root system. Root knot nematodes are soil inhabitants and can be spread by movement of soil on tools, equipment, and plant material. Sanitation is important in reducing root knot nematode problems. Check plants for lumps or swellings on roots before purchasing or installing in a landscape. Take steps to avoid soil movement from areas known to have root knot problems to uninfested areas.