



2024-2025 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.

2024-2025 New York and New England Management Guidelines for Greenhouse Floriculture and Herbaceous Ornamentals

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Special Appreciation

Special appreciation goes to Mike Helms, 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	TBSP tablespoon
AI active ingredient	L liquid	TSP teaspoon
D dust	ME micro-encapsulated	W wettable
DF dry flowable	P pellets	WDG water-dispersible granules
DG dispersible granule	REI restricted-entry interval	WP wettable powder
E emulsion, emulsifiable	S soluble	WSB water soluble bag
EC emulsifiable concentrate	SC soluble concentrate	WSP water soluble packet
F or FLO flowable	SP soluble powder	
* Federal restricted use pesticide.		
* ^{NY} Restricted use pesticide in New York State.		
† Not for use in Nassau and Suffolk Counties in New York State.		
^ Not registered for use in New York State.		
§ Organic-acceptable pesticide.		

Every effort has been made to provide correct, complete, and up-to-date pest management information for New York State and New England at the time this publication was released for printing (October 2023). Changes in pesticide registrations, regulations, and guidelines occurring after publication are available from your state's Cooperative Extension specialists or the pesticide regulatory agency. Contact information for these agencies can be found in Chapter 9 – Resources. Trade names used herein are for convenience only. No endorsement of products is intended, nor is criticism of unnamed products implied.

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

The guidelines in this bulletin reflect the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this bulletin does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of particular discharge levels from agricultural land.

Cover photo by: Margery Daughtrey, Riverhead, NY.

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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 used 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 (licensing) and training requirements vary from state to state. Information on pesticide certification and classification is available from your state pesticide safety education program or state pesticide regulatory agency. See Chapter 11 - Resources 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 comply with 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 contribute 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 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 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.

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

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 small enough to ensure thorough coverage. These sprayers

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-dehydrogenase inhibitors (SDHI)	N-methoxy-(phenyl-ethyl)-pyrazole-carboxamides	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-demethylation	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
* ^{NY} 26GT (Bayer)	iprodione	432-888	12 or 24	2	G, N, NRL	
* ^{NY} 3336 DG Lite	thiophanate-methyl	1001-70	12	1	G, N, L	
* ^{NY} 3336-F	thiophanate-methyl	1001-69	12	1	G, N, L	
* ^{NY} 6672 4.5F	thiophanate-methyl	59807-5	12	1	G, N, L	
* ^{NY} 6672 50WP	thiophanate-methyl	59807-6	12	1	G, N, L	
§ Actinovate SP	<i>Streptomyces lydicus</i> WYEC 108	73314-20	4	BM 02	G, N, L, I	
* ^{NY} Adorn	fluopicolide	59639-141	12	43	G, N, L	
Affirm WDG	polyoxin D zinc salt	68173-3-1001	4	19	G, N, L	
* ^{NY} Agri-Mycin 50	streptomycin sulfate	55146-98	12	25	G, N, L	NH, VT
Aliette WDG Brand Fungicide	fosetyl-Al	432-890	12	P 07	G, N, L	
* ^{NY} Areca	aluminum tris (O-ethyl phosphonate)	53883-320-59807	12	P 07	G, N, NRL	
* ^{NY} Astun	isofetamid	71512-23-59807	12	7	G, N	
§ ASPERELLO T34 Biocontrol	<i>Trichoderma asperellum</i> T34	87301-1-91594	12	BM 02	G	VT
Atticus Artavia 2SC	azoxystrobin	91234-74	4	11	G, N, L	MA, VT
* ^{NY} Avelyo	mefentrifluconazole	7969-461	12	3	G, I, N	ME
§ Aviv	<i>Bacillus subtilis</i> IAB/BS03	91473-1-88783	4	BM 02	G	VT
Azoxystrobin Select	azoxystrobin	89442-21	4	11	G, N, L	
Banner MAXX II	propiconazole	100-1326	12	3	N, L	
Banol Turf and Ornamental Fungicide	propamocarb	432-942	24	28	G, N (containers)	
* ^{NY} Banrot 40 WP	etrifazole + thiophanate-methyl	58185-10	12	14 + 1	G, N	
* ^{NY} Banrot 8G	etrifazole + thiophanate-methyl	58185-23	12	14 + 1	G, N	
§ Bio-Tam 2.0	<i>Trichoderma asperellum</i> ICC 012 and <i>Trichoderma gamsii</i> ICC 080	80289-9	4/0	BM 02	G, N	NH, ME, VT
§ Botector	<i>Aureobasidium pullulans</i> strains	86174-3	4	BM 02	G, N	ME, NH, VT
§ BotryStop WP	<i>Ulocladium oudemansii</i> (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	<i>Bacillus subtilis</i> QST 713	264-1155-68539	4	BM 02	G, N	
* ^{NY} Chipco 26019 Flo (Bayer)	iprodione	432-888	12/24	2	G, N, NRL	
Chlorothalonil-Zn	chlorothalonil	19713-709	12	M 05	G, N	CT, RI, VT
§ Companion MAXX Liquid Biological Fungicide	<i>Bacillus amyloliquefaciens</i> strain ENV 503	94485-4	4	BM 02	G, N	
Compass Fungicide	trifloxystrobin	432-1371	12	11	G, N, L	
Concert II	chlorothalonil + propiconazole	100-1347	12	M 05 + 3	L, N	

Table 4.2.2. Fungicides and bactericides mentioned in this publication ordered by active ingredient.

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.

Active Ingredient	Trade Name	EPA Reg. No.	REI (hrs.) ¹	FRAC Code ²	Use Site(s)	Not For Use In
<i>Bacillus amyloliquefaciens</i> strain ENV 503	§Companion MAXX Liquid Biological Fungicide	94485-4	4	BM 02	G, N	
<i>Bacillus amyloliquefaciens</i> F727	§Stargus	84059-28	4	BM 02	G, N	
<i>Bacillus subtilis</i> var. <i>amyloliquefaciens</i> Strain FZB24	§Taegro 2	70127-12	4 or 0	BM 02	G, N	
<i>Bacillus amyloliquefaciens</i> MBI 600	§Serifel NG Biological Fungicide	71840-8	12	BM 02	G, N	
<i>Bacillus pumilus</i> GHA 180	Pro-Mix HPCC Biofungicide + Mycorrhizae	74267	0	BM 02	G	
<i>Bacillus subtilis</i> IAB/BS03	§Aviv	9143-1-86182	4	BM 02	G	VT
<i>Bacillus subtilis</i> MBI-600	Pro-Mix Biofungicide	74267-1	0	BM 02	G, N	MA, ME, RI
<i>Bacillus subtilis</i> QST 713	§Cease	264-1155-68539	4	BM 02	G, N	
basic copper sulfate	Cuproxat FL Copper Sulfate	55146-151	48/24	M 01	G, N, L	
BLAD	Problad Verde	84876-2	4	BM 01	G, N	ME
	Regime	84876-1-279	4	BM 01	G, N	MA
capric acid and caprylic acid	§Dart Fungicide EC	51517-11	24	NC	G, N	CT, ME, RI, VT
chlorothalonil	Chlorothalonil-Zn	19713-709	12	M 05	G, N	CT, RI, VT
	Daconil Ultrex	50534-202-100	12	M 05	G, N, L	
	Daconil Weather Stik	50534-209-100	12	M 05	G, N	
	Dornic 720F	91234-112	12	M 05	G, N	
	Echo 720 T&O	60063-7	12	M 05	G, N	
	Echo Ultimate T&O	60063-3	12	M 05	G, N	
	Echo Zn T&O	60063-4	12	M 05	G, N	
	Lesco Manicure 6 FL	60063-7-10404	12	M 05	G, N	
	Lesco Manicure Ultra	60063-3-10404	12	M 05	G, N	
	Pegasus 6L	70506-262	12	M 05	G, N	
	Quali-Pro Chlorothalonil 720 SFT	53883-310	12	M 05	G, N	
	Quali-Pro Chlorothalonil DF	53883-313	12	M 05	G, N	
chlorothalonil + thiophanate-methyl	* ^{NY} Spectro 90WDG	1001-72	12	B1+ M 05	G, N, L	
chlorothalonil + iprodione + thiophanate methyl + tebuconazole	* ^{NY} Quali-Pro Enclave	53883-309	12	M 05 + 2 + 1 + 3	G, N, L	
chlorothalonil + propiconazole	Concert II	100-1347	12	M 05 + 3	L, N	
<i>Clonostachys rosea</i> J1446	§Lalstop G46 WG	64137-13	4	BM 02	G, N	
	§Prestop WG	64137-13	4	BM 02	G, N	RI
	§Pvent	64137-13-70299	4	BM 02	G, N	
copper hydroxide	§CuPRO 5000	10163-395-67690	48	M 01	G, N, L	
	§Kalmor	91411-11-59807	48/24	M 01	G, N, L	
	§Kocide 50 DF	64744-5-70051	48/24	M 01	G, N, L	

Table 4.2.2. Fungicides and bactericides mentioned in this publication ordered by active ingredient.

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.

Active Ingredient	Trade Name	EPA Reg. No.	REI (hrs.) ¹	FRAC Code ²	Use Site(s)	Not For Use In
hydrogen dioxide + peroxyacetic acid + octanoic acid	X3	49538-4	See label	NC	G, N, L, GC	
iprodione	* ^{NY} 26GT (Bayer)	432-888	12 or 24	2	G, N, NRL	
	* ^{NY} Chipco 26019 Flo (Bayer)	432-888	12/24	2	G, N, NRL	
	* ^{NY} Lesco 18 Plus Turf and Ornamental Fungicide	432-888-10404	24	2	G, N, NRL	
	* ^{NY} OHP Chipco 26019	59807-16	12	2	G, N, NRL	
iprodione + thiophanate-methyl	* ^{NY} Lesco TwoSome Fungicide	228-630-10404	24	2 + 1	G, N	
isofetamid	* ^{NY} Astun	71512-23-59807	12	7	G, N	
laminarin	Vacciplant	83941-2-66330	4	P4	G, N, L	
mancozeb	* ^{NY} Fore 80 WP Rainshield	62719-388	24	M3	G, N	
	Koverall Fungicide	279-3580	24	M3	G, N	
	* ^{NY} Lesco Mancozeb DG T&O	62719-402-10404	24	M3	G, N	
	* ^{NY} Manzate Pro-Stick T&O Fungicide	70506-234	24	M3	G, N	
	Protect DF	1001-77	24	M3	G, N	
mancozeb + azoxystrobin	* ^{NY} Dexter Max	70506-329	24	M3 + 11	G, N	
mandipropamid	Micora	100-1388	4	40	G, N	
mefenoxam	Subdue GR	100-794	0 or 48	4	G, N, L	
	SubdueMAXX	100-796	48	4	G, N, L	
mefentrifluconazole	* ^{NY} Avelyo	7969-461	12	3	G, I, N	ME
metam-sodium	*Vapam HL	5481-468	see label		G	
metconazole	Tourney	59639-144	12	3	G, N, L	
mineral oil	SuffOil-X	48813-1-68539	4	NC	G, N	
	Ultra-Pure Oil Horticultural	69526-5-499	4	NC	G, N	
mono- and dibasic sodium, potassium and ammonium phosphites	Phostrol	55146-83	4	P 07	G, I, L, N	
mono- and di-potassium salts of phosphorous acid	Reliant	83416-1	4	P 07	G, I, L, N	
mono- and di-potassium salts of phosphorous acid + hydrogen peroxide	OxiPhos	70299-22	4	P 07 + NC	G, N, L	
myclobutanil	* ^{NY} †Eagle 20 EW	62719-463	24	3	G, N, L	
	* ^{NY} †Quali-Pro Myclobutanil 20EW T&O	53883-431	24	3	G, N, L	
neem oil extract, clarified	§Triact 70	70051-2-59807	4	46	G, N, L	
neem oil, cold pressed	§Ecoworks EC	89152-4	4	NC	G, N, L	
	§Rango	88760-10	4	46	G, N	
oxathiapiprolin	Segovis	100-1533	4	49	G, N, NRL	

4.2.2 Organic-acceptable Fungicides and Bactericides

Table 4.2.3. Organic-acceptable 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

Trade Name	Active Ingredient	EPA Reg. No.	REI (hrs.) ¹	FRAC Code ²	Use Site(s)	Not For Use In
Actinovate SP	<i>Streptomyces lydicus</i> WYEC 108	524-641	4	BM 02	G, N, L	CT, ME, VT
ASPERELLO T34 Biocontrol	<i>Trichoderma asperellum</i> T34	87301-1-91594	12	BM 02	G	VT
Aviv	<i>Bacillus subtilis</i> IAB/BS03	91473-1-88783	4	BM 02	G	VT
Bio-Tam 2.0	<i>Trichoderma asperellum</i> ICC 012 and <i>Trichoderma gamsii</i> ICC 080	80289-9	4/0	BM 02	G, N	NH, ME, VT
Botector	<i>Aureobasidium pullulans</i> strains	86174-3	4	BM 02	G, N	ME, NH, VT
BotryStop WP	<i>Ulocladium oudemansii</i> (U3 Strain)	68539-17	4	BM 02	G, N	
Camelot O	copper octanoate	67702-2-67690	4	M 01	G, N, L	
Cease	<i>Bacillus subtilis</i> QST 713	264-1155-68539	4	BM 02	G, N	
Companion MAXX Liquid Biological Fungicide	<i>Bacillus amyloliquefaciens</i> strain ENV 503	94485-4	4	BM 02	G, N	
Cosavet-DF Edge	sulfur	70905-1	24	M 02	N	CT, MA
CuPRO 5000	copper hydroxide	10163-395-67690	48	M 01	G, N, L	
Cuproxat FL Copper Fungicide	basic copper sulfate	55146-151	48/24	M 01	G, N, L	
Dart Fungicide EC	capric acid and caprylic acid	51517-11	24	NC	G, N	CT, ME, RI, VT
Double Nickel 55 Biofungicide	<i>Bacillus amyloliquefaciens</i> Strain D747	70051-108	4	BM 02	G, N	
Ecoswing Botanical Fungicide	<i>Swinglea glutinosa</i> extract	10163-357	4	BM 01	G, N, L	
Ecoworks EC	neem oil, cold pressed	89152-4	4	NC	G, N, L	
§Grotto	copper octanoate	67702-2-59807	4	M 01	G, N, I	
Howler Fungicide	<i>Pseudomonas chlororaphis</i> strain AFS009	91197-3-92488	4	BM 02	G, N	
Kaligreen	potassium bicarbonate	11581-2	4	NC	G, N	
Kalmor	copper hydroxide	91411-11-59807	48/24	M 01	G, N, L	
Kocide 50 DF	copper hydroxide	64744-5-70051	48/24	M 01	G, N, L	
Kocide 2000-O	copper hydroxide	91411-10-70051	48/24	M 01	G, N, L	
Kopa Insecticidal Soap	potassium salts of fatty acids	67702-11-59807	12	NC	G, N	
Lalstop G46 WG	<i>Clonostachys rosea</i> J1446	64137-13	4	BM 02	G, N	RI
Lalstop K61 WP	<i>Streptomyces griseoviridis</i> K61	64137-5	4	BM 02	G, N	RI
Microthiol Disperss	sulfur	70506-187	24	M 02	G, N	
MilStop SP	potassium bicarbonate	68539-13	1	NC	G, N	
Mycostop Biofungicide	<i>Streptomyces griseoviridis</i> K61	64137-5	4	BM 02	G, N	VT
Nu-Cop 50WP	copper hydroxide	45002-7	24	M 01	G, N, L	ME
Nu-Cop HB	copper hydroxide	42750-132	48	M 01	G, N, L	
Obtego Fungicide and Plant Symbiont	<i>Trichoderma asperellum</i> (ICC 012) and <i>T. gamsii</i> (ICC080)	80289-9-67690	4/0	BM 02	G, N	
Prestop WG	<i>Clonostachys rosea</i> J1446	64137-13	4	BM 02	G, N	RI
Rango	neem oil, cold pressed	88760-10	4	46	G, N	
Regalia CG	<i>Reynoutria sachalinensis</i> extract	84059-3	4	P 05	G, N	
RootShield WP	<i>Trichoderma harzianum</i> Rifai KRL-AG2	68539-7	4	BM 02	G, N, L	
RootShield Granules	<i>Trichoderma harzianum</i> Rifai T-22	68539-3	4	BM 02	G, N	

Table 4.2.4. Organic-acceptable fungicides and bactericides mentioned in this publication ordered by active ingredient.

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

Active Ingredient	Trade Name	EPA Reg. No.	REI (hrs.) ¹	FRAC Code ²	Use Site(s)	Not For Use In
copper hydroxide	CuPRO 5000	10163-395-67690	48	M 01	G, N, L	
	Kalmor	91411-11-59807	48/24	M 01	G, N, L	
	Kocide 50 DF	64744-5-70051	48/24	M 01	G, N, L	
	Kocide 2000-O	91411-10-70051	48	M 01	G, N, L	
	Nu-Cop 50WP	45002-7	24	M 01	G, N, L	ME
	Nu-Cop HB	42750-132	48	M 01	G, N, L	
copper octanoate	Camelot O	67702-2-67690	4	M 01	G, N, L	
	Grotto	67702-2-59807	4	M 01	G, N, I	
neem oil extract, clarified	Triact 70	70051-2-59807	4	46	G, N, L	
neem oil, cold pressed	Ecoworks EC	89152-4	4	NC	G, N, L	
	Rango	88760-10	4	46	G, N	
potassium bicarbonate	Kaligreen	11581-2	4	NC	G, N	
	MilStop SP	68539-13	1	NC	G, N	
potassium salts of fatty acids	Kopa Insecticidal Soap	67702-11-59807	12	NC	G, N	
<i>Pseudomonas chlororaphis</i> strain AFS009	Howler Fungicide	91197-3-92488	4	BM 02	G, N	
	Zio Fungicide	67690-77	4	BM 02	G, N, L	
<i>Reynoutria sachalinensis</i> extract	Regalia CG	84059-3	4	P 05	G, N	
rhamnolipid biosurfactant	Zonix Biofungicide	72431-1	4	NC	G, NL	
<i>Streptomyces griseoviridis</i> K61	Lalstop K61 WP	64137-5	4	BM 02	G, N	
	Mycostop Biofungicide	64137-5	4	BM 02	G, N	VT
	Actinovate SP	524-641	4	BM 02	G, N, L	CT, MA, VT
sulfur	Auron DF	62562-4-94100	24	M 02	G, N, L	
	Cosavet-DF Edge	70905-1	24	M 02	N	CT, MA
	Microthiol Disperss	70506-187	24	M 02	G, N	
<i>Swinglea glutinosa</i> extract	Ecoswing Botanical Fungicide	10163-357	4	BM 01	G, N, L	
<i>Trichoderma asperellum</i> T-34	§ASPERELLO T34 Biocontrol	87301-1-91594	12	BM 02	G	VT
<i>Trichoderma asperellum</i> (ICC 012) and <i>T. gamsii</i> (ICC080)	Bio-Tam 2.0	80289-9	4/0	BM 02	G, N	NH, ME, VT
	Obtego Fungicide and Plant Symbiont	80289-9-67690	4/0	BM 02	G, N	
<i>Trichoderma harzianum</i> and <i>Trichoderma virens</i> G-41	RootShield Plus Granules	68539-10	4	BM 02	G, N	
<i>Trichoderma harzianum</i> Rifai KRL-AG2	RootShield WP	68539-7	4	BM 02	G, N, L	
<i>Trichoderma harzianum</i> Rifai T-22	RootShield Granules	68539-3	4	BM 02	G, N	
<i>Trichoderma harzianum</i> Rifai T-22 and <i>Trichoderma virens</i> G-41	RootShield Plus WP	68539-9	4	BM 02	G, N	
<i>Ulocladium oudemansii</i> (U3 Strain)	BotryStop WP	68539-17	4	BM 02	G, N	

NOTES:¹ Restricted-entry interval in accordance with Worker Protection Standard for Agricultural Pesticides.² FRAC Code: Refer to Table 4.1.1 for Mode of Action classifications.

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

4.3.1 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)		
Precautions for all azoxystrobin materials: Do not use a silicone-based surfactant. Do not exceed 2.0 fl oz/100 gal on pansy.		
Atticus Artavia 2SC	G, N, L	
Azoxystrobin 2SC Select	G, N, L	
Dexter SC	G, N, L	
Endow 2 SC	G, N, L	
* ^{VT} Heritage Fungicide	G, N, L	
* ^{VT} Heritage SC	G, N, L	
Strobe 2L	G, N, L	
azoxystrobin + benzovindiflupyr (11 + 7)		
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.		
* ^{NY} Mural	G, N, NRL	
Bacillus amyloliquefaciens D747 (BM 02)		
§Triathlon BA	G, N	
§Double Nickel 55	G, N	
Biological Fungicide		
Bacillus amyloliquefaciens strain ENV 503 (BM 02)		
§Companion MAXX	G, N	Do not mix with copper-based materials, concentrated acids, solvents, oxidizing agents or bactericides.
Liquid Biological Fungicide		
Bacillus subtilis QST 713 (BM 02)		
§Cease	G, N	
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 82.5%	G, N, L	
Daconil Weather-Stik 54F		
Dornic 720F	G, N	
Echo Ultimate T&O	G, N	
Echo Zn 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	

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–ft² greenhouse space, or a minimum of one card per 1,000 ft², 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

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	
^{*NY} Acephate 97 UP	acephate	70506-8	24	1B	G, OO	
Adept	diflubenzuron	400-477	12	15	G, LH, SH	ME, NH, VT
Akari 5SC	fenpyroximate	71711-4-67690	12	21A	G, N	
^{*NY} †Altus	flupyradifurone	432-1575	4	4D	G, LH, SH, L, N, I	
§Ancora	<i>Isaria fumosorosea</i> Apopka Strain 97	70051-19-59807	4	UNF	G, L, LH, N, OO, SH	
§Antixx Plus	iron phosphate + spinosad	67702-24	4	5 + UN	G, L, N	
Ardent 0.15EC	abamectin	100-896	12	6	FG, G, SH	ME
^{*NY} Aria	flonicamid	279-3287	12	29	G, N, L	
Ascertain TR	bifenthrin	91234-70	12	3A	G	
Attain TR	bifenthrin	499-472	12	3A	G	ME
*Avensis	abamectin	5481-627	12	6	FG, G, SH	ME
Insecticide/Miticide						
^{*NY} Avatar PLX	acephate + imidacloprid	94396-29	24	1 + 4A	G, N, SH	
Avid 0.15EC	abamectin	100-896	12	6	FG, G, SH	
§Aza-Direct	azadirachtin	71908-1-10163	4	UN	G, L, N, SH	
§AzaGuard	azadirachtin	70299-17	4	UN	CL, G, I, N, SH	
§Azatin O	azadirachtin	70051-9-59807	4	UN	G, I, N, OO, SH	
§Azatrol	azadirachtin	2217-836	4	UN	G, I, N, OO, SH MA, NY	
Beethoven TR	etoxazole	499-533	4/24	10B	G	
^{*NY} Benefit 60WP	imidacloprid	42750-153-58185	12	4A	G, I, N	
§BioBit HP	<i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	73049-54	4	11A	G	
§BioCeres WP	<i>Beauveria bassiana</i> strain ANT-03	89600-2	4	UNF	G, L	
BotaniGard 22WP	<i>Beauveria bassiana</i> Strain GHA	82074-2	4	UNF	CL, G, I, N, SH	
BotaniGard ES	<i>Beauveria bassiana</i> Strain GHA	82074-1	4	UNF	G, L, N	
BotaniGard Maxx	pyrethrins + <i>Beauveria bassiana</i> Strain GHA	82074-5	12	3A + UNF	G, I, L, N	ME
Citation	cyromazine	100-667	12	17	C, G, L, LH, SH	ME
Conserve SC	spinosad	62719-291	4	5	G, LH, N, OO SH	
^{*NY} Deadline Bullets	metaldehyde	5481-507	12	UN	G, N, OO	ME, NH
^{*NY} Decathlon 20WP	cyfluthrin	59807-17	12	3A	G, I, L, N	
Defiance	pyriproxyfen	91234-58	12	7C	G, I, LH, OO, SH	

Table 5.4.2. Insecticides mentioned in this publication listed by active ingredient

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
abamectin	Ardent 0.15EC	100-896	12	6	FG, G, SH	ME
	*Avensis Insecticide/Miticide	5481-627	12	6	FG, G, SH	ME
	Avid 0.15EC	100-896	12	6	FG, G, SH	
acephate	1300 Orthene TR	499-421	24	1B	CG	ME
	* ^{NY} Acephate 97 UP	70506-8	24	1B	G, OO	
	* ^{NY} Orthene TTO 97	5481-8978	24	1B	G, N, OO	ME
	* ^{NY} Orthene TTO WSP	5481-8971	24	1B	G, N, OO	ME
acephate + imidacloprid	*Avatar PLX	94396-29	24	1 + 4A	G, N, SH	
acequinocyl	Shuttle O	66330-38-59807	12	20B	CG, N, SH	
acetamiprid	* ^{NY} TriStar 30 SG	8033-94	12	4A	G, LH, OO, SH	
	* ^{NY} TriStar 70 WSP	8033-22	12	4A	G, LH, OO, SH	
	* ^{NY} TriStar 8.5 SL	8033-106-1001	12	4A	G, LH, OO, SH	
afidopyropen	* ^{NY} †Ventigra	7969-393	12	9D	G, I, L, LH, N, SH	
azadirachtin	§Aza-Direct	71908-1-10163	4	UN	G, L, N, SH	
	§AzaGuard	70299-17	4	UN	CL, G, I, N, SH	
	§Azatin O	70051-9-59807	4	UN	G, I, N, OO, SH	
	§Azatrol	2217-836	4	UN	G, I, N, OO, SH	MA, NY
	§Molt-X	68539-11	4	UN	G, I, N, OO, SH	
	Ornazin 3%EC	5481-476-67690	12	UN	G, I, N, OO, SH	
Bacillus thuringiensis subsp. israelensis	§Gnatrol WDG	73049-56	4	11A	G, I	
Bacillus thuringiensis subsp. kurstaki	§DiPel PRO DF	73049-39	4	11A	G, N, SH	
	§Javelin WG	70051-66	4	11A	G, OO	
	§BioBit HP	73049-54	4	11A	G	
	§Thuricide N/G	70051-53-59807	4	11A	G, OO	
Beauveria bassiana strain ANT-03	§BioCeres WP	89600-2	4	UNF	G, L	
Beauveria bassiana strain GHA	BotaniGard 22WP	82074-2	4	UNF	CL, G, I, N, SH	
	BotaniGard ES	82074-1	4	UNF	G, L, N	
	Mycotrol ESO	82074-1	4	UNF	CL, G, I, N, SH	
	Mycotrol WPO	82074-2	4	UNF	CL, G, I, N, SH	

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
NoFly WP	<i>Isaria fumosorosea</i> Strain FE 9901	88664-1	12	UNF	G, N, L	
PureSpray Green	mineral oil	69526-9	4	UNM	C, G, I	
PyGanic Specialty	pyrethrins	1021-1772	12	3A	G, N	
Rango	neem oil	88760-10	4	UNE	G, I, L, N	
Sluggo Slug & Snail Bait	iron phosphate	67702-3-70051	0	UN	G, N (container), OO	
SuffOil-X	mineral oil	48813-1-68539	4	UNM	G, L, N	
Thuricide N/G	<i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	70051-53-59807	4	11A	G, OO	
Triact 70	clarified hydrophobic extract of neem oil	70051-2-59807	4	UNE	G, L, N	

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.**Table 5.4.4. Organic-acceptable insecticides mentioned in this publication listed by active ingredient**

Use Site Key:

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

Active Ingredient	Trade Name	EPA Reg. No.	REI (hrs.) ¹	IRAC Code ²	Use Site(s)	Not For Use In
azadirachtin	Aza-Direct	71908-1-10163	4	UN	G, L, N, SH	
	AzaGuard	70299-17	4	UN	CL, G, I, N, SH	
	Azatin O	70051-9-59807	4	UN	G, I, N, OO, SH	
	Azatrol	2217-836	4	UN	G, I, N, OO, SH	MA, NY
	Molt-X	68539-11	4	UN	G, L, N, SH	
<i>Bacillus thuringiensis</i> subsp. <i>israelensis</i>	Gnatrol WDG	73049-56	4	11A	G, I	
<i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	DiPel PRO DF	73049-39	4	11A	G, N, SH	
	Javelin WG	70051-66	4	11A	G, OO	
	BioBit HP	73049-54	4	11A	G	
	Thuricide N/G	70051-53-59807	4	11A	G, OO	
<i>Beauveria bassiana</i> strain ANT-03	BioCeres WP	89600-2	4	UNF	G, L	
<i>Chromobacterium subtsugae</i> strain PRAA4-1 + spent fermentation media	Grandevo PTO	84059-17	4	biological	FG, G	NY
clarified hydrophobic extract of neem oil	Triact 70	70051-2-59807	4	UNE	G, L, N	
iron phosphate	Sluggo Slug & Snail Bait	67702-3-70051	0	UN	G, N (container), OO	
iron phosphate + spinosad	Antixx Plus	67702-24	4	5 + UN	G, L, N	

5.5.9 Fungus Gnats

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

Compound(s)

Common name (IRAC Code)

Trade name	Use Site(s) ¹	Comments
acephate (1B)		
1300 Orthene TR	CG	Adult control only.
acetamiprid (4A)		
* ^{NY} TriStar 30SG	G, LH, OO, SH	Adult control.
* ^{NY} TriStar 70WSP	G, LH, OO, SH	Adult control.
* ^{NY} TriStar 8.5 SL	G, LH, OO, SH	Larvae control only. Do not use on verbena.
azadirachtin (UN)		
§Aza-Direct	G, L, N, SH	Larvae only.
§AzaGuard	CL, G, I, N, SH	Larvae only.
§Azatin O	G, I, N, OO, SH	Larvae only.
§Molt-X	G, L, N, SH	Larvae only.
Ornazin 3% EC	G, I, N, OO, SH	Larvae only.
Bacillus thuringiensis ssp. israelensis (11A)		
§Gnatrol WDG	G, I	Larvae only.
Beauveria bassiana strain GHA + pyrethrins (3A)		
BotaniGard Maxx	G, I, L, N	
bifenthrin (3A)		
Ascertain TR	G	For adults.
Attain TR	G	
*Talstar S	G, L, N	Product can be used for larval control in potting media of containerized plants
*Wisdom Flowable	G, L, N	
canola oil + pyrethrins (3A + UN)		
Pycana	G, N, SH, C	For adults.
chlorfenapyr (13)		
* ^{NY} Pylon	G	Phytotoxicity is likely to occur to some varieties of: carnations, dianthus, kalanchoe, poinsettia, roses, salvia and zinnias.
cyfluthrin (3A)		
* ^{NY} Decathlon 20WP	G, I, L, N	Adults.
cyfluthrin + imidacloprid (3 + 4A)		
* ^{NY} Discus L	CG, CGO, N, FG	Larval control only.
cyromazine (17)		
Citation	C, G, L, LH, SH	For control of fungus gnat larvae in all listed sites and for shore flies in greenhouse ornamental crops and interiorscapes only.
Synterra WSP	G, I, L, LH, N, SH	For larvae only.
diflubenzuron (15)		
Adept	G, LH, SH	For larvae.
mineral oil (UNM)		
§PureSpray Green	C, G, I	Adults.
§SuffOil-X	G, L, N	Adults.
Ultra-Pure Oil	C, G, N	Adults.
Isaria fumosorosea Strain FE 9901 (biological)		
§NoFly WP	G, N, L	

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

6.6 Herbicides For use on Herbaceous Ornamentals

6.6.1 Herbaceous Ornamentals Herbicides

Table 6.6.1. Herbicides for use on herbaceous ornamentals mentioned in this publication listed by product trade name

Trade Name	Active Ingredient	EPA Reg. No.	REI (hrs.) ¹	Group Number(s) ²	Not For Use In
Acclaim Extra	fenoxaprop	432-950	24	1	
*NY Barricade 65WG	prodiamine	100-834	12	3	
Barricade 4FL	prodiamine	100-1139	12	3	
Basagran T&O	bentazon	7969-326	48	6	
Biathlon	oxyfluorfen + prodiamine	59807-12	24	14+3	
*NY Corral	pendimethalin	58185-179	24	14	
Devrinol 2 XT	napropamide	70506-301	24	15	
*NY Dimension 2EW	dithiopyr	62719-542	12	3	
*NY Dimension Ultra 40WP	dithiopyr	62719-445	12	3	
Diquat SPC 2L	diquat	228-675	24	22	
*NY Envoy Plus	clethodim	59639-132	24	1	
†Finale	glufosinate-ammonium	7969-444	12	10	
Fortress/Crew	isoxaben+dithiopyr	59807-19/62719-742	12	21+3	NY
Freehand	dimethenamid-p+pendimethalin	7969-239	24	15+3	NY
Fusilade II	fluzifop-P-butyl	100-1084	12	1	
Gallery 75 DF	isoxaben	62719-145	12	21	NY
Gallery SC	isoxaben	62719-658	12	21	NY
Gemini G	isoxaben+prodiamine	58185-180	12	21+3	NY
Gemini L	isoxaben+prodiamine	53883-325-58185	12	21+3	NY
*NY†Lontrel	clopyralid	62719-305	12	4	
*NY†Marengo	indaziflam	432-1518	12	29	
*NY†Marengo G	indaziflam	432-1523	12	29	
Ornamec OTT	fluzifop-P-butyl	2217-728	4	1	
Pendulum Aquacap	pendimethalin	241-416	24	14	
Pendulum 2G	pendimethalin	241-375	24	14	
Pendulum 3.3EC	pendimethalin	241-341	24	14	
*NY†Pennant Magnum	s-metolachlor	100-950	24	15	
*NY Ronstar Flo	oxadiazon	432-1465	12	3	
*NY Ronstar G	oxadiazon	432-886	12	3	
Roundup Pro	glyphosate	524-475	4	9	
Roundup ProMax	glyphosate	524-579	4	9	
Scythe	pelargonic acid	10163-325	12	17	
Segment	sethoxydim	7969-317	12	1	NY
Segment II	sethoxydim	7969-398	12	1	
Snapshot TG	isoxaben+trifluralin	62719-175	12	21+3	NY
*NY†Specticle Flo	indaziflam	432-1518	12	29	
*NY†Specticle	indaziflam	432-1523	12	29	
Surflan AS	oryzalin	70506-44	24	3	
Surflan Flex	oryzalin	70506-308	24	3	
Tower	dimethenamid-p	7969-239	12	15	NY
Treflan	trifluralin	961-405	see label	21	
XL 2G(Surflan XL 2G)	benefin + oryzalin	70506-45-38167/ 70506-45	24	3	

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.

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>	0.02 to 0.17 lb.	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. Japanese stiltgrass *Microstegium viminium* is controlled.

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 nonionic surfactant is generally 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. per acre per 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 6.7.1 Herbicides registered for use on ornamentals in the Northeast.

Key: <i>Ornamental Species:</i> 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												
				Ornamental species registered								
Applica- tion Type	Long Island Use?	New York Use?	Trade Name	<i>Shade Trees</i>	<i>Narrow Leaf (Needle) Ever- greens</i>	<i>Broad- leaf Ever- greens</i>	<i>Decid- uous Shrubs</i>	<i>Ground- covers (Woody & Semi - Woody)</i>	<i>Peren- nials (Herba- ceous)</i>	<i>Orna- mental Grasses</i>	<i>Bulbs</i>	<i>Annuals (Bed- ding Plants)</i>
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	* ^{NY} Reward	Several (f)	Several (f)	Several (f)	Several (f)	None	None	None	None	None
pre	yes	yes	* ^{NY} Ronstar (G)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Few (f/c)	Few (f/c)	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	* ^{NY} Sureguard	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)

Table 6.7.2. Herbicides registered for landscape use in the Northeastern States.

Trade Name	Common Name	Spray or Granular	Pre or Post	Plant Types that may be found on the Label ***Check Label for Species***					Weeds Controlled	Application	Post-Plant Interval	Residential landscape restrictions ³
				Turf	Annuals	Perennials	Trees & Shrubs	Orn. Grasses				
Pendulum 2G	pendimethalin	G	pre	✓	✓	✓	✓	✓	ann grass & bl weeds	OT	Established	
Pendulum Aquacap	pendimethalin	S	pre	✓	✓	✓	✓	✓	ann grass & bl weeds	OT	Newly planted (after soil settles)	
*NY†Pennant Magnum	s-metolachlor	S	pre	✓	✓	✓	✓	✓	ann grass, ann bl weeds, y. nutsedge	OT	Newly planted (after soil settles)	
Quicksilver T&O ²	carfentrazone	S	post	✓					ann bl weeds			
*NYRonstar 2G	oxadiazon	G	pre	non-resid		✓	✓		ann grass & bl weeds	OT	Established or Newly planted	✓
*NYRonstar 50WSP	oxadiazon	S	pre	✓		✓	✓		ann grass & bl weeds	D	Established or Newly planted	✓
Roundup	glyphosate	S	post	directed	directed	directed	directed	directed	grass & bl weeds	D	Established	
Scythe	pelargonic acid	S	post	directed	directed	directed	directed	directed	grass & bl weeds	D	Label does not specify	
SedgeHammer	halosulfuron	S	post	✓			✓		nutsedge, kyllinga, horsetail	D	Established	
^Segment	sethoxydim	S	post	✓	✓	✓	✓		ann & per grasses	OT	Newly planted (after soil settles)	
^Snapshot	isoxaben + trifluralin	G	pre			✓	✓	✓	ann grass & bl weeds	OT	Newly planted (after soil settles)	
*NY†Specticle	indaziflam	Flo G	pre	warm season		✓	✓		ann grass & bl weeds	D	Established	
*NYSureGuard	flumioxazin	S	pre				✓		ann grass & bl weeds	D	Established	
Surflan 4AS, Flex	oryzalin	S	pre	warm season	✓	✓	✓	✓	ann grass & bl weeds	OT	Established	
^Tower	dimetheneamid	S	pre	✓	✓	✓	✓		ann grass, ann bl weeds, y. nutsedge	D or OT	Newly planted (after soil settles)	
Treflan	trifluralin	G	pre		✓	✓	✓	✓	ann grass & bl weeds	OT	Established	
XL (Surflan XL)	benefin + oryzalin	G	pre	warm season	✓	✓	✓	✓	ann grass & bl weeds	OT	Newly planted (after soil settles)	

¹ Biobarrier & Biobarrier II: EPA Reg. No. 59823-1 & 59823-3, Fiberweb, Inc.² Quicksilver 1.9EC: EPA Reg. No. 279-3265, FMC Corporation³ Product has residential landscape use restrictions. See label.

Application: OT: Over top, D: Directed

*NY Restricted use pesticide in New York State.

†Not for use in Nassau and Suffolk Counties NY.

^ Not registered for use in New York State.

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 molds are 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 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., 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 B-Nine and Cycocel, while material

Table 8.4.1. Greenhouse floral crop growth regulators mentioned in this publication listed by product trade name

Trade Name	Active Ingredient	EPA Reg. No.	REI (hrs.) ¹	Not For Use In
* ^{NY} Dazide 85 WSG	daminozide	62097-17-82917	12	
Dip ‘N Grow	indole-3-butyric acid + 1-naphthaleneacetic acid	64388-1	24	
EthylBloc	1-methylcyclopropene	71297-1-32258	ventilation requirements must be met	
EthylBloc Sachet	1-methylcyclopropene	71297-5-32258	ventilation requirements must be met	
Fascination	benzyladenine + gibberellins A4A7	73049-41	4	
Florel Brand Pistill	ethephon	54705-8	48	
Fresco	benzyladenine + gibberellins A4A7	62097-6-82917	4	
GibGro 4LS	gibberellic acid	55146-62	4	
Hormex 1	indole-3-butyric acid	8281-6	12	
Hormex 8	indole-3-butyric acid	8281-1	12	
Hormodin 1	indole-3-butyric acid	59807-4	0	
Hormodin 2	indole-3-butyric acid	59807-2	0	
Hormodin 3	indole-3-butyric acid	59807-3	0	
Hortus IBA Water Soluble Salts	indole-3-butyric acid	63310-22	0	
N-LARGE	gibberellic acid	57538-18	4	CT, NH, MA, ME, RI, VT
Off-Shoot-O	methyl esters of fatty acids	57582-1	12	
Pac O	paclobutrazol	62097-11-59807	12	
Paclo Pro	paclobutrazol	100-996	12	
Piccolo	paclobutrazol	62097-11-82917	12	
Piccolo 10XC	paclobutrazol	62097-25-82917	12	
ProGibb LV PLUS T&O	gibberellic acid	73049-498	4	
ProGibb T&O	gibberellic acid	73049-15	12	
ProGibb TVO	gibberellic acid	73049-15	12	
Rhizopon AA #1	indole-3-butyric acid	63310-19	0	
Rhizopon AA #2	indole-3-butyric acid	63310-20	0	
Rhizopon AA #3	indole-3-butyric acid	63310-21	0	
RiteWay	benzyladenine	71368-60	12	
Southern Ag Florel	ethephon	264-263-829	48	
Stimplex	kinetin	75287-3	4	
Sumagic	uniconazole-P	59639-37	12	
* ^{NY} Topflor	flurprimidol	67690-20	12	
* ^{NY} Verve	ethephon	228-660	48	

NOTES:*^{NY} Restricted use pesticide in New York State.¹ Restricted-entry interval in accordance with Worker Protection Standard for Agricultural Pesticides.

Table 8.5.1. Growth regulators for greenhouse crops and herbaceous ornamentals

Common Name	Brand Name	Formulation	EPA Reg. No.	REI (hrs.)
<i>Promoters of Flowering and/or Breaking of Dormancy</i>				
chlormequat	Altercel	11.8% L	62097-21-59807	12
	Citadel	11.8% L	62097-21-82917	12
	Cycocel	11.8% L	241-74-59807	12
Registered crops: ornamentals in greenhouses				
Registered methods of application: spray, drench				
Registered rates of application: determine optimal rates through trials as specified on the labels; see labels for rates for azalea and seed geranium.				
daminozide	* ^{NY} B-Nine WSG	85% WSG	400-478-59807	24
	* ^{NY} Dazide 85 WSG	85% WSG	62097-17-82917	12
Registered crops: azalea				
Registered methods of application: spray				
Registered rates of application: see label for rates for florist azalea.				
ethephon	* ^{NY} Collate	21.7% F	85678-9-82917	48
	Florel Brand Pistill	3.9% L	54705-8	48
	Southern Ag Florel	3.9% L	264-263-829	48
	* ^{NY} Verve	21.7% L	228-660	48
Registered crops: greenhouse, shade house, and field-grown floriculture crops				
Registered method of application: foliar spray				
Registered rates of application: determine optimal rates through trials as specified on the labels; see labels for rates for several bromeliad genera.				
gibberellic acid	GibGro 4LS	4% L	55146-62	4
	^{NE} N-LARGE	4% L	57538-18	4
	ProGibb LV PLUS T&O	5.7% L	73049-498	4
	§ProGibb T&O	4% L	73049-15	12
	§ProGibb TVO	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 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 azalea, calla lily, camellia, geranium, and cut flower aster, gypsophila, spathiphyllum, and statice (Limonium).				
paclobutrazol	Bonzi	0.4% L	100-996	12
	Pac O	0.4% L	62097-11-59807	12
	Paclo Pro	0.4% L	100-996	12
	Piccolo	0.4% L/EC	62097-11-82917	12
	Piccolo 10XC	4% L	62097-25-82917	12
Registered crops: container-grown ornamentals in nursery, greenhouse, shade house, and interior plants				
Registered methods of application: bulb soak, chemigation, drench, spray				
Registered rates of application: determine optimal rates through trials as specified on the labels; see labels for rates for florist azalea.				
<i>Promoters of Flower Size</i>				
gibberellic acid	GibGro 4LS	4% L	55146-62	4
	^{NE} N-LARGE	4% L	57538-18	4
	ProGibb LV PLUS T&O	5.7% L	73049-498	4
	§ProGibb T&O	4% L	73049-15	12
	§ProGibb TVO	4% L	73049-15	12

9 Resources

Table 9.1. University/State/County Greenhouse Herbaceous Ornamentals Specialists & Diagnosticians

State	Name	Specialty	Contact Information
Connecticut	Nick Goltz	Plant Diagnostician, Storrs	nick.goltz@uconn.edu 860-486-6271
	Yonghao Li	Plant Diagnostician, New Haven	Yonghao.Li@ct.gov 203-974-8565
	Felicia Millett	Plant Diagnostician, New Haven	Felicia.Millett@ct.gov 203-974-8505
	Rosa E. Raudales	Associate Professor & Greenhouse Extension Specialist	rosa.raudales@uconn.edu 860-486-6043
Maine	Stephanie Burnett	Associate Professor of Horticulture	sburnett@maine.edu 207-581-2937
	James Dill	IPM Specialist	james.dill@maine.edu 207-581-3879
	Alicyn Smart	Associate Extension Professor – Plant Pathology; Diagnostic Lab	alicyn.smart@maine.edu 207-581-3883
Massachusetts	Jason D. Lanier	Extension Educator – Greenhouse Crops & Floriculture	jdl@umass.edu 413-545-2965
	Angela Madeiras	Plant Diagnostician	madeiras@umass.edu 413-545-3209
	Geoffrey Njue	Extension Educator – Green Industry Sustainability Specialist	gnjue@umext.umass.edu 614-243-1932
New Hampshire	Jonathan Ebba	Landscape & Greenhouse Field Specialist	jonathan.ebba@unh.edu 603-749-2529
	Amber Vinchesi-Vahl	IPM Coordinator	Amber.Vinchesi@unh.edu 603-696-3312
New York	Mark Bridgen	Professor of Horticulture and Plant Breeding	mpb27@cornell.edu 631-727-3595
	Nora Catlin	Floriculture Specialist	nora.catlin@cornell.edu 631-727-3595 631-727-7850
	Margery Daughtrey	Greenhouse/Ornamentals Plant Pathology	mld9@cornell.edu 631-727-3595
	Jason Dombroskie	Insect Diagnostic Lab Manager	jjd278@cornell.edu 607-255-5530
	Dan Gilrein	Greenhouse/Ornamentals Entomologist	dog1@cornell.edu 631-727-3595
	Elizabeth Lamb	Greenhouse/Ornamentals IPM	eml38@cornell.edu 607-254-8800
	Neil Mattson	Professor of Horticulture	nsm47@cornell.edu 607-255-0621
	Bill Miller	Professor of Horticulture	wbm8@cornell.edu 607-255-1799
	Karen Snover-Clift	Director, Plant Disease Diagnostic Clinic	kls13@cornell.edu 607-255-7860

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**.

PESTICIDE EMERGENCY NUMBERS

Poison Control Centers

Poison Control Centers nationwide800-222-1222

Emergency responder information on pesticide spills and accidents...

CHEMTREC800-424-9300

For pesticide information...

National Pesticide Information Center800-858-7378

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

NYS Spill Hotline800-457-7362

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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 Cooperative Extension Pesticide Safety Education Program (CCE-PSEP)
CALS Surge Facility
525 Tower Road
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Ithaca, New York 14853-7401
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