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# Fungicides for Bedding Plants in Connecticut



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Connecticut has a robust greenhouse industry that produces a wide range of ornamental crops worth over \$193 million in sales annually. Bedding plants are an important category and bring in significant revenue for greenhouse operations each spring. Bedding plants include any herbaceous plant started under controlled conditions, and purchased and grown on by the customer. Most bedding plants are seed propagated, and are grown from plugs. The bedding plant crop has a rapid turnaround time in the greenhouse. There are many factors involved in the production of high quality bedding plants including cultivar selection, fertilizer, light, temperature, and control of pests and diseases. Growers accurately time plantings to meet contract obligations and customer schedules.

Diseases can cause significant losses in bedding plant production. Losses can occur from stunting and plant death during production or reduction in aesthetic quality due to leaf spots and blights. Pathogens are often present in the greenhouse and infect when conditions are favorable. *Alternaria* leaf spot and damping off, Botrytis blight, Pythium root rot, bacterial leaf spot, and *Thielaviopsis* can all reduce seedling quality and stand count, leading to uneven seedling trays. During production, Botrytis blight, *Cercospora* leaf spot, *Myrothecium*, powdery mildew, rust, Fusarium root rot, and *Thielaviopsis* can make production difficult, reduce the quality of packs, and increase disease management costs. During shipping and at retail gray mold is commonly observed.

The pathogens that infect during greenhouse production of bedding plants are numerous and usually require specific conditions for infection. Pythium root rot causes stunting and yellowing. Many bedding plants are affected by *Pythium* while still in plug trays or when moisture levels are high for extended periods of cool cloudy weather. Sanitation and fungicides are necessary to protect plants against this pathogen. Leaf spot diseases and powdery mildew are generally less of an issue

during bedding plant production than in the landscape. Fungicides and biocontrols can be applied that limit many of the common leaf spot pathogens. Bacterial blights spread rapidly in seedling trays, as they can be seedborne, and spread when conditions are warm and humid during propagation. Vegetatively growing geranium, zinnia, and begonia can also be affected by bacterial blight during production.

Certain pathogens are very difficult to control in bedding plant production. Botrytis blight caused by *Botrytis cinerea* affects almost all bedding plants grown, and can infect at any stage of production. Botrytis blight is widespread and frequently observed on a wide range of crops. The pathogen is able to grow on debris in the greenhouse and produces abundant spores that travel to neighboring plants. Using forced heated air beneath benches is an effective method to reduce the humid environmental conditions needed for successful infection. A fungicide program that includes a rotation of highly effective systemic and protective fungicides is recommended to control this pathogen.

Management of plant pathogens in bedding plant production starts with cultural controls such as sanitation and improving the environmental conditions for crop growth. Cleaning the benches and greenhouse walls followed by application of a chemical sanitizer will help to reduce inoculum sources in the greenhouse. If pots and trays are reused, they should be cleaned and sanitized to kill any pathogen spores that may be present.

There are many fungicides available. Each fungicide contains one or more active ingredients that are the active chemistry that inhibits the fungal pathogen and inactive ingredients that may include adjuvants or carriers. These inactive ingredients are proprietary and often not listed on the label. Fungicide formulations are made for 1) convenience, 2) stability, 3) compatibility, and 4)

biology. Fungicides have a mode of action, that is represented by the Fungicide Resistance Action Committee (FRAC) code. Fungicides have many possible mechanisms of action against pathogens, for example inhibiting melanin synthesis, or disrupting mitosis. The FRAC codes were designed to aid in making fungicide resistance management decisions. Rotating among FRAC codes can delay the development of fungicide resistance. Some fungicides have a very high risk for resistance development, and should be used with caution to ensure maximum use and efficacy. A broad spectrum fungicide has a low resistance risk. In general, applying the same FRAC code multiple times in succession is not recommended. Overuse of fungicides can also have a negative impact on the crop, although this is uncommon in bedding plant production. Triazole fungicides may have growth regulating effects leading to bunchy or thickened leaves in sensitive species. Drenches of certain fungicides can cause phytotoxicity to the roots of plants, leading to stunting. Seedlings may be sensitive to fungicide application, but usually sensitivity is related more to the crop species. Check to make sure that the crop being drenched is listed on the label to reduce the chances of phytotoxicity.

Biological fungicides containing *Bacillus*, *Streptomyces*, and plant extracts can help to reduce pathogen competition and establishment. The biological fungicides are often labeled for organic production or can be rotated with synthetic fungicides in a program. Some potting media comes premixed with beneficial fungi. Applying a fungicide drench may negatively effect these beneficial organisms.

Surfactants are used for improving leaf wetting and fungicide coverage. The surfactants typically fall into four categories, anionic, non-ionic, cationic, and ampholytic (positive and negative). The cationic surfactants are cost prohibitive and may cause phytotoxicity. Most

commercial surfactants are non-ionic compounds that are safe on the majority of plants and mix well with fungicides. Oils and plant extracts can also improve uptake and leaf wetting at low rates. Surfactants may cause phytotoxicity to certain plant species, and can physically interact with a fungicide by extending the period of leaf wetness or increasing uptake, potentially enhancing phytotoxicity from the fungicide.

Using appropriate spray equipment for making applications can improve fungicide performance. There are a number of different sprayers that are used in greenhouse production. The backpack sprayer is simple and easy to use. Track sprayers and hydraulic sprayers are designed for larger greenhouses. Overhead irrigation of fungicides is generally not recommended and can lead to wasted fungicide and runoff. Cold fogging is a popular method to apply fungicides during the evening when the greenhouse is empty. Fungicides with systemic or translaminar activity should be used for most fogging applications. Spray equipment should be calibrated and cleaned regularly to ensure optimal performance. Fungicides active against specific pathogens may be applied preventively to provide optimal control.

Disclaimer: The data in Table 1 and 2 are based on information from the University of Connecticut, regional universities, Chase Agricultural Consulting, and chemical companies. A blank response does not indicate that the fungicide is ineffective against the pathogen listed. The ratings represent typical pathogen response from many trials summarized for each pathogen. Many of the fungicides listed are available in other formulations. The efficacies of the products listed have not all been tested on bedding plants in Connecticut.

Consult the label for specific use requirements and crop safety recommendations. Pesticides must be used in a safe and effective manner in accordance with the label. It is important to have the label with you prior to application. Product names are given for educational purposes and not as an endorsement.

The information presented is accurate to currently printed labels, however, it is still useful to check this information to verify that it is correct by reading the corresponding pesticide label before using the product. There are free online databases for looking up label information including: [greenbook.net](http://greenbook.net), [cdms.com](http://cdms.com), and [agrian.com](http://agrian.com). Additional information: FRAC = Fungicide Resistance Action Committee. Code included for resistance management planning. Copper compounds include: Copper sulfate pentahydrate, sulfate monohydrate, oxychloride, sulfate, hydroxide, oxide, and others. The application site must be listed on the label in order to legally use the product on that crop and site. RUP restricted use pesticides require training and license prior to application.

Table 1: Registered fungicides for bedding plant diseases.

E=excellent, G=good, P=poor

Fungicide	Common Name	Foliar Diseases										Root/Crown Diseases			
		<i>Alternaria</i>	Bacterial leaf spot	<i>Botrytis</i>	<i>Cercospora</i>	<i>Myrothecium</i>	<i>Phoma</i>	Powdery mildew	Rhizoctonia foliar blight	Rust	<i>Septoria</i>	<i>Fusarium</i>	<i>Rhizoctonia</i>	<i>Sclerotinia</i>	<i>Thielaviopsis</i>
3336F	thiophanate-methyl			G	G	G		G	E	P		G	G		E
Affirm WDG	polyoxin D zinc salt			E				E	E						E
Astun	isofetamid	G		E				G							
Broadform	fluopyram/ trifloxystrobin	E		E		E		E	E		G			G	
Chipco 26019	iprodione	E		E	G							E	E		
Copper products*	Copper hydroxide		E	G	G										
Daconil	chlorothalonil	E	G	E	E	E		E	E	E	E			E	
Decree 50WDG	fenhexamid	G		E				E							
Eagle 20EW	myclobutanil	E			E	G	E	E		E	E				
Heritage	azoxystrobin	E		E	E	E	G	G	E	E	E	E	E	E	
Medalion WDG	fludioxonil	E		E	E	E	G		E		E	E	E	E	E
Mural	azoxystrobin/ benzovindiflupyr	E		E	E	E	E	E	E	E	E	E	E	E	G
Orkestra Intrinsic	fluxapyroxad/ pyraclostrobin	E		E	E	E	E	E		E		E	E	E	
Pageant	pyraclostrobin/ boscalid	E		E	E	E	E	E	E	E		G	E	E	
Palladium	cyprodinil/ fludioxonil	E		E	E	E	E	E							
Postiva	pydiflumetofen/ difenoconazole	E	G	E	E	E	E	E	E	E	E	E	E	E	
Protect DF	mancozeb	G		G	G	P			E	E	G			G	
Terraguard	triflumizole	E			E	E		E	E				G	G	E
Torque	tebuconazole	E			E			E		G				G	
Tourney	metconazole				E			E						G	E

\*Badge SC, Camelot O, Champ Formula 2, Kalmor, Phytan 27, and others.

Table 2: Fungicides for bedding plant diseases caused by oomycetes.

E=excellent, G=good, P=poor

Fungicide	Common Name	FRAC	Downy mildew	<i>Phytophthora</i>	<i>Pythium</i>
Adorn	fluopicolide	43	E	E	G
Fenstop	fenamidone	11	E	E	G
Micora	mandipropamid	40	E	E	G
Phostrol	phosphites	33	G	G	G
Segovis	oxathiapiprolin	U15	E	E	G
Segway O	cyazofamid	21	G	G	E
Stature SC	dimethomorph	40	E	E	G
SubdueMaxx	mefenoxam	4	E	E	E
Terrazole	etridiazole	14		G	E

Table 3: Registered fungicides used to control bedding plant diseases.

Trade name (common name)	Mode of action	FRAC code	Rate/100 gal. for foliar appl. (soil)	Timing	Notes
3336F (Thiophanate-methyl)	Tubulin polymerization	1	12-16 fl oz (8-12 fl oz)	Cutting dip, seedlings, vegetative	Do not exceed 36 lb/A per crop season for foliar sprays. Add NIS surfactant at 0.25-0.5%.
Adorn (fluopicolide)	Spectrin-like proteins	43	1-4 fl oz (1-4 fl oz)	Cutting dip, seedlings, vegetative	Do not make more than 2 applications per crop cycle.
Affirm WDG (polyoxin D zinc salt)	Chitin synthase	19	0.25-0.5 lb (0.25-0.5 lb)	Seedlings, vegetative	Apply as a preventive or curative treatment.
Aliette WDG (Al tris (O-ethyl phosphonate)	Host defense	33	1.5-4 lb	Vegetative	Do not tank mix with Daconil or Copper products.
Alude (Mono- and di-potassium salts of Phosphorous Acid)	Host defense	33	32-80 fl oz (6.25-12.75 fl oz)	Cutting dip, seedlings, vegetative	Acidic fungicide. One drench/month. *Label varies by manufacturer.
Astun (Isofetamid)	Respiration inhibitor	7	10-17 fl oz	Seedlings, vegetative	Botrytis only. Maximum 102 fl oz per year.
Aveylo (mefentrifluconazole)	Cell membrane sterol synthesis	3	3-5 fl oz (2-3 fl oz)	Seedlings, vegetative	Maximum 30 fl oz per crop cycle.
Badge (Copper oxychloride/hydroxide)	Multi-site	M01	1.5-2 pts	Seedlings, vegetative	Spray solution should be above pH 6.5.
Banol (propamocarb hydrochloride)	Membrane integrity	28	(20-30 fl oz)	Soil	Apply to soil only, no bedding plant drenches.
Broadform (fluopyram/pyoxystrobin)	Respiration inhibitor/ QOI inhibitor	7/11	2-8 fl oz	Seedlings, vegetative	Maximum 27.3 fl oz per crop cycle.
Compass O 50WDG (trifloxystrobin)	QOI inhibitor	11	1-4 oz (0.5 oz)	Cutting dip, seedlings, vegetative	Do not drench pansy.
Daconil (chlorothalonil)	Multi-site	M05	1 3/8 pts	Seedlings, vegetative	Avoid applications to blooms.
Decree 50WDG (fenhexamid)	Sterol biosynthesis	17	0.75-1.5 lb	Seedlings, vegetative	Botrytis only.
Eagle 20EW (myclobutanil)	Cell membrane sterol synthesis	3	6-12 fl oz	Seedlings, vegetative	Cutting dip chrysanthemum only. Add NIS surfactant at 0.25-0.5%. Maximum 153 fl oz/year.
Empress Intrinsic (pyraclostrobin)	QOI inhibitor	11	(1-6 fl oz)	Seedlings, vegetative	Drench only. Begonia, impatiens, petunia possible flower discoloration.
Fenstop (fenamidone)	QOI inhibitor	11	7-14 fl oz (7-14 fl oz)	Cutting dip, seedlings, vegetative	Add NIS surfactant at 0.25-0.5%.
Heritage (azoxystrobin)	QOI inhibitor	11	1-4 oz (0.2-0.9 oz)	Cutting dip, seedlings, vegetative	Do not make more than 3 consecutive applications. Can apply 8 oz for Botrytis.
Medalion WDG (fludioxonil)	Signal transduction	12	1-4 oz (1-2 oz, low rate for seedlings)	Cutting dip, seedlings, vegetative	Do not apply to impatiens seedlings, or to geranium.

Micora (mandipropamid)	Cell wall biosynthesis	40	4-8 fl oz (4-8 fl oz)	Cutting dip, seedlings, vegetative	Maximum 32 fl oz per year.
Mural (benzovindiflupyr/ azoxystrobin)	Respiration inhibitor/ QOI inhibitor	7/11	4-7 oz (2-3 oz)	Seedlings, vegetative	Maximum 28 oz per crop cycle.
Orkestra Intrinsic (fluxapyroxad/ pyraclostrobin)	Respiration inhibitor/ QOI inhibitor	7/11	4-10 fl oz (8-10 fl oz)	Cutting dip, seedlings, vegetative	Impatiens and petunia flowers sensitive. Stunting after drench to dianthus, impatiens, viola.
Pageant (boscalid/ pyraclostrobin)	Respiration inhibitor/ QOI inhibitor	7/11	6-18 oz (12-18 oz)	Cutting dip, seedlings, vegetative	Impatiens and petunia flowers sensitive.
Palladium (cyprodinil/ fludioxonil)	Protein synthesis/ Signal transduction	9/12	2-6 oz	Seedlings, vegetative	Foliar only. Minimum volume 50 gal/A.
Postiva (pydiflumetofen/ difenoconazole)	Cell membrane sterol synthesis/ Respiration inhibitor	3/7	10-28 fl oz (10-28 fl oz)	Cutting dip, seedlings, vegetative	Vegetable transplants use lower rate.
Protect DF (mancozeb)	Multi-site	M03	1-2 lb	Seedlings, vegetative	Add NIS surfactant at 0.15%. Do not apply to marigold.
Segovis (oxathiapiprolin)	Oxysterol-binding protein	49	0.6-2.4 fl oz (0.65-3.2)	Cutting dip, seedlings, vegetative	Do not use for more than 33% of applied fungicides for crop cycle.
Segway (cyazofamid)	Respiration inhibitor	21	2.1-6.0 fl oz (1.5-6.0 fl oz)	Cutting dip, seedlings, vegetative	Do not make more than 2 applications per crop cycle.
Stature (dimethomorph)	Cellulose synthase	40	6.12-12.25 fl oz (3.06-6.12 fl oz)	Cutting dip, seedlings, vegetative	Maximum 8 applications.
Strike 50WDG (triadimefon)	Cell membrane sterol synthesis	3	1-2 oz	Seedlings, vegetative	Do not drench.
SubdueMaxx (mefenoxam)	RNA polymerase	4	0.5-1.0 fl oz (0.125-1.0)	Cutting dip, seedlings, vegetative	Drench on 1-2 month interval.
Terrachlor 75WP (PCNB)	Lipid synthesis	14	(4-8 oz)	Soil, seedlings, vegetative	Drench only.
Terraguard (triflumizole)	Cell membrane sterol synthesis	3	2-16 fl oz (2-8 fl oz)	Cutting dip, seedlings, vegetative	Powdery mildew use higher rate.
Terrazole (etridiazole)	Lipid synthesis	14	(3.5-10 oz)	Cutting dip, seedlings, vegetative	Drench on 4-12 week interval.
Torque (tebuconazole)	Cell membrane sterol synthesis	3	4-10 fl oz	Cutting dip, seedlings, vegetative	Minimum volume 50 gal/A. 3 application max. Do not apply to begonia or geranium.
Tourney 50WG (metconazole)	Cell membrane sterol synthesis	3	1-4 fl oz (1-4 fl oz)	Cutting dip, seedlings, vegetative	Can cause growth regulation on some crops.



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