

Management of Botrytis Blight

Botrytis blight is one of the most common fungus diseases of greenhouse crops. The disease is often referred to as “gray mold” because a crop of gray fuzzy-appearing spores develops on the surface of infected tissues. A variety of plants including ornamentals, vegetables and herbs are susceptible. Management of environmental conditions, sound cultural practices and fungicides control this disease.

Depending on the host and environmental conditions, *Botrytis* can cause leaf and flower blight, fruit rot, cankers, damping off and root rot. Plants may be attacked at any stage but new tender growth, freshly injured tissues and senescing or dead tissue are most susceptible. Spores are produced in abundance on lesions as well as on plant debris left on benches, the greenhouse floor and cull piles. Spores are easily disseminated by air currents and splashing water. Given the common occurrence of *Botrytis* in greenhouses and the large number of spores it produces, greenhouse managers must avoid conditions that are conducive to disease development.

Like other fungi, *Botrytis* has a specific range of temperature and relative humidity that are necessary for spore germination, infection and disease development. In general terms, germination of spores and infection of the host depends on a film of moisture for 8 to 12 hours, relative humidity 93% or greater, and temperatures between 55-65F. Following infection, colonization of plant tissues occurs at temperatures up to 70F. *Botrytis* is mostly a problem in the spring and fall because warm days followed by cool evenings result in condensation on plant surfaces. Regulation of temperature, humidity and leaf wetness duration can prevent disease development.

Botrytis blight cannot be effectively controlled with fungicides alone. An integrated approach is necessary for successful management of this disease.

1. Control weeds and remove plant debris between crop cycles and during production.
2. Space plants to allow good air circulation and reduce humidity within the canopy.
3. Reduce humidity and leaf wetness duration to prevent spore germination. Reduction of humidity by heating and ventilating is relatively inexpensive compared to the loss of revenue that can result from *Botrytis* blight and other plant diseases.

Warm air holds considerably more moisture than cool air. In the evening, as warm air becomes cooler, the relative humidity (RH) rises until water vapor begins to form a film of moisture on surfaces (dew formation). This film of moisture is essential for *Botrytis* (and other fungal pathogens) to germinate and cause infection. To prevent excessive humidity and dew formation, turn on the heat and open the vents. The warm humid air is vented to the outside as the cooler outside air is drawn into the greenhouse. As the incoming air is heated up (even if it is saturated), the RH drops significantly. This air exchange should only take 5 or 10 minutes. The energy necessary to run fans and provide heat is not significant. Under some conditions, this cycle may have to be repeated several times during the evening. The process can be simplified by installing timing devices. Moving air, even in a closed greenhouse, helps to reduce moisture on plant surfaces. Horizontal air flow produces more uniform temperatures and reduces the probability that cool spots in the greenhouse will develop a condensation problem. See page C-40 for a description of horizontal air flow. Humidity can also be reduced by watering in the morning when it is cool so that rising temperatures absorb moisture.

Fungicides for Botrytis Blight

Group	Trade Name	Common name
Chloronitrile*		
	Daconil	chlorothalonil
	Exotherm termil	chlorothalonil
Dicarboximide		
	Sextant	iprodione
	26 GT	iprodione
DMI (demethylation inhibitor)		
	Terraguard	triflumizole
EBDC (ethylenebisdithiocarbamate)*		
	Protect T&O	mancozeb
	Dithane	mancozeb
Hydroxylanilide		
	Decree	fenhexamid
Phenyl pyroles		
	Medallion	fludioxonil
Quinone outside Inhibitor (QoI)		
	Compass	trifloxystrobin
	Heritage	azoxystrobin

Note: this table is to help you manage the development of fungicide resistance in *Botrytis*. Do not use the same fungicide repeatedly, and rotate outside of a fungicide group. Fungicide groups marked with an asterisk are not known to result in resistance development.

Fungicides and Rates for Botrytis Blight

The benzimidazole fungicides Fungo Flo® and Cleary's 3336® have broad-crop clearance for ornamentals and are registered for control of *Botrytis* blight. However, there have been several reports that *Botrytis* has widespread resistance to these fungicides. When using benzimidazole fungicides for *Botrytis*, alternate with another fungicide from the list below. Other fungicides such as GT 26® and Sextant® have also resulted in resistant *Botrytis* strains.

Compass: 0.5 to 1 oz/25 gallons. Apply at 7 to 14 day intervals when conditions are favorable for disease. This is a strobilurin fungicide and may result in resistance development. Do not rotate with Heritage. See label for precautions.

Decree: 4 to 6 oz/25 gal (1 tsp/gal). Decree is to be used for *Botrytis* only. Apply when conditions are favorable for disease development. Apply at 7 to 14 day intervals. Do not apply more than 2.25 oz/1000 sq ft.

26 GT: 8 to 20 fl oz/25 gal (2 to 5 tsp/gal) Apply when conditions are favorable for disease development. Apply every 7 to 14 days. See label for precautions.

Daconil Weather Stik: 5.5 fl oz/25 gal (1.3 tsp/gal), or **Daconil Ultrex 82 WDG** 1.4 oz/25 gal. Do not apply Daconil to azalea or hydrangea flowers.

Dithane Rainshield WF: 9.2 fl oz/25 gal (2 tsp/gal), or **Fore Flo XL;** 9.5 fl oz/25 gal (2 tsp/gal). The addition of **Latron B-1956** to spray solutions improves performance. Apply when conditions are favorable for disease development. Apply every 7 to 10 days.

Exotherm Termil: 3.5 oz/1,000 sq ft. Apply when conditions are favorable for disease development. Apply every 10 to 14 days. Use only when plants are dry. Do not use when temperature exceeds 75F.

Heritage: 0.5 to 1 oz/25 gallons. Apply at 7 to 21 day intervals when conditions are favorable for disease. This is a strobilurin fungicide and may result in resistance development. Do not rotate with Compass. See label for precautions.

Medallion: 2 to 4 water soluble bags/100 gal. Apply at 7 to 14 day intervals when conditions are favorable for disease.

Protect T/O: one water soluble bag /50 gal of water. For improved performance, add 1 to 2 oz Cleary's ClearSpray. Apply when conditions are favorable for disease development. Apply at 7 to 10 day intervals.

Terraguard 50W: 1 to 4 oz/25 gal (0.66 to 1.3 tsp/gal). For bedding plant plugs and impatiens transplants, do not exceed 0.5 oz/25 gal. Repeat applications at 7 to 14 day intervals as needed. Do not apply to impatiens plugs.

Sextant: 8 to 20 fl oz/25 gal (2 to 5 tsp/gal) Apply when conditions are favorable for disease development. See label for precautions.

Key to Symbols in Table C.2 on page C-27

- ✓ = Registered for use on this crop.
- = Not registered for use on this crop.
- E = The fungicide has broad crop clearance but this host does not appear on the label; use experimentally before applying to the entire crop. The user assumes all risks arising out of application to unlabeled plants.
- a Do not use 26 GT, Sextant or Medallion as a drench for impatiens. Do not use Terraguard with impatiens plugs; see label.
- b Discontinue applications prior to bract formation; phytotoxicity is possible on bracts.
- c For roses, 4 fl oz/25 gal Daconil Weather Stik.
- d Dithane is registered for use on *Dendrobium*.
- e Do not use on French, dwarf double or signet type-marigold seedlings.

Table C.2 Fungicides for the Control of *Botrytis* (See key to symbols on page C-26)

	Compass	26 GT	Daconil	Decree	Dithane	Exotherm Termil	Heritage	Medallion	Terraguard	Sextant	Protect T/O
African Violet	E	E	—	✓	✓	✓	E	✓	E	E	✓
Aster	E	✓	—	E	✓	✓ ^e	✓	✓	E	✓	✓
Azalea	✓	✓	✓	E	✓	✓	✓	✓	E	✓	✓
Begonia	✓	E	✓	E	✓	✓ ^e	✓	✓	E	E	✓
Calibrachoa	E	E	—	E	—	—	E	E	E	E	—
Carnation	E	✓	✓	E	✓	✓ ^e	✓	✓	E	✓	✓
Chrysanthemum	✓	✓	✓	E	✓	✓	✓	✓	E	✓	✓
Cineraria	E	✓	—	E	—	✓	E	E	E	✓	✓
Cyclamen	E	✓	—	E	—	✓	✓	✓	E	✓	✓
Exacum	E	E	—	E	—	—	E	E	E	E	—
Fuchsia	E	E	—	E	✓	✓	E	✓	E	E	✓
Geranium	✓	✓	✓	✓	✓	✓	✓	✓	E	✓	✓
Gerbera	E	E	—	E	—	—	✓	✓	E	E	✓
Gloxinia	E	✓	—	E	—	✓	E	E	E	✓	—
Hydrangea	E	✓	✓	E	✓	✓	✓	E	E	✓	✓
Impatiens	E	✓ ^a	—	E	—	✓	✓	E ^a	E ^a	✓ ^a	✓
Iris	✓	✓	✓	E	✓	—	✓	E	E	✓	✓
Lily	E	✓	✓	E	—	✓	✓	E	E	✓	✓
Lisianthus	E	E	—	E	—	—	E	E	E	E	—
Marigold	✓	✓	—	E	✓ ^e	✓	✓	✓	E	✓	—
Orchids	E	E	—	E	✓ ^d	—	E	E	E	E	✓
Poinsettia	✓	✓	✓ ^b	✓	✓	✓ ^b	✓	✓ ^b	E	✓	✓
Primula	E	E	—	E	—	—	E	E	E	E	—
Rose	✓	✓	✓ ^c	✓	✓	✓	✓	✓	E	✓	✓
Snapdragons	✓	✓	—	E	✓	✓	✓	✓	E	✓	✓
Statice	E	✓	✓	E	✓	—	E	E	E	✓	✓
Stocks	E	E	—	E	—	—	E	E	E	E	—
Streptocarpus	E	E	—	E	—	—	E	E	E	E	—
Tulip	E	✓	—	E	✓	—	E	E	E	✓	—
Verbena	✓	E	—	E	—	✓	✓	✓	E	E	✓

Management of Crown and Root Rot

Above-ground symptoms of root rot include stunted growth, yellowing and wilting. Earlier symptoms can only be detected by removing the pot and examining the roots. Healthy roots are generally white and firm; decayed roots may be water-soaked in appearance and/or darkened and easily macerated between the fingers. Some root colonizing fungi move into the stem and cause a canker or “black leg.” *Pythium* is one of the most common fungi found in roots of greenhouse crops. The genus includes many species which vary in their pathogenicity to plants and sensitivity to fungicides. *Phytophthora*, a related fungus, is generally more pathogenic than *Pythium* but is encountered less frequently in greenhouses. *Pythium* and *Phytophthora* are most destructive when soil moisture is abundant and fertility is high. Most fungicides registered for *Pythium* and *Phytophthora* do not control *Rhizoctonia*, *Thielaviopsis*, *Sclerotinia*, *Fusarium* and *Cylindrocladium*.

Rhizoctonia is also a common cause of root disease and stem canker. Unlike *Pythium*, drier soil is more favorable for *Rhizoctonia*. For this reason, *Rhizoctonia* is more active in the upper portion of the soil. When humidity is high and foliage wet, *Rhizoctonia* may grow over the foliage of plugs and bedding plants resulting in a severe blight. This disease is often called web-blight because close inspection of the foliage reveals a fine webbing of fungal growth. Other crown and root pathogens occasionally encountered include *Thielaviopsis*, *Fusarium*, *Sclerotinia* and *Cylindrocladium*. Most fungicides registered for use against these pathogens do not control *Pythium* and *Phytophthora*. A laboratory diagnosis is necessary to determine the cause of root rot.

Sources of Root Disease Fungi

Fungi that attack root systems are natural inhabitants of the soil and survive in the soil indefinitely. They are easily introduced into the growth medium by soiled hands, tools, flats and colonized transplants. *Rhizoctonia* and *Pythium* reside in and on dirt floors, and even in dust and debris on concrete so it is important to keep hose-ends off the floor. Fungus gnats and shore flies may also introduce plant pathogenic fungi into a crop.

Fumigation or steaming of soilless media is not necessary. However, when a soilless medium becomes contaminated with plant pathogens, root rot can develop quickly. When a soilless medium is amended with field soil, it must be treated to prevent the introduction of plant pathogens, nematodes, insects and weeds.

Management

Used pots or flats should be washed with soap and disinfested in 10% household bleach or a similar agent. If field soil is used wholly or as an amendment to a soilless medium, it must be treated. Steam is the least expensive, safest and most effective method. The whole soil mass must reach a temperature of 160F to 180F for at least 30 minutes. Soil can be fumigated with Basamid (dazomet). Methyl bromide may also be used. Fumigants can be hazardous and must be handled cautiously. Residual fumigant in the treated medium may be phytotoxic. Be sure to follow the directions closely. For some crops, protectant fungicides should be used from the beginning of the planting cycle and repeated at regular intervals. Banrot® or other appropriate combinations of fungicides provide a broader spectrum of activity.

Shore fly adults can move *Pythium* and other fungi from soil to plant or from plant to plant. Fungus gnat adults do not move fungi efficiently but their larvae ingest spores of *Pythium* and mycelia of *Rhizoctonia* and deposit them into wounds they create in the roots and stems of plants. Thus, these two insects greatly increase the chance of spread of fungi and the severity of disease. Biological and chemical methods are available for controlling these insects.

Fungicides for *Pythium* and *Phytophthora* Root Rot

Group	Trade Name	Common Name
Carbamate	Banol	propamocarb
Heteroaromatic*	Terrazole	etr Diazole
	Truban	etr Diazole
Phenyl amide	Subdue Maxx	mefenoxam
Phosphonate	Aliette	Fosetyl-Al
Combination	Banrot	etr Diazole + thiophanate methyl

Note: this table is to help you manage the development of fungicide resistance in *Pythium* and *Phytophthora*. More than half of *Pythium* isolates cultured from greenhouse grown plants have been found to be resistant to Subdue Maxx. Do not use the same fungicide repeatedly, and rotate outside of a fungicide group. Fungicide groups marked with an asterisk are not known to result in resistance development.

Fungicides and Rates for *Pythium* and *Phytophthora*

See page C-31 for Fungicides for Rhizoctonia and Other Fungi

Most fungicides registered for *Pythium* and *Phytophthora* do not control *Rhizoctonia*, *Fusarium*, *Thielaviopsis* and *Cylindrocladium*. An exception is Banrot® which is a combination fungicide. Banrot® is composed of thiophanate methyl and etridiazole. Thiophanate methyl is the active ingredient of Fungo Flo® and Cleary's 3336®. Etridiazole is the active ingredient in Terrazole® and Truban®.

Aliette WDG: 5 to 16 oz/25 gal. See label for specific rates. Do not apply more than once every 30 days. Aliette has broad crop clearance; use experimentally on plants not listed on the label.

Banol: 5 to 7.5 fl oz/25 gal (1.2 to 1.8 tsp/gal). See label for specific rates. Drench at 3 to 6 week intervals. May be tank mixed with thiophanate methyl for control of *Rhizoctonia*.

Banrot 40WP: 1.5 to 3 oz/25 gal. Banrot is a combination fungicide containing etridiazole and thiophanate methyl. Etridiazole controls *Pythium* and *Phytophthora*, and thiophanate methyl controls *Rhizoctonia*, *Fusarium* and *Thielaviopsis*.

See the label for specific rates. For container and bed-grown plants, apply in sufficient amount to saturate the soil mixture, such as 0.5 pint per 6 inch pot. After application, irrigate immediately with additional water equal to half the volume of the fungicidal drench. Treat at 4 to 12 week intervals.

Subdue Maxx: See label for specific mixing and drenching rates. See table on this page for mixing smaller volumes.

Terrazole 35 WP: 3.5 to 10 oz/100 gal (0.5 to 1.5 tsp/gal). Drench with enough to saturate the soil such as 0.5 pt/6 inch pot. Repeat at 4 to 12 week intervals.

Truban 30 WP: 3 to 10 oz/100 gal, or **Truban 25 EC:** 4 to 8 fl oz/100 gal. See label for specific rates. For container and bed-grown plants, apply in sufficient amount to saturate the soil mixture, such as 0.5 pint / 6 inch pot. After application, irrigate immediately with additional water equal to half the volume of the fungicidal drench. Treat at 4 to 12 week intervals.

Rate of Subdue Maxx (fl oz)	Table C.3. Amount of Subdue Maxx to add to water to make the following quantities (drops, milliliters or teaspoons)			
	1 gal	5 gal	10 gal	25 gal
0.25	4 drops	18 drops	37 drops/0.75 ml	1.9 ml/3/8 tsp
0.5	7 drops	37 drops/ 0.75 ml	75 drops/1.5 ml	3.8 ml/3/4 tsp
1.0	15 drops	75 drops/ 1.5 ml	3.0 ml/1/2 tsp	7.5 ml/1.5 tsp
1.5	22 drops	3.0 ml/1/2 tsp	4.5 ml/ 1 tsp	11.3 ml/2.25 tsp
2.0	30 drops	4.5 ml/1 tsp	6.0 ml/1.5 tsp	15 ml/3 tsp

Key to Symbols in Table C.4 on page C-30

✓ = Registered for use on this crop; — = Not registered for use on this crop; E = The fungicide has broad crop clearance but this host does not appear on the label; use experimentally before applying to the entire crop. The user assumes all risks arising out of application to unlabeled plants; ^a Labeled only for Easter lily.

Table C.4 Fungicides for Control of Pythium and Phytophthora Root Rot

(See key to symbols on page C-29)

	Aliette	Banol	Banrot	Subdue Maxx	Terrazole	Truban WP	Truban EC
African Violet	E	✓	✓	✓	✓	✓	✓
Alstroemeria	E	E	—	E	E	—	—
Azalea	✓	✓	✓	✓	✓	—	✓
Begonia	✓	E	✓	✓	✓	✓	—
Calibrachoa	E	E	—	E	E	—	—
Calceolaria	E	E	—	E	✓	✓	—
Calla	E	E	—	E	E	—	—
Carnation	E	✓	✓	✓	✓	✓	—
Catharanthus	✓	✓	—	✓	✓	✓	✓
Chrysanthemum	E	✓	✓	✓	✓	✓	✓
Delphinium	E	E	✓	✓	✓	✓	✓
Exacum	E	E	—	E	E	—	—
Fuchsia	E	E	—	E	E	—	—
Gardenia	E	E	✓	E	E	—	—
Geranium	✓	✓	✓	✓	✓	✓	✓
Gerbera	E	E	✓	E	✓	✓	✓
Gloxinia	E	✓	✓	✓	✓	✓	✓
Holiday cactus	E	E	✓	E	E	✓	✓
Hydrangea	E	E	—	E	E	—	—
Impatiens	✓	✓	✓	✓	✓	✓	—
Kalanchoe	E	E	✓	E	✓	—	✓
Lily	E	✓ ^a	✓ ^a	✓ ^a	✓	✓ ^a	✓ ^a
Lisianthus	E	E	—	E	E	—	—
Orchids	E	E	—	E	✓	✓	—
Osteospermum	E	E	—	E	E	—	—
Pansy	✓	E	—	✓	E	—	—
Poinsettia	E	✓	✓	✓	✓	✓	✓
Primula	E	E	—	E	E	—	—
Snapdragons	E	✓	✓	✓	✓	✓	✓
Statice	E	E	✓	E	✓	✓	—
Tulip	E	E	—	E	E	—	—
Zinnia	E	E	✓	✓	✓	✓	✓

Fungicides and Rates for *Rhizoctonia, Thielaviopsis, Fusarium and Cylindrocladium*

See page C-29 for Fungicides for *Pythium and Phytophthora*

The fungicides listed below are all effective against *Rhizoctonia* but may vary in their effectiveness against other root pathogens. Check the label to be sure that the fungicide is effective against the target pest.

Banrot® is a combination of etridiazole and thiophanate methyl. Etridiazole is the active ingredient for Truban® thus this combination fungicide controls both *Pythium* and *Phytophthora*. Thiophanate methyl is the same active ingredient found in Fungo Flo® and Cleary's 3336®.

Banrot 40WP: 1.5 to 3 oz/25 gal. Banrot is a combination fungicide containing etridiazole and thiophanate methyl. Etridiazole controls *Pythium* and *Phytophthora*, and thiophanate methyl controls *Rhizoctonia*, *Fusarium* and *Thielaviopsis*. See the label for specific rates. For container and bed-grown plants, apply a sufficient amount to saturate the soil mixture, such as 0.5 pint/6 inch pot. After application, irrigate immediately with additional water equal to half the volume of the fungicidal drench. Retreat at 4 to 12 week intervals.

26 GT: 13 fl oz/100 gal (3.25 fl oz/25gal; 0.75 tsp/gal). This rate is for the control of *Rhizoctonia* root and crown rot. Apply 1 to 2 pints of solution / sq ft and repeat at 14 day intervals. See the label for rates for dipping roses, azalea and gladiolus. Do not use as a drench on impatiens.

Cleary's 3336 F: 4 to 5 fl oz/25 gal (1 tsp/gal), or **Cleary's 3336 50WP:** 3 to 4 oz/25 gal (2 to 3 tsp/gal). Apply as a drench or heavy spray after transplanting to propagation bed or container at a rate to thoroughly soak the growing media. Repeat at 21 to 28 day intervals. See label for seedlings and transplants. Phytotoxicity may occur to Boston fern, Swedish ivy and Easter cactus. Do not tank mix with copper or alkaline materials.

Contrast 70WSP: 3 to 6 one oz packets/100 gal. Repeat at 21 to 28 days if necessary. See label for volume of drench.

Defend 75WP: 1oz/25 gal. Apply 25 gal to 200 sq ft for soil less than 4 inches deep. For soil deeper than 4 inches, apply 50 gal/200 sq ft. Defend and Terraclor have the same active ingredient, pentachloronitrobenzene (PCNB).

Fungo Flo XL: 5 fl oz/25 gal (1 tsp/gal). Apply 1 to 2 pt/sq ft after transplanting into benches or containers. Repeat at 2 to 4 week intervals during periods favorable for disease.

Medallion: 1 to 2 one oz packets/100 gal. For *Rhizoctonia*, apply sufficient drench to wet the top half of the growing medium. For other pathogens, completely drench the growing medium. Medallion can be mixed with Subdue for broad spectrum control.

Sextant: 13 fl oz/100 gal (3.25 fl oz/25gal; 0.75 tsp/gal). This rate is for the control of *Rhizoctonia* root and crown rot. Apply 1 to 2 pints of solution / sq ft and repeat at 14 day intervals. See the label for rates for dipping roses, azalea and gladiolus. Do not use as a drench on impatiens.

Terraclor 75 WP: 1 to 2 oz/25 gal, or **Terraclor 400F:** 1.5 to 3 fl oz/25 gal. Apply 25 gal to 200 sq ft for soil 2 inches or less in depth. Apply 25 gal to 100 sq ft for soil 4 inches or more in depth. Apply approximately 4 fl oz/ 6 inch pot. One repeat application may be made 4 to 6 weeks later. Terraclor and Defend have the same active ingredient, pentachloronitrobenzene (PCNB).

Terraguard 50 W: 1 to 2 oz/25 gal (0.66 to 1.3 tsp/gal). Apply approximately 4 fl oz/ 6 inch pot. For best results do not irrigate with additional water until 24 hr after application. Apply at 3 to 4 week intervals as needed. Do not use on impatiens plugs. On impatiens transplants, do not exceed 2 oz/100 gal.

Fungicides for Root Rot Other than Pythium and Phytophthora

Group	Trade Name	Common Name
Aromatic hydrocarbon	Defend	pentachloronitrobenzene
	Terraclor	pentachloronitrobenzene
Benzimidazole	Cleary's 3336	benzimidazole
	Fungo Flo	benzimidazole
Carboximide	Contrast	flutolanil
Dicarboximide	26GT	iprodione
	Sextant	iprodione
DMI (demethylation inhibitor)	Terraguard	triflumizole
Phenyl pyrrole	Medallion	fludioxonil
Combination*	Banrot	etridiazole + thiophanate methyl

Key to Symbols in Table C.5 on page C-33

√ = Registered for use on this crop.
 — = Not registered for use on this crop.
 E = The fungicide has broad crop clearance but this host does not appear on the label; use experimentally before applying to the entire crop. The user assumes all risks arising out of application to unlabeled plants.
 a Do not use on impatiens plugs. On impatiens transplants, do not exceed 2 oz/100 gal.
 b Use caution when these plants are in bloom.
 c Labeled for Easter lily only.

Note: this table is to help you manage the development of fungicide resistance. Do not use the same fungicide repeatedly, and rotate outside of a fungicide group. Fungicide groups marked with an asterisk are not known to result in resistance development.

Notes:

Table C.5 Fungicides for Root Rot Fungi *Rhizoctonia*, *Thielaviopsis, *Fusarium* and *Cylindrocladium*.**

Please note: these fungicides vary considerably in their spectrum of activity against root pathogens. Check the label to be sure the chosen fungicide is effective against the target pest. (See key to symbols on page C-32)

	Banrot WP	26 GT	Cleary's 3336*	Contrast*	Defend	Fungo Flo*	Medallion*	Sextant	Terraclor WP	Terraguard*
African Violet	✓	E	E	E	E	E	✓	E	E	E
Alstroemeria	—	E	E	E	E	E	E	E	E	E
Azalea	✓	✓	E	✓	E	E	✓	✓	✓	✓
Calibrachoa	—	E	E	E	E	E	E	E	E	E
Calla	—	E	E	E	E	E	E	E	E	E
Camellia	✓	E	E	E	E	E	E	E	E	E
Carnation	✓	✓	E	E	✓	E	✓	✓	✓	E
Catharanthus	—	E	E	E	E	E	✓	E	✓	✓
Chrysanthemum	✓	✓	E	✓	✓	E	✓	✓	✓	E
Cineraria	—	✓	E	E	E	E	E	✓	✓	E
Cyclamen	—	✓	E	E	E	E	✓	✓	✓	E
Exacum	—	E	E	E	E	E	E	E	E	E
Freesia	—	E	E	E	E	E	E	E	E	E
Fuchsia	—	E	E	E	E	E	✓	E	E	E
Gardenia	✓	E	E	E	E	E	E	E	✓	E
Geranium	✓	✓	E	E	✓	E	✓	✓	✓	E
Gerbera	✓	E	E	E	E	E	✓	E	E	E
Gloxinia	✓	✓	E	E	E	E	E	✓	✓	E
Holiday cactus	✓	E	E	E	E	E	E	E	E	E
Hyacinth	—	E	E	E	E	E	E	E	E	E
Hydrangea	✓	✓	E	E	E	E	E	✓	E	E
Iris	—	✓	E	✓	E	E	E	✓	✓	E
Impatiens	✓	—	E	E	E	E	E ^b	—	E	✓ ^a
Kalanchoe	✓	✓	E	E	✓	E	E	✓	E	E
Lily	✓ ^c	✓	E	✓	✓	E	E	✓	✓	E
Lisianthus	—	E	E	E	E	E	E	E	E	E
Poinsettia	✓	✓	E	✓	E	E	✓	✓	✓	✓
Primula	—	E	E	E	E	E	E	E	E	E
Roses	—	✓	E	✓	E	E	✓	✓	✓	E
Snapdragons	✓	✓	E	✓	E	E	✓	✓	✓	E
Statice	✓	✓	E	E	E	E	E	✓	E	E
Stock	—	—	E	E	E	E	E	E	E	E
Succulents	—	E	E	E	E	E	E	E	E	E
Tulip	—	✓	E	E	E	E	E	✓	✓	E
Verbena	✓	E	E	E	E	E	✓	E	✓	E
Zinnia	✓	✓	E	E	✓	E	✓	✓	✓	E

Management of Powdery Mildew

As the name implies, powdery mildew fungi usually produce a conspicuous crop of white spores on the foliage or, in some cases, stems or flowers. On most hosts, the disease is easy to recognize but occasionally other diseases produce similar symptoms. Also, powdery mildew may damage some plants such as kalanchoe, but not develop the characteristic powdery spores.

Powdery mildew fungi behave somewhat differently than other plant pathogens such as *Botrytis*. For example, powdery mildews do not need free water for spore germination; free water may actually kill spores and inhibit disease development. Powdery mildew is most prevalent under conditions of high humidity. The powdery mildew fungi are fairly host specific, meaning they do not spread from rose to zinnia, for example. However, plants in the same family, such as the *Asteraceae*, may be susceptible to the same powdery mildew species.

Unlike most fungi, powdery mildews only colonize the upper layer of plant cells, and for this reason, chemical eradication of infection is possible. Therefore, it is not necessary to use fungicides to *prevent* powdery mildew. Wait until disease first occurs before applying fungicide. There are a number of different genera and species of powdery mildew fungi, and some variation in fungicide effectiveness may be observed.

Different species of powdery mildew fungi vary in their requirements for temperature, humidity and moisture. Reducing humidity below 96% inhibits some, while others may cause disease at considerably lower humidity. Optimum temperature for disease occurs between 70F and 85F. Poinsettia powdery mildew does not occur above 86F, so plants taken inside during the summer months do not show obvious symptoms. It is a good management practice to keep humidity below 93% and to remove diseased plants from the greenhouse. This helps reduce other diseases as well.

Suggested Rotations to Reduce Resistance Development

To avoid fungicide resistance, rotate among fungicides from different classes. In the table below, Cleary's 3336® and Fungo Flo® have the same active ingredient (thiophanate methyl). Rubigan®, Strike® and Systhane® are in the same chemical family and should not be rotated with each other. Zyban® is a mixture of thiophanate methyl and mancozeb, and this mixture

prevents the fungus from becoming resistant to thiophanate methyl. Cleary's®, Strike® and Zyban® are toxic to some insect predators. Note: Cleary's 3336®, Fungo Flo®, Spectro 90WDG® and Zyban® may leave a visible residue and should be tested for esthetic acceptability.

Fungicide for Powdery Mildew

Group	Trade Name	Common Name
Amine		
	Pipron	piperalin
Benzimidazole		
	Cleary's 3336	thiophanate methyl
	Fungo Flo	thiophanate methyl
Chloronitrile*		
	Daconil	chlorothalonil
DMI (demethylation inhibitor)		
	Banner	propiconazole
	Rubigan	fenarimol
	Strike	triadimefon
	Systhane	myclobutanil
	Terraguard	triflumizole
Quinone outside Inhibitor (QoI)		
	Compass	trifloxystrobin
	Cygnus	kresoxim-methyl
	Heritage	azoxystrobin
Inorganic*		
	Armcarb 100	potassium bicarbonate
	MilStop	potassium bicarbonate
	Kocide	cupric hydroxide
	Phyton 27	copper pentahydrate
Combination*		
	Spectro 90	chlorothalonil + thiophanate methyl

Note: this table is to help you manage the development of fungicide resistance in powdery mildew fungi. Do not use the same fungicide repeatedly, and rotate outside of a fungicide group. Fungicide groups marked with an asterisk are not known to result in resistance development.

Fungicides and Rates for Powdery Mildews

Armicarb 100: 10 to 20 oz/25 gal. Repeat at 10 to 14 day intervals as needed. Do not use on pansies at early stages of growth. Use low rate for impatiens and do not spray when blossom buds are visible.

Banner Maxx: 1.25 to 2 fl oz/gal (0.5 to 0.75 tsp/gal). Apply every 14 to 21 days as need.

Cleary's 3336 50WP: 2-3 oz/25 gal (2 tsp/gal), or **Cleary's 3336 F:** 2.5 fl oz/25 gal (0.5 tsp/gal). Apply when conditions favor disease. Repeat at 10 to 14 day intervals. Cleary's 3336 has broad crop clearance for ornamentals. It is a benzimidazole type fungicide; continued use may result in resistance.

Compass: 1.5 to 3 tsp/25 gal. Apply the higher rate if powdery mildew is present. Reapply every 7 to 14 days. Continued use may result in resistance. Do not rotate with Cygnus or Heritage.

Cygnus: 2.25 to 4.5 tsp/gal. Apply the higher rate if powdery mildew is present. Reapply every 7 to 10 days. Continued use may result in resistance. Do not rotate with Compass or Heritage.

Daconil Weather Stik: 5.5 fl oz/25 gal (1/3 tsp/gal). Apply when conditions favor disease development. Reapply every 7 to 14 days. Do not use mistblowers or high pressure spray equipment to apply Daconil in the greenhouse.

First Step: 10 to 20 oz/25 to 50 gal. Potassium bicarbonate.

Fungo Flo: 2.5 fl oz/25 gal (0.5 tsp/gal). Apply when conditions favor disease. Repeat at 10 to 14 day intervals. Fungo Flo has broad crop clearance for ornamentals. Fungo Flo is a benzimidazole fungicide; continued use may result in resistance.

Heritage: 1.5 tsp to 4 tbsp/25 gal. Apply the higher rate when powdery mildew is present. Reapply every 7 to 28 days. Continued use may result in resistance. Do not rotate with Cygnus or Compass.

Kocide: 4.5 LF; 5.2 fl oz/25 gal (1.3 tsp/gal). Apply at first sign of disease. Repeat at 7 to 14 day intervals. Do not tank mix with Aliette fungicide.

Milstop: 10 to 20 oz/25 gal. Repeat at 10 to 14 day intervals as needed. Do not use on pansies at early stages of growth. Use low rate for impatiens and do not spare when blossom buds are visible.

Phyton 27: See label for rate. The rate varies widely depending on the crop.

Pipron: 1 to 2 oz/25 gal. Begin when powdery mildew first appears. Use the higher rate if mildew is already present.

Rubigan EC: 0.75 to 1.25 fl oz/25 gal. Begin when powdery mildew first appears. Or, use the low rate as a preventive and the high rate when greater than 10% of the leaves are infected. Reapply at 10 to 14 day intervals if conditions remain favorable for disease. Continued use may result in resistance. Do not rotate with Systhane or Strike.

Spectro 90 WDG: 4 to 8 oz/25 gal (1 to 2 Tbsp/gal). Begin when powdery mildew first appears. Reapply at 7 to 21 day intervals.

Strike 25WP: For greenhouse use, winter rate: 0.5 oz/25 gal; summer rate, 1 oz/25 gal. For outdoor use: 0.5 to 1 oz/25 gal. Apply when conditions favor disease development. Continued use may result in resistance. Do not rotate with Systhane or Rubigan.

Systhane WSB: one water soluble pouch/50 gal. Apply at 10 to 14 day intervals. Adding a spray adjuvant improves coverage. Overdosage can result in increased greening and stunting. Do not use with a growth regulator without a prior trial. Continued use may result in resistance. Do not rotate with Strike or Rubigan.

Terrazole 50W: 1 to 2 oz/25 gal (0.66 to 1.33 tsp/gal). Use higher rates under heavy disease pressure, lower rates for subsequent applications.