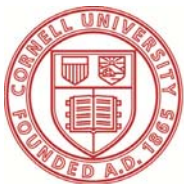




2017-2018 Cornell Guide for the Integrated Management of Greenhouse Crops and Herbaceous Ornamentals



Cornell University
Cooperative Extension

These guidelines are not a substitute for pesticide labeling. Always read and understand the product label before using any pesticide.

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1 Pesticide Information

1.1 Pesticide Classification and Certification

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) created two classifications of pesticides – general-use and restricted-use. **General-use pesticides** may be purchased and used by anyone. **Restricted-use pesticides can** only be purchased by a certified applicator. Restricted-use pesticides must also be used by a certified applicator or someone under their supervision.

The same federal law that classifies pesticides divided applicators into two groups: private and commercial. **Private applicators** use or supervise the use of pesticides to produce agricultural commodities or forest crops on land owned or rented by the private applicator or their employer. A farmer must be certified as a private applicator in order to purchase and use restricted-use pesticides on agricultural commodities. (No certification is needed if a farmer does not use restricted-use pesticides.)

A **commercial applicator** uses or supervises the use of pesticides for any purpose or on any property not covered by the private applicator classification. In New York, a commercial applicator must be certified to purchase or use any pesticide whether it is general- or restricted-use.

More information about pesticide certification and classification is available from your Cornell Cooperative Extension office (cce.cornell.edu/learnAbout/Pages/Local_Offices.aspx), regional NYSDEC pesticide specialist (www.dec.ny.gov/about/558.html), the Pesticide Applicator Training Manuals (store.cornell.edu/c-876-manuals.aspx), or the Pesticide Management Education Program (PMEP) at Cornell University (psep.cce.cornell.edu).

1.2 Use Pesticides Safely

Using pesticides imparts a great responsibility on the user to be a good steward of their health and that of others. Keep in mind that there is more to “pesticide use” than the application. Pesticide use includes mixing, loading, transporting, storing, or handling pesticides after the manufacturer’s seal is broken; cleaning pesticide application equipment; and preparation of a container for disposal. All of these activities require thoughtful planning and preparation. They are also regulated by state and federal laws and regulations intended to protect the user, the community, and the environment from any adverse effects pesticides may cause.

1.2.1 Plan Ahead

Many safety precautions should be taken *before* you actually begin using pesticides. Too many pesticide applicators are dangerously and needlessly exposed to pesticides while they are preparing to apply them. Most

pesticide accidents can be prevented with informed and careful practices. **Always read the label on the pesticide container before you begin to use the pesticide.** Make sure you understand and can follow all directions and precautions on the label. Be prepared to handle an emergency exposure or spill. Know the first aid procedures for the pesticides you use.

1.2.2 Move Pesticides Safely

Carelessness in transporting pesticides can result in broken containers, spills, and contamination of people and the environment. Once pesticides are in your possession, you are responsible for safely transporting them. Accidents can occur even when transporting materials a short distance. You are responsible for a pesticide accident so take every effort to transport pesticides safely. Be prepared for an emergency.

1.2.3 Personal Protective Equipment and Engineering Controls

Personal protective equipment needs depend on the pesticide being handled. **Required personal protective equipment (PPE) are listed on pesticide labels.** These requirements are based on the pesticide’s toxicity, route(s) of exposure, and formulation. Label PPE requirements are the minimum that must be worn during the pesticide’s use. Pesticide users can always wear more protection than the label requires.

The choice of protective equipment depends on the activity, environment, and handler. The type and duration of the activity, where pesticides are being used, and exposure of the handler influences the equipment you should use. Mixing/loading procedures often require extra precautions. Studies show you are at a greater risk of accidental poisoning when handling pesticide concentrates. Pouring concentrated pesticide from one container to another is the most hazardous activity. More information on personal protective equipment can be found online at umes.edu/NC170/Default.aspx?id=7184.

Engineering controls are devices that help prevent accidents and reduce a pesticide user’s exposure. One example is a closed mixing/loading system that reduces the risk of exposure when dispensing concentrated pesticides. More information on engineering controls can be found online at umes.edu/NC170/Default.aspx?id=7196.

1.2.4 Avoid Drift, Runoff, and Spills

Pesticides that move out of the target area can injure people, damage crops, and harm the environment. Choose weather conditions, pesticides, application equipment, pressure, droplet size, formulations, and adjuvants that

minimize drift and runoff hazards. Check the product label for specific application and equipment requirements.

1.2.5 Avoid Equipment Accidents

Properly maintained and carefully used equipment contribute to safe pesticide application. Use the following guidelines to prevent accidents:

- Be sure to turn off your machinery before making any adjustments.
- Do not allow children, pets, or unauthorized people near the pesticide equipment.
- Depressurize tanks or systems between jobs.
- Always return equipment to appropriate areas for cleaning and storage when the application is completed.

1.2.6 Pesticide Storage

Most pesticide applicators use existing buildings or areas within existing buildings to store pesticides. Whether you choose to build a new storage area or use existing buildings, consider several points:

- The site should be where flooding is unlikely.
- It should be downwind and downhill from sensitive areas like houses, ponds, and play areas.
- There should be no chance that runoff or drainage from the site could contaminate surface or groundwater.

Storage facility check list:

- ☐ Is the facility separated from:
 - o Offices, workshops, and livestock areas?
 - o Wells, streams, lakes, ponds, wildlife?
 - o Food and feed?
- ☐ Is the facility made of fire resistant building materials?
- ☐ Does the facility have
 - o Impermeable flooring?
 - o Liquid spill containment (berms to hold 25% of liquid storage)?
- ☐ Can the doors be locked?
- ☐ Is the facility fenced in?
- ☐ Are warning signs posted?
- ☐ Is a spill kit readily available?
- ☐ Are fire extinguishers readily available?
- ☐ Is personal protective equipment readily available?

1.3 Pollinator Protection

Honey bees, wild bees, and other insects are important for proper pollination of many crops. Poor pollination results in small or odd-shaped fruit as well as low yields. Many factors affect pollinator health including lack of seasonal forage, parasites, predators, pathogens, lack of genetic diversity, and pesticide exposure.

To avoid harming bees, remember these general points:

- Before using a pesticide, always read the label for specific pollinator protection requirements;

- Do not spray or allow the pesticide to drift onto blooming crops or weeds;
- Mow blooming weeds before treatment or spray when the blossoms are closed;
- Avoid application during the time of day when bees are most numerous;
- Make applications in the early morning or evening; and
- Avoid making applications over or allowing drift onto hives or apiaries.

Labels on pesticides that are highly toxic to honey bees may carry a statement warning you about hazards to bees and other pollinators. If pesticide sprays that are highly toxic to bees are used in strict accordance with label directions, little to no harm should be done to bees. Note that some pesticides with relatively low toxicity to honey bees can be synergized (made more toxic) by adding other pesticides. Special care should be taken with tank mixes where pollinator safety may be unknown.

EPA has established bee labeling requirements for nitroguanidine neonicotinoid-containing pesticides (☞imidacloprid, ☞dinotefuran, ☞clothianidin, ☞thiamethoxam) with outdoor foliar use labeling. These labels have a bee icon and an advisory box with information on routes of exposure and spray drift precautions.

In early 2015 the EPA proposed new pollinator protection label language to protect managed bees under contract pollination services. The intent of this new language is to protect bees from contact exposure to pesticides that are acutely toxic to bees. Once the new language is finalized, the new wording and requirements will be added to pesticide labels. In the proposal, the EPA identified certain pesticide active ingredients that are acutely toxic to bees. To help familiarize you with these, active ingredients in this publication meeting this criterion are preceded by a bee symbol (☞).

In 2016, New York State released its pollinator protection plan. This plan discusses the status of pollinators in New York State and how they can be protected. The plan can be viewed online at www.dec.ny.gov/docs/administration_pdf/nyspollinatorplan.pdf.

Additional information on pollinator protection can be found online at www2.epa.gov/pollinator-protection and pesticidestewardship.org/PollinatorProtection/Pages/default.aspx.

1.4 New York State Pesticide Use Restrictions

1.4.1 Restricted-Use Pesticides

In accordance with New York State law, pesticides that are highly toxic or that are persistent and accumulative are classified as restricted-use in New York State. The

4 Biology and Management of Diseases of Greenhouse Crops and Herbaceous Ornamentals

4.1 Common Diseases

4.1.1 Powdery Mildew

Powdery mildew, one of the most easily recognized of all plant diseases, is characterized by the presence of a whitish, powdery mildew growth on the surfaces of leaves, stems, and sometimes petals. The fungal threads and the spores (which develop on short, erect branches) are visible with a strong hand lens. Under some conditions, however, the threads are so sparse that the mildew can be detected only by examination under strong light with a good lens or dissecting microscope. In some cases, the mildew develops only in small areas in which the leaf cells are killed and turn red, purple, brown or black.

The mildew spores are easily detached and carried by air currents to surrounding plants where they initiate new infections. On some plants, such as grape ivy, rose, and delphinium, the young foliage and stems often become severely distorted in addition to being covered by the whitish mildew growth.

Watch for this disease on susceptible crops, including verbena, gerbera, begonia, mini-rose, hydrangea, petunia, calibrachoa, New Guinea impatiens, zinnia, African violet, phlox and monarda. Seriously affected crops may lose their sales value. Don't forget that poinsettias are susceptible to a powdery mildew disease. The disease develops rapidly during the fall. While scouting for whiteflies on poinsettias, also watch for powdery mildew colonies on the upper or lower surface of older leaves. At times a yellow spot on the upper leaf surface may indicate a mildew colony growing on the undersurface. Pick off affected leaves and initiate fungicide treatment immediately.

Bioenvironmental Control

Unlike the spores of nearly all other fungi, powdery mildew spores can germinate and initiate infections on plant surfaces that are not visibly wet. Development of mildew following infection is most rapid and luxurious at higher humidities. As a deterrent to mildew in greenhouses, ventilation and heating should be adjusted to avoid high-humidity conditions. Heat at least one hour before sunset, and provide adequate ventilation. Horizontal airflow systems assist in management of powdery mildew. For both outdoor and indoor crops, provide sufficient space between plants and water early in the day.

Chemical Control

Under some conditions, fungicides are essential for mildew control. Systemic and nonsystemic protectant materials are available for spray application (see Section 4.5.32). Practice fungicide rotation among different mode of action groups.

4.1.2 Botrytis Blight

The common gray mold fungus, *Botrytis cinerea*, attacks a wide variety of ornamental plants, probably causing more losses than any other single pathogen. The fungus causes a brown rotting and blighting of affected tissues. It commonly attacks the stems of geranium stock plants and wounds on cuttings. Some plants (e.g. lily, tulip and peony) are susceptible to other more host-specialized species of *Botrytis* as well. As a result of *Botrytis cinerea* infection, very small seedlings can be rotted; stems of poinsettia, snapdragon, zinnia, exacum, angelonia or lisianthus can be girdled; and petal tissues of many plants, including carnations, chrysanthemums, roses, azaleas, geraniums and peonies, can be spotted and ruined. The fungus is usually identified by the development of fuzzy grayish spore masses over the surface of the rotted tissues, although such sporulation will not develop under dry conditions.

Spores of the causal fungus are produced on distinctive dark-colored, hairlike sporophores and are readily dislodged and carried by air currents to new plant surfaces. The spores will not germinate and produce new infections, however, except when in contact with water, whether from splashing, condensation, or exudation. Only tender tissues (seedlings, petals), weakened tissues (e.g. stubs left in taking cuttings), injured tissues (bases of cuttings), or old and dead tissues are attacked on most crops. Active, healthy tissues, other than petals, are seldom invaded. Petals shed from crops in hanging baskets may encourage Botrytis blight on leaves of crops grown below.

Bioenvironmental Control

Because high humidity is required for spore production and actual condensation is necessary for spore germination and infection, Botrytis blight is a particular challenge in the greenhouse. It can usually be controlled by watering early and by heating and ventilating to prevent any condensation on the plant surfaces. Because the fungus readily attacks old or dead tissues and produces tremendous quantities of airborne spores, the importance of strict sanitation cannot be overemphasized. All old blossoms and dead leaves should be removed, and all fallen leaves and plant debris on or under the benches should be gathered and disposed of in bags or other closed containers.

Chemical Control

Fungicides may be required to protect highly susceptible crops such as exacum, geranium, poinsettia, lisianthus, bacopa, angelonia and fuchsia if weather conditions are especially favorable. Fungicide resistance is reported for *Botrytis cinerea* (benzimidazole and dicarboximide materials, as well as fenhexamid).

4.2.4 Begonia

- **Damping-off:** Collapse of young plants may be caused by *Pythium*, *Rhizoctonia*, or *Botrytis* species.
- **Botrytis leaf spot:** Large, irregularly outlined brown leaf spots, particularly common on large plants given insufficient spacing; stems may also be invaded, leading to wilt of the cankered portion.
- **Powdery mildew:** Fuzzy white patches on leaves or flowers. In some cases, leaf tissue shows dark, greasy-looking spots beneath a sparse colony of powdery mildew. Begonias are highly susceptible.
- **Bacterial leaf spot (*Xanthomonas axonopodis* pv. *begoniae*):** Dark, greasy spots appear on leaves, or brown V-shaped dead areas develop at leaf margins. Spots are surrounded by a speckled or chlorotic zone of leaf tissue. With high temperatures, disease may progress until plants collapse. Certain Elatior begonias are particularly susceptible; Non-Stop begonias may show less extensive leaf spotting.
- **Foliar nematodes (*Aphelenchoides fragariae*):** Sunken gray-green blotches that turn reddish brown or black. Infected leaves may wilt, die, and hang limply from the plant. Elatior begonias are extremely susceptible to foliar nematodes.
- **Fusarium wilt (*Fusarium foetens*):** This new disease causes dulling of foliage, internal stem discoloration and cankers at the base of stems. All or part of the plant will collapse as a result.
- **Impatiens necrotic spot virus (INSV):** Yellow variegation or round brown spots in leaves, chlorotic mottling, brown streaking along veins, and brown patches in the leaf at the petiole end. Control of the vector, the western flower thrips, is essential.

4.2.5 Bulb Crops for Forcing

- **Botrytis:** Occasionally, when aeration is insufficient during forcing, *Botrytis* may cause lesions on foliage and cripple the expansion of leaves. Good cultural conditions prevent this problem. Bulbs and roots may also be affected.
- **Tulip fire (*Botrytis tulipae*):** Foliar lesions on tulip may be caused by a host-specific species of *Botrytis* introduced via sclerotia on diseased bulbs. Destroy infected plants and protect others with appropriate fungicides during foliage expansion.
- **Iris ink disease (*Mystrosporium adustum*):** Scales are blackened. Destroy bulbs in which fleshy scales are affected. Not common in North America.
- **Bulb rots (*Penicillium* sp., etc.):** Portions of bulbs are discolored, most often resulting from invasion of stressed tissue by weak pathogens. Avoid bruising or overheating during handling or storage. *Phytophthora* spp. may cause rotting of the stem, basal plate, and roots; bulb scales are not affected.
- **Gray bulb rot (*Sclerotium tuliparum*):** A dry rot with sclerotia sometimes evident.

- **Flower break or mosaic:** Interruption of flower petal color by white streaks or yellow mottling of foliage. Caused by virus infections. Aphid control is important for preventing spread.

4.2.6 Calceolaria (*Calceolaria herbeohybrida*, *C. integrifolia*)

- **Impatiens necrotic spot virus (INSV):** Pale patches in lower leaves enlarge and brown with time; young plants may be more severely affected. Control of western flower thrips is essential.
- **Stem or crown rot:** Stem collapse, possibly resulting from infection by *Botrytis* or *Sclerotinia sclerotiorum*.

4.2.7 Calibrachoa (*Calibrachoa* hybrids)

- **Pythium root rot:** Plants are stunted and may wilt. Roots are soft and mushy.
- **Phytophthora root rot:** Plants may grow normally until they suddenly wilt at flowering. The *Phytophthora* often attacks at the stem base.
- **Powdery mildew:** Lower leaves turn yellow, brown, and dry. This is a common problem, often misidentified.
- **Thielaviopsis root rot:** Plants are stunted, yellowed or purplish. Roots are also stunted and may be discolored. Infected plants will wilt. Very common on this plant.

4.2.8 Calla

- **Soft rot (*Pectobacterium carotovorum* or *P. aroideae*; previously called *Erwinia* spp.):** A soft, mushy, foul-smelling rot of rhizomes or stem bases. Cut out rotted spots before planting. Place rhizomes in separate containers and water individually if possible to reduce disease spread. Use a well-drained growing medium. Water sparingly.
- **Root rot (*Phytophthora* or *Pythium* spp.):** Roots are decayed back to the rhizomes.
- **Viruses:** Small plants, chlorotic foliar streaking, flower distortion. Discard affected plants.

4.2.9 Carnation (*Dianthus caryophyllus*)

Note: For cut-flower carnations use culture-indexed plants, and steam-pasteurize or fumigate growing media and beds.

- **Fusarium wilt (*Fusarium oxysporum* f. sp. *dianthi*):** Stunting, wilting, foliar yellowing or browning, purplish vascular discoloration.
- **Rhizoctonia stem rot:** Brown canker at the soil line.
- **Alternaria leaf spot (*Alternaria dianthi*):** Ashy white spots with dark fungus spore structures on the center of older spots.
- **Bacterial wilt (*Pseudomonas caryophylli*):** Sudden wilting and drying of the top of the plant or of one branch. Vascular system shows yellow streaks. Root system also decays, and sticky cankered areas may

4.5 Fungicides and Bactericides for Use on Herbaceous Ornamentals

4.5.1 Alternaria Leaf Spot

Where a concern: Greenhouse, nursery and landscape

Time for concern: This disease is usually a problem only under warm, wet conditions.

Key characteristics: *Alternaria* leaf spots are sometimes accompanied by yellow haloes

Management Option		Guideline
Cultural Practices	Reduce the periods of leaf wetness to facilitate disease management.	
Fungicide use	Thiophanate-methyl will not control <i>Alternaria</i> .	
Compound(s)		
Common name (FRAC Code)		
Trade name	Use Site(s) ¹	Comments
azoxystrobin(11)		
Heritage	G, N, L	Spray 1-4 oz/100 gal as needed, with a 7 to 28 day interval. User should conduct small-scale tests to ensure safety when applying to plants not listed on the label. Conduct trials before using in a tank mix with any material. Do not use a silicone-based surfactant. For resistance management, do not make more than 3 sequential applications of Heritage; alternate with 2 applications of a non-strobilurin fungicide. Do not exceed 2 oz/100 gal on pansy.
Bacillus amyloliquefaciens D747 (44)		
Triathlon BA	G, N	This biological fungicide/bactericide is used as a foliar spray at 0.5-6 quarts/100 gal, applied as a spray to wet with minimal runoff every 3-28 days. Or use as a drench at 0.5 to 4.5 pints/100 gal on ornamentals or food crops every 14-28 days as needed.
Bacillus subtilis GB03 (NC)		
Companion Liquid Biological Fungicide for Greenhouse Nursery and Ornamental Crops 2-3-2	G, N	Spray 1-2 quarts/100 gal (2-4 tsp/gal). Drench at 16 fl oz/100 gal. Re-treat at 14-28 day intervals.
Bacillus subtilis QST 713 (44)		
Cease	G, N	This is a biological fungicide/bactericide used as a foliar spray at 2-8 qts/100 gal/A, with a 3- to 10-day retreatment interval.
chlorothalonil (M5)		
Daconil Ultrex 82.5%	G, N, L	Precaution for all chlorothalonil materials: Contact material. Labels warn against some tank mixes with oil, fertilizer or certain spreader-stickers, or treating within 1 week before or after an oil or oil-based pesticide. Some crops are sensitive to some or all of the formulations: warnings are given regarding ferns, pittosporum, schefflera, and KnockOut and Double Delight roses. Any flowers may be injured. Do not use in mist-blowers or cold foggers in greenhouses. Test for safety to crops not on the labels. Rates: Unless otherwise noted on label, apply 1.4 lbs/100 gal Daconil Ultrex; 1.37 pts/100 gal Quali-Pro Chlorothalonil 720 SFT; 1-2.5 lbs/100 gal Quali-Pro Chlorothalonil DF; 1.9 pts/100 gal Quali-Pro Chlorothalonil 500 Zn; 1 3/8 pts/100 gal Pegasus 6L, Daconil Weather-Stik 54F, Echo 720, NuFarm CTN SPC 720, or Lesco Manicure 6 FL; or 2 pts/100 gal Echo Zn T&O; or 1.25 lbs/100 gal Echo Ultimate T&O or Lesco Manicure Ultra.
Daconil Weather-Stik 54F	G, N, L	
Echo Ultimate T&O	G, N	
Echo Zn T&O	G, N	
Echo 720 T&O	G, N	
Nufarm CTN SPC 720	G, N, NRL	
Pegasus 6L	G, N	
Quali-Pro	G, N, L	
Chlorothalonil 500 ZN	G, N, L	
Quali-Pro	G, N, L	
Chlorothalonil 720 SFT	G, N, L	
Quali-Pro	G, N	
Chlorothalonil DF	G, N	
Lesco Manicure 6 FL	G, N	
Lesco Manicure Ultra	G, N	
chlorothalonil + thiophanate-methyl (M5+1)		
*Spectro 90WDG	G, N, L	Spray 1-2 lbs/100 gal. Label cautions grower to conduct tests for safety to plants not mentioned on the label before widespread use. *Spectro is not recommended for use on Swedish ivy, Boston fern, or Easter cactus (<i>Hatiora gaertneri</i>). Do not apply *Spectro to Pittosporum or Schefflera more than once to avoid phytotoxicity. Cautions appropriate for chlorothalonil materials are appropriate for this combination product as well.

5.4 Common Arthropod Pests of Floral Crops

For specific pesticides currently registered in New York State, refer to Section 5.6.

5.4.1 Aphids

Identification of Some Common Aphids

Aphids are generally small (1-3 mm) and soft-bodied, and have a pair of unique structures, called cornicles, that resemble “tailpipes” near the end of their abdomen. Adults may or may not have wings. More than 20 aphid species can infest various greenhouse crops. The following are three of the most common aphids:

Green peach aphid (*Myzus persicae*). This very common aphid varies in color from light green to rose. It has a pronounced indentation between the bases of its antennae on the front of the head, visible with magnification ($\geq 10\times$). The cornicles are the same color as the body except the extreme tips, which are dark.

Melon aphid (*Aphis gossypii*). Also called the cotton aphid, it is common, smaller than green peach aphid, and its color varies from light yellow to very dark green, almost black. It has no pronounced indentation between the bases of its antennae. The entire length of the cornicles is always black, regardless of body color.

Foxglove aphid (*Aulacorthum solani*). In recent years this has become a common aphid pest in greenhouses. Also called the glasshouse potato aphid, it has a broad host range. It has often been found on ivy and zonal geraniums, salvia, and cineraria among many other crops in the northeastern United States. It strongly resembles the green peach aphid in shape and color, but it is slightly larger, shiny, with a dark green area on the abdomen at the base of each cornicle. Indentation between the bases of its antennae is easy to see under magnification.

Damage

Aphids can infest most greenhouse crops. Their mere presence can ruin the beauty of a plant. They feed by inserting their stylet-like mouthparts through plant tissue directly into the phloem and removing plant sap. Feeding can cause stunting and plant or leaf deformities. Large infestations can reduce plant vigor. Aphids produce a sweet, sticky secretion called “honeydew,” which leads to unsightly grey, sooty mold. They leave behind unsightly white cast skins as they molt from one stage to another. Aphids are responsible for the transmission of about 60 percent of all plant viruses on agricultural crops worldwide. Generally, virus transmission by aphids has not been a problem in greenhouse crops, although it is an important issue to consider in propagation ranges and clean stock production.

Biology of Common Greenhouse Aphids

Aphids reproduce parthenogenetically, i.e., all the insects present are females, and each female gives birth to more

females without the need to mate. These females give birth to living nymphs rather than lay eggs. An unborn aphid already contains a complement of developing nymphs (=“paedogenesis”). Aphid nymphs are genetic clones of their mothers. Populations can increase explosively—newborns can reach adulthood and begin to reproduce in as little as seven days. As a colony increases in age and size on individual plants, the proportion of winged forms increases. Outdoors in cold climates some aphids will mate and lay eggs on overwintering host plants.

Aphids often prefer certain crop cultivars over others. Ask your plant supplier for information on aphid cultivar preferences or keep records of aphid infestations by cultivar to aid you in choosing cultivars.

Aphids will feed on buds, stems, and the lower surfaces of leaves. Some will migrate to new host plants or young plant tissue and will actively search for soft, fresh plant tissue. As plants begin to form flower buds, a previously undetected aphid infestation can become terribly apparent as they move up the plant onto the recently developed stems, buds, and flowers. Green peach aphids tend to be found on the upper leaves of a plant, although a few may be found on the middle and lower leaves. Melon aphids tend to be found throughout a plant canopy on lower surfaces of leaves. Melon aphids on the lower canopy may be harder to detect while populations are low. Failure to detect lower canopy infestations, coupled with the rapid population growth of melon aphids on mums, can lead to explosive problems. Feeding by foxglove aphids often causes serious leaf distortion (twisting, cupping, and stunting).

Aphids on the upper canopy will be easier to contact with sprays. Systemic insecticides will be most effective against those feeding on new growth. Aphids on older growth lower in the canopy are often most difficult to kill chemically and may be responsible for producing new aphids that will reinfest the upper canopy. Green peach aphids are prone to develop winged forms on mums and may be more likely to spread quickly throughout a mum crop. Melon aphids do not develop winged forms as readily and are not as likely to be detected on yellow sticky traps. Resistance to various insecticides is common in aphids. Strains of some species are resistant to carbamate, organophosphate, and/or pyrethroid insecticides.

Monitoring

White cast skins on leaves of a plant may indicate an aphid colony on the leaves or stems above. Ants are often attracted to the honeydew, so inspect plants carefully for aphids where ants are observed. Group aphid-susceptible plants together for easier monitoring. Aphids can be spread on clothing, so plants located near walkways and doors should be examined. Inspect plant material brought into your growing areas; do not purchase infested plants or cuttings. Inspect the greenhouse thoroughly for all sources (weeds, older plants, plants by outside fans or vents) of all pests, including aphids, before a new crop arrives. If

5.6.16 Leafrollers

Where a concern: Greenhouse, herbaceous ornamentals in nursery and landscape

Compound(s)

Common name (IRAC Code)

Trade name	Use Site(s)	Comments
acephate (1B)		
*Acephate 97 UP	greenhouse, outdoor ornamentals	Application to poinsettias after bract formation may result in phytotoxicity on certain varieties. Do not apply to roses or chrysanthemums with open blooms. Some phytotoxicity has been observed on certain foliage plants and some chrysanthemum varieties. See label for complete plant list, rates, and specific instructions.
1300 Orthene TR	commercial greenhouses	Apply during early evening when foliage is dry. Greenhouse temperatures should be between 60° and 80°F for best results. Greenhouse should be ventilated before reentry. See label for complete plant list, rates, and specific instructions.
*Orthene TTO 97	nursery, greenhouse, outdoor ornamentals	For use on roses only. Product is readily absorbed by plant foliage and roots to provide systemic control of feeding insects. Do not apply to freshly rooted cuttings. Can be used on limited kinds of crops. See label for complete plant list, rates, and specific instructions.
*Orthene TTO WSP	nursery, greenhouse and outdoor ornamentals	For use on roses only. Product supplied as a water-soluble packet. Readily absorbed by plant foliage and roots to provide systemic control of feeding insects. Do not apply to freshly rooted cuttings. Can be used on limited kinds of crops. See label for complete plant list, rates, and specific instructions. Before treating large areas, spray on a few plants and observe for 2 weeks.
azadirachtin (unknown)		
Aza-Direct	greenhouses, shadehouses, nurseries, landscape	For use as a drench or as a foliar spray. Product controls target pests on contact or by ingestion. The product acts on pests by way of repellence, antifeedance and interference with the molting process. Apply when insects appear or feeding is noticed. The optimum pH range for application is 5-6.5. If needed, the pH of the water can be adjusted by use of a suitable buffering agent. See label for specific rates and instructions.
AzaGuard	shadehouse, greenhouse, interiorscapes, nursery, commercial landscapes	Acts as an insect growth regulator and does not control adult insects. However, it also has repellency towards some adult insect species. See label for specific rates and instructions. Use as a foliar spray or a drench. May be applied using any powered or manual pesticide application equipment, including but not restricted to high-volume, low-volume, ultra-low volume, electrostatic, fogging, and chemigation. May be used on greenhouse food crops. Will break down in spray tank mixtures that have pH values exceeding 7.0. The optimum pH for application is a range of 5.5 to 6.5. If needed, the pH can be adjusted by use of a suitable buffering agent. Always use this product promptly after mixing with water.
Azatin O	ornamentals, vegetables, and other horticultural crops	Insect growth regulator that may be applied by high or low volume application equipment, drenches, or via chemigation. Follow label directions.
Molt-X	greenhouses, shadehouses, nurseries	Molt-X is an insect growth regulator and does not control adult insects. However, Molt-X is also effective as a repellent towards adults of some species. Controls insects in the larval, pupal, and nymphal stages by interfering with the metabolism of ecdysone. For use as a foliar spray. Molt-X will break down in the spray solution if not used within 8 hours. Molt-X will break down in spray tank mixtures that have pH values exceeding 7.0. The recommended pH range is between 5.5 and 6.5. Apply when insects appear or feeding is noticed. If needed, the pH of the water can be adjusted by use of a suitable buffering agent. See label for specific rates and instructions.

6.7 Descriptions and Characteristics of Herbicides Registered for Nursery and Landscape Use

Acclaim Extra

Common Name: fenoxaprop

Formulation: 0.57EC

Uses: Postemergence control of annual and perennial grass weeds in established turfgrass, nursery crops, and landscape ornamentals, including many trees, shrubs, herbaceous perennials, and annuals.

	<i>Amount of active ingredient</i>	<i>Amount by formulation</i>
		0.57EC
<i>Per Acre</i>	0.1 to 0.3 lb.	3.5 to 39 oz.
<i>Per 1,000 sq. ft.</i>		0.08 to 0.90 oz.

Recommended rates for annual grass control:

<i>Growth stage</i>	<i>oz./A</i>	<i>oz./1,000 sq. ft.</i>
seedling (untillered)	13	0.30
1–2 tillers	20	0.46
3–4 tillers	28	0.64

Major Weeds Controlled: Annual grasses such as crabgrass, goosegrass, barnyardgrass, foxtails, and panicums.

Major Weeds Not Controlled: Annual bluegrass, broadleaf weeds, or sedges. Most perennial grasses are tolerant.

For Best Results: Apply to young (seedling to 3-tiller) actively growing grasses. May be tank mixed, following label directions with other pre- and postemergence herbicides. Thorough spray coverage is essential for optimal results. Flat fan nozzles are recommended. Addition of a surfactant is generally not recommended.

Cautions and Precautions: Do not use on Bar Harbor juniper, Salvia, Philodendron, Podocarpus, or Pittosporum. Check label for other species restrictions. Weed and crop tolerance may vary according to environmental conditions, and tolerance should be determined before extensive use. Do not apply more than a total of 120 oz/acre/growing season. Do not apply more than 28 oz./A to Kentucky bluegrass or zoysiagrass.

Residual Activity: Up to two weeks of residual control has been reported.

Volatility and Leaching Potential: Loss from volatility is minimal. Leaching is negligible.

Symptoms and Mode of Action: Growth inhibition occurs within 48 hr. Meristems turn black shortly thereafter. Yellow to red foliage develops in about 7 to 10 days, leading to death within about 14 days. Mechanism of action involves inhibition of lipid synthesis at the root and shoot meristems.

Manufacturer: Bayer Environmental Science

EPA Reg. No.: 432-950

Table 6.7.2. Weed susceptibilities to PREemergence herbicides.

KEY: ful =Full control is expected. par =Partial control is expected.		Barricade	Biathlon	*†Dacthal	Devrinol	*ΔDimension	Pendulum	*†Pennant Magnum	*Ronstar	Surflan	Treflan	XL 2G
Genus, species	Common name											
Broadleaves (continued)												
<i>Stellaria media</i>	chickweed, common	ful	ful	ful	ful	ful	ful			ful	ful	ful
<i>Taraxicum officinale</i>	dandelion		ful									
<i>Trifolium pratense</i>	clover, red											
<i>Trifolium procumbens</i>	clover, hop						ful					
<i>Trifolium repens</i>	clover, white											
<i>Urtica dioica</i>	nettle, stinging										ful	
<i>Urtica urens</i>	nettle, burning			ful								
<i>Veronica arvensis</i>	speedwell, corn					ful	ful					
<i>Veronica persica</i>	speedwell, Persian/birdseye	ful										
<i>Veronica</i> spp.	speedwell species								ful			
<i>Xanthium strumarium</i>	cocklebur, common											
Grasses and Sedges												
<i>Avena fatua</i>	oats, wild				ful	ful			ful	ful	ful	ful
<i>Avena sativa</i>	oats, volunteer											
<i>Barbarea vulgaris</i>	rocket, yellow											
<i>Bromus catharticus</i>	rescuegrass	par				ful						
<i>Bromus mollis</i>	brome, soft				ful	ful						
<i>Bromus rigidus</i>	brome, ripgut				ful	ful			ful			
<i>Bromus secalinus</i>	brome, cheat				ful	ful					ful	
<i>Bromus tectorum</i>	brome, downy				ful	ful						
<i>Cynodon dactylon</i>	bermudagrass											
<i>Cyperus compressus</i>	sedge, annual							ful	ful			
<i>Cyperus esculentus</i>	nutsedge, yellow							ful				
<i>Dactylis glomerata</i>	orchardgrass											
<i>Digitaria ischaemum</i>	crabgrass, smooth	ful		ful	ful	ful	ful	ful	ful	ful	ful	ful
<i>Digitaria sanguinalis</i>	crabgrass, hairy/large	ful	ful	ful	ful	ful	ful	ful	ful	ful	ful	ful
<i>Echinochloa crus-galli</i>	barnyardgrass	ful	ful	par	ful	ful	ful	ful	par	ful	ful	ful
<i>Eleusine indica</i>	goosegrass	ful	ful	par	ful	ful	ful	ful	ful	ful	ful	ful
<i>Elytrigia repens</i>	quackgrass											
<i>Eragrostis</i> spp.	lovegrass/stinkgrass	ful		ful	ful		par			ful	ful	ful
<i>Festuca arundinacea</i>	fescue, tall											
<i>Hordeum jubatum</i>	barley, foxtail					ful						
<i>Hordeum leporinum</i>	barley, wild/hare				ful	ful					ful	
<i>Hordeum pusillum</i>	barley, little					ful				ful		ful
<i>Hordeum vulgare</i>	barley, volunteer					ful						
<i>Leptochloa uninervia</i>	sprangletop, red	ful	ful		ful		ful	ful		ful	ful	ful
<i>Lolium multiflorum</i>	ryegrass, Italian/annual				ful	ful						ful
<i>Lolium perenne</i>	ryegrass, perennial					ful						
<i>Panicum capillare</i>	witchgrass	ful		ful	ful		ful	ful		ful	ful	ful
<i>Panicum dichotomiflorum</i>	panicum, fall	ful	ful		ful		ful	ful	ful	ful	ful	ful
<i>Phalaris canariensis</i>	canarygrass											
<i>Phleum pratense</i>	timothy											
<i>Poa annua</i>	bluegrass, annual	ful	ful	par	ful	ful	ful	ful	ful	ful	ful	ful

growth retardants can promote uniform flower bud initiation of Florist's azalea.

8.9 Management of Flower Size

A flower grows larger if immediately adjacent flowers in a spray are removed when the buds are young (about pea-sized). Disbudding to a single flower on a stem is performed manually on some cultivars of crops such as carnation, chrysanthemum, and rose.

In some cases, chemical growth regulators can promote a larger flower size. For certain plants the application of gibberellin containing products (ProGibb, GibGro) promotes cell expansion and thus final flower size. The synthetic cytokinin 6-benzyladenine (Configure) can promote an increase in the number of flower buds in Christmas cactus (*Schlumbergera* spp.). A formulation of

gibberellin and benzyladenine (Fascination) can be used to promote bract size in poinsettia.

8.10 Suppression of Senescence

Leaves, flower buds, and flowers can sometimes be retained on plants and cut flowers longer with chemical treatment. Leaf yellowing after storage, flower bud drop, and deterioration of open flowers is delayed in some crops by application of an inhibitor of ethylene action (EthylBloc) or gibberellin/benzyladenine formulation (Fascination).

8.11 Crop Defoliation

Crop defoliation is sometimes desirable for prevention of disease during storage. This procedure is also used to store rose bushes and dormant hydrangea plants. Ethylene (apple gas, ethylene-generating products such as Florel/Pistill (see Table 8.12.1), and several other chemicals have been successfully used for this purpose.

8.12 Growth Regulators for Greenhouse Crops and Herbaceous Ornamentals

Table 8.12.1. Growth regulators for greenhouse crops and herbaceous ornamentals

Common Name	Brand Name	Formulation	EPA Reg. No.	REI§
Defoliation				
ethephon	*Collate	21.7% F	85678-9-82917	48
	Florel Brand Ethephon	3.9% L	264-263	48
	Southern Ag Florel	3.9% L	264-263-829	48
	*Verve	21.7% L	228-660	48
Registered crops: greenhouse, shade house, and field-grown floriculture crops				
Registered method of application: spray				
Registered rates of application: determine optimal rates through trials as specified on the labels; see label for rates and methods for rose.				
Promoters of Stem Elongation				
gibberellic acid	GibGro 4LS	4% L	55146-62	4
	N-LARGE	4% L	57538-18	4
	ProGibb T&O	4% L	73049-15	12
Registered crops: ornamental crops, bedding plants, annual and perennial potted crops, field grown ornamentals and bulb crops, cut flowers, and turfgrass				
Registered methods of application: spray				
Registered rates of application: determine optimal rates through trials as specified on the labels; see label for rates and methods for pompom chrysanthemum peduncles, and stems of aster, delphinium, larkspur, Queen Anne's lace, stock, and sweet william and additional cut flowers.				
benzyladenine + gibberellins A4A7	Fascination	1.8%+1.8% L	73049-41	4
Registered crops: bedding plants, annual and perennial potted crops, bulb crops				
Registered method of application: spray				
Registered rates of application: determine optimal rates through trials as specified on the labels				
Promoters of Branching and/or Pinching				
dikegulac-sodium	Augeo	18.5% L	2217-932-59807	4
Registered crops: greenhouse, lath and shadehouse and nursery ornamentals				
Registered method of application: spray				

Table 10.2.1. Insecticides mentioned in this publication listed by product trade name

Trade Name	Active Ingredient	EPA Reg. No.	REI ¹ (hrs.)	IRAC Code ²	Organic- approved
SuffOil-X	horticultural oil	48813-1-68539	4	M	OMRI
Sultan Miticide	cyflumetofen	7969-337	12	25	
SunSpray Ultra-Fine	horticultural oil	86330-11	4	M	
*Talstar S	☞bifenthrin	279-3155	12	3	
*†Talus 70 DF	buprofezin	71711-21-67690	12	16	
*Tame 2.4EC	☞fenpropathrin	59639-77	24	3	
Tame/Orthene TR	☞fenpropathrin + ☞acephate	499-441	24	3 + 1B	
*TetraSan	etoxazole	59639-108	12	10B	
Triact 70	neem oil	70051-2-59807	4	18B + NS	OMRI
TriStar 8.5SL	☞acetamiprid	8033-106	12	4A	
Ultra-Pure Oil	horticultural oil	69526-5-499	4	M	
*Up-Star SC	☞bifenthrin	70506-23	12	3	
*Wisdom Flowable	☞bifenthrin	5481-519	12	3	

NOTES:

*Restricted-use pesticide; may be purchased and used only by certified applicators or used by someone under the direct supervision of a certified applicator

† Not for use in Nassau and Suffolk Counties; pesticide labels that indicate “Not for use on Long Island, N.Y.” means that use is prohibited in Nassau and Suffolk Counties only.

Δ Rate and/or other application restrictions apply. See label for more information.

☞ Active ingredient meets EPA criteria for acute toxicity to bees.

¹ Restricted-entry interval in accordance with Worker Protection Standard for Agricultural Pesticides.

² IRAC Code: Refer to Table 6.3.1 for Mode of Action classifications

Table 10.2.2. Insecticides mentioned in this publication listed by active ingredient

Active Ingredient	Trade Name	EPA Reg. No.	REI ¹	IRAC Code ²	Organic- approved
☞abamectin	Ardent 0.15EC	100-896	12	6	
	Avid 0.15EC	100-896	12	6	
☞acephate	1300 Orthene TR	499-421	24	1B	
	*Acephate 97 UP	70506-8	24	1B	
	*Orthene TTO 97	5481-8978	24	1B	
	*Orthene TTO WSP	5481-8971	24	1B	
acequinocyl	Shuttle O	66330-38-59807	12	20B	
☞acetamiprid	TriStar 8.5SL	8033-106	12	4A	
☞azadirachtin	Aza-Direct	71908-1-10163	4	18B	OMRI
	AzaGuard	70299-17	4	18B	OMRI
	Azatin O	70051-9-59807	4	18B	OMRI
	Molt-X	68539-11	4	18B	OMRI
	Neemix 4.5	70051-9	4	18B	OMRI
	Ornazin 3%EC	5481-476-67690	12	18B	
<i>Bacillus thuringiensis</i> subsp. <i>israelensis</i>	Gnatrol WDG	73049-56	4	11A1	OMRI
	DiPel PRO DF	73049-39	4	11B2	OMRI
	Javelin WG	70051-66	4	11B2	OMRI
	BioBit HP	73049-54	4	11B2	OMRI
<i>Beauveria bassiana</i> strain GHA	BotaniGard 22WP	82074-2	4	Biological	
	BotaniGard ES	82074-1	4	Biological	
☞bifenazate	Floramite SC	400-508-59807	12	25	
☞bifenazate + ☞abamectin	Sirocco	400-582-59807	12	6 + un	