

# TIMELY INFORMATION

## Agriculture & Natural Resources

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PP-603

### CONTROL OF ROOT, CROWN AND FOLIAR DISEASES OF BEDDING PLANTS AND FLOWERS IN THE GREENHOUSE AND LANDSCAPE

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#### Disease Control Strategies for Greenhouse Bedding and Floral Crops

Prevention is the key to minimizing disease-related plant and income losses during the production, shipping, and sales of greenhouse bedding and floral crops. Strategies involved in preventing disease outbreaks include the use of disease-resistant cultivars or selections, good cultural practices, crop sanitation, greenhouse design features, and chemical control. In the near future, biocontrol practices may also become an integral part of a disease management program for bedding and floral crops. Generally, no single control strategy will insure complete control from damaging diseases, particularly root rots. Rather, several strategies are usually combined to prevent costly disease outbreaks in greenhouse crops.

#### Disease Resistance

Production and establishing of disease resistant cultivars or selections is an inexpensive and often effective means of reducing the risk of damaging disease outbreaks as well as production costs. Disease resistance is, however, rarely included among the criteria used to identify new selections or lines of bedding and floral crops. In particular, many popular bedding and floral crops are highly sensitive to one or more root rot diseases. Some differences in the reaction of cultivars or lines of selected bedding floral crops to certain diseases have been noted and every effort should be made to exploit available sources of resistance.

#### Cultural Practices

Cultural practices utilized to minimize the risk of disease outbreaks in bedding and floral crops include greenhouse design, sanitation, potting media components, watering patterns, as well as media fertility and pH.

**Greenhouse Design:** Preferably, bedding and floral crops should be grown on raised benches covered with heavy gauge wire or similar material. Cedar slat-covered benches should be avoided. Where bedding plants are produced on porous concrete or gravel floors, beds should be slightly crowned to speed drainage of excess water and prevent ponding of water around flats or pot-grown stock. Avoid growing greenhouse crops on flat beds on plastic or fiber-covered native soil. Native soil is a common source for root rot causing fungi and severe disease outbreaks are likely to occur.

In poorly ventilated greenhouses, selected floral and foliar diseases are quite common on certain bedding and floral crops. Moisture condenses on plant foliage as damp, humid air cools at or shortly after sundown. Heavy dews can form anytime in late fall through spring especially during a day or more of mild, rainy, overcast weather [typically a warm front accompanied by lots of rain]. Only a few hours of dampness or free water on leaves or stems is sufficient for infection by some disease-causing bacteria and powdery mildew fungi. Overnight wetting of the foliage is extremely conducive to outbreaks of diseases such as Botrytis blight and Rhizoctonia web blight.

Timely ventilation and heating is the most effective means of managing moisture in a greenhouse, particularly in the fall, winter and spring. By venting the humid, warm ambient air in the late afternoon or early evening hours and slightly heating [and thereby driving] the incoming air, humidity in the greenhouse can often be held below the threshold for disease development [85% for Botrytis blight]. Greenhouse moisture management can be particularly tricky during mild, wet winter weather. Also, sufficient fans or similar ventilation equipment should be installed to prevent isolated pockets of damp air from settling around greenhouse crops and to facilitate air circulation. During humid, summer months, a combination of evaporative cooling pads and fans will also help remove excess moisture. Finally, space out pot-grown crops on benches to allow air to circulate around the foliage.

**Potting Media:** The occurrence and severity of soilborne diseases is often tied to the accidental contamination of potting media by plant pathogenic fungi during propagation or production of bedding plants and floral crops. The soilless media used by nearly all greenhouse operations comes from the supplier relatively pathogen-free. Contamination of selected peat-containing mixes by *Thielaviopsis basicola*, which is the fungus that causes black root rot on pansy, vinca, and other floral crops, is not uncommon.

Crops grown in poorly-drained or compacted potting media are the greatest risk from root rot diseases. To drain quickly, potting media must have about 20 to 30 percent air space. Addition of fine amendments, such as additional peat moss or fine clay, slow the percolation of water and will lead to a waterlogged, poorly aerated media. Peat moss and composed bark materials will decay and often become compacted; thereby slowing the movement of water through potting media. Finally, never add raw soil to potting media.

**Watering Practices:** Moisture is a critical component in the development of both soil, foliar, and floral diseases of greenhouse crops. While all greenhouse crops require a good bit of water for optimum growth, excessive moisture levels in the media and on the foliage will increase the incidence and severity of most diseases. To avoid over or under watering, pot and flat-grown stock should be segregated according to water needs, especially when using an ebb & flow or similar automated watering system. When scheduling overhead irrigation, water at mid-day but not late enough in afternoon or early evening that the leaves remain wet all night. Wetting of the foliage can also be minimized by installing a drip, ebb & flow, or similar irrigation system. Never recycle greenhouse or nursery run-off unless a chlorination or similar water treatment system has been installed.

**Soil Fertility:** The impact of soil fertility has been demonstrated for only a handful of diseases of greenhouse crops. Nitrogen form, i.e. ammoniacal vs. nitrate nitrogen, has been shown to influence the development of *Thielaviopsis* black root rot on pansy. A deficiency of calcium may greatly increase the sensitivity of floral crops to the Botrytis blight. Excessive rates of nitrogen fertilizers raise salt levels in potting media, which may ultimately predispose the roots attack by root rot fungi like *Pythium* or *Phytophthora* pathogens. Salt damage on greenhouse crops can be avoided by using a salt meter or similar device to monitor nitrogen fertility levels.

**Sanitation:** Spent blooms and other debris from previous greenhouse crops as well as discarded potting media are important sources of foliar and soilborne plant pathogenic fungi and bacteria. During the production cycle, remove and discard unsalable or dead plants as well as other crop debris from production areas. Between crops, clear loose potting media and debris from propagation benches and production areas. If root rot disease have caused serious loss, wash down benches and other work areas with a greenhouse disinfectant. Periodically, treat (paint) cedar benches or other wooden surfaces with copper naphthlate.

Plug trays, flats, and pots should not be reused unless they are carefully rinsed of loose trash, sanitized with a surface disinfectant, and air dried. Water breakers, hoses, and tools should also be kept off of the greenhouse floor and occasionally cleaned. Knives and other pruning tools, particularly those used to take cutting from stock plants, must be cleaned with surfaces disinfectant, such as rubbing alcohol, after each cut.

Plugs, cuttings, and other propagative plant material are sources of damaging diseases, particularly those caused by viruses and root rot fungi. Shipments of propagation stock should be inspected immediately upon arrival for damaged caused by diseases and insect pests. If a serious disease problem is found, contact the shipper. Diseased or otherwise damage should be discarded.

Potting media bags or bulk components should be stored on raised and if possible covered concrete or asphalt pads. Periodic steam cleaning of bulk mixers, hoppers, and other media handling equipment may also help minimize losses due to root and crown-rot diseases.

## CHEMICAL CONTROL

In the bedding and floral crop market, quality sells. There is no tolerance in the market for poor quality bedding and floral crops. As a result, fungicides and bactericides often must be used in order to insure the uniformity and marketability of bedding plant and pot-grown floral crops as well as to avoid damage caused by plant pathogenic fungi and bacteria. Annually, disease such as crown and root rots caused by the fungi *Phytophthora*, *Pythium*, *Thielaviopsis*, *Myrothecium* and *Rhizoctonia*, along with a blossom and foliar blight caused by *Botrytis* are common and significant threats to the appearance and marketability of many widely grown bedding plants and potted flowers. Depending on the crop grown and target disease, one or multiple applications of a selected fungicide and/or bactericide may be needed to prevent damaging disease outbreaks.

Effective selection and use of preventative fungicide and bactericide treatment demands that greenhouse managers be familiar with the damaging diseases of the crops in their production mix as well as on the influence of environmental conditions on their development and spread. It's also critical that managers be able to recognize and monitor outbreaks of damaging diseases and the effectiveness of their disease control program. Preventative treatment programs should be targeted at those

diseases, such as Phytophthora root rot on petunia or Botrytis blight on poinsettia, that can and often do cause severe losses on a given crop. Applications should be continued at interval specified on the product label until the crop is no longer vulnerable to attack, environmental conditions are unfavorable for the disease, or the crop is marketed. Typically, preventative fungicide and bactericide treatments are most effective when combined with recommended sanitation and crop management practices.

Curative treatment programs begun after disease symptoms are recognized are generally much less effective in controlling both foliar and soilborne diseases especially root and crown rot, than a preventative treatment regime. Many of the damaging diseases of the bedding and floral crops widely grown in Alabama are listed in the Table (1) below.

Table 1. Major Diseases of Bedding and Floral Crops in Alabama.

CROP	DISEASE	COMMENTS
Ageratum	Botrytis Blight	Develops during several days of humid, rainy, cloudy weather.
Begonia	Bacterial Blight Botrytis Blight Powdery Mildew Pythium Root Rot Root-Knot Nematode	Sanitation critical.
Chrysanthemum	Ascochyta Ray Blight	On blooms.
Cyclamen	Fusarium Crown Rot	Inspect incoming stock.
Dianthus	Heterosporium Leaf Spot Rhizoctonia Crown and Stem Rot	
Geranium	Alternaria Leaf Spot Bacterial Leaf Spot Botrytis Blight Pythium Root Rot Rust	Clean cuttings.
Impatiens	Alternaria Leaf Spot Bacterial Leaf Spot Botrytis Blight Phytophthora Root Rot Rhizoctonia Crown Rot Tomato Spotted Wilt	Watch overhead watering.
Latana	Foliar Nematode	Healthy cuttings.
Marigold	Alternaria Leaf Spot Cercospora Leaf Spot	Seen on all marigold cultivars.
Pansy	Anthracnose Black Root Rot Botrytis Blight Cercospora Leaf Spot Myrothecium Crown Rot Phytophthora Root Rot Pythium Root Rot	Clean plugs critical.

CROP	DISEASE	COMMENTS
Petunia	Botrytis Blight Phytophthora Shoot and Root Rot	Sanitation critical.
Poinsettia	Botrytis Blight Pythium Root Rot Rhizoctonia Root Rot	Watch watering and fertilization practices.
Rose (Miniature)	Powdery Mildew	
Rose (Mother's Day)	Downy Mildew	Particularly destructive in closed greenhouses during extended periods of heavy clouds and rain.
Snapdragon	Botrytis Blight Rhizoctonia Collar Rot Root-knot Nematode Rust	Serious disease problems in ground beds.
Verbena	Foliar Nematode Powdery Mildew	Sanitation critical.
Vinca	Phytophthora Shoot Blight and Root Rot Rhizoctonia Crown Rot	Sanitation critical as are protective fungicide sprays.
Zinnia	Alternaria Leaf Spot Bacterial Leaf Spot Botrytis Blight Powdery Mildew	Healthy plugs or seedlings.

On bedding and floral crops, root and crown rot diseases often cause the greatest loss and are most difficult to control. Best results can generally be obtained by mixing a fungicide into the potting medium before transplanting plugs, rooted cuttings, or liners. Drenching a fungicide immediately after transplanting may be a somewhat less effective but more practical alternative. Given the long residual activity of many soil fungicides (see Table 2), only a single fungicide treatment is usually required prior to finishing many bedding and some floral crops. Drenches should always be applied when the crop needs to be watered.

Due in part to continued plant growth and weathering of fungicide deposits, applications of fungicides and bactericides for the control of foliar diseases must be made more often than drench treatments. For best results, start preventative sprays when the window for infection opens and continue treating until the plants are not vulnerable to attack or the crop is sold. Again, the total number of sprays required to control foliar diseases on bedding and floral typically will be fairly small. Timing of those sprays is, however, quite critical. Uniform coverage of the target area is also crucial for obtaining effective disease control with foliar-applied fungicides and bactericides. Typically, spray until the leaves are wet or until run-off.

To avoid any nasty surprises just before shipping, flat and pot-grown crops must be routinely inspected during the production cycle for symptoms of damaging diseases. This advice holds true for treated and untreated crops. From a distance, uneven or yellowed top growth as well as open cells in flats are good indicators of a foliar or soilborne disease outbreak. Should symptomatic plants [consider insect, disease or nutritional/environmental disorders], be found, immediately identify the cause. If a disease is diagnosed, dump any unmarketable stock and apply, when appropriate a recommended fungicide or bactericide at the highest rate and shortest treatment interval on the label.

### Pythium and Phytophthora Root Rot

	Rate/100 gal	Retreat Every	Comments
Truban 30W/ Terrazole 35W	4-6 oz	1-2 mo.	Drench at Seeding and Transplanting: Covers 800 sq. ft. bed area. Irrigate immediately. Repeat at 1- to 2-month intervals as needed. See label for plant list.

	Rate/100 gal	Retreat Every	Comments
Truban 25E	3-4 fl oz	1-2 mo.	
Banrot 40W	4-8 oz	1-2 mo.	(Also controls diseases caused by <i>Rhizoctonia</i> , <i>Fusarium</i> , and <i>Thielaviopsis</i> .)
Banol 67S	30 fl oz	3-6 wks.	Drench at Seedling and Transplanting (Seedlings): Apply 3 quarts spray mixture to 10 sq. ft. bench or bed area. See label for plant list.
	20 fl oz	3-6 wks.	Drench When Transplanting Cuttings: Drench with 2 quarts of spray mixture per 10 sq. ft. bed or bench area.
	20 fl oz	3-6 wks.	Drench: Thoroughly wet media with 3.5 oz. spray mix per 4 inch pot.
Subdue MAXX	0.13-0.25 fl oz	1-2 mo.	Drench at Seeding: Covers 400 & 800 sq. ft. bed or bench area. See label for plant list and use restrictions.
	0.5-2.0 fl oz	1-2 mo.	Drench at Transplanting: Covers 400 & 800 sq. ft. bed or bench area. See label for Plant list and use restrictions.

	Rate/100 gal	Retreat Every	Comments
Subdue 2X WSP	0.1-0.5 oz	1-2 mo.	Drench at Transplanting: Apply 1 pint of drench solution per sq. ft. of bed or bench area. For media depths greater than 4 inches, apply 1.5 to 2 pints of drench suspension per sq. ft.
Alude	1-2 qt	2-3 wks.	Foliar Spray: Apply to thoroughly wet Foliage. Drench: Apply 25 gallons of solution per 100 square foot of bench area.
Aliette T/O	1.25-4.0 lb	1 mo.	Foliar Spray: Apply to wet foliage, using no more than 400 gallons of spray volume per acre. Repeat as needed.

### Soil Mixes (Phytophthora and Pythium)

	Rate/cu. yd.	Retreat Every	Comments
Truban 30W	1.5-3.0 oz	1-2 mo.	Dry Mix: Mix thoroughly. Follow as needed with drench or foliar spray. See label for plant list.
Terrazole 35W	1.5-3.0 oz		
Truban 5G	5 oz	1-2 mo.	Dry Mix: Mix thoroughly. Medium should be free of bumps and dry enough to prevent clumping when mixing.
Banrot 8G	8 oz	1-2 mo.	Dry Mix: Mix thoroughly. Follow as needed with soil drench or foliar spray after 1-2 months. See label for plant list. Also controls root rots caused by <i>Rhizoctonia</i> , <i>Thielaviopsis</i> , and <i>Fusarium</i> .
Subdue GR	1.6-8 oz	1-2 mo.	Dry Soil Mix: Mix thoroughly and apply enough. Water to wet root zone. Follow with soil drench or spray as needed.

### Rhizoctonia Damping-Off, Root and Crown Rot

	Rate/100 gal	Retreat Every	Comments
3336 50W	12-16 oz	2-4 wks.	Drench at Seeding or Transplanting: Apply 1 to 2 pints of spray mixture per sq. ft. of bench or bed area.
3336 4.5F	16-20 fl oz		
OHP6672 5OW	12-16 oz		
OHP6672 4.5F	16-20 fl oz		

	Rate/100 gal	Retreat Every	Comments
Chipco GT Sextant 2F	13 fl oz 13 fl oz	2 wks.	Drench at Seeding or Transplanting: Apply 1 to 2 pints per sq. ft. of bed or bench area. See label for plant list.
Defend 75W Terraclor 75W Defend 2E	4-8 oz 4-8 oz 0.75 pt	4-6 wks.	Drench at Seeding or Transplanting: Apply 100 gal. mixture to 400 to 800 sq. ft. bed or bench area. Agitate.
Banrot 40W	4-8 oz	1-2 mo.	Drench at Seeding or Transplanting: Apply 100 gal. to 800 sq. ft. of bed area. Irrigate immediately. See label for plant list. Also control <i>Pythium</i> and <i>Phytophthora</i> -incited diseases.
Terraguard 50W	4-8 oz	3-4 wks.	Drench as needed. See label for plant list.
Medallion	1 oz	1-3 wks.	Drench at Seeding: Apply 1 pint of suspension per square foot of bench or bed area. Make one application prior to transplanting. <b>Do Not</b> apply to pansy or geranium.
	1-2 oz	3-4 wks.	Drench at Transplanting: Repeat as needed to control disease. See above comments.
Heritage 50W	1-4 oz	1-3 wks.	Heavy Spray/Drench at Transplanting: Apply in enough water to wet foliage of target plant. Repeat as needed to prevent disease at specified intervals. Use higher rate at shorter interval when conditions favor disease and target plant is vulnerable. Not cleared for use on poinsettia. See label for plant list.
Compass 50W Compass O	0.5 oz 0.5 oz	3-4 wks.	Drench at Seeding and Transplanting: Wet upper ½ of potting media. May injure bracts of poinsettia. See label for list of labeled bedding plants and floral crops. Compass O is labeled for greenhouse use.
Sys Star WDG	2-4 oz		Drench: Apply 1 to 2 pints per square foot of bed or bench area. Repeat as needed.
Contrast 70WDG	3-6 oz	3-4 wks.	Drench: Apply 1 to 2 pints of suspension per square foot of bench area. See label for more information.

## Thielaviopsis Root Rot

	Rate/100 gal	Retreat Every	Comments
3336 50W	12-16 oz	2-4 wks.	Drench at Seeding or Transplanting: Apply 1 to 2 pints mixture per square foot of bench or bed area. Also controls root rot caused by <i>Fusarium</i> .
3336 4.5 F	16-20 fl oz		
OHP6672 50W	12-16 oz		
OHP6672 4.5F	16-20 fl oz		

	Rate/100 gal	Retreat Every	Comments
Banrot 40W	4-8 oz	1-2 mo.	Drench at Seeding or Transplanting: 100 gal. mixture covers 800 sq. ft. of bed area. Irrigate immedi- ately. See label for plant list. Also controls root rot caused by <i>Fusarium</i> .
Terraguard 50W	4-8 oz	3-4 mo.	Drench as needed. See label for plant list.

## Dry Soil Mix (All Root-Rot Fungi)

	Rate/cu. yd.	Retreat Every	Comments
Banrot 8G	8 oz	1-2 mo.	Dry Mix: Mix thoroughly. Medium should be of bumpo and dry enough to prevent clumping when mixing. Also controls root rot caused by <i>Fusarium</i> . See label for plant list.

## Botrytis Blight

	Rate/100 gal	Retreat Every	Comments
Daconil Ultrex	1.4 lb	7-14 d.	Foliar Spray: Begin sprays at transplanting or as needed. See label for plant list. Use higher rate at shorter interval when conditions favor disease.
Daconil Weather Stik	1.4 pt	7-14 d.	
Echo 720	1.4 pt	7-14 d.	
Chipco 26GT	1.0-2.5 qt/A		
Sextant	1.0-2.5 qt/A		
Dithane T/O	1.5 lb	7-10 d.	Foliar Spray: Begin when plants fully leaf-out and repeat as needed. Add wetting agent to T/O tank-mixes. See label for plant list.
Protect T/O	1.5 lb	7-10 d.	
Fore Flo 37F	1.2 qt	7-10 d.	
Sys Star WDG	4-8 oz	10-14 d.	Foliar Spray: Apply to drip and repeat as needed.
3336 50W	12-16 oz	10-14 d.	Foliar Spray: Apply when conditions favor disease and repeat at specified
3336 4.5F	10-20 fl oz	10-14 d.	

OHP6672 50W 12-16 oz interval as needed. Shorten spray interval  
 OHP6672 4.5F 10-20 fl oz during rainy, overcast weather.

	Rate/100 gal	Retreat Every	Comments
Compass 50W Compass O	2-4 oz 2-4 oz	7-14 d.	Foliar Spray: Apply before disease is detected and when conditions favor disease. Repeat as needed. Under heavy disease pressure, use highest rate at shortest interval. See label for plant list. Compass O is labeled for greenhouse use.
Heritage 50W	4-8 oz	7-21 d.	Foliar Spray: For suspension only. Do Not exceed 24 oz/A per growing season, (4 hr. REI). Use higher rate at shorter interval when conditions favor disease. Repeat as needed as specified interval. See label for plant list.
Decree 50W	1.0-1.5 lb	7-14 d.	Foliar Spray: Apply 100 gallons of spray volume per acre. For use on outdoor and greenhouse grown floral crops (4 hr. REI).
Cygnus	1.6-3.2 oz	7-10 d.	Preventative Foliar Spray. Curative: Apply higher retreat. Shorter interval.

#### Leaf Spots (Caused by bacteria)

	Rate/100 gal	Retreat Every	Comments
Kocide 2000 T/N/O	12 oz	7-14 d.	Foliar Spray: Apply at first sign of disease and repeat every 7 to 14 days. See label for recommended plant list.
Phyton 27	15-35 fl oz	7-14 d.	Foliar Spray: Apply at first sign of disease and repeat as needed. May be phytotoxic on plants previously treated with Aliette T/O. See label for recommended plant list.

#### Leaf Spots, Rusts, and Blight (Caused by fungi)

	Rate/100 gal	Retreat Every	Comments
3336 50W 3336 4.5F OHP6672 50W OHP6672 4.5F	12-16 oz 16-20 fl of 12-16 oz 16-20 fl oz	7-14 d.	Foliar Spray: Begin at transplant or first sign of disease. Shorten intervals to 7 days when conditions favor disease. Repeat as needed.

	Rate/100 gal	Retreat Every	Comments
Daconil Weather Stik	1.4 pt	7-14 d.	Foliar Spray: Begin sprays at transplant or first sign of disease. Repeat sprays as needed. Shorten intervals when conditions favor disease. Apply when foliage and flowers are dry or nearly dry. <b>DO NOT</b> apply with high-pressure spray equipment or a mist blower.
Daconil Ultres	1.4 lb		
Kocide 2000	12 oz	7-14 d.	Foliar Spray: Begin sprays at first sign of disease and repeat as needed. Shorten intervals between sprays when conditions favor disease.
Chipco 26GT Sextant	1.0-2.5 qt/A 1.0-2.5 qt/A	7-14 d.	Foliar Spray: Apply when conditions favor disease. Use higher rate and shorter intervals when severe damage is likely. Controls Alternaria leaf spot and Botrytis blight.
Dithane T/O Fore Flo 37F Protect T/O 80W	1.5 lb 1.2 qt 1.5 lb	7-10 d.	Foliar Spray: Begin sprays when plants are fully leafed out and repeat as needed. Add a wetting agent to tank mix. See label for recommended plant list.
Heritage 50W	1-4 oz	7-28 d.	Foliar Spray: Apply to drip in enough water to inspire complete coverage of the foliage. Begin sprays before symptoms appear and repeat as needed. Controls Alternaria and Septoria leaf spot as well as Anthracnose, Rust and Phytophthora shoot blight.
Medallion	1-2 oz	7-10 d.	Foliar Spray: For control of Alternaria, Septoria, Myrothecium, and Cercospora leaf spots. Also controls Rhizoctonia aerial or web blight.
Stature WDG	1.75 lb	7-10 d.	Foliar Spray: For control of downy Mildew, Phytophthora shoot blight, rust and leaf spot diseases.
Compass 50W Compass O	2-4 oz 2-4 oz	7-14 d.	Foliar Spray: For control of Anthracnose, Septoria leaf spot, and rust. See label for plant list and application instructions.

	Rate/100 gal	Retreat Every	Comments
Compass 50W Compass O	1-2 oz 1-2 oz	7-14 d.	Foliar Spray: For control of downy mildew, Myrothecium leaf spot and powdery mildew. See label for plant list and application instructions. May damage bracts of poinsettia. Compass O is labeled for greenhouse use.
Eagle 20XW Eagle 40W	6-12 fl oz 3-6 oz	10-14 d.	Foliar Spray: Apply at first sign of disease and repeat as needed. Eagle is not cleared for greenhouse use.

## Powdery Mildew

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	Rate/100 gal	Retreat Every	Comments
Banner MAXX	5-8 fl oz	14-21 d.	Foliar Spray: Apply as a full cover spray. Apply as needed.
3336 50W	8 oz	7-14 d.	Foliar Spray: Apply as needed when conditions favor disease.
3336 4.5F	10-20 fl oz		
OHP6672 50W	12-24 oz		
OHP6672 4.5F	10-20 fl oz		
Bayleton T/O	2-4 oz	14-28 d.	Use lower rate in winter. Spray intervals should not be shorter than 30 days to avoid shortening flower stalk length. Bayleton T/O is not labeled for greenhouse use.
Strike 25W	2-4 oz		
Eagle 20EW	6-12 fl oz	10-14 d.	Foliar Spray: Apply at first sign of disease and repeat as needed.
Eagle 40W	3-6 oz		
Heritage 50W	1-4 oz	7-28 d.	Foliar Spray: Begin sprays before symptoms appear on leaves. Apply higher rate at shorter interval when conditions favor disease. Apply to drip at spray intervals specified on label.
Compass 50W	1-2 oz	7-14 d.	Foliar Spray: Apply at first sign of disease and repeat as needed. See label for list of recommended plants.
Compass O	1-2 oz		

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## BIOLOGICAL CONTROL

For the past two decades, USDA, land-grant universities, and private organizations have dedicated considerable resources to developing disease control strategies that do not involve the use of fungicides or similar pesticides. Due to tighter worker protection standards, concerns of pesticide exposure, and impending loss of the fumigant methyl bromide, the pace of product development has, in recent years, greatly accelerated. A number of beneficial soil-inhabiting microbes have been identified that either produce antibiotics or other compounds which suppress disease-causing fungi, are parasites of those fungi, or stimulate host defenses. Several have been registered for use on greenhouse or nursery crops as biopesticides. In research trials, some biopesticides have performed as well as recommended soil fungicides. However, corroborating field data often is not available.

Like many synthetic soil fungicides, biopesticides are most effective only when used as preventative treatment. Biopesticides will, however, have little or no effect on existing leaf or root infections. Best results have been obtained when those products are incorporated into potting media prior to seedling or transplanting. If additional disease protection is needed, follow the use of a biopesticide with an application of a recommended fungicide. Some of these products are also formulated for use as a seed treatment to control seed rot, pre- and post-emergence damping off.

Since biopesticides are so new, no one has a great deal of experience using these products. To avoid a catastrophic crop failure, test one or more of these products on a small portion of a greenhouse crop. If possible, compare their performance with that of the fungicide treatment regime usually employed. Once an individual is confident that these products will work, then they can be used with no further restrictions. The biopesticides (biofungicides) registered for use on greenhouse crops are listed in the table below.

Table 3. Biopesticides Registered For Use On Greenhouse Crops.

PRODUCT	RATE	COMMENTS
Mycostop	0.08 oz./lb. of seed	SEED DRESSING for control of Alternaria, Fusarium, and Phomopsis.
	1.4 oz	SOIL DRENCH. Repeat every 3 to 6 wk. For control of Fusarium, Phytophthora, and Pythium root and crown rot.
	5 g./1.3 gal.	SOIL SPRAY. Repeat every 3 to 6 wk.
	5 g./1.3 gal.	TRANSPLANT DRIP. Dip roots before transplanting.
Rootshield	1 to 1.5 lb./cu. yd.	DRY SOIL MIX. Thoroughly incorporate during mixing of media or pot filling. For control of root and crown rot pathogens such as Pythium, Rhizoctonia, and Fusarium.
Soilgard	1 to 1.5 lb./cu. yd.	DRY SOIL MIX. Thoroughly incorporate during mixing of media or pot filling.
Bio-Trek 22G	1 to 1.5 lb./cu. yd.	DRY SOIL MIX. Thoroughly incorporate during mixing of media or pot filling. For control of pathogens such as Pythium, Rhizoctonia, and Fusarium.

## APPENDIX

### REACTION OF BEE BALM (MONARDA) TO POWDERY MILDEW

Resistant: Blue Stocking, Marshall's, Delight, Violet Queen.

Moderately Susceptible: Gardenview Scarlet, Kardinal, Mrs. Perry, Ohio Glow, Red Stocking, Stone's Throw Pink.

Susceptible: Mahogany, Prairie Night, Snow White, Adam, Cambridge Scarlet, Croftway Pink, Purple Crown, Souris.

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### SENSITIVITY OF MARIGOLDS TO FLOWER BLIGHT (*Choanephora cucurbitarum*)

Moderately Susceptible: American Indian Orange, Papaya Crush, Pineapple Crush, Inca Orange, Cortez Yellow, Excel Primrose.

Susceptible: Inca Gold, Excel Yellow, Pumpkin Crush, Perfection Gold, Perfection Orange, Excel Orange, Perfection Yellow, Antiqua Gold, Marvel Orange.

Highly Susceptible: Discovery Orange, Antiqua Orange, Marvel Yellow, Inca Yellow, Marvel Gold.

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### ANNUAL SALVIA CULTIVARS RESIST ALTERNARIA PETAL SPOT

Very Highly Resistant (Little or no petal spot): Carabinieri Red, Covergirl, Empire Burgundy, Salmon Lilac, Salmon Purple, Salmon Red, Firecracker Blue, Firecracker Burgundy, Firecracker Cherry, Firecracker Lilac, Firecracker Red, Firecracker Rose, Hotline Red, Hotline Violet, Hot Stuff Red, Hot Stuff, Rose, Maestro, Primco Red, Rambo Scarlet, Red Hot Sally, Red Vista, Salsa Burgundy, Salsa Scarlet, Sizzler Burgundy, Salsa Bicolor, Sizzler Lavender.

Highly Resistant: Hotline Salmon, Empire Light Salmon, Firecracker Orange, Firecracker Salmon, Hot Stuff Salmon, Salsa Salmon, Salsa Salmon Bicolor.

Resistant: Hotline White.

Highly Susceptible: Empire White, Firecracker White, Salsa White, Sizzler White.

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### BASIL CULTIVARS RESIST ANTHRACNOSE (*Colletotrichum gloeosporioides*)

Highly Resistant to Immune: Purple Ruffles, Green Bouquet, Dark Opal, Greek Ruffles, Aussie Sweet, Lemon, Genovese, Thai, Large Green, Mexican Spice, Sweet Basil, Mrs. Burns Lemon.

Moderately Resistant: Variegated Spicy Globe, Lettuce Leaved, Bush Green.

Holcomb, G. E. 1998. Reaction of Basil Cultivars to *Colletotrichum* leaf spot. Biol. Cult. Tests 13:43.