2026-2027
New York and New England Management Guidelines for Greenhouse Floriculture and Herbaceous Ornamentals

Supplemental information available at: greenhouse.cornell.edu/pests-diseases/guidelines.

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

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2026-2027 New York and New England Management Guidelines for Greenhouse Floriculture and Herbaceous Ornamentals

Authors

Margery L. Daughtrey (Cornell University, Long Island Horticultural Research and Extension Center, Riverhead, NY; *Editor; disease management*)

Dan Gilrein (Cornell Cooperative Extension – Suffolk County, Riverhead, NY; *insect management*)

Michael Helms (Cornell Integrated Pest Management Pesticide Safety Education, Ithaca, NY; *pesticide information*)

Neil Mattson (Cornell University, Section of Horticulture, Ithaca, NY; *growth regulation*)

Andrew Senesac (*Retired.* Cornell Cooperative Extension – Suffolk County, Riverhead, NY; *weed management*)

Special Appreciation

Special thanks to John Sanderson (Cornell) and Leann Pundt (University of Connecticut) for their contributions to this Guideline over the years. Additional appreciation goes to Craig Cramer, Shari Romar, and Tom Weiler for their assistance in putting together these Guidelines.

Abbreviations and Symbols Used in This Publication

A ..... acre	G ..... granular	SP ..... soluble powder
AI ..... active ingredient	L ..... liquid	W ..... wettable
AS ..... aqueous suspension	PGR ..... plant growth regulator	WDG ..... water-dispersible granules
DF ..... dry flowable	REI ..... restricted-entry interval	WG ..... wettable granule
DG ..... dispersible granule	SC ..... soluble concentrate	WP ..... wettable powder
EC ..... emulsifiable concentrate	SG ..... soluble granule	WSG ..... water soluble granule
F, FL ..... flowable		WSP ..... water soluble packet

* ..... Federal restricted use pesticide.
*^{XX} .... Restricted use pesticide in state noted by superscript letters.
† ..... Not for use in Nassau and Suffolk Counties in New York State.
^ ..... Not allowed for use in New York or a New England state. See applicable pesticide summary table for details.
§ ..... Organic-acceptable pesticide.

Cover photo by: *Margery Daughtrey, Riverhead, NY.*

1 Pesticide Information

1.1 Pesticide Classification and Certification

Pesticides can be classified as general use or restricted use. **General use pesticides** may be purchased and used by anyone. **Restricted use pesticides** can only be purchased and used by a certified applicator or by someone under a certified applicator's supervision. In some cases, the pesticide label may limit use of a restricted use pesticide to only a certified applicator.

Certification (or licensing) and training requirements vary from state to state. Information on pesticide certification and classification is available from your state's pesticide safety education program or pesticide regulatory agency. See Table 9.2 in Chapter 9 for contact information.

1.2 Use Pesticides Properly

Using pesticides requires the user to protect their health, the health of others, and the environment. Keep in mind "pesticide use" is more than just the application. It includes mixing, loading, transporting, storing, or handling pesticides after the manufacturer's seal is broken; cleaning pesticide application equipment; and preparing a container for disposal. These activities require thoughtful planning and preparation. They also require you to follow state and federal laws and regulations intended to protect human health and the environment from the adverse effects pesticides may cause.

1.2.1 Plan Ahead

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

1.2.2 Move Pesticides Safely

Transporting pesticides carelessly can result in broken containers, spills, and contamination of people and the environment. Accidents can occur even when transporting pesticides 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 (PPE) needs depend on the pesticide being handled. **Required PPE are listed on pesticide labels.** Any required PPE is based on the pesticide's toxicity, route(s) of exposure, and formulation. Label-listed PPE are the minimum that must be worn when using a pesticide. You can always use more than what's listed!

The type of PPE used depends on the type and duration of the activity, where pesticides are being used, and the user's exposure. For example, mixing/loading procedures often require more PPE than when applying a pesticide. Studies show you are at a greater risk of accidental poisoning when handling pesticide concentrates. Pouring pesticide concentrates is the most hazardous activity.

Engineering controls are devices that help reduce a pesticide user's exposure. An example is a closed transfer system that reduces the exposure risk when dispensing pesticide concentrates. Consult the product label for more information on using engineering controls in place of PPE.

1.2.4 Avoid Drift, Runoff, and Spills

Pesticides that move out of the target area can injure people, damage non-target areas, and harm the environment. Choose weather conditions, pesticides, application equipment, pressure, droplet size, formulations, and adjuvants to minimize drift and runoff potential. Product labels may have specific application and/or equipment requirements to reduce issues with drift and runoff.

1.2.5 Avoid Equipment Accidents

Properly maintained and carefully used equipment contributes to safe pesticide application. The following guidelines will help you prevent accidents:

- Be sure to turn off machinery before making any adjustments.
- Do not allow children, pets, or unauthorized people to be 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

Existing buildings or areas within existing buildings are often used to store pesticides. Whether you build a new storage area or use existing buildings, consider these 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.

2 Integrated Pest Management

2.1 Introduction

Integrated pest management (IPM) is a systematic approach to managing pests that focuses on long-term prevention or suppression with minimal impact on human health, the environment, and non-target organisms. IPM incorporates all reasonable measures to prevent pest problems by properly identifying pests, monitoring population dynamics, and using cultural, physical, biological, or chemical pest population control methods to reduce pests to acceptable levels. An upgrading of the facility may be the key to management of some pests. For example, building a screened cover for vents or heating the floor may solve pest problems. The site history determines an IPM strategy; correct pest identification and better understanding of pest biology are critical to successful IPM. With a long-term perspective it is easier to see that an investment in IPM can pay for itself in a higher-quality crop and a cleaner environment. In reality, all growers currently practice some level of IPM. It is a site-specific strategy for managing pests that relies on understanding pest biology.

2.2 Basics of Integrated Pest Management

Many floral crops require specific cultural conditions and preventive strategies for pest management. Learning to grow a crop may take several seasons of personal experience, absorbing the details from colleagues, suppliers, special classes, extension programs, and reading. Unique crop susceptibilities to insects and disease and the features of a particular greenhouse determine which IPM tools will be necessary, such as screening, seed or bulb treatment, careful examination of newly arrived stock plants, or ventilation to reduce humidity. Each operation must develop its own IPM strategy to produce high-quality crops and thrive economically. Continuous education is required as new pests, crops, and management techniques appear.

Through each year's experience and attendance at professional meetings, you will increase your understanding of the impacts of sanitation, early detection of pests, proper timing of sprays, and effective use of new products. You will adopt new IPM practices over time as you increase your knowledge and skill levels. Many of the methods incorporated in an IPM strategy are logical operating procedures and basic horticultural practices. The following methods will produce a healthier crop, prevent many pest problems, and isolate pests to smaller areas in the greenhouse: preseason cleanup, cultural practices in IPM, scouting, careful identification of pests, examination of plants upon arrival, and keeping records. The primary goal of IPM is to optimize pest management in an economically and ecologically sound way.

2.2.1 Preseason Cleanup

Before introducing a new crop into the greenhouse, it is extremely important to eliminate the pests from the previous crop. Remove all plant debris from the site and compost it to kill pathogens and insect and mite pests. Clean up spilled media on benches because it is likely to contain fungal spores, nematodes, or insect eggs, larvae, or pupae. Remove any weeds in the greenhouse by hand pulling or use an herbicide followed by removal. Please refer to Chapter 7 – Weed Management in Greenhouses (and Table 7.2.1) before using an herbicide indoors and around the greenhouse to prevent damage to future crops. Clean the floor thoroughly. Next disinfest surfaces with a labeled product, being careful to wear goggles or other protective clothing as described on the label. Chlorine bleach may be used for pots, flats, and benches. If using bleach, make up fresh solutions regularly because the active components will dissipate after two hours. If cut flowers are grown in ground beds, pasteurization of the soil by steam is recommended. See Table 2.3.2.

A fallow period of four weeks will reduce the pest load considerably, but having an empty greenhouse for even two weeks can help. The house should be free of both crops and weeds. To determine whether thrips, fungus gnats, or other insects are present, set up yellow sticky cards and indicator plants after watering all benches and the floor. Close up the greenhouse (turn on the heat to break dormancy in winter). Observe any insects that are trapped on the cards after two days.

2.2.2 Cultural Practices in Integrated Pest Management

Proper plant nutrition balance, water pH, and fertilizer salt concentration are critical to plant health. Many insects and diseases have an advantage when the plant is compromised by excess amounts of nitrogen, excess fertilizer salts in solution, or deficiencies in calcium or other nutrients. Floral crops differ in their temperature requirements; recording maximum and minimum temperatures will help determine whether the heating or cooling is set appropriately for the species grown. Appropriate growing conditions allow the plant to develop its natural resistance to the fullest. Plant defense mechanisms include the physical barriers of strong stems, sturdy cell walls, and waxy cuticle as well as the ability to manufacture toxic response compounds to discourage insect feeding and resist infection.

Testing water and nutrient solutions for pH and electrical conductivity (EC) has become an industry standard practice since it is easy and inexpensive. Problems can be detected before a major crop loss. Where a large volume of any species is grown, such as chrysanthemum, snapdragon, or rose, it makes sense to send in foliar samples to a laboratory

Although heat is an effective sterilant, materials such as plastics may not withstand high-temperature treatment. Chemical disinfestants are more commonly used. Labeled products are listed in Table 2.3.1.

2.3.3 Pasteurization Methods (Steam and Fumigants)

Pasteurization of the growing medium is required if soil, sand, or other shallow-dug material exposed to pests is used. Table 2.3.2 lists methods of pasteurization of greenhouse growing media using heat.

Table 2.3.1. Disinfectants for benches and equipment

Chemical	Brand Name/Formulation	EPA Reg. No.	REI (hrs)
sodium hypochlorite	Multiple	Multiple	0
Use on inanimate surfaces with adequate ventilation. Useful for disinfesting pots, tools, benches, potting surfaces, and shelves. Will bleach clothing and can irritate eyes and unprotected skin. Use with care. Injury has occurred to poinsettias set upon capillary mats treated with sodium hypochlorite. Rinse treated areas thoroughly and ventilate after treatment. Use registered products labeled for use in greenhouses and/or surfaces being disinfested.			
ammonium chloride	Physan 20/20%	55364-5	12
	KleenGrow	81820-2	48
For control of fungi, bacteria, and algae on hard, inanimate surfaces. Registered for use in greenhouses.			
hydrogen dioxide + peroxyacetic acid	ZeroTol 2.0	70299-12	0 or 1
For use as a surface disinfestant to reduce problems with fungi, bacteria, and algae. Registered for use in greenhouses.			

Table 2.3.2. Sterilization methods (steam and fumigants)

Method/Chemical	Brand Name/Formulation	EPA Reg. No.
steam	NA	NA
Effective against weed seeds, fungi, bacteria, nematodes, and soil insects.		
Raise temperature of entire soil mass to 71°C (160°F) for 1/2 hr. Check with thermometer at center of soil mass. If an accurate temperature reading of 71°C cannot be assured, heat the soil to 82°C (180°F) for 1/2 hr. Add organic matter, superphosphate, and other fertilizers before sterilization. Avoid recontamination. Do not place unsterilized flats, pots, tools, or watering systems on sterilized areas. Leach soil after sterilization to reduce accumulation of soluble salts. Neutralizing amines such as diethylaminoethanol are often used in steam condensate lines to prevent acid corrosion. This material may cause chlorosis and growth abnormalities in many plants. Age sterilized soil for two to three weeks before use to allow toxic materials to dissipate.		
aerated steam	NA	NA
Effective against some weed seeds, pathogenic fungi, some bacteria, and nematodes as well as soil insects.		
Aerated steam treatment is preferable to steam treatment because it kills the pathogenic microorganisms and allows some of the beneficial organisms to survive. Aerated steam is best suited for use with potting media and well-raised benches. Add organic matter, fertilizers, and other soil amendments before sterilization. Introduce sufficient air into the steam line to lower the temperature to supply 60°C (140°F) to the soil mass. Measure temperature at the coldest spot with a thermometer until 60°C is reached, and continue treatment for 30 min. Take strict precautions to prevent recontamination of steamed soil.		
metam sodium	*Vapam	5481-468
Effective against nematodes, most weeds, and fungi.		
NOT FOR USE IN GREENHOUSES OR OTHER ENCLOSED ENVIRONMENTS. Follow all label precautions to ensure worker safety as well as all applicable use instructions.		

* Federal restricted use pesticide.

3 Effective Pesticide Use

3.1 Sources of More Information on Pesticides

More information about pesticides is available from your state's pesticide safety education program or your state pesticide regulatory agency. Contact information for these organizations is in Chapter 11 - Resources.

3.2 Compatibility of Pesticides

Insecticides, miticides, and fungicides in this publication are compatible with each other if these following guidelines are followed:

- Read the pesticide label carefully for compatibility statements.
- Avoid mixing different kinds of formulations; for example, do not mix emulsifiable concentrates and wettable powders.
- Do not mix pesticides with oils before compatibility is determined.
- Most pesticides are not compatible with alkaline solutions.
- Never mix herbicides with other pesticides. Apply herbicides with spray equipment reserved for their use only.

3.3 Phytotoxicity of Pesticides

Pesticide injury to the crop (phytotoxicity) can be avoided by following the pesticide label. If you are unsure of the effect of a certain pesticide on a crop or on a particular variety, apply the pesticide to a few trial plants before making a widespread treatment.

3.4 Pesticide Shelf Life

Pesticides should be purchased in reasonable quantities so that it is not necessary to store them for long periods. Most commercial formulations will retain their effectiveness for two or more years if stored above freezing temperatures under dry conditions with the container properly closed. Follow any label directions on proper storage.

The symptoms of ineffectiveness are listed in Table 3.5.1, but they may be useful in determining the value of your pesticide supply. A pesticide may be ineffective without showing these typical symptoms. If you are not sure that a pesticide supply is still effective, dispose of the material properly rather than take a chance.

Table 3.5.1. Typical indicators of deterioration for six types of pesticide formulations

Formulation	General Symptoms of Ineffectiveness
Emulsifiable concentrate (EC)	When a milky formation does not occur with the addition of water; when an insoluble sludge and/or separation or layering of the EC occurs.
Oil spray	When a milky formation does not occur with the addition of water and/or when an oil slick forms on the water surface.
Wettable powder	When lumping occurs and the powder will not suspend in water.
Dust	When excessive lumping occurs.
Granular	When excessive lumping or disintegration occurs.
Aerosol	Generally effective until the opening of the aerosol can becomes obstructed and no longer sprays or until the container is emptied.

3.5 Pesticide Formulations and Application Methods

The basic goal of pesticide application is to apply the pesticide to the target in a safe and efficient manner. Before purchasing a pesticide applicator, make critical comparisons of the equipment available. You should observe the equipment in operation and handle it yourself. The application equipment selected should be suited to the size of your operation. No one piece of equipment can adequately handle every situation you may encounter. Operators should check pesticide labels for equipment guidelines or to see if there are any restrictions on equipment use. Pesticide label rates based on dilution in a certain volume of carrier could limit the use of low-volume spray equipment.

3.5.1 Hydraulic Sprayers

Hydraulic sprayers operate with dilute sprays and with variable pressures up to several hundred pounds per square inch. When using a hydraulic sprayer, nozzles should be free of obstruction and have minimal wear on their openings. The pressure used should be maintained to achieve uniform coverage and desired canopy penetration. Follow any specific label requirements for nozzle types and spray droplet sizes.

Small, hand-held compressed air sprayers that apply sprays at pressure less than 60 psi usually cannot produce drops

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

4.1 Suggestions for Managing Fungicide Resistance

Only certain pathogens are highly likely to develop resistance to fungicides. Powdery mildews, downy mildews, and Botrytis blight are the foliar diseases for which resistance management is most crucial. Resistance is often first seen in greenhouse culture, so greenhouse operators should be especially careful stewards of effective chemistry.

The key to resistance management is not using a single-site mode of action material over and over again, week after week. Many of the older fungicides are multi-site mode of action materials that are not subject to this problem. Newer fungicides are more likely to have the single-site mode of action. To learn about which materials have the same mode of action, check the Fungicide Resistance Action Committee (FRAC) group codes listed in Table 4.1.1. FRAC codes are also listed along with each fungicide noted in section 4.2.

Table 4.1.1 Mode of Action Classification of Fungicides Used on Ornamentals

FRAC Code	Target Site	Chemical Class	Active Ingredient
1	tubulin polymerization	thiophanates	thiophanate-methyl
2	MAP/Histidine Kinase in osmotic signal transduction	dicarboximides	iprodione
3	C14-demethylase in sterol biosynthesis - demethylation inhibitor (DMI)	imidazoles	triflumizole
		triazoles	mefentrifluconazole, metconazole, myclobutanil, propiconazole, tebuconazole, triadimefon
4	RNA polymerase I	acylalanines	mefenoxam
5	Δ^{14}-reductase and $\Delta^{8}\rightarrow\Delta^{7}$-isomerase in sterol biosynthesis	piperidines	piperalin
7	complex II: succinate-dehydro-genase inhibitors (SDHI)	N-methoxy-(phenyl-ethyl)-pyrazole-carboxamdes	pydiflumetofen
		phenyl-benzamides	flutolanil
		pyrazole-4-carboxamides	benzovindiflupyr, fluxapyroxad
		pyridine-carboxamides	boscalid
		pyridinyl-ethyl-benzamides	fluopyram
		phenyl-oxo-ethyl thiophene amide	isofetamid
9	methionine biosynthesis	aniline-pyrimidines	cyprodinil
11	complex III: cytochrome bc1 (ubiquinol oxidase). Quinone outside inhibitors (QoI)	dihydro-dioxazines	fluoxastrobin
		imidazolinones	fenamidone
		methoxy-acrylates	azoxystrobin
		methoxy-carbamates	pyraclostrobin
		oximino acetates	kresoxim methyl, trifloxystrobin
12	MAP/Histidine-Kinase in osmotic signal transduction	phenylpyrroles	fludioxonil
14	lipid peroxidation	1,2,4-thiadiazoles	etridiazole
17	3-keto reductase, c4-de-methylation	hydroxyanilides	fenhexamid
19	chitin synthase	peptidyl pyrimidine nucleoside	polyoxin D zinc salt
21	Complex III: cytochrome bc1	cyano-imidazole	cyazofamid

4.2 Fungicides and Bactericides for Use in Greenhouses and Outdoors on Herbaceous Ornamentals

4.2.1 Fungicides and Bactericides

Table 4.2.1. Fungicides and bactericides mentioned in this publication ordered by trade name.

Use Site Key:
CL = commercial landscape; G = greenhouse; GC = garden center; I = interiorscape; L = landscape; N = nursery; NRL = non-residential landscape; O = ornamentals; OO = outdoor ornamentals

Symbol Key:
* = Federal restricted use pesticide; *NY = Restricted use pesticide in New York State; *VT = Restricted use pesticide in Vermont; † = Not for use in Nassau and Suffolk Counties NY; § = Organic-acceptable.

Trade Name	Active Ingredient	EPA Reg. No.	REI (hrs.)[1]	FRAC Code[2]	Use Site(s)	Not For Use In
*NY26GT (Bayer)	iprodione	432-888	12 or 24	2	G, N, NRL	
*NY26/36	iprodione/thiophanate methyl	228-630	12	2/1	G, N, NRL	
*NY3336 DG Lite	thiophanate-methyl	1001-70	12	1	G, N, L	
*NY3336-F	thiophanate-methyl	1001-69	12	1	G, N, L	
*NY6672 4.5F	thiophanate-methyl	59807-5	12	1	G, N, L	
*NY6672 50WP	thiophanate-methyl	59807-6	12	1	G, N, L	
§Actinovate SP	*Streptomyces lydicus* WYEC 108	73314-20	4	BM 02	G, N, L, I	
*NYAdorn	fluopicolide	59639-141	12	43	G, N, L	
Affirm WDG	polyoxin D zinc salt	68173-3-1001	4	19	G, N, L	
*NYAgri-Mycin 50	streptomycin sulfate	55146-98	12	25	G, N, L	NH
Aliette WDG Brand Fungicide	fosetyl-Al	432-890	12	P 07	G, N, L	
*NYAreca	aluminum tris (O-ethyl phosphonate)	53883-320-59807	12	P 07	G, N, NRL	
*NYAstun	isofetamid	71512-23-59807	12	7	G, N	
§ASPERELLO T34 Biocontrol	*Trichoderma asperellum* T34	87301-1-91594	12	BM 02	G, N	
Atticus Artavia 2SC	azoxystrobin	91234-74	4	11	G, N, L	MA
*NYAvelyo	mefentrifluconazole	7969-461	12	3	G, I, N	ME
§Aviv	*Bacillus subtilis* IAB/BS03	91473-1-88783	4	BM 02	G	VT
Azoxy 2SC Select	azoxystrobin	89442-21	4	11	G, N, L	
§Bacilirid Biological Fungicide	*Bacillus amyloliquefaciens* MBI 600	71840-8-89635	BM 02	12	G	ME, NH, RI, VT
Banner MAXX II	propiconazole	100-1326	12	3	N, L	
Banol Fungicide	propamocarb	101563-21	12	28	G, N (con-tainers)	
*NYBanrot 40 WP	etridiazole + thiophanate-methyl	58185-10	12	14 + 1	G, N	
*NYBanrot 8G	etridiazole + thiophanate-methyl	58185-23	12	14 + 1	G, N	
Boscalid Fungicide	boscalid	83529-164-53883	12	7	G, N, L, I	
§Botector	*Aureobasidium pullulans strains*	86174-3	4	BM 02	G, N	NH, RI
§BotryStop WP	*Ulocladium oudemansii* (U3 Strain)	68539-17	4	BM 02	G, N	
*NY†Broadform	fluopyram + trifloxystrobin	432-1537	12	7 + 11	G, N, L	
§Camelot O	copper octanoate	67702-2-67690	4	M 01	G, N, I	
§Cease	*Bacillus subtilis* QST 713	264-1155-68539	4	BM 02	G, N, NRL	
*NYChipco 26019 Flo (Bayer)	iprodione	432-888	12	2	G, N, NRL	
Chlorothalonil-Zn	chlorothalonil	19713-709	12	M 05	G, N	CT, NH, VT

4.3.9 Cercospora Leaf Spot

Where a concern: Herbaceous ornamentals in greenhouse, nursery and landscape
Time for concern: Spring
Key characteristics: Leaf spots which are host-specific. Especially likely on pansies, violas.

Management Option	*Guideline*
Cultural practices	Avoid wetting foliage; improve air circulation; scout for symptoms in plug trays and older crops.
Environmental control	Keep greenhouses at less than 85% relative humidity.

Compound(s)
Common name (FRAC Code)

Trade name	Use site(s)[1]	Comments
azoxystrobin (11)		
Precautions for all azoxystrobin materials: Do not use a silicone-based surfactant or use on leatherleaf fern. Do not exceed 2.0 fl oz/100 gal on pansy. For resistance management, make no more than 3 applications before rotating except use only twice before rotating to a fungicide with a different mode of action if managing *Pythium*.		
^Atticus Artavia 2SC	G, N, L	
Azoxy 2SC Select	G, N, L	
Dexter SC	G, N, L	
Endow 2 SC	G, N, L	
*[VT]^Harrell's ProtectMAX Azoxy 2SC T&O Fungicide	G, N, L, I	
*[VT]Heritage Fungicide	G, N, L	
*[VT]Heritage SC	G, N, L	
Strobe 2L	G, N, L	
azoxystrobin + benzovindiflupyr (11 + 7)		
*[NY]Mural	G, N, NRL	Test before applying to young bedding plants. Injury has been seen on some Rieger begonias and African violets. Do not apply to leatherleaf fern or other ferns for cut foliage.
***Bacillus amyloliquefaciens* D747 (*BM 02*)**		
§Triathlon BA	G, N	
§Double Nickel 55 Biological Fungicide	G, N	
Bacillus subtilis* QST 713 *(BM 02)		
§Cease	G, N, NRL	
chlorothalonil (M 05)		
Precautions for all chlorothalonil materials: 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. Rates for application to roses may be lower than for other crops. Any flowers may be injured; discontinue treatment to poinsettias before bract formation. Foliage should be dry or nearly dry. Do not use in mist-blowers or cold foggers in greenhouses.		
^Chlorothalonil-Zn	G, N	
Daconil Ultrex Turf Care	G, N, L	
Dornic 720F	G, N	
Echo Ultimate T&O	G, N	
Echo 720 T&O	G, N	
Lesco Manicure 6 FL	G, N	
Lesco Manicure Ultra	G, N	
Pegasus 6L	G, N	
Quali-Pro Chlorothalonil 720 SFT	G, N	
Quali-Pro Chlorothalonil DF	G, N	

5 Biology and Management of Arthropod Pests of Greenhouses and Herbaceous Ornamentals

5.1 Integrated Pest Management

Consumer and grower concerns about widespread pesticide use, possible health risks from pesticide residues, problems with insecticide resistance, and groundwater contamination have led to increased interest in pest management programs that reduce use of broad spectrum, non-selective pesticides. A pest management program based upon Integrated Pest Management (IPM) strategies helps address these issues. Successful IPM programs combine accurate pest identification and scouting with cultural, biological and chemical controls in an economically and ecologically sound manner.

5.1.1 Pest Identification

Pest management decisions are initially based on correct/accurate identification and understanding of the arthropod (insect or mite) pest's life cycle (egg to adult). Effective pest management depends on a greenhouse grower's ability to determine which life stages are present and susceptible to pest management tactics. For example, spraying a pest control material (in this case an insecticide) to manage whiteflies is most effective when they are in the nymphal stages. Mis-identification of arthropod pests or their life stages can be costly and lead to inadequate control such that arthropod pest populations increase to levels that result in crop damage. Arthropod pest identification may be improved by participating in state-wide workshops and IPM training programs; by referring to manuals, picture guides and fact sheets; by using a text and image search engine such as Google; and by submitting specimens to an Extension entomologist or diagnostic laboratory (see Chapter 11).

5.1.2 IPM Scouting and Decision-Making

Pre-Crop Site Evaluation
One month before introducing a crop, evaluate the entire greenhouse and surrounding area. Remove weeds, algae, "pet plants", and any plant or growing medium debris located throughout the greenhouse, particularly underneath benches, because these may provide refuge for certain arthropod pests. In addition, repair any drainage problems that may contribute to recurring arthropod pest outbreaks.

A fallow period (with greenhouses empty of crops and weeds) of at least four weeks may help to reduce pest pressure for the upcoming growing season. A break in production of as little as two weeks can help to reduce pest pressure.

Next, review previous pest problems in the greenhouse and current management strategies. Develop a plan of action to avoid or reduce these pest problems. You may easily prevent arthropod pest problems if you take the time to identify, analyze and correct problems before introducing crops.

Scouting
Scouting is the regular inspection of crops for insects, mites, diseases and cultural problems. The individual responsible for scouting could be an employee or an outside consultant. For employee scouts, it is best that scouting be the acknowledged responsibility, so that routine greenhouse tasks do not interfere with any scouting duties.

Scouting Tools
Helpful scouting tools include a 10x to 20x hand lens, Optivisor™, dissecting microscope, digital camera, sticky cards, flagging tape (of different colors), scouting forms, pH and electrical conductivity (EC) meters, disease detection kits (see www.agdia.com), and resource information (listed at the end of this section).

Inspection of Incoming Plants
Inspect incoming plant material for the presence of insects, mites, diseases, or cultural problems such as nutritional deficiencies. If feasible, quarantine infested or problematic plants in an isolated greenhouse or area so they can be treated with a pest control material (insecticide or miticide) before they are placed in production areas.

Scouting Program
Conduct regular weekly scouting through use of colored sticky cards, potato disks (to monitor for fungus-gnat larvae), random plant inspections, plant tapping and sentinel plants.

Yellow and Blue Sticky Cards
Yellow sticky cards are commonly used in greenhouses to scout for or monitor insect pest populations. These cards capture adult whiteflies, thrips, fungus gnats, shore flies, leafminers, and winged aphids. Remember that mites, mealybugs, scales, and nonwinged aphids don't fly, so they are not captured on sticky cards. Also, it is important to note that many beneficial insects including parasitoids and predators may also be caught on yellow sticky cards. For information on identifying greenhouse insects, view the PowerPoint presentation, "Identifying Some Pest and Beneficial Species on Your Sticky Cards" on the UConn IPM Web site; go to www.ipm.uconn.edu and click on "greenhouse", then "general".

Position yellow sticky cards throughout the greenhouse, approximately 3-to-4 per 1,000–ft^2 greenhouse space, or a minimum of one card per 1,000 ft^2, with additional cards placed near openings such as doors, vents and sidewalls. Use clothespins and stakes to vertically attach sticky cards 4 to 6 inches (10 to 15 cm) above the crop canopy. As

A less widely used banker plant system is the use of mullein (*Verbascum thapsus*) banker plants to rear *Dicyphus hesperus*, a generalist predator that feeds upon greenhouse whiteflies and mites. Mullein plants need to be grown for 10 to 12 weeks before incorporating them into the main crop. *D. hesperus* populations are slow to establish and this can take up to 2 months. *D. hesperus* also feeds upon plant fluids, however, populations can be increased by using *Ephestia (*sterile moth*)* eggs as a supplemental food source.

For more information on identifying beneficial insects, see references listed at the end of this chapter. However, it should be noted that habitat planters, in addition to attracting natural enemies, may also attract a variety of insect pests.

Table 5.2.1. Some biological control organisms for greenhouse pests

The following list includes some commercially available predators and parasitoids for use against certain insect and mite pests. Guidelines for use, including release rates, methods, and timing, should be available from commercial suppliers. Some of the following organisms are available as mixtures of more than one organism. Some organisms are available in several formulations for various release strategies.

	Natural Enemy	
Pest	**Common Name**	**Scientific Name**
Aphids	lady beetle	*Hippodamia convergens, Adalia bipunctata*
	aphid midge	*Aphidoletes aphidimyza*
	green lacewing	*Chrysoperla carnea, C. rufiliabrus*
	brown lacewing	*Micromus angulatus*
	aphid parasitoids	*Aphidius colemani*
		Aphidius ervi
		Aphidius matricariae
		Aphelinus abdominalis
Broad/cyclamen mites	predaceous mites	*Neoseiulus (Amblyseius) californicus*
		Neoseiulus (Amblyseius) cucumeris
		Amblyseius swirskii
Beetle larvae, grubs	insect-killing nematodes	*Steinernema feltiae, S. carpocapsae*
		S. kraussei
		Heterorhabditis bacteriophora
Citrus mealybug	mealybug destroyer	*Cryptolaemus montrouzieri*
	green lacewing	*Chrysoperla rufilabrus/carnea*
	mealybug parasitoid	*Leptomastix dactylopii*
	mealybug parasitoid	*Anagyrus pseudococci*
Fungus gnats	predaceous mite	*Stratiolaelaps (=Hypoaspis) scimitus*
	insect-killing nematode	*Steinernema feltiae*
	rove beetle	*Dalotia (=Atheta) coriaria*
Leafminer	leafminer parasitoids	*Diglyphus isaea*
		Dacnusa siberica
Brown soft scale	scale parasitoids	*Macroterys flavus*
		Metaphycus helvolus
	predaceous ladybeetle	*Chilocorus nigritus*
Shore flies	insect-killing nematode	*Steinernema carpocapsae*
	rove beetle	*Dalotia (=Atheta) coriaria*
Spider mites	predaceous mites	*Phytoseiulus persimilis*
		Phytoseiulus longipes
		Neoseiulus (Amblyseius) californicus
		Neoseiulus fallacis
	spider mite destroyer	*Stethorus punctillum*
	predaceous midge	*Feltiella acarisuga*
Western flower thrips	predaceous mites	*Neoseiulus (Amblyseius) cucumeris*
		Amblyseius degenerans
		Amblyseius swirskii
		Amblydromalus limonicus
		Strateolaelaps (=Hypoaspis) scimitus
	minute pirate bug	*Orius insidiosus*

Table 5.3.1 Mode of Action Classification of Insecticides and Miticides

Symbol key: * = Federal restricted use pesticide; *NY = Restricted use pesticide in New York State; † = Not for use in Nassau and Suffolk Counties NY; ^ = Not for use in all states; see Table 5.4.1 or 5.4.2 for details; § = Organic-acceptable.

IRAC Code	Primary Site of Action	Chemical Class	Trade Name(s) (Active Ingredient)
UNE	Botanical essence including synthetic, extracts and unrefined oils with unknown or uncertain MOA	neem oil	§Triact 70 (clarified hydrophobic extract of neem oil) §Rango
UNF	Fungal agents of unkown or uncertain MOA	*Beauveria bassiana* strains *Metarhizium brunneum* strains *Isaria fumosorosea* strains	BotaniGard, Mycotrol (Bb strain GHA), ^Velifer (Bb strain PPRI 5339) §LalGuard M52 OD (Mb strain F52) Ancora (If Apopka strain 97), §NoFly (If strain FE9901)
NS	Miscellaneous non-specific, multi-site action		(Tartar emetic)

5.4 Insecticides for Use in Greenhouses and Outdoors on Herbaceous Ornamentals

5.4.1 Insecticides

Table 5.4.1. Insecticides mentioned in this publication listed by product trade name

Use Site Key:

C = container-grown; CG = commercial greenhouse; CGO = commercially grown ornamentals; CL = commercial landscape; FG = field grown; G = greenhouse; I = interiorscape; L = landscape; LH = lathhouse; N = nursery; OO = outdoor ornamentals; RN = retail nursery; SH = shadehouse

Symbol Key:

* = Federal restricted use pesticide; *NY = Restricted use pesticide in New York State; † = Not for use in Nassau and Suffolk Counties NY; § = Organic-acceptable.

Trade Name	Active Ingredient	EPA Reg. No.	REI (hrs.)[1]	IRAC Code[2]	Use Site(s)	Not For Use In
1300 Orthene TR	acephate	499-421	24	1B	CG	ME
*NY†Acelepryn[3]	chlorantraniliprole	100-1489	4	28	G, I, L, N	
*NYAcephate 97 UP	acephate	70506-8	24	1B	G, OO	
Adept	diflubenzuron	70506-531-101563	12	15	G	RI
Akari 5SC	fenpyroximate	71711-4-67690	12	21A	G, N	
*NYAiraxo	flonicamid	91234-302	12	29	G, N, L, I	
*NY†Altus	flupyradifurone	432-1575	4	4D	G, LH, SH, L, N, I	
§Ancora	*Isaria fumosorosea* Apopka Strain 97	70051-19-59807	4	UNF	G, L, LH, N, OO, SH	
§Antixx Plus	iron phosphate + spinosad	67702-24	4	5 + UN	L	
Ardent 0.15EC	abamectin	100-896	12	6	FG, G, SH	ME
*NYAria	flonicamid	279-3287	12	29	G, N, L, I	
*NY†Armortech Balata[3]	chlorantraniliprole	89442-70	4	28	G, N, L, I	RI
Ascertain TR	bifenthrin	91234-70	12	3A	G	
*NY†Asenra[3]	chlorantraniliprole	91234-365	4	28	G, N, L, I	RI
*NY†Asenra G[3]	chlorantraniliprole	91234-362	4	28	L, I	RI
Attain TR	bifenthrin	499-472	12	3A	G	ME
*Avensis Insecticide/Miticide	abamectin	5481-627	12	6	FG, G, SH	ME
*NYAvatar PLX	acephate + imidacloprid	94396-29	24	1 + 4A	G, N, SH	
Avid 0.15EC	abamectin	100-896	12	6	FG, G, SH	

Table 5.4.2. Insecticides mentioned in this publication listed by active ingredient *(continued)*

Use Site Key:
C = container-grown; CG = commercial greenhouse; CGO = commercially grown ornamentals; CL = commercial landscape; FG = field grown; G = greenhouse; I = interiorscape; L = landscape; LH = lathhouse; N = nursery; OO = outdoor ornamentals; RN = retail nursery; SH = shadehouse

Symbol Key:
* = Federal restricted use pesticide; *NY = Restricted use pesticide in New York State; † = Not for use in Nassau and Suffolk Counties NY; § = Organic-acceptable.

Active Ingredient	Trade Name	EPA Reg. No.	REI (hrs.)[1]	IRAC Code[2]	Use Site(s)	Not For Use In
pyriproxyfen	Defiance	91234-58	12	7C	G, I, LH, OO, SH	
	Distance	59639-96	12	7C	G, I, LH, OO, SH	
	Fulcrum	59807-14	12	7C	G, OO	
s-kinoprene	Enstar AQ	2724-793	4	7A	G, I, LH, SH	
sodium ferric EDTA	IronFist Slug & Snail Bait	67702-32-87865	0	UN	G, OO,	
spinetoram + sulfoxyflor	XXpire	62719-676	12	5 + 4C	G, N	NY
spinosad	Conserve SC	62719-291	4	5	G, LH, N, OO SH	
	Contraxio SC	91234-281	4	5	G, N	MA, RI
	§Entrust	62719-282	4	5	G, N	
	§Estero SC	91234-1278	4	5	G, N, L	
	§Kibosh SC	62719-621	4	5	G, N, OO	
spiromesifen	Savate	432-1280	12	23	G, N, SH, C, FG	NY
spirotetramat	Kontos (Bayer)	432-1471	24	23	G, N, I	
	Kontos (Envu)	101563-130	24	23	G, N, I	RI
thiamethoxam	*NY†Flagship 25WG	100-955	See label	4A	G	
tolfenpyrad	Hachi-Hachi	71711-36-67690	12	21A	G, OO	NY
xanthan gum	§Entrapment CK	92988-3	4	UN	G, N, OO	CT, MA, ME, NH, RI, VT
	§Entrapment SP	92988-2	4	UN	G, N, OO	RI

NOTES:
[1] Restricted-entry interval in accordance with Worker Protection Standard for Agricultural Pesticides.
[2] IRAC Code: Refer to Table 5.3.1 for Mode of Action classifications.
[3] Use in Kings and Queens Counties in New York State prohibited.

5.4.2 Insecticides – Organic-acceptable

Table 5.4.3. Organic-acceptable insecticides mentioned in this publication listed by product trade name

Use Site Key:
CL = commercial landscape; FG = field grown; G = greenhouse; I = interiorscape; L = landscape; LH = lathhouse; N = nursery; OO = outdoor ornamentals; SH = shadehouse

Trade Name	Active Ingredient	EPA Reg. No.	REI (hrs.)[1]	IRAC Code[2]	Use Site(s)	Not For Use In
Ancora	*Isaria fumosorosea* Apopka Strain 97	70051-19-59807	4	UNF	G, L, LH, N, OO, SH	
Antixx Plus	iron phosphate + spinosad	67702-24	4	5 + UN	L	
Aza-Direct	azadirachtin	71908-1-10163	4	UN	G, L, N, SH	

5.5. Pesticide Products for Insects and Mites of Greenhouse Crops and Herbaceous Ornamentals

5.5.1 Ants

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

Compound(s) ***Common name (IRAC Code)*** Trade name	Use Site(s)[1]	Comments
bifenthrin (3A)		
*Banister 2EC	N, L, I	
*Bifender FC Insecticide		
*OnyxPro	I, L, N	Not for use on golf courses or sod farms on Long Island. See label for specific rates and instructions.
*Talstar S	G, L, N	
^Talstar Nursery Granular	G, N	
^Talstar One	G, I, L	
*Wisdom Flowable	G, L, N	
canola oil + pyrethrins (3A + UN)		
Pycana	G, N, SH, C	Do not use within 21 days of sulfur application.
iron phosphate + spinosad (5 + UN)		
§Antixx Plus	L	
lambda-cyhalothrin (3A)		
*Scimitar GC	G, N, SH	
*^Quali-Pro Lambda GC-O	G, N, L	
pyrethrins (3A)		
§PyGanic Specialty	G, N	
pyrethrins + piperonyl butoxide (3A + 27A)		
Pyrethrum TR	G	
spinosad (5)		
Conserve SC	G, LH, N, OO SH	
^Contraxio SC	G, N	Fire ants only.
§Entrust	G, N	
§Kibosh SC	G, N, OO	Fire ants only.
§Estero SC	G, N, L	Red imported fire ants only.
thiamethoxam (4A)		
Note: Many states have or will be placing restrictions on the use of products containing thiamethoxam. Consult your state pesticide regulatory agency to determine any requirements.		
*[NY]†Flagship 25WG	G	

Symbol key: * = Federal restricted use; ^ = Not for use in all states; see Table 5.4.1 or 5.4.2 for details; § = Organic-acceptable.
[1] Key: CGO = commercially grown ornamentals; FG = field grown; G = greenhouse; I = interiorscape; L = landscape; LH = lathhouse; N = nursery; OO = outdoor ornamentals; SH = shadehouse

5.5.2 Aphids

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

Compound(s) ***Common name (IRAC Code)*** Trade name	Use Site(s)[1]	Comments
abamectin (6)		
^Ardent 0.15EC	FG, G, SH	Not recommended for use on ferns and Shasta daisies. Suppression only. The addition of 0.6 to 1.0% horticultural spray oil may increase residual control, but use carefully according to label precautions.

6 Weed Management for Herbaceous Ornamentals

6.1 Weed Management Options

This guide is intended to help the commercial grower and landscaper choose a safe and effective weed management program for herbaceous ornamentals. Every attempt has been made to provide updated information on the currently registered herbicides. It is the applicator's responsibility, however, to check the most current state and federal registration information and to read and follow label directions.

Weed management is an integral and important part of all commercial production of herbaceous ornamentals. Weeds compete and interfere with plant growth and devalue the yield and quality of landscape-, container-, and field-grown ornamentals. It is important to develop a weed control strategy that uses all the available options at your disposal. These include preventive measures such as organic and inorganic mulches, preemergence herbicides, and sanitary practices that prevent weed seeds and vegetative parts from spreading. This is especially important in container operations where the potting medium is often soilless and initially weed-free.

Several pictorial guides and botanical identification keys are available to identify the most common weeds. It is essential to know the correct names to understand herbicide labels and control guidelines. Most weeds that infest ornamentals have one of four life cycles: summer annuals, which emerge in the spring, flower, and set seed before the first frost; winter annuals, which germinate at the end of the summer and overwinter as small dormant but green plants; biennials, which are similar to winter annuals but germinate earlier in the summer; or perennials, which survive more than two seasons and can propagate by seed or vegetative reproduction. Knowing the weed life cycle is key to determining the optimal timing of an herbicide application or cultural practice. It is important to scout the weed population during and after the growing season to assess the success of the weed control program. For instance, at the end of the season in the fall, escaped summer annuals and some perennials will be dead but can be identified by their characteristic "skeletons." Escaped winter annuals, biennials, and most perennial weeds will survive the winter as dormant rosettes, crowns, or underground rhizomes.

Several herbicides are available that can be used safely and legally to control weeds in herbaceous ornamentals. Herbicides are commonly classified by their mechanism of action and use pattern. Preemergence herbicides are applied before weeds emerge and generally provide residual control of weed seedlings for several weeks.

Postemergence herbicides, applied after the weeds have emerged, are of two types. *Contact herbicides* kill only the portion of the plant with which the herbicide actually comes in contact. Good spray coverage is important when using contact herbicides. *Systemic herbicides* are absorbed and move through the plant. These are useful for controlling the creeping roots and rhizomes of perennial weeds. With systemic herbicides, the weeds must be actively growing so that the herbicide can be fully translocated. The post emergence herbicides that are labeled for herbaceous ornamentals are nonresidual and have little or no soil activity.

In many situations, herbicides cannot be used or are not effective in controlling all the weeds. In these cases, cultivation and hand pulling are often the only available options. There are two important facts to remember about mechanical cultivation. Hoeing and tilling will control small annual weeds fairly well. However, successive flushes of germinating weeds, stimulated by the cultivation itself, need to be controlled on a two- to three-week cycle. Once residual herbicides are applied and activated with water, they need to be in intimate contact with the germinating weed seedlings to work well. Mechanical cultivation will often destroy this contact.

Hand pulling is often an important, if backbreaking, component of a weed management program. It should be considered when no other cultural or herbicide options are available and when weeds are present, that will disperse their seed by wind to weed-free areas.

6.2 Types of Herbaceous Ornamentals

Plant species that are listed on herbicide labels have been tested by independent researchers and approved or registered by state and federal agencies. Because of the great number of herbaceous species, it is possible to test only a small fraction of all plants that are commercially grown. Table 6.6.1 contains information regarding herbicides that are currently registered on herbaceous ornamentals.

Spring-flowering bulbs that are planted in the fall can be treated with preemergence herbicides shortly after planting and again in the spring. If the planting is late, herbicides can be applied in early spring before summer annual weeds germinate.

Annual bedding plants are generally seeded in the greenhouse and transplanted in the landscape bed in midspring. In most cases, preemergence herbicides should be applied after transplanting to weed-free soil and then irrigated in. Research has shown that cultivars of a species can respond differently to the same herbicides. If possible, always test any herbicide on a small area first.

Perennials are propagated in several ways – e.g., seed, transplants, vegetative division – and are grown in the landscape as well as containers and the field. Most preemergence herbicides should be applied soon after transplanting.

Cut flowers are usually started from transplants, divisions, or tubers but sometimes are grown in the field from seed. For the most part, preemergence herbicides should be applied after transplanting. Research has shown that most

Table 6.6.2 Herbicides for use on herbaceous ornamentals mentioned in this publication listed by active ingredient

Active Ingredient	Trade Name	EPA Reg. No.	REI (hrs.)[1]	Group Number(s)[2]	Not For Use In
benefin + oryzalin	Surflan XL 2G	70506-45-38167	24	3	
	XL 2G	70506-45-38167	24	3	NY
bentazon	Basagran T&O	7969-45	48	6	
clethodim	*[NY]Envoy Plus	59639-132	24	1	
clopyralid	*[NY]†Lontrel	62719-305	12	4	
dimethenamid-p	Tower	7969-239	12	15	NY, ME
dimethenamid-p+pendimethalin	Freehand	7969-239	24	15 + 3	NY
dithiopyr	*[NY]Dimension 2EW	62719-542	12	3	
	*[NY]Dimension Ultra40	62719-445	12	3	
diquat	*Diquat SPC 2L	228-675	24	22	
fenoxaprop	Acclaim Extra	432-950	24	1	
fluazifop-P-butyl	Fusilade II	100-1084	12	1	
	Ornamec OTT	2217-728	4	1	
glufosinate-ammonium	Finale	7969-444	12	10	NY
glyphosate	Glyfos 4EC	4787-31	12	9	
	Roundup Pro	524-475	4	9	
	Roundup ProMax	524-579	4	9	NH
indaziflam	*[NY]†Marengo	432-1518	12	29	
	*[NY]†Marengo G	432-1523	12	29	
	*[NY]†Specticle Flo	432-1518	12	29	
	*[NY]†Specticle G	432-1523	12	29	
isoxaben	Gallery 75 DF	62719-145	12	21	NY
	Gallery SC	62719-658	12	21	NY
isoxaben+dithiopyr	Fortress/Crew	59807-19/62719-742	12	21 + 3	NY
isoxaben+prodiamine	Gemini G	58185-180	12	21 + 3	NY
	Gemini L	53883-325-58185	12	21 + 3	NY
isoxaben+trifluralin	Snapshot TG	62719-175	12	21 + 3	NY
napropamide	Devrinol 2-XT	70506-301	24	15	
oryzalin	Surflan AS	70506-44	24	3	
	Surflan Flex	70506-308	24	3	
oxadiazon	*[NY]Ronstar Flo	432-1465	12	3	
oxyfluorfen + prodiamine	Biathlon	59807-12	24	14 + 3	
pelargonic acid	Scythe	10163-325	12	17	
pendimethalin	*[NY]Corral	58185-179	24	14	
	Pendulum 2G	241-375	24	14	ME
	Pendulum 3.3EC	241-341	24	14	ME
	Pendulum Aquacap	241-416	24	14	
prodiamine	Barricade 4FL	100-1139	12	3	
sethoxydim	Segment	7969-317	12	1	NY
	Segment II	7969-398	12	1	
s-metolachlor	*[NY]†Pennant Magnum	100-950	24	15	
trifluralin	Treflan	961-405	see label	21	

NOTES:
*[NY] Restricted use pesticide in New York State.
† Not for use in Nassau and Suffolk Counties NY.
.[1] Restricted-entry interval in accordance with Worker Protection Standard for Agricultural Pesticides.
[2] WSSA Classification of Herbicides according to Mode of Action.

*[NY]Envoy Plus

Common Name: clethodim
Formulation: 0.97EC

Uses: Selective postemergence control of annual and perennial grass weeds in conifer trees, non-bearing food crops, ornamentals, and noncrop areas. Can be used in Christmas tree farms, conifer nurseries, greenhouses, shadehouses, and around outdoor ornamentals including nurseries, parks, roadside plantings, and structure landscapes.

	Amount of active ingredient	***Amount by formulation***
		0.97EC
Per Acre	0.06 to 0.25 lb.	9 to 32 fl. oz.
Per 1,000 sq. ft.		0.2 to 0.7 fl. oz.

NOTE: Application on Long Island, New York is restricted to no more than 32 fl. oz. of *[NY]Envoy Plus (0.25 lb. AI) per acre per season.

Major Weeds Controlled: Many annual and some perennial grasses such as barnyardgrass, crabgrass, foxtails, bermudagrass, johnsongrass, and quackgrass. Annual bluegrass (*Poa annua*) is well controlled.

Major Weeds Not Controlled: Sedges and broadleaf weeds.

For Best Results: Apply to actively growing grasses that are not under environmental stress. Consult label for appropriate application method and timing for perennial grass control. Use nonionic surfactant only.

Cautions and Precautions: Unsatisfactory control may result if grasses are stressed or if grasses are not at the correct growth stage at the time of application. Do not cultivate treated grasses seven days before or seven days after application or control may be reduced. Do not apply a broadleaf herbicide within one day following application. Do not apply if rainfall is expected within one hour of application. Do not apply more than 0.5 lb AI per acre per season (and no more than 0.25 lb AI per acre per season on Long Island, New York). Sugar maples cannot be tapped for syrup within one year of application. Repeated use of postemergence grass herbicides with the same mode of action may lead to selection of resistant biotypes. See label for list of species in which foliar or flower speckling has been observed.

Residual Activity: No residual activity.

Volatility and Leaching Potential: Little volatility. Clethodim is rapidly degraded through activity of microbes and exposure to sunlight. The chemical is only slightly adsorbed and has the potential to leach, but degradation is very rapid so the actual amount of leaching is probably slight.

Symptoms and Mode of Action: Slow-acting herbicide; requires 7 to 14 days for control. Inhibits acetyl coenzyme A carboxylase, an important enzyme for many biosynthetic pathways. Classified as Group 1 Herbicide.

Manufacturer: Valent USA Corporation

EPA Reg. No.: 59639-132

*[NY] = Restricted use pesticide in New York State.

Table 6.7.1 Herbicides registered for use on ornamentals in the Northeast.

Key: *Ornamental Species:* Several = 6 species or more registered; Few = 1-4 species registered; None = 0 species registered
f/c = field and container c = container use only f = field
* = Federal restricted use pesticide; *NY = Restricted use pesticide in New York State; † = Not for use in Nassau or Suffolk Counties NY; ^ = Not for use in all states; see Table 6.6.1 or 6.6.2 for details.

				Ornamental species registered								
Application Type	**Long Island Use?**	**New York Use?**	**Trade Name**	*Shade Trees*	*Narrow Leaf (Needle) Evergreens*	*Broadleaf Evergreens*	*Deciduous Shrubs*	*Groundcovers (Woody &Semi - Woody)*	*Perennials (Herbaceous)*	*Ornamental Grasses*	*Bulbs*	*Annuals (Bedding Plants)*
post (over top)	no	yes	*NY†Lontrel	None	Several (f)	Few (f)	None	None	None	Several (f)	Few (f)	None
pre	no	yes	*NY†Marengo, *NY†Specticle	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	None	Few (f/c)	None	None	None
pre	yes	yes	Pendulum	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)
pre	no	yes	*NY†Pennant Magnum	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Few (f/c)	Few (f)	Several (f)
post directed	yes	yes	*NYReward	Several (f)	Several (f)	Several (f)	Several (f)	None	None	None	None	None
post directed	yes	yes	Roundup Pro	Several (f)	Several (f)	Several (f)	Several (f)	None	None	None	None	None
post directed	yes	yes	Scythe	Several (f)	Several (f)	Several (f)	Several (f)	Several (f)	Several (f)	Several (f)	Several (f)	Several (f)
post directed	yes	yes	Sedgehammer+	Several (f)	Several (f)	Several (f)	Several (f)	Several (f)	None	None	None	None
pre	yes/no	yes/no	Simazine (several)	Several (f)	Several (f)	Several (f)	Few (f)	None	None	None	None	None
pre	no	no	Snapshot	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Few (f/c)	Few (f/c)	None
pre	yes	yes	*NYSureguard	Several (f/c)	Several (f/c)	None	None	None	None	None	None	None
pre	yes	yes	Surflan	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Few (f/c)	Several (f/c)	Several (f/c)
pre	no	no	^Tower	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	None	None	Several
pre	yes	yes	Treflan	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)
pre	yes	yes	^XL 2G	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	None	Several (f/c)	Several (f/c)

7 Weed Management in Greenhouses

7.1 Weeds in the Greenhouse

Weeds such as creeping wood sorrel (*Oxalis corniculata*), hairy bittercress (*Cardamine hirsuta*), prostrate spurge (*Euphorbia humistrata*), and others are persistent problems in greenhouses. Wood sorrel, in particular, can rapidly spread throughout a greenhouse crop. Dehiscent seed pods which disperse seeds by propulsion allow seed to be spread throughout the greenhouse. Not only do these weeds detract from the perceived quality of plants produced, but some are also known to harbor insects such as whiteflies, mites, and thrips. Therefore, the removal of weeds from greenhouse pots, benches, and floors is important for aesthetic and pest management reasons. Several options are available to the greenhouse manager for controlling these pests. The first and most important control measure is sanitation. Keep weed propagules out of the greenhouse by using pasteurized soil or other seed-free growing media, introduce only "clean" plant materials, and use management strategies to control weeds outside of the greenhouse. Where possible, screening vents and windows will limit the introduction of wind-blown seed as well as insect movement. Concrete, gravel or mulched floors will also limit weed establishment. Despite these measures, some weeds will get into the greenhouse. These should be removed manually or by herbicide treatment before seed set. If the weeds are already established in the greenhouse they can be killed by (1) manual removal, (2) emptying the range and allowing the weeds to desiccate, or (3) using a postemergence herbicide (see Table 7.2.1). Each method will remove only the vegetation that is present; it does nothing to prevent reestablishment from seed that is present. Continuous removal can be expensive and time consuming. Currently, no residual herbicides are labeled for greenhouse use. Where weeds are a continual problem, clean up the area, remove soil and organic matter, or cover soil with gravel or mulch. Geotextile fabrics covered by gravel (or other mulches) have been successfully used in many greenhouses. Only under extremely rare circumstances would fumigation be recommended for weed control.

Slimes, algae and molds are not weeds, but their growth may also be a nuisance in the greenhouse. These organisms can establish in pots, beds or walkways under damp conditions. Surface growth of bacteria, algae or fungi may interfere with water penetration into growing media or create unsafe footing in walkways. New products that destroy membrane integrity of slimes and moldsare now available for enhanced control of these infestations both inside and outside the greenhouse.

7.2 Chemical Control of Greenhouse Weeds

A few herbicides are currently labeled for use inside greenhouses (see Table 7.2.1). There are very specific restrictions on the use of herbicides in greenhouses. Read the label and carefully observe any precautions. When applying any herbicide, the greenhouse should be well ventilated (but not so strongly that air currents will cause drift) or empty at the time of treatment. Although organic-type products, such as acetic acid herbicides, are now available for use outside the greenhouse, they are not labeled for use in the house. These products should be applied only external to the greenhouse, but with the same precautions: greenhouse windows and vents should be closed during external application to minimize drift and volatility issues.

7.3 Outside the Greenhouse

The primary objective of weed control outside the greenhouse is to eliminate a major source of airborne weed seed that can enter through doors or vents. Perennial weeds such as quackgrass or bindweed may also grow under the foundation and enter the greenhouse through openings or cracks. Many options are available for controlling these weeds outside the greenhouse. Mowing carefully around the greenhouse and perimeter will prevent the majority of weeds from setting seed. However, a vegetation-free strip is recommended immediately adjacent to the foundation. After application of a systemic herbicide such as Roundup Pro, use a geotextile fabric covered with gravel or other inorganic mulch to suppress annual and perennial weed growth. As an alternative to the geotextile or as a supplement when weeds grow in the mulch, postemergent and soil residual herbicides may be used. Treflan, Surflan (oryzalin), and others are often used successfully for short-term annual grass control. Apply Surflan with a calibrated sprayer to achieve a dosage of 2 to 4 lb. AI/A. Surflan may also be mixed with either *[NY]Reward or Roundup to obtain both pre- and post-emergent weed control. It is generally inadvisable to use auxin-type herbicides, such as those labeled for broadleaf weed control in turf, near greenhouses because of their volatility and the exceptional sensitivity of greenhouse crops to phenoxy herbicides. When spraying weeds around the greenhouse it is best to close windows and vents to prevent spray drift from entering the greenhouse. Vents and windows may be opened almost immediately after spraying.

Because no herbicide will provide complete control, some escapes will occur. Supplement the herbicide treatments with manual removal to keep the greenhouse clean. When sanitation, mulching, postemergence herbicide application, and manual weed removal are combined in a comprehensive weed management program, weed pressure will be reduced, thus resulting in less time spent removing weeds and lower costs for production. In addition, control of weeds under the benches will likely prevent weed infestation in plants growing on the benches and reduce other associated problems such as whitefly, mite, and thrips infestation. Try to prevent weeds in outdoor locations near the greenhouse from setting seed; frequent mowing will aid in prevention of seed formation and dissemination.

8 Growth Regulation of Greenhouse Crops and Herbaceous Ornamentals

8.1 Introduction

Growth regulation is the use of chemical or cultural techniques to alter plant form. This section discusses several aspects of crop growth regulation, such as promotion of growth and flowering, controlling plant height, promotion of branching, defoliation, and promoting longevity. Chemical plant growth regulators (PGRs) are regulated as pesticides and carry EPA registration numbers.

8.2 Chemical Growth Regulators

A chemical plant growth regulator is a natural or synthetic chemical substance that in very small quantities regulates or controls some aspects of plant growth, such as stem length, rooting, flowering, leaf abscission, fruiting, and winter hardiness. Regulators either promote or retard plant growth and development, depending on the chemical chosen and the concentration used.

In commercial production of greenhouse crops and herbaceous ornamentals, PGRs are used primarily to enhance rooting of cuttings, control plant size (i.e. growth retardants), and induce branching. Growth retardants may be primarily used to reduce stem elongation but sometimes also have the desirable effects of strengthening stems and and darkening foliar color. Depending on the product, PGRs may be applied as a spray on the foliage, as a drench to the root substrate, or as a dip for bulbs or cuttings. Table 8.5.1 summarizes label-approved uses of growth-regulating chemicals.

PGRs are not substitutes for good cultural practices. When intelligently used, however, they cut labor and overall production costs and create a better crop than could be achieved otherwise. Categorization of chemicals as stimulants or retardants of plant growth and development is not absolute. For example, ethylene occurs naturally in plants. Low concentrations may promote rooting of cuttings when used in combination with auxins. Elevated concentrations reduce postharvest life of floral crops, distort foliage of growing crops, retard elongation of some bulb crops, induce flowering of bromeliads, promote branching and retard flowering of stock plants of geraniums, and cause leaf abscission.

It should be noted that height management must take place while a plant is actively growing/elongating. Chemical growth regulators cannot be used to reduce the existing size of a plant, only to promote or reduce future growth. Because of the potentially detrimental effects of growth regulators on the crop (phytotoxicity of leaves or flowers), the environment, and the grower, label instructions should be read and followed carefully. When using a material for the first time on a crop or under unique environmental conditions, always conduct trials to determine optimal rates as indicated on the labels. Purchase growth regulators only in required quantities to ensure fresh stocks of chemicals. Consult the label for storage instructions. Once mixed with water, chemicals should be used immediately because solutions deteriorate if stored. ALWAYS CONSULT THE CHEMICAL LABEL FOR SPECIFIC INSTRUCTIONS ON APPLICATION.

8.3 Formulating & Applying PGRs

Recommended formulations vary with each product. Read the entire label and use the product according to directions. Measure the dosage accurately. Use only properly calibrated weighing and measuring devices.

Note: Dosage recommendations for some PGRs are based on the concentration of the applied solution, while recommendations for other PGRs are based on total active ingredient (a.i.) per pot.

8.3.1 Application Methods

PGRs are usually applied as sprays or drenches. The exceptions include bulb dips and soaks with lilies, pre–planting dips on rooted or unrooted cuttings and on plugs, pre–plant soil–surface sprays (PSS), gaseous fumigation (as per EthylBloc) and the use of rooting hormones on woody and herbaceous cuttings. When using a PGR for the first time, treat a small group of plants and keep accurate records of the response and of the prevailing plant status, and environmental and physical conditions in the greenhouse.

Many PGRs specify a single mode of application for the grower to use (e.g., *[NY]^B-Nine, Fascination and Florel are used solely as sprays). Others provide a choice; for example, A-Rest, Bonzi, ^Cycocel, Concise and Sumagic can be applied as drenches or sprays. In general, sprays require less labor and are more convenient. The actual amount of active ingredient used with a spray may be more or less than with a drench depending on the PGR (e.g. ^Cycocel uses considerably less a.i. as a spray, while Bonzi and A-Rest require less a.i. when applied as drenches). Sprays require great care to achieve uniform coverage. Multiple low concentration sprays produce the best quality crops. Drenches distribute the active ingredient more evenly within the plant, give better control, and are less likely to damage leaves.

8.3.2 Applying Sprays

- Spray only recently irrigated and turgid plants.
- Observe the proper waiting period between PGR spray application and overhead irrigation – several hours (until dry) for brand–name PGRs with the same active ingredients as *[NY]^B-Nine and ^Cycocel, while

Table 8.4.1. Greenhouse floral crop and herbaceous ornamental growth regulators mentioned in this publication listed by product trade name *(continued)*

Symbol key: *[NY] = Restricted use pesticide in New York State; § = Organic-acceptable

Trade Name	Active Ingredient	EPA Reg. No.	REI (hrs.)[1]	Not For Use In
Stimplex	kinetin	75287-3	4	
Sumagic	uniconazole-P	59639-37	12	
*[NY]Topflor	flurprimidol	67690-20	12	ME
*[NY]Verve	ethephon	228-660	48	

NOTES:
[1] Restricted-entry interval in accordance with Worker Protection Standard for Agricultural Pesticides.

Table 8.4.2. Greenhouse floral crop and herbaceous ornamental growth regulators mentioned in this publication listed by active ingredient

Symbol key: *[NY] = Restricted use pesticide in New York State; § = Organic-acceptable

Active Ingredient	Trade Name	EPA Reg. No.	REI (hrs.)[1]	Not For Use In
1-methylcyclopropene	EthylBloc	71297-1	ventilation requirements must be met	
	EthylBloc Sachet	71297-5-32258	ventilation requirements must be met	
ancymidol	Abide	62097-22-82917	12	
	A-Rest	67690-2	12	
benzyladenine	Configure	62097-19-82917	12	
	RiteWay	71368-60	12	ME
benzyladenine + gibberellins A4A7	Fascination	73049-41	4	
	Fresco	62097-6-82917	4	
chlormequat	Altercel	62097-21-59807	12	
	Citadel	62097-21-82917	12	
	Cycocel	241-74-59807	12	MA, ME, NH, RI, VT
daminozide	*[NY]B-Nine WSG	70506-532-59807	12	RI
	*[NY]Dazide 85 WSG	62097-17-82917	12	CT, MA, ME, VT
dikegulac-sodium	Atrimmec	2217-776	4	
ethephon	*[NY]Collate/*[NY]Motivate	228-660-82917	48	RI
	Florel Brand Pistill	54705-8	48	
	Southern Ag Florel	264-263-829	48	MA, ME
	*[NY]Verve	228-660	48	
flurprimidol	*[NY]Topflor	67690-20	12	ME
gibberellic acid	GibGro 4LS	55146-62	4	MA, ME, NH, NY, RI, VT
	N-LARGE	57538-18	4	CT, MA, ME, NH, RI, VT
	ProGibb LV PLUS T&O	73049-498	4	
	§ProGibb T&O	73049-15	12	MA, ME
	§ProGibb TVO	73049-15	12	MA, ME
indole-3-butyric acid	Advocate	62097-58-82917	12	RI, VT
	Clonex Rooting Gel	79664-1	-	
	Hormex 1	8281-6	12	CT, MA, ME, NH, RI, VT

Table 8.5.1. Growth regulators for greenhouse crops and herbaceous ornamentals

Symbol Key: *[NY] = Restricted use pesticide in New York State; ^ = Not for use in certain states; see Table 8.4.1 or 8.4.2 for details; § = Organic-acceptable.

Common Name	Brand Name	Formulation	EPA Reg. No.	REI (hrs.)
benzyladenine	Configure	2% L	62097-19-82917	12
	^RiteWay	1.9% L	71368-60	12
Registered crops: greenhouse and actively growing stock plants of Hosta spp.				
Registered method of application: spray				
Registered rates of application: determine optimal rates through trials as specified on the labels. See labels for rates for increasing flower buds on Christmas cactus (Schlumbergera spp.)				
benzyladenine + gibberellins A4A7	Fascination	1.8%+1.8% L	73049-41	4
	Fresco	1.8%+1.8% L	62097-6-82917	4
Registered crops: bedding plants, annual and perennial potted crops, bulb crops, promotes bract size in poinsettia				
Registered method of application: spray				
Registered rates of application: see label for rates and methods				
Promoters of Rooting				
indole-3-butyric acid	^Advocate	20% L	62097-58-82917	12
	Clonex Rooting Gel	0.3% L	79664-1	-
	^Hormex 1	0.1% P	8281-6	12
	^Hormex 8	0.8% P	8281-1	12
	Hormodin 1	0.1% P	59807-4	0
	Hormodin 2	0.3% P	59807-2	0
	Hormodin 3	0.8% P	59807-3	0
	^Hortus IBA Water Soluble Salts	20% P	63310-22	0
	^Miracle-Gro Fast Root 1	0.1% P	63310-19-62355	-
	^Rhizopon AA #1	0.1% P	63310-19	0
	^Rhizopon AA #2	0.3% P	63310-20	0
	^Rhizopon AA #3	0.8% P	63310-21	0
Registered crops: cuttings of ornamentals				
Registered method of application: dip of basal end of cuttings; ^Hortus IBA Water Soluble Salts may also be applied as a foliar spray to leafy cuttings after stick				
Registered rates of application: see label for rates and methods				
indole-3-butyric acid + 1-naphthaleneacetic acid	Dip 'N Grow	1.0% + 0.5% L	64388-1	24
Registered crops: cuttings of ornamentals				
Registered method of application: dip of basal end of cuttings				
Registered rates of application: see label for rates and methods				
Retardants of Stem Elongation				
ancymidol	Abide	0.0264% F	62097-22-82917	12
	A-Rest	0.0264% L	67690-2	12
Registered crops: ornamental plants grown in nurseries, greenhouses, shade houses, and interiorscapes (except Abide)				
Registered methods of application: spray, drench, chemigation				
Registered rates of application: determine optimal rates through trials as specified on the labels; see labels for rates for azalea, several bedding plant species, bleeding heart, bulb or fibrous root crops, chrysanthemum, columbine, delphinium, Easter lily, fatshedera, gardenia, hydrangea, liatris, plugs, poinsettia.				

Tips for Laundering Pesticide-Contaminated Clothing

Pre-Laundering Information

Remove contaminated clothing **before** entering enclosed tractor cabs.

Remove contaminated clothing **outdoors** or in an entry. If a granular pesticide was used, shake clothing outdoors. **Empty pockets and cuffs.**

Save clothing worn while handling pesticides for that use only. Keep separate from other clothing **before, during, and after** laundering.

Wash contaminated clothing after **each** use. When applying pesticides daily, wash clothing **daily**.

Clean gloves, aprons, boots, rigid hats, respirators, and eyewear by scrubbing with detergent and warm water. Rinse thoroughly and hang in a clean area to dry.

Take these **precautions** when handling contaminated clothing:

- Ventilate area.
- Avoid inhaling steam from washer or dryer.
- Wash hands thoroughly.
- Consider wearing chemical-resistant gloves.
- Keep out of reach of children and pets.

Air

Hang garments outdoors to air.

Pre-rinse

Use one of three methods:

1. Hose off garments outdoors.
2. Rinse in separate tub or pail.
3. Rinse in automatic washer at full water level.

Pretreat (heavily soiled garments)

Use heavy-duty liquid detergent.

Washer Load

Wash garments separate from family wash.

Wash garments contaminated with the same pesticide together.

Never use the “sudsaver” feature on your machine when laundering pesticide-soiled clothes.

Load Size

Wash only a few garments at once.

Water Level

Use full water level.

Water Temperature

Use **hot** water, as hot as possible.

Wash Cycle

Use **regular** wash cycle, at least 12-minutes.

Laundry Detergent

Use a **heavy-duty** detergent.

Use amount recommended on package or more for heavy soil or hard water.

Remember to use high-efficiency (HE) detergents in HE and front-loading washers.

Rinse

Use a **full** warm rinse.

Rewash

Rewash contaminated garments **two or three times** before reuse for more complete pesticide removal.

Dry

Line drying is preferable to avoid contaminating dryer.

Clean Washer

Run complete, but empty, cycle.
Use **hot water and detergent.**

Prepared by Charlotte Coffman, College of Human Ecology, Department of Fiber Science and Apparel Design, Cornell University

PESTICIDE EMERGENCY NUMBERS

Poison Control Centers

Poison Control Centers nationwide 800-222-1222

Emergency responder information on pesticide spills and accidents…

CHEMTREC 800-424-9300

For pesticide information…

National Pesticide Information Center 800-858-7378

To report oil and hazardous material spills in New York State…

NYS Spill Hotline 800-457-7362

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This publication is issued to further Cooperative Extension work mandated by acts of Congress of May 8 and June 30, 1914. It was produced with the cooperation of the U.S. Department of Agriculture, Cornell Cooperative Extension, New York State College of Agriculture and Life Sciences, New York State College of Human Ecology, and New York State College of Veterinary Medicine, at Cornell University. Cornell Cooperative Extension provides equal program and employment opportunities.

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Published by:
Cornell Integrated Pest Management
Pesticide Safety Education Program
CALS Surge Facility
525 Tower Road
Cornell University
Ithaca, New York 14853-7401
607.255.1866
Michael Helms, Managing Editor (mjh14@cornell.edu)