Chapter Three

DISEASES OF GREENHOUSE CROPS

GENERAL DISEASE CONTROL METHODS FOR GREENHOUSE CROPS

Successful disease control relies on proper disease prevention practices and plant disease diagnosis. Once the major diseases and pest problems have been identified, an integrated pest management (IPM) program can be followed. Several important cultural practices to control diseases should be integrated into all greenhouse IPM programs to control diseases. These serve to both prevent and minimize/eradicate diseases. Analogous cultural control methods may be applied to specific diseases that are common to several crops. These methods will be discussed in detail here to avoid repetition in the text.

Good Growing Practices

Greenhouse producers must strive to provide environmental conditions that are more favorable to plant growth and development than to disease development. Careful attention to such details helps to prevent the onset and spread of diseases and may reduce the need for an expensive eradicative program.

a. Damping-off, root and stem rots, and vascular wilt

- plant in a light, well drained, well prepared, pasteurized soil or a rooting medium such as sand, soil, rockwool, vermiculite, perlite, foam or sphagnum moss maintained at the recommended temperature. If pasteurized rooting media are not available, apply fungicides such as metalaxyl (COM) or quintozene (COM) as granules, drenches, or powders and mix well into the media. Softwood and hardwood cuttings of ornamentals can be dipped in etridiazole + indolebutyric acid (DOM) for control of stem rot caused by *Pythium* spp. Follow label recommendations for crop use, rates and whether pre- or post-plant applications should be made.
- where possible, keep soil on the dry side.
- use new pots, flats, etc., or ones that have been disinfected.
- disinfect tools prior to taking cuttings.
- use disease-free certified seeds or propagation stock.
- maintain healthy vigorously growing stock plants.
- avoid overcrowding, and planting too deeply.
- provide good ventilation and air circulation to reduce humidity.
- water in the morning to allow plants and soil surfaces to dry before evening.
- avoid overfertilizing, especially with nitrogen.
- irrigate with clean water.
- do not sow seeds too closely.
- fungus gnats should be controlled to prevent infection and spread of fungi and bacteria.
- remove any plant materials and debris from soil or rooting medium surface.
- provide adequate bottom heat where appropriate.

b. Gray mold, powdery mildew, rust, and leaf spots (bacterial and fungal)

- purchase disease-free stock plants from a reputable supplier.
- isolate any new plant shipments in a separate, thoroughly disinfected area of the greenhouse
- rogue out diseased plants early.
- avoid overcrowding and placing plants in damp, shady locations.
- do not sprinkle foliage, particularly in late afternoon or evening.
- avoid overhead-irrigation to minimize leaf wetness and disease spread.
- take cuttings from healthy plants only and disinfest tools between cuts. See chart in Bench and Equipment Sterilization section.
- provide good air circulation by venting and raise night temperatures to reduce humidity; avoid sudden changes in climate and condensation on plants.
- avoid overfertilizing, especially with nitrogen.

- take cuttings off dry plants only.
- do not use wet mulches.
- space plants to promote air circulation and eliminate foliage contact, especially 'mother' plants used for cuttings.
- control weeds in the greenhouse.

c. Viruses

- purchase virus indexed or certified plant material, if possible.
- propagate cuttings from healthy plants only.
- disinfest cutting tools between stock plants from which cuttings are being taken.
- avoid mixing old and new plants, or plants from different sources.
- keep insect pests (vectors), especially aphids, whiteflies and thrips under control.
- space plants to eliminate foliage contact, especially 'mother' plants used for cuttings.
- the evening prior to transplanting or handling seedlings which are susceptible to tobacco mosaic, pepper mild mottle and related viruses, spray them with a 10% skim milk powder solution. Always dip hands in the skim milk solution prior to handling susceptible plants.
- handle plants as little as necessary.

d. Nematodes (root and foliar)

- if possible, use pasteurized or fumigated soil or rooting medium.
- procure root and foliar stock that is nematode-free.
- avoid introducing soil-borne nematodes from gardens and other greenhouses by strict sanitation procedures including foot baths or overshoes for visitors.
- avoid spreading foliar nematodes by not allowing leaves and stems to stay wet for long periods.
- if possible, take soil samples and have them checked for plant parasitic nematodes. Careful, representative sampling is essential if harmful nematodes are to be detected.

Sanitation

Sanitation should be an integral part of a greenhouse pest control program. If a source of infection is constantly present, control measures may be expensive and ineffective.

a. Remove all dead and dying leaves and flowers from the greenhouse. Take debris to an off-site disposal area or a covered compost area.
b. Keep walks and the surfaces of beds and benches clean, including free of algae.
c. Control weeds in and around greenhouses.
d. Hang up the ends of hoses.
e. When bringing new stock into the greenhouse, check carefully for possible diseases or insect infestations. Isolate new stock until you are sure it is healthy.
f. Use a foot bath with Chemprocide (PCP# 13148).
g. Keep traffic flows from clean to dirty, i.e. do not go into the greenhouse after working at the cull pile.
h. Between crops, pressure wash the entire greenhouse interior from ceiling to walls, supports, wires and walkways. Use a strong detergent to start then repeat the wash with a registered disinfectant, Chemprocide (PCP 13148) following label directions. Disinfectants are toxic so follow all safety precautions and label directions. Wear protective clothing including rubber or neoprene gloves that are unlined, goggles and an approved respirator. Waterproof clothing consisting of boots, jacket, pants and a wide brimmed hat is needed. Do not tuck pant legs into boots. After any spraying, clean the protective clothing separately from other laundry. Any sprayed area should be well ventilated before work is conducted in that area. When planting chlorine sensitive crops, such as poinsettia, ensure bleach-treated areas are well rinsed. See the BCMAFF “Greenhouse Vegetable Clean-Up” factsheet http://www.agf.gov.bc.ca/cropprot/cleanup.htm (accessed March 31, 2012) for more detailed information.

Soil Pasteurization

Soil pasteurization eliminates organisms that could be harmful to plants. Ideally it can be accomplished with minimum injury to beneficial organisms. Soil should be in fine tilth to allow rapid, uniform penetration of steam or fumigants. Freedom from clods, large lumps and undecomposed crop remains is also desirable. If possible, incorporate fertilizers and organic amendments before treatment. Soil should be moist, but not wet. The soil temperature at 15 cm depth must be 13^{o}C or higher for successful treatment with chemicals.

a. Soil Steaming

Steam is the most common source of heat for pasteurization. To pasteurize large volumes, many pot plant growers find it efficient to inject steam into the bottom of a wagon or old truck body. After cooling, the pasteurized soil can be moved without further handling to the area in which it will be used. Growers using groundbeds may use surface or subsurface techniques. If their ground beds are drained with agricultural tile (top of tile 38 cm below the surface and rows on 60 cm centers), it may be possible to inject steam into these tiles and effectively pasteurize the soil to the sides and above them. If tiles are not installed, the steam is injected directly under a tarp covering the bed through either a canvas hose or a perforated, flexible plastic field tile to obtain even distribution.

Aerated steam is being used widely today. In this system, live steam is mixed with air in a chamber and the mixture at 71^{o}C is used to pasteurize soil. Lower steam temperatures allow the soil to be pasteurized and avoid any of the hazards of over steaming. Unless there are specific problems requiring higher temperatures, 71^{o}C is adequate to control most insect and disease problems.

The following chart gives an idea of the time-temperature relationships necessary to destroy undesirable organisms during steaming:

Organism	**Temperature (^{o}C)**	**Time (min.)**
Weeds (most)	70-80	15
Insects & mites	60-70	20
Bacteria (most)	60	10
Fusarium	57	30
Botrytis	55	15
Nematodes	55	15
Rhizoctonia	52	30
Sclerotinia	50	5
Pythium	46	40

Most undesirable organisms can be eliminated, under ideal conditions, by 60^{o}C for 30 min. Above 82^{o}C, some beneficial soil organisms are destroyed. Soil heated at too high a temperature for too long becomes sterile and liable to a greater degree of infestation than before simply because all beneficial organisms have been destroyed. Other undesirable effects of over-steaming include:

- excessive ammonia release.
- manganese toxicity may occur on steamed soils with a pH below 6.0.
- higher total salts levels.
- destruction of organic matter.

b. Soil Fumigation

CANADIAN LAWS EXIST TO PROTECT APPLICATORS, BYSTANDERS, CONSUMERS AND THE ENVIRONMENT WHEN PESTICIDES ARE USED. THERE ARE SPECIFIC PROVINCIAL RULES ABOUT THE SALE AND USE OF PESTICIDES. GREENHOUSE GROWERS NEED TO KNOW PESTICIDE REGULATIONS AND SAFETY. CONSULT CURRENT PROVINCIAL PRODUCTION GUIDES. WHEN USING FUMIGANTS, FOLLOW ALL PRESCRIBED PESTICIDE REGULATIONS AND SAFETY MEASURES. EXERCISE EXTREME CAUTION TO MINIMIZE HEALTH RISKS WHEN USING SOIL FUMIGANTS. An effective, full gas mask with correct canister **must** be used during treatment and at any time when fumes remain in the greenhouse. Seal the soil with a plastic cover after the chemical is injected. **All** label recommendations must be carefully followed.

The commercial use of chemicals such as methyl bromide (RES), methyl isothiocyanate (COM), dazomet (COM), metam sodium (COM), 1,3-dichloropropene (COM), or chloropicrin (COM) for soil pasteurization has become more popular with the increasing cost of steaming. The bromide residue that lingers in the soil after methyl bromide fumigation may reduce the germination and/or growth of salvia, dianthus, ageratum, alyssum, antirrhinum, aster, calendula, celosia, chrysanthemum, cleome, coleus, coreopsis, dahlia, digitalis, godetia, helichrysum, iberis, lobelia, matricaria, myosotis, nemesia, nierembergia, portulaca, salpiglossis, verbena, viola, and vinca.

Some fumigants control fungi, bacteria, nematodes, insects, and weeds, whereas others, which are more specific in their action, control only nematodes or fungi. Soil fumigation is not always an adequate substitute for soil steaming. Fumigants do not destroy all soil-borne viruses harbored in root debris and other plant parts.

c. Other Methods

Electric soil pasteurizers are useful for small volumes of soil when no other method is available. Overcooking the soil can occur very easily because, for the temperature between the finned heat sources to reach 82^{o}C, the fins themselves must be at a higher temperature.

Hobby greenhouse growers can pasteurize small quantities of soil in an oven, pressure cooker, or suitable covered container. A soil temperature of 60^{o}C should be maintained for at least 30 min. The soil to be treated must be moist, but not too wet. Poor heat penetration can be expected if too great a volume of soil is treated, or if it is too compacted in the container. If pasteurization is impractical, fungicides such as oxine benzoate (COM, DOM) or captan can be mixed into the soil to control damping-off.

Prevent recontamination of treated soil by disease-causing organisms by disinfesting all cultivating tools, pots, flats, and other equipment that could come in contact with the treated soil. Plants grown in contaminated soil, or contaminated soil itself, should not be placed in treated soil. Plant only disease-free or fungicide-treated seed in pasteurized soil.

Bench, Tools, Equipment, Irrigation Line and Structural Sanitation

Benches and equipment should be disinfected regularly as part of every greenhouse management program. To help eliminate disease organisms, all production equipment should be as clean as possible. Tools, potting benches, carts, walkways and growing benches should be disinfected between crops. For a general greenhouse cleanup, use a commercial disinfestant such as Chemprocide (PCP# 13148) or a 0.5% bleach dilution. Growers should also sterilize automatic watering systems and equipment in the propagating area. Wash hands between crops or houses. If available, a steam hose is ideal to clean tools, wheelbarrows and other equipment. Knives used to make cuttings should be sterilized between individual ‘mother’ plants.

Many greenhouse vegetable growers in B.C. are disinfecting irrigation lines and structures at the end of the cropping season. See the BCMAFF factsheet "Greenhouse Vegetable Crop Clean-Up" http://www.agf.gov.bc.ca/cropprot/cleanup.htm (accessed Feb 21, 2012) for further information. The following chart is based on tests conducted by BCMAFF and lists guidelines only.

Disinfectant for Pruning Knives	Immersion Time	Pathogens Controlled
0.525% sodium hypochlorite	quick dip	bacteria, most fungi*
DCD Floralife (16 mL/L)	quick dip	bacteria
70% ethyl alcohol	20 seconds	bacteria, fungi
50% concentrated Lysol	60 seconds	bacteria**
undiluted Roccal	60 seconds	bacteria**

* Where Penicillium is a concern, dip for 10 seconds
** Tests were not conducted with fungi.

Wood Preservatives

Copper 8-quinolinolate is the only preservative specifically recommended for treatment of picking baskets, boxes, etc., where contact with food is a possibility. Copper naphthenate, although not specifically recommended, is often used for the treatment of flats, benches, etc., in greenhouses. There have been several reports of damage to young plants where this material has been used for such purposes. In such cases, it appears that the solvent rather than the active ingredient (copper) is phytotoxic. Two commonly available wood preservatives, creosote and pentachlorophenol, are very efficacious **but can be extremely injurious to crops**. Therefore, do not use these materials around or in a greenhouse.

Disinfesting Recirculating Nutrient Solutions

With mounting environmental concerns, untreated drain to waste systems will no longer be appropriate. Recirculation of nutrient solutions is one feasible option. However, pathogens such as *Erwinia, Fusarium, Pythium* and *Phytophthora* will spread in recirculating nutrient solutions. Technology to reduce pathogen levels in recirculating systems is being developed and includes heat pasteurization, slow sand filtration, ultraviolet radiation and/or ozone. See the BCMAFF factsheet "Bio-Sand Filtration" http://www.agf.gov.bc.ca/resmgmt/publist/500Series/512000-2.pdf (accessed Feb 21, 2012) for information on using slow-sand filtration which has been quite effective in grower trials.

AFRICAN VIOLET (*Saintpaulia ionantha*)

DAMPING-OFF

See Bedding Plants, DAMPING OFF AND ROOT ROT on page 18.

DOWNY MILDEW

Peronospora spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Dimethomorph (COM) WP. Limitations: As per label.

GRAY-MOLD BLIGHT

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. It is important to control spider mites as their injury is often followed by *Botrytis.*

Resistant Cultivars: None.

Biological: *Gliocladium catenulatum* Strain J1446 (COM) WP. Limitations: As per label.

Chemical: Fenhexamid (COM) WG; iprodione (COM) WG, WP. Limitations: As per label.

Notes: When applying iprodione, use tepid water to prepare the spray mixture. Phytotoxicity may occur if cold water is used. Repeated use of iprodione may induce resistance in *Botrytis* to the fungicide.

PETIOLE ROT

Physiological - chemical injury due to accumulated salts on pot rims or the soil surface.

Cultural: Petiole rot may be prevented by avoiding the excessive use of fertilizer and flushing the soil occasionally by watering heavily. A collar made of metal foil, cardboard dipped in paraffin, or paraffin dripped on the rim of the pot will prevent contact of the petioles with the accumulated salts.

Resistant Cultivars: None.

Chemical: None.

POWDERY MILDEW

Erysiphe spp., *Microsphaera* spp., *Oidium* spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: None.

RING SPOT

Physiological - cold water on the foliage or strong sunshine on wet leaves.

Cultural: Ring spot can be avoided by watering plants from below or by applying the water carefully to keep it off the leaves. It may be helpful to use water that is a few degrees warmer than the air temperature.

Resistant Cultivars: None.

Chemical: None.

ROOT and CROWN ROT (Pythium)

Pythium spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Streptomyces griseoviridis* Strain K61 (COM) GR; *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP; *Gliocladium catenulatum* Strain J1446 (COM) WP. Limitations: As per label.

Chemical: Etridiazole (COM) EC; propamocarb hydrochloride (COM) AS. Limitations: As per label.

ROOT ROT (Phytophthora)

Phytophthora spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Gliocladium catenulatum* Strain J1446 (COM) WP. Limitations: As per label.

Chemical: Propamocarb hydrochloride (COM) AS. Limitations: As per label.

ALYSSUM

DAMPING-OFF

See Bedding Plants, DAMPING OFF AND ROOT ROT on page 18.

DOWNY MILDEW

Peronospora spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Dimethomorph (COM) WP. Limitations: As per label.

GRAY-MOLD BLIGHT

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Gliocladium catenulatum* Strain J1446 (COM) WP. Limitations: As per label.

Chemical: Nothing specific. Refer to Chemical Controls for Bedding Plants - GRAY MOLD page 19.

ROOT and CROWN ROT (Pythium)

Pythium spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Gliocladium catenulatum* Strain J1446 (COM) WP. Limitations: As per label.

Chemical: Etridiazole (COM) EC. Limitations: As per label.

ROOT ROT (Phytophthora)

Phytophthora spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Gliocladium catenulatum* Strain J1446 (COM) WP. Limitations: As per label.

Chemical: Etridiazole (COM) EC. Limitations: As per label.

ROOT ROT (Rhizoctonia)

Rhizoctonia solani

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Trifloxystrobin (COM) WG. Limitations: As per label.

ALSTROMERIA

DAMPING-OFF

See Bedding Plants, DAMPING-OFF AND ROOT ROT on page 18.

GRAY MOLD

See Bedding Plants, GRAY MOLD on page 19.

Chemical: Copper complex (COM) SN. Limitations: As per label.

ANEMONE (*A. coronaria*)

DAMPING-OFF

See Bedding Plants, DAMPING-OFF AND ROOT ROT on page 18.

DOWNY MILDEW

Plasmopara pygmaea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. Discard badly infected plants or remove spotted flowers and leaves.

Resistant Cultivars: None.

Chemical: None.

FOLIAR NEMATODE

Aphelenchoides sp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None known.

Chemical: None.

GRAY MOLD

See Bedding Plants, GRAY MOLD on page 19.

ASTER

DAMPING-OFF

See Bedding Plants, Greenhouse Ornamentals, DAMPING OFF AND ROOT ROT on page 18.

POWDERY MILDEW

Sphaerotheca pannosa, *Erysiphe cichoracearum*

Cultural: Refer to ‘General Disease Control Methods for Greenhouse Crops’ at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Myclobutanil (COM) WP. Limitations: As per label.

GRAY-MOLD FLOWER BLIGHT

Botrytis cinerea

Cultural: Refer to ‘General Disease Control Methods for Greenhouse Crops’ at the beginning of this chapter.

Resistant Cultivars: None.

Biological: None.

Chemical: Captan (COM) WP. Limitations: As per label

ROOT and CROWN ROT (Pythium)

Pythium spp.

Cultural: Refer to ‘General Disease Control Methods for Greenhouse Crops’ at the beginning of this chapter.

Resistant Cultivars: None.

Biological: None.

Chemical: Etridiazole (COM) EC; metalaxyl-M & S-isomer (COM) EC. Limitations: As per label.

ROOT ROT (Phytophthora)

Phytophthora spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: None

Chemical: Etridiazole (COM) EC; metalaxyl-M & S-isomer (COM) EC. Limitations: As per label.

RUST

Puccinia sp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Myclobutanil (COM) WP. Limitations: As per label.

AZALEA (*Rhododendron* spp.)

DAMPING-OFF

See Bedding Plants, DAMPING-OFF AND ROOT ROT on page 18.

Chemical: Captan (COM) WG, WP. Limitations: As per label.

DOWNY MILDEW

Peronospora spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Dimethomorph (COM) WP. Limitations: As per label.

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Iprodione (COM) WG, WP. Limitations: As per label.

ROOT and CROWN ROT (Pythium)

Pythium spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP; Limitations: As per label.

Chemical: Etridiazole (COM) EC; metalaxyl-M & S-isomer (COM) EC. Limitations: As per label.

ROOT ROT (Cylindrocladium)

Cylindrocladium sp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Copper complex (COM) SN. Limitations: As per label.

ROOT ROT (Phytophthora)

Phytophthora spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP. Limitations: As per label.

Chemical: Fosetyl-AL (COM) WG, WP; propamocarb hydrochloride (COM) AS. Limitations: As per label.

ROOT ROT (Rhizoctonia)

Rhizoctonia solani

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Trifloxystrobin (COM) WG. Limitations: As per label.

STEM ROT

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Captan (COM) WP, WG; folpet (COM) WP, WG. Limitations: As per label.

RED LEAF and STEM GALL

Exobasidium vaccinii

Cultural: Young galls should be hand-picked and destroyed.

Resistant Cultivars: None.

Chemical: None.

BEDDING PLANTS
(also anemone, begonia, celosia, chrysanthemum, coleus, geranium, salvia)

BLACK ROOT ROT

Thielaviopsis basicola (*Chalara elegans*)

Cultural: Adjust the pH of the potting mix to 5.5 or below if the crop will tolerate it. *Thielaviopsis* is suppressed at lower pH levels. See section on 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter for general management.

Resistant Cultivars: None.

Chemical: None.

References:

1. 1999 Floriculture Production Guide, BCMAFF.

DAMPING-OFF AND ROOT ROT

Fusarium spp., *Phytophthora* spp., *Pythium* spp., *Rhizoctonia solani*

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Gliocladium catenulatum* Strain J1446 (COM) WP; *Streptomyces griseoviridis* Strain K61 (COM) WP; *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP. Limitations: As per label.

Chemical: Captan (COM) WG, WP; etridiazole (COM) WP, EC; fosetyl-Al (COM) WG, WP; iprodione (COM) WG, WP; metalaxyl-M & S (COM) EC; oxine benzoate (COM, DOM) SN; trifloxystrobin (COM) WG.

Limitations: As per label. Iprodione is safe for use on celosia and salvia only. Check tolerance to iprodione on a few plants before large scale use. Fosetyl-Al is registered for use on azalea, begonia, celosia, geranium, impatiens, petunia, salvia and vinca.

Notes: Trifloxystrobin and iprodione are effective against *Rhizoctonia.* Captan, etridiazole, fosetyl-Al and metalaxyl will control *Pythium* and *Phytophthora*.

References:

1. Pervaiz, A.A. *et al*. 2004. Suppression of *Rhizoctonia* and *Pythium* damping-off of radish and cucumber seedlings by addition of fish emulsion to peat mix soil. Can. J. Plant Path. 26: 177-187.

DOWNY MILDEW

Peronospora spp., *Plasmopara* spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. Discard badly infected plants or remove infected leaves. Carryover to new crops is via dead infested plant material and soil.

Resistant cultivars: None.

Chemical: None.

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Gliocladium catenulatum* Strain J1446 (COM) WP. Limitations: As per label.

Chemical: Fenhexamid (COM) WG; iprodione (COM) WG, WP. Limitations: As per label.

Notes: Repeated use of iprodione may induce resistance in *Botrytis* to the fungicide.

IMPATIENS NECROTIC SPOT

Impatiens Necrotic Spot Virus

Cultural: Use disease-free propagative stock. Control weeds in and around the greenhouse as they can harbour INSV and TSWV. The use of 'double doors' in greenhouses may be useful in preventing the entry of thrips. The use of indicator plants such as petunia 'Calypso', 'Summer Madness' and 'Super Blue Magic' are good indicators for INSV and TSWV infection.

Resistant Cultivars: None.

Chemical: None.

Notes: Use recommended methods to control the vectors of INSV and TSWV (western flower thrips and other thrips).

References: See Tomato, TOMATO SPOTTED WILT references on page 68.

POWDERY MILDEW

Erysiphe spp., *Microsphaera* spp., *Sphaerotheca* spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Copper complex (COM) SN for begonia and New Guinea impatiens; thiophanate-methyl (COM) WP for begonia and cineraria. Potassium bicarbonate (COM) DU for multiple species; trifloxystrobin (COM) WG. Limitations: As per label.

BEGONIA (*Begonia* spp.)

DAMPING-OFF

See Bedding Plants, DAMPING-OFF AND ROOT ROT on page 18.

DOWNY MILDEW

Peronospora spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Dimethomorph (COM) WP. Limitations: As per label.

FOLIAR NEMATODES

Aphelenchoides fragariae, Aphelenchoides ritzemabosi

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: None.

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Iprodione (COM) WG, WP; thiophanate-methyl (COM) WP. Limitations: As per label.

Notes: Repeated use of iprodione may induce resistance in *Botrytis* to the fungicide.

IMPATIENS NECROTIC SPOT

See Bedding Plants, IMPATIENS NECROTIC SPOT on page 19.

POWDERY MILDEW

Erysiphe cichoracearum

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Copper complex (COM) SN; thiophanate-methyl (COM) WP; trifloxystrobin (COM) WG. Limitations: As per label.

ROOT and STEM ROT

Fusarium spp., *Phytophthora* spp., *Pythium* spp., *Rhizoctonia solani*

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Streptomyces griseoviridis* Strain K61 (COM) WP; *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP. Limitations: As per label.

Chemical: Captan (COM) WG, WP; etridiazole (COM) EC; fosetyl-Al (COM) WG, WP; metalaxyl-M & S (COM) EC; oxine benzoate (COM, DOM) SN; thiophanate-methyl (COM) WP; trifloxystrobin (COM) WG. Limitations: As per label.

Notes: Fosetyl-Al, etridiazole and captan will control *Pythium* and *Phytophthora*. Thiophanate-methyl is registered for *Fusarium* and *Rhizoctonia*. *Streptomyces griseoviridis* has activity against *Fusarium, Pythium, Phytophthora* and *Rhizoctonia*.

BULBS

(also Amaryllis, Calla Lily, Narcissus, Dahlia, Dutch Iris, Freesias, Gladiolus, Hyacinth, Liatris, Ranunculus and Tulips)

BACTERIAL SOFT ROT

*Erwinia carotovor*a var. *aroideae* (on Calla Lily)

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. Discard all badly infected corms and tubers.

Resistant Cultivars: None.

Chemical: None.

References:

1. Gracia-Garza, J.A. *et al*. 2002. Pre- and post-plant applications of copper-based compounds to control *Erwinia* soft rot of calla lilies. Can. J. Plant Pathol. 24: 274-280.

DAMPING-OFF

Cultural: See bedding plants, DAMPING-OFF AND ROOT ROT on page 18.

Resistant Cultivars: None.

Biological: *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP. Limitations: As per label.

Chemical: Captan + carbaryl (DOM) DU; captan (COM) WP, WG. Limitations: As per label.

DRY ROT (on Gladiolus)

Stromatinia gladioli (on Gladiolus)

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. Discard badly infected bulbs. Rogue out and destroy yellowed or stunted plants when they are seen.

Resistant Cultivars: None.

Chemical: Dip corms for 30 minutes in water at 53-55^{o}C to which formaldehyde (COM) LI has been added at the rate of 500 mL/100 L. Dry quickly and store at cool temperatures until replanting. Fumigate with dazomet (COM) GR or metam-sodium (COM) SN if it is necessary to replant in infested soil. Follow label directions and fumigate during the fall preceding planting.

FUSARIUM BULB ROT

Fusarium spp. Narcissus are most commonly affected by Fusarium. Other diseases include sour rot of tulip, gladiolus yellows and Fusarium rot of lily, iris and freesia.

Cultural: Harvest during dry weather taking care not to injure bulbs. Keep harvested bulbs away from the heat of the sun and provide cool, well-ventilated storage. Discard infected bulbs well away from the site. Rotate for as long as possible with a non-host crop.

Resistant Cultivars: None.

Biological: *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP. Limitations: As per label.

Chemical: Captan (COM) WG, WP; captan + carbaryl (DOM) DU. Limitations: As per label.

GRAY MOLD

Botrytis spp. See Bedding Plants, GRAY MOLD on page 19 and Bulbs, LEAF SPOTS on page 23.

LEAF SCORCH

Stagonospora curtisii (on Amaryllis)

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. Discard badly infected bulbs. Plenty of light should be provided; the temperature in forcing houses should be kept as low as possible. Remove infected leaves and bulb scales.

Resistant Cultivars: None.

Chemical: None.

LEAF SPOTS

Botrytis spp., *Penicillium* spp., *Curvularia* spp.

Cultural: Avoid replanting in infested areas for at least 3 years. Remove primary infections. Hot water treatments for nematodes helps to reduce infection on narcissus and gladiolus. Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Iprodione (COM) WG, WP for *Botrytis*. Iris, lily, gladiolus - chlorothalonil (COM) WG, SU. Limitations as per label.

NEMATODES

Ditylenchus dipsaci, *Pratylenchus* spp.

Cultural: Follow a 3-4 year rotation between crops and avoid fields known to be infested.

Resistant Cultivars: None.

Chemical: Treat narcissus stocks routinely with hot water every two years. Bulbs must be dormant and should not be treated until 2 weeks after digging. To minimize flower damage, hold the bulbs at 30°C for one week prior to treatment and then immerse in cool (25°C) water plus formaldehyde overnight to re-activate the nematodes. Bulbs should then be treated for 3-4 hours at 43-44°C in water containing formaldehyde (COM) LI at 500 mL/100 L. Dry quickly and return bulbs to cool storage. Also see Nematodes under 'General Disease Control Methods for Greenhouse Crops' on page 7.

References:

1. 1999 Floriculture Production Guide, BCMAFF.

POWDERY MILDEW

See Bedding Plants, POWDERY MILDEW on page 20.

VIRUS DISEASES

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

References:

1. 1999 Floriculture Production Guide, BCMAFF.

CALCEOLARIA (*Calceolaria* spp.)

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: None.

CARNATION (*Dianthus caryophyllus*)

ALTERNARIA BLIGHT

Alternaria dianthi and *Alternaria dianthicola*

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Chlorothalonil (COM) SU, WG. Limitations: As per label.

Notes: Captan (COM) WP is registered for control of Alternaria blight of carnation, but is not specifically labeled for greenhouse use.

References: See Forsberg (1975) under General References at the end of this chapter.

DAMPING-OFF

See Bedding Plants, DAMPING-OFF AND ROOT ROT on page 18.

Biological: *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP. Limitations: As per label.

Chemical: Captan (COM) WP; metalaxyl-M & S-isomer (COM) EC; etridiazole (COM) WP; oxine benzoate (COM) SN. Limitations: As per label.

DOWNY MILDEW

Peronospora spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Dimethomorph (COM) WP. Limitations: As per label.

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Chlorothalonil (COM) SU, WG; thiophanate-methyl (COM) WP. Limitations: As per label.

Notes: Apply chlorothalonil when foliage and blossoms are dry and when greenhouse temperatures do not exceed 24^{o}C.

RUST

Uromyces dianthi, Puccinia arenariae

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Oxycarboxin (COM) LI. Limitations: As per label.

STEM ROT

Rhizoctonia solani and *Fusarium* spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP. Limitations: As per label.

Chemical: Captan (COM) WP, WG; thiophanate-methyl (COM) WP. Limitations: As per label.

WILT

Fusarium oxysporum f. sp. *dianthi, Phialophora cinerescens*

Cultural: Remove wilted plants as soon as possible after detection. Use disease-free cuttings. Disinfest benches with steam or chemicals. Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: Among the most commonly grown flower colours, pink cultivars are most susceptible, red most resistant and white intermediate or variable (1).

Biological: None.

Chemical: None. See Notes.

Notes: It has been observed that thiophanate-methyl, registered for control of gray mold, or metam-sodium registered for control of damping-off, will also control wilt, but are not registered for this use.

References:

1. Baker, R. 1980. Measures to control fusarium and phialophora wilt pathogens of carnations. Plant Disease 64: 743-749.

CELOSIA

DAMPING-OFF

Cultural: See Bedding Plants, DAMPING-OFF AND ROOT ROT on page 18.

Resistant Cultivars: None.

Biological: *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP. Limitations: As per label.

Chemical: Iprodione (COM) WP, WG. Limitations: As per label.

ROOT and STEM ROT

Phytophthora spp., *Pythium* spp., *Rhizoctonia solani*

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP. Limitations: As per label.

Chemical: Captan (COM) WG, WP; etridiazole (COM) EC; fosetyl-Al (COM) WG, WP; trifloxystrobin (COM) WG. Limitations: As per label.

Notes: Fosetyl-Al, etridiazole and captan will control *Pythium* and *Phytophthora*.

SCLEROTINIA ROT

Sclerotinia sclerotiorum

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Coniothyrium minitans* CON/M/91-08 (COM) WG. Limitations: As per label.

Chemical: None.

CHRISTMAS CACTUS

ROOT ROT

See Bedding Plants, DAMPING-OFF AND ROOT ROT, page 18.

CHRYSANTHEMUM (*Chrysanthemum* spp.)

DAMPING-OFF

See Bedding Plants, DAMPING-OFF AND ROOT ROT on page 18.

Chemical: Captan (COM) WP, WG. Limitations: See label.

DOWNY MILDEW

Peronospora spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Dimethomorph (COM) WP. Limitations: As per label.

FOLIAR NEMATODES

Aphelenchoides fragariae and *Aphelenchoides itzemabosi*

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: None.

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Captan (COM) WP; chlorothalonil (COM) SU, WG; dicloran (COM) WP; iprodione (COM) WG, WP; thiophanate-methyl (COM) WP. Limitations: As per label.

Notes: Apply chlorothalonil only when foliage and blossom surfaces are dry, and when greenhouse temperatures do not exceed 24°C. Repeated use of iprodione may induce resistance in *Botrytis* to the fungicide.

IMPATIENS NECROTIC SPOT

See Bedding Plants, IMPATIENS NECROTIC SPOT on page 19.

POWDERY MILDEW

Erysiphe cichoracearum

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Myclobutanil (COM) WP for cut chrysanthemum; thiophanate-methyl (COM) WP and myclobutanil (COM) WP for chrysanthemums. Limitations: As per label.

ROOT and STEM ROT

Fusarium spp., *Pythium* spp. and *Rhizoctonia solani*

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP. Limitations: As per label.

Chemical: Captan (COM) WP, WG; etridiazole (COM) EC; metalaxyl-M & S-isomer (COM) EC; oxine benzoate (COM, DOM) SN; thiophanate-methyl (COM) WP; trifloxystrobin (COM) WG. Limitations: As per label.

Note: Thiophanate-methyl is not effective on *Pythium*.

RUST

Puccinia sp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Myclobutanil (COM) WP. Limitations: As per label.

SCLEROTINIA ROT

Sclerotinia sclerotiorum

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Coniothyrium minitans* CON/M/91-08 (COM) WG. Limitations: As per label.

Chemical: None.

VIRUS DISEASES

Chrysanthemum stunt virus, aster yellows, impatiens necrotic spot virus, tomato spotted wilt virus

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: None.

WILT

Fusarium oxysporum, Verticillium albo-atrum

Cultural: Use clean stock only. Discard and destroy all infected plant material. The causal organism is usually soil-borne. Follow other cultural control practices discussed under 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: None.

Chemical: None.

QUARANTINE DISEASES

The following disease of chrysanthemum does not occur or is of limited distribution in Canada and is under quarantine regulations:

White Rust (*Puccinia horiana*) - See B.C. Ministry of Agriculture, Fisheries and Food bulletin, or www.agf.gov.bc.ca/cropprot/cwrust.htm (accessed Feb 10, 2012). Status of white rust is under review byAgriculture and AgriFood Canada. www.inspection.gc.ca/plants/plant-protection/directives/horticulture/d-97-05/eng/1312331283196/1312331655294 (accessed Feb 10, 2012).

CINERARIA (*Senecio cruentus*)

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Iprodione (COM) WG, WP. Limitations: As per label.

Notes: When applying iprodione use tepid water to prepare spray mixture. Phytotoxicity may occur if cold water is used. Repeated use of iprodione may induce resistance in *Botrytis* to the fungicide.

IMPATIENS NECROTIC SPOT

See Bedding Plants, IMPATIENS NECROTIC SPOT on page 19.

POWDERY MILDEW

Erysiphe cichoracearum

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: None

COLEUS (*Coleus* spp.)

DAMPING-OFF

See Bedding Plants, DAMPING-OFF AND ROOT ROT on page 18.

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: None.

IMPATIENS NECROTIC SPOT

See Bedding Plants, IMPATIENS NECROTIC SPOT on page 19.

ROOT and STEM ROT

Pythium spp., *Phytophthora* spp. and *Rhizoctonia solani*

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP. Limitations: As per label.

Chemical: Captan (COM) WP, WG; etridiazole (COM) EC; metalaxyl-M & S-isomer (COM) EC; oxine benzoate (COM, DOM) SN; trifloxystrobin (COM) WG. Limitations: As per label.

ROOT-KNOT NEMATODE

Meloidogyne spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Fumigate soil (preplant) with - methyl bromide (RES) LI; dazomet (COM) GR; metam-sodium (COM) SN; methyl isothiocyanate (COM) LI; chloropicrin + 1,3-dichloropropene (COM) SN; 1,3-dichloropropene (COM) SN. Limitations: As per label.

CUCUMBER (*Cucumis sativus*)

ALTERNARIA LEAF SPOT

Alternaria cucumerina

Cultural: Use disease-free seed. Avoid prolonged periods of high humidity. Minimize injury to leaves. Do not grow other cucurbits, especially melons, in the same greenhouse. Follow other cultural control practices listed under 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: None.

ANGULAR LEAF SPOT

Pseudomonas lachrymans

Cultural: Use disease-free seed. Avoid prolonged periods of high humidity. Minimize injury to leaves. Avoid working with plants if foliage or fruit is wet. Follow other cultural control practices listed under 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: None.

BLACK ROOT ROT

Phomopsis sclerotioides

Cultural: Use soilless growing media such as sawdust. Keep soil floor covered to reduce contamination onto growing mixes. Avoid introducing the disease from gardens and other greenhouses by strict sanitation procedures including footbaths or overshoes for visitors. If using soil, steam or chemically pasteurize soil (refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter). Use only fresh sawdust or steam soil thoroughly before replanting. Rotate cucumbers with tomatoes. If discovered in early stages, mound the base of the stem with sawdust as soilless mix to initiate new root growth. Avoid growing transplants under 'slow growing conditions'. Maintain day and night temperatures of 21-22^{o}/24^{o}C. Thick basal stem transplants are more prone to disease infection.

Resistant Cultivars: None (see Note 2).

Chemical: None.

Notes:

1. *Gliocladium roseum* has shown promise as a biological control agent for *Phomopsis* (1).

2. *Cucurbita ficifolia* is resistant. Susceptible commercial cultivars can be grafted on *C. ficifolia* root stocks to obtain resistant plants.

References:

1. Moody, A.R. and Gindrat, D. 1977. Biological control of cucumber black root rot by *Gliocladium roseum.* Phytopathology 67: 1159-1162.

2. Ormrod, D.J. and Christie, W.D. 1972. *Phomopsis* root rot of greenhouse cucumbers in British Columbia. Plant Dis. Rep. 56: 53-55.

CUCUMBER MOSAIC

Cucumber mosaic virus

Cultural: Minimal handling of plants is important to reduce virus spread. Always handle 'healthy' plants before working in diseased zones. Work along the row in one direction only. Control weeds that may act as reservoir hosts. Control aphid vectors.

Resistant Cultivars: None.

Intermediate: Burpee Hybrid and High Mark II varieties of American type cucumbers.

Susceptible: Most of the European seedless varieties.

Chemical: None.

Notes: Avoid growing chrysanthemums near a cucumber crop. Chrysanthemums are latent carriers of CMV.

CUCUMBER PALE FRUIT

Cucumber Pale Fruit Viroid

Cultural: During pruning and harvesting, use good sanitation practices. Remove infected plants. Take extra precautions by surface sterilizing pruning tools and when handling plants.

Resistant Cultivars: None.

Chemical: None.

Notes: The cucumber pale fruit viroid has been transmitted experimentally in seed, but not by insects and does not overwinter in crop residue.

References:

1. Diener, T.O. 1987. Chapter 12, Cucumber pale fruit *in* The viroids, T.O. Diener (ed).

2. van Dorst, H.J.M. and Peters, D. 1974. Some biological observations on pale fruit, a viroid-incited disease of cucumber. Neth. J. Plant Pathol. 80: 85-96.

DAMPING-OFF

Pythium spp., *Rhizoctonia solani*, *Fusarium* spp.

Cultural: **Early damping-off -** plant fresh, good quality seed of high percentage germination. Use new rockwool cubes, or pasteurize soil and follow other cultural control practices outlined under 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. Avoid high temperature irrigation water (>23°C) especially in summer plantings.

Late damping-off - use only vigorous, disease-free transplants. Plant into a well prepared, warm soil or growing mix (16-21°C). Avoid cold water shock to young plants by using tepid water at about 20-23°C.

Resistant Cultivars: None.

Biological: *Streptomyces griseoviridis* Strain K61 (COM) WP; *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP; *Gliocladium catenulatum* Strain J1446 (COM) WP. Limitation: As per label.

Chemical: Metalaxyl-M & S (COM) EC; oxine benzoate (COM, DOM) SN; propamocarb hydrochloride (COM) SN. Limitations: As per label.

Notes:

1. Pythium can also cause root rot in mature plants (see under Root Rot on page 37).

2. Propamocarb hydrochloride and metalaxyl M & S will only control *Pythium*.

References:

1. Pervaiz, A.A. *et al*. 2004. Suppression of *Rhizoctonia* and *Pythium* damping-off of radish and cucumber seedlings by addition of fish emulsion to peat mix soil. Can. J. Plant Path. 26: 177-187.

2. Punja, Z.K. and Yip, R. 2003. Biological control of damping-off and root rot caused by *Pythium aphanidermatum* on greenhouse cucumbers. Can. J. Plant Pathol. 25: 411-417.

FUSARIUM ROOT & STEM ROT

Fusarium oxysporum f.sp. *radicis-cucumerinum*

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. Many spores are produced on infected stems which can spread from routine crop handling. Control fungus gnats and shore flies to reduce spread. Remove infected plants and growing media. Disinfect irrigation lines.

Resistant Cultivars: Varieties with reduced infection levels include 'Kariboe', 'Imagine', and 'Ventura'. The most susceptible are 'Serami', 'Mustang', and 'Flamingo'. The rootstock *Cucurbita ficifolia* is resistant.

Biological: *Streptomyces griseoviridis* Strain K61 (COM) WP; *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP; *Gliocladium catenulatum* Strain J1446 (COM) WP. Limitation: As per label.

Chemical: None.

References:

1. Punja, Z.K. 1999. Fusarium rot and stem rot of greenhouse cucumbers. Greenhouse vegetable factsheet, BCMAFF.

2. Vakalounakis, D.J. 1996. Root and stem rot of cucumber caused by *Fusarium oxysporum* f.sp. *radicis-cucumerinum* f.sp. *nov*. Plant Dis. 80: 313-316.

3. 1996-97 Greenhouse Vegetable Production Guide, BCMAFF.

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. Problem periods are spring and fall when humidity is high and plant surfaces may be wet for extended periods. Reduce humidity by providing good air circulation and higher temperatures and ventilation. If detected, early disease areas on the stem may be cleaned up by removing with a knife (scrapper) and applying a fungicide paste of iprodione (COM) WP. Avoid full venting when outside temperatures are less than 15^{o}C. Cool air 'dropping' from roof vents creates a climate that favours establishment of the disease.

Resistant Cultivars: None.

Biological: *Gliocladium catenulatum* Strain J1446 (COM) WP. Limitations: See label

Chemical: Ferbam (COM) WG; iprodione (COM) WG, WP (see Notes).

Limitations: Preharvest interval - 1 day (ferbam); 2 days (iprodione).

Notes:

1. The U.S. has a zero tolerance for iprodione (Rovral) residues.

2. Ferbam causes severe damage to English cucumber.

3. Anilazine which is registered for the control of certain other foliage diseases of greenhouse cucumbers, is also effective against gray mold.

4. Repeated use of iprodione may induce resistance in *B. cinerea* to the fungicide.

GUMMY STEM BLIGHT

Didymella bryoniae

Cultural: Plant disease-free seed. Consider growing two or three crops per year to minimize disease build-up. Follow other cultural control practices discussed under 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Gliocladium catenulatum* Strain J1446 (COM) WP. Limitations: See Label

Chemical: Iprodione (COM) WG, WP; mancozeb (COM) WP; myclobutanil (COM) WP stem sprays; boscalid/pyraclostrobin (suppression) (COM) WG. Alternate between the recommended fungicides to avoid buildup of resistance.

Limitations: Preharvest intervals - 2 days (iprodione, myclobutanil); 14 days (mancozeb).

LEAF SCORCH

Physiological - salt toxicity

Cultural: Plants growing in soils with high levels of soluble salts lack vigorous growth, have small blossoms and scorched or mottled leaves, and generally fail to respond to fertilizer applications. A soil analysis should be used to determine salt levels. To correct the problem, leach with water. In soilless culture, reduce the electrical conductivity of the nutrient solution to 1.8 to 2.0 millisiemens (1). Avoid using water containing high salt concentrations for irrigation. Since leaf scorch is accentuated by a low relative humidity, intermittent misting of the foliage is recommended if angular leaf spot is not a problem.

Resistant Cultivars: None.

Chemical: None.

References:

1. Mirza, M. and Howard, R.J. 1984. Personal communication. Alta. Hort. Res. Center, Brooks, Alta.

PENICILLIUM STEM ROT

Penicillium oxalicum

Cultural: Refer to ‘General Disease Control Methods for Greenhouse Crops’ at the beginning of this chapter. Disinfect pruners and work disease rows last. Dispose of infected stems. Leave 5 mm of stem on the fruit when harvesting and quickly cool fruit. Carefully handle fruit to avoid wounds.

Resistant Cultivars: None.

Chemical: None.

Notes: Rovral applied for gummy stem blight will control the fungus, but limit sprays as resistance can develop quickly.

References:

1. BCMAFF. Pest Management Note 95-04. 1995.

2. Jarvis, W.R. and Barrie, S.D. 1988. Stem rot of greenhouse cucumbers caused by *Penicillium crustosum.* Plant Dis. 72: 363.

3. Jarvis, W.R. 1989. Spotting the *Botrytis* look-alike. Grower (Lond.) III (14): 16-19.

POWDERY MILDEW

Sphaerotheca fuliginea, Erysiphe cichoracearum

Cultural: The amendment of hydroponic nutrient solutions with 100 ppm of soluble silicon in the form of potassium silicate can help control this disease. Use 50 ppm for mildew tolerant cultivars. Maintain a uniform RH of 70-80%. Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: Bella, Cordoba, Fidelio, K8200, Marillo, Milanda, Profito, TW242. Mildew tolerant cultivars: DR347, Enigma, Flamingo. Consult your seed company.

Biological: *Pseudozyma flocculosa* (COM) SU. *Bacillus subtilis* Strain QST 713 (COM) WP. Limitations: As per label.

Chemical: Myclobutanil (COM) WP; potassium bicarbonate (COM) DU; sulphur (COM) WG, WP; cyprodinil / fludioxonil (COM) WG; boscalid / pyraclostrobin (COM) WG; garlic (COM) WP.

Limitations: Preharvest intervals - 1 day (sulphur, cyprodinil/fludioxonil); 2 days (myclobutanil); 0 days (*Pseudozyma flocculosa*, boscalid/pyraclostrobin).

Notes:

1. Repeated application of sulphur may cause leaf injury. Avoid use during high temperatures (+29^{o}C).

2. Allow two to three weeks between crops to thoroughly clean the greenhouse.

References:

1. Kharbanda, P. and Howard, R. 1981. Identity and control of powdery mildew of greenhouse cucumbers in southern Alberta. Can. J. Plant Pathol. 3: 115.

2. Menzies, J.G. *et al*. 1991. Effects of soluble silicon on the parasitic fitness of *Sphaerotheca fuliginea* on *Cucumis sativus*. Phytopathology 81: 84-88.

ROOT-KNOT NEMATODE

Meloidogyne spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Fumigate soil (preplant) with - chloropicrin + 1,3-dichloropropene (COM) SN; 1,3-dichloropropene (COM); methyl bromide (RES) LI, SN; metam-sodium (COM) SN. Limitations: As per label.

ROOT ROT, STEM ROT and WILT

Fusarium spp., *Pythium* spp., *Verticillium* spp.

Cultural: Follow cultural control practices listed under 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

For soil culture - use individual containers rather than beds to avoid spread from plant to plant; reduce watering on infected plants to allow soil surface to dry; rotate cucumbers with tomatoes.

For sawdust culture - use only fresh sawdust or thoroughly steam it before replanting.

For hydroponic culture - employ ultra-violet sterilization of nutrient solution to prevent spread of the pathogens (Ref. 2). Activated slow sand filtration will remove Pythium in recirculated nutrient solutions and 95% of Fusarium propagules (Ref. 3).

Resistant Cultivars: None.

Biological: For *Fusarium*, *Streptomyces griseoviridis* strain K61 (COM) WP; for *Fusarium* and *Pythium* root infections, *Trichodermna harzianum* Rifai strain KRL-AG2 (COM) GR, WP. Limitations: As per label.

Chemical: Captan (COM) WP, propamocarb hydrochloride (COM) LI or thiram (COM) WP may be applied as protective seed treatments; metalaxyl-M & S (COM) EC. Limitations: As per label. Metalaxyl-M & S and propamocarb hydrochloride will only control Pythium. Captan may cause phytotoxicity on some varieties; test first on a small batch.

Notes:

1. On occasion, *Fusarium* may be carried on seed.
2. Remove crop debris off site or bury.

References:

1. Ehret, D. 1998. Personal communication. Pacific Agricultural Research Centre, Agassiz, B.C.
2. Howard, R.J. 1982. Efficacy of the Trojan ultra-violet water sterilizer for the control of plant pathogens in hydroponic systems. Can. J. Plant Pathol. 4: 306.
3. Ng, K. 1999. Personal communication. Ng Consulting, Vancouver, B. C.
4. Punja, Z.K. and Yip, R. 2003. Biological control of damping-off and root rot caused by *Pythium aphanidermatum* on greenhouse cucumbers. Can. J. Plant Pathol. 25: 411-417.

SCAB and LEAF MOLD

Cladosporium cucumerinum

Cultural: Maintain night temperatures at or above 18°C and ventilate to reduce humidity. Follow other cultural control procedures given under 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: All Long English varieties.

Chemical: None.

References:

1. Anonymous. 1980. Grower Guide 15: Cucumbers. Grower Books, London, Eng. 71 pp.

STEM and FRUIT ROT (Sclerotinia)

Sclerotinia sclerotiorum

Cultural: Refer to 'General Disease Control Practices for Greenhouse Crops' at the beginning of this chapter. It is especially important to collect and destroy infected plant debris as large numbers of persistent sclerotia may be present. These fall to the soil and later act as a major inoculum source. Avoid planting tomato or lettuce in rotation with cucumbers where stem and fruit rot occurs.

Resistant Cultivars: None.

Chemical: None.

CYCLAMEN (*Cyclamen indicum*)

CORM ROT

Erwinia carotovora

Cultural: Avoid wounding of tubers. Plant into sterilized growth media.

Resistant Cultivars: None.

Chemical: Copper complex (COM) SN. Limitations: As per label.

FUSARIUM WILT

Fusarium oxysporum f.sp. *cyclaminis*

Cultural: Follow cultural control practices listed under 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: None.

Chemical: None.

Notes:

1. It is very important to sterilize the plug trays when seeding cyclamen. Styrofoam plug trays are extremely difficult to sterilize and are a good source of this pathogen (1).

2. Fusarium spores spread easily in recirculated nutrient solutions.

References:

1. Copeman, R. Personal communication. U.B.C., British Columbia

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Copper complex (COM) SN; iprodione (COM) WG, WP. Limitations: As per label.

Notes: Repeated use of iprodione may induce resistance in *Botrytis* to the fungicide.

IMPATIENS NECROTIC SPOT

See Bedding Plants, IMPATIENS NECROTIC SPOT on page 19.

ROOT ROT

Pythium spp. and *Phytophthora spp.*

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: None.

Chemical: Ttrifloxystrobin (COM) WG. Limitations: As per label.

ROOT-KNOT NEMATODE

Meloidogyne spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Fumigate soil (preplant) with - methyl bromide (RES) LI; dazomet (COM) GR; metam-sodium (COM) SN; methyl isothiocyanate + 1,3-dichloropropene + chloropicrin (COM) SN; chloropicrin + 1,3-dichloropropene (COM) SN; 1,3-dichloropropene (COM) SN. Limitations: As per label.

FUCHSIA (*Fuchsia* hybrids)

BLACK ROOT ROT

Thielaviopsis basicola (see under BEDDING PLANTS, page 18)

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Copper complex (COM) SN; iprodione (COM) WG, WP. Limitations: As per label.

Notes: Repeated use of iprodione may induce resistance in *Botrytis* to the fungicide.

RUST

Pucciniastrum epilobii

Cultural: Pick and destroy infected leaves. Destroy fireweed (*Epilobium*) the alternate host for fuchsia rust, if practical. Follow other control measures discussed under 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: None.

GERANIUM (*Pelargonium* spp.)

BACTERIAL LEAF SPOT and STEM ROT, BLACK ROT

Xanthomonas campestris pv. *pelargonii*

Cultural: Control measures must be based upon establishing disease-free planting stock and practicing strict sanitary measures. Avoid wetting the foliage when watering. For details refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Bacillus subtilis* Strain QST 713 (COM) Aqueous Suspension. Limitations, as per label.

Chemical: Copper complex (COM) SN will reduce spread from plant to plant but will not cure infected plants.

Notes: *Xanthomonas* can survive on leaves or wounded stems of ornamentals such as tuberous begonia, chrysanthemum, coleus, fuschia, impatiens, lantana, spike, verbena and vinca vine.

References:

1. BCMAFF Floriculture Production Guide.

BLACK ROOT ROT

Thielaviopsis basicola (see under BEDDING PLANTS, page 18)

BLACKLEG

Pythium spp.

Cultural: Plant only disease-free stock. Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: None.

Chemical: Oxine benzoate (COM, DOM) SN. Limitations: As per label.

DAMPING-OFF

Pythium spp., *Rhizoctonia solani*

See Bedding Plants, DAMPING-OFF AND ROOT ROT on page 18.

DOWNY MILDEW

Peronospora spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Dimethomorph (COM) WP. Limitations: As per label.

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Bacillus subtilis* Strain QST 713 (COM) AS; *Gliocladium catenulatum* Strain J1446 (COM) WP. Limitations, as per label

Chemical: Chlorothalonil (COM) SU, WG; copper complex (COM) SN; dicloran (COM) WP; fenhexamid (COM) WG; iprodione (COM) WG, WP. Limitations: As per label.

Notes:

1. Apply chlorothalonil only when foliage and blossom surfaces are dry, and when greenhouse temperatures do not exceed 24^{o}C.

2. Repeated use of iprodione may induce resistance in *Botrytis* to the fungicide.

OEDEMA

Physiological - Excessive soil moisture, low light, retarded transpiration

Cultural: If plants are given sufficient air circulation and light without excessive relative humidity, oedema is rarely a problem. Once a leaf has oedema symptoms, it will not recover. New growth will be normal if beneficial environmental changes are made.

Resistant Cultivars: See Notes.

Chemical: None.

Notes: Ivy leaf geraniums are more prone to oedema than other types.

POWDERY MILDEW

Sphaerotheca pannosa, *Erysiphe cichoracearum*

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Myclobutanil (COM) WP; trfiloxystrobin (COM) WG. Limitations: As per label.

ROOT and STEM ROT

Pythium spp., *Phytophthora spp., and Rhizoctonia solani*

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP; *Gliocladium catenulatum* Strain J1446 (COM) WP. Limitation: As per label.

Chemical: Captan (COM) WG; etridiazole (COM) EC; fosetyl-AL (COM) WG, WP; metalaxyl-M & S-isomer (COM) EC; oxine benzoate (COM) SN. Limitations: As per label.

Note: Thiophanate-methyl is not effective on *Pythium.*

RUST

Puccinia pelargonii-zonalis

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Chlorothalonil (COM) SU, WG; myclobutanil (COM) WP. Limitations: As per label.

Notes:

1. Apply chlorothalonil only when foliage and blossom surfaces are dry, and when greenhouse temperatures do not exceed 24^{o}C.

2. This was previously a quarantine disease in Canada under regulations of the Plant Health Division, Agriculture & Agri-Food Canada, but is no longer classified as such.

VIRUS DISEASES

Pelargonium leaf-curl virus, cucumber mosaic virus, impatiens necrotic spot virus

Cultural: Propagate only from virus-free mother plants. Follow other cultural control methods listed under 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: None. Control thrips.

QUARANTINE DISEASES

The following disease of geranium and potato does not occur in Canada and is under quarantine regulations. The North American Plant Protection Organization (NAPPO) recently listed this pathogen as a quarantine pest of potatoes for the NAPPO region:

Bacterial Wilt (*Ralstonia solanacearum* race 3-biovar 2) - See Agriculture and Agri-Food Canada, www.inspection.gc.ca/english/plaveg/pestrava/ralsol/ralsole.shtml (accessed Feb 10, 2012) and B.C. Ministry of Agriculture, Fisheries and Food, www.agf.gov.bc.ca/cropprot/ralstonia.htm **.**

GLOXINIA (*Sinningia speciosa*)

BUD ROT

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Iprodione (COM) WG, WP. Limitations: As per label.

Notes: Repeated use of iprodione may induce resistance in *Botrytis* to the fungicide.

DAMPING-OFF

See Bedding Plants, DAMPING-OFF AND ROOT ROT on page 18.

CROWN ROT AND LEAF BLIGHT

Sclerotinia sclerotiorum

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. Collect and destroy infected plant debris as large numbers of persistent sclerotia may be present.

Resistant Cultivars: None.

Chemical: None.

ROOT, STEM AND CROWN ROTS

Fusarium spp., *Pythium* spp., *Rhizoctonia* spp. *Phytophthora* spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP. Limitations: As per label.

Chemical: Captan (COM) WP, WG; etridiazole (COM) EC; metalaxyl-M & S (COM) EC; oxine benzoate (COM, DOM) SN. Limitations: As per label.

Note: Etridiazole and metalaxyl-M & S are effective against *Pythium* and *Phytophthora*.

IMPATIENS NECROTIC SPOT

See Bedding Plants, IMPATIENS NECROTIC SPOT on page 19.

HIBISCUS (*Hibiscus syriacus*)

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Copper complex (COM) SN. Limitations: As per label.

HYDRANGEA (*Hydrangea macrophylla*)

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Dicloran (COM) WP; thiophanate-methyl (COM) WP. Limitations: As per label.

POWDERY MILDEW

Erysiphe cichoracearum

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Copper complex (COM) SN; potassium bicarbonate (COM) DU. Limitations: As per label.

LEAF SPOTS

Cercospora spp. and *Septoria* spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Chlorothalonil (COM) WG, SU. Limitations: As per label.

Notes: Apply chlorothalonil only when foliage and blossom surfaces are dry, and when greenhouse temperatures do not exceed 24^{o}C.

ROOT, STEM AND CROWN ROTS

Fusarium spp., *Pythium* spp., *Rhizoctonia* spp. *Phytophthora* spp.

See Bedding Plants, DAMPING-OFF AND ROOT ROT page 18.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP. Limitations: As per label.

Chemical: Captan (COM) WG, WP; etridiazole (COM) EC; oxine benzoate (COM, DOM). Limitations: As per label.

IMPATIENS

DOWNY MILDEW

Peronospora spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Dimethomorph (COM) WP. Limitations: As per label.

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Iprodione (COM) WP, WG. Limitations: As per label.

POWDERY MILDEW

Erysiphe spp., *Oidium* spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: None

Chemical: Boscalid / pyraclostrobin (COM) WG. Limitations: See label.

ROOT and STEM ROT

Rhizoctonia solani, and Pythium spp., *Phytophthora* spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: None.

Chemical: Etridiazole (COM) EC, WP; fosetyl-AL (COM) WP, WG; metalaxyl-M & S-isomer (COM) EC; trifloxystrobin (COM) WG. Limitations: As per label.

Notes: Etridiazole, fosetyl-AL and metalaxyl are only effective against *Pythium* and *Phytophthora*.

LETTUCE (*Lactuca sativa*)

DAMPING-OFF

Pythium spp., *Rhizoctonia solani*

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Gliocladium catenulatum* J1446 (COM) WP. Limitations: See label.

Chemical: Oxine benzoate (COM, DOM) SN. Limitations: As per label.

DOWNY MILDEW

Bremia lactucae

Cultural: Can be a problem in fall and spring under conditions of high humidity and where leaf tissue remains wet for prolonged periods. Control climate with temperature and ventilation.

Resistant Cultivars: Consult seed companies.

Biological: *Bacillus subtilis* Strain QST 713 (COM) WP. Limitations, as per label

Chemical: Fosetyl-al (COM) WG, WP. Limitations: For use in B.C. only. Preharvest interval - 14 days (fosetyl-Al).

Notes: Spray within 1 week of transplanting and repeat in 2 weeks. Ensure good foliage coverage.

References:

1. Publication 365, 1990 Pest Management Recommendations for Ontario Greenhouse Crops.

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Gliocladium catenulatum* J1446 (COM) WP. Limitations: See label.

Chemical: Ferbam (COM) WG; iprodione (COM) WG, WP; fenhexamid (COM) WG
Limitations: Preharvest interval -1 day (ferbam); 14 days (iprodione), 3 days (fenhexamid)

POWDERY MILDEW

Erysiphye cichoracearum

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Bacillus subtilis* Strain QST 713 (COM) WP. Limitations, as per label.

Chemical: Boscalid / pyraclostrobin (COM) WG. Limitations, as per label.

SCLEROTINIA ROT (DROP)

Sclerotinia sclerotiorum

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. Collect and destroy infected plant debris as large numbers of persistent sclerotia may be present. Avoid planting cucumbers or tomatoes in rotation with lettuce where Sclerotinia rot occurs.

Resistant Cultivars: None.

Biological: *Bacillus subtilis* Strain QST 713 (COM) WP. Limitations, as per label

Chemical: Iprodione (COM) WG, WP. Limitations: 14 days (iprodione).

TIPBURN

Nonpathogenic

Cultural: Maintain a steady rate of plant growth. Avoid wide fluctuations in moisture stress and air temperature. Lettuce is more prone to visible tip burn in the later stages of maturity. Ensure adequate levels of calcium in the media, and that the EC is not too high.

Resistant Cultivars: Consult seed companies.

Chemical: None.

Notes: Harvesting heads before full maturity is one approach to reducing visible damage.

TOMATO SPOTTED WILT

See Tomato, TOMATO SPOTTED WILT on page 68.

LILY (EASTER) (*Lilium* spp.)

GRAY MOLD and BLIGHT

Botrytis cinerea, B. elliptica

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Chlorothalonil (COM) WG, SU. Limitations: As per label.

Notes: Apply chlorothalonil only when foliage and blossom surfaces are dry, and when greenhouse temperatures do not exceed 24°C.

ROOT and BULB ROT

Rhizoctonia solani, Fusarium spp., *Pythium* spp., *Phytophthora* spp., *Cylindrocarpon radicicola*

Cultural: Propagating from healthy planting stock is the most effective means of controlling this disease complex. Also follow the other cultural practices listed under 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: None.

Chemical: Etridiazole (COM) EC, WP. Limitations: As per label.

Notes: Etridiazole is only effective against *Pythium* and *Phytophthora*.

SCLEROTINIA ROT

Sclerotinia sclerotiorum

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Coniothyrium minitans* CON/M/91-08 (COM) WG. Limitations: As per label.

Chemical: None.

PANSY (*Viola* spp.)

BLACK ROOT ROT

Thielaviopsis basicola (see under BEDDING PLANTS, page 18)

Cultural: Maintain balanced fertility and moisture.

Chemical: None.

Notes: In pansy, black root rot may be confused with *Pythium* root rot.

References:

1. Mullen, J. and Hagan, A. 2001. Diseases of Pansies and Their Control. ANR-1214. Alabama Co-operative Extension Program. http://www.aces.edu/pubs/docs/A/ANR-1214/. (accessed Feb 12, 2012)

DOWNY MILDEW

Peronospora parasitica, P. violae, P. sparsa, P. antirrhini, P. phlogina

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Dimethomorph (COM) WP. Limitations: As per label.

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Gliocladium catenulatum* J1446 (COM) WP. Limitations: As per label.

Chemical: None.

ROOT ROTS

Fusarium oxysporum var. *aurantiacum, Helicobasidium purpureum, Phymatotrichum omnivorum, Rhizoctonia solani, Ciborinia violae, Pellicularia filamentosa*

Cultural: These soil inhabiting fungi are difficult to control once they infest growth media. Drastic measures are necessary, such as steam-pasteurization. Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: None.

Chemical: Trifloxystrobin (COM) WG for Rhizoctonia root rot only. Limitations: see label.

ROOT AND STEM ROTS

Pythium spp., *Rhizoctonia* spp., *Phytophthora* spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Gliocladium catenulatum* J1446 (COM) WP. Limitations: As per label.

Chemical: Etridiazole (COM) EC; metalaxyl-M & S-isomer (COM) EC; trifloxystrobin (COM) WG. Limitations: As per label.

Notes: Trifloxystrobin is only effective against *Rhizoctonia*. Etridiazole and metalaxyl are only effective against *Pythium* and *Phytophthora*

PEPPER (SWEET PEPPER [*Capsicum* spp.])

BACTERIAL SPOT

Xanthomonas campestris pv. *vesicatoria*, *Xanthomonas vesicatoria*

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: None.

Chemical: Copper hydroxide (COM) WP. Limitations: As per label.

BLOSSOM END ROT

Nonpathogenic

Cultural: Avoid plant stresses mentioned under notes. Apply calcium chloride at 100-200 g/100 litres water as a foliar spray at the first sign of blossom end rot. Maintain reasonably high humidity levels in the afternoon or warm days by restricting venting. Ensure soluble salts in the growing medium are below 2.5 EC during conditions that favour BER.

Resistant Cultivars: None.

Chemical: None.

Notes: This is a very common physiological disorder of peppers. It is caused by a moisture shortage within the plant in relation to calcium movement. Water soaked spots appear at the blossom end which enlarge and take on a black, leathery appearance. Moisture shortages can be caused by a number of factors. Underwatering during warm periods, high concentrations of fertilizer salts which impede root uptake of calcium, root problems, very low humidity causing high transpiration rates, and sudden changes in the weather from cool to hot periods can all cause moisture stress on the plant, affecting calcium mobility. Often more blossom end rot occurs during periods of rapid fruit expansion. Actual calcium deficiency is usually a secondary factor, since regular feeding should supply adequate amounts.

References:

1. 1996-97 Greenhouse Vegetable Production Guide, BCMAFF.

DAMPING-OFF, ROOT or CROWN ROT

Phytophthora spp., *Pythium* spp., *Rhizoctonia* spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Streptomyces griseoviridis* Strain K61 (COM) WP as a seedling treatment but not a seed treatment; *Gliocladium catenulatum* J1446 (COM) WP. Limitations: As per label.

Chemical: Buy treated seed or apply thiram as a seed treatment. Captan (COM) WP or oxine benzoate (COM, DOM) SN, as a seedling drench; propamocarb hyrdrochloride (COM). Limitations: As per label.

References:

1. 1996-97 Greenhouse Vegetable Production Guide, BCMAFF.

ROOT AND STEM ROT AND WILT (Phytophthora)

Phytophthora spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Streptomyces griseoviridis* Strain K61 (COM) WP; *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP. Limitations: As per label.

Chemical: None.

References:

1. Nielsen, C.J. *et al*. 2006. Efficacy of biosurfactants in the management of *Phytophthora capsici* on pepper in recirculating hydroponic systems. Can. J. Plant Path. 28: 450-460.

ROOT AND CROWN ROT AND WILT (Fusarium)

Fusarium spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Streptomyces griseoviridis* Strain K61 (COM) WP; *Gliocladium catenulatum* J1446 (COM) WP. Limitations: As per label.

Chemical: None.

FUSARIUM STEM ROT and FRUIT ROT

Fusarium solani, Nectria haematococca

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Streptomyces griseoviridis* strain K61 (COM) WP as a seedling drench; *Gliocladium catenulatum* J1446 (COM) WP. Limitations: As per label.

Chemical: None.

References:

1. 1996-97 Greenhouse Vegetable Production Guide, BCMAFF.

2. Cerkauskas, R. 2001. Fusarium Stem and Fruit Rot of Greenhouse Pepper. Factsheet 01-083 OMAFRA. http://www.omafra.gov.on.ca/english/crops/facts/01-083.htm (accessed Feb 12, 2012)

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. Reduce humidity and improve air circulation around the plants. Strictly control greenhouse climate by adequate heating and venting to prevent condensation on plants. Practice a high degree of sanitation by removing crop debris including prunings from the greenhouse.

Resistant Cultivars: None.

Chemical: None.

References:

1. 1996-97 Greenhouse Vegetable Production Guide, BCMAFF.

PEPPER MILD MOTTLE

Pepper mild mottle virus

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. Seed should be treated against virus infection (one hour in 10% solution of tri-sodium phosphate (TSP) unless already treated by the seed company). The evening prior to picking out seedlings or prior to any handling, spray the seedlings with 10% skim milk powder solution. Use 10% low fat milk (containing 35% protein per litre of water). Always dip hands in skim milk solution before handling the plants.

Resistant Cultivars: Adele, Cubico, DRS 5033, Kelvin, Madara, and Samantha. Consult your seed company.

Chemical: None.

References:

1. 1990 Pest Control Notes, PMMV, BCMAFF.

2. Stace-Smith, R. 1990. Pepper mild mottle virus on greenhouse grown peppers. Phytopathology 80: 892.

POWDERY MILDEW

Leveillula taurica

Cultural: Powdery mildew of greenhouse pepper is a new and serious disease. Avoid introducing this disease into your greenhouse. Follow strict sanitation and guidelines under 'General Disease Control Methods'. Early infection causes serious crop yield losses depending on the cultivar.

Resistant Cultivars: Inspiration. Check with seed suppliers.

Biological: *Bacillus subtilis* Strain QST 713 (COM) WP; *Streptomyces lydicus* (COM) SP. Limitations, as per label.

Chemical: Myclobutanil (COM) WP foliar spray as soon as mildew is detected and again 12 days later if disease pressure warrants control. Maximum number of applications is three and re-entry interval is 12 hours. Sulphur (COM) WP as required but do not exceed 10 applications per crop cycle. Apply on a minimum interval of 14 days. Potassium bicarbonate (COM) DU; boscalid / pyraclostrobin (COM) WG. **Limitations**: As per labels. Preharvest interval - 3 days for myclobutanil.

References:

1. Cerkauskas, R.F and A. Buonassisi. 2003. First report of powdery mildew of greenhouse pepper caused by *Leveillula taurica* in British Columbia, Canada. Plant Dis. 87: 1151.

SHRINK CRACKING

Nonpathogenic

Cultural: Control is achieved by lower humidity levels early in the morning plus providing adequate leaf cover for the fruit during the summer. The first flush of fruit that takes longer than 8 weeks to harvest from flower are more prone to shrink cracking.

Resistant Cultivars: None. The variety Delphin has been noted to be particularly susceptible. Yellow (Samantha) and orange cultivars tend to be more prone to shrink cracking.

Chemical: None.

Notes: Numerous small cracks may appear on the fruit as they mature. They are usually associated with swelling of the fruit caused by excessive water uptake, or possible fruit expansion due to heating of the fruit by the sun.

References:

1. 1996-97 Greenhouse Vegetable Production Manual, BCMAFF.

SUNSCALD

Nonpathogenic

Cultural: Peppers are very susceptible to sun scald, which causes light tan coloured areas on exposed fruit. Maintain good leaf canopy and apply shading or use moveable screen during bright hot weather.

Resistant Cultivars: None.

Chemical: None.

References:

1. 1996-97 Greenhouse vegetable production guide, BCMAFF.

TOBACCO MOSAIC

Tobacco mosaic virus

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. This disease can be transmitted by seeds, soil, water, insects and pruning. Use one year old seed, soak seed for one hour in a 10% solution of tri-sodium phosphate (TSP). Before handling plants dip hands in a 10% solution of skim milk powder (100 g/L water). Do not smoke near plants or in the greenhouse since tobacco carries the virus. Rogue out any suspicious plants and handle plants as little as possible. Sprays of dried milk powder have been shown to slow the spread of TMV.

Resistant Cultivars: None.

Chemical: None.

Notes: Symptoms include mosaic mottling on leaves and necrosis of leaf veins. Defoliation often follows. Fruit may be bronze in appearance or malformed.

References:

1. 1996-97 Greenhouse vegetable production guide, BCMAFF.

TOMATO SPOTTED WILT

Tomato spotted wilt virus

Cultural: Use disease-free propagative stock. Control weeds in and around the greenhouse as they can harbour TSWV. The use of 'double doors' in greenhouses may be useful in preventing the entry of thrips. The use of indicator plants such as petunia 'Calypso', 'Summer Madness' and 'Super Blue Magic' are good indicators for INSV and TSWV infections.

Resistant Cultivars: None.

Chemical: None.

Notes: Use recommended methods to control the western flower thrips vector of TSWV (see Tomato).

WHITE ROT

Sclerotinia sclerotiorum

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. Use soilless culture methods. In areas with a history of Sclerotinia, lay white plastic ground sheets to completely cover exposed soil and place bags on top to isolate the bags from infection.

Resistant Cultivars: None.

Chemical: None.

References:

1. 1996-97 Greenhouse Vegetable Production Guide, BCMAFF.

PETUNIA

DAMPING-OFF, ROOT, STEM or CROWN ROT

Phytophthora spp., *Pythium* spp., *Rhizoctonia* spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP; *Gliocladium catenulatum* J1446 (COM) WP. Limitations: As per label.

Chemical: Chlorothalonil (COM) SU, WG; copper complex (COM) SN; etridiazole (COM) EC; fosetyl-AL (COM) WG, WP; metalaxyl-M & S-isomer (COM) EC; trifloxystrobin (COM) WG. Limitations: As per label.

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Bacillus subtilis* Strain QST 713 (COM) AS*; Gliocladium catenulatum* J1446 (COM) WP. Limitations: As per label.

Chemical: Chlorothalonil (COM) SU; fenhexamid (COM) WG. Limitations: As per label.

POWDERY MILDEW

Podosphaera sp., *Oidium* sp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Bacillus subtilis* Strain QST 713 (COM) AS. Limitations: As per label.

Chemical: Boscalid / pyraclostrobin (COM) WG. Limitations: As per label.

POINSETTIA (*Euphorbia pulcherrima*)

BLACK ROOT ROT

Thielaviopsis basicola (see under BEDDING PLANTS, page 18)

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. Humidity should be kept below 93%. Do not allow canopy to close; move pots apart as necessary.

Resistant Cultivars: None.

Biological: *Bacillus subtilis* Strain QST 713 (COM) AS; *Gliocladium catenulatum* J1446 (COM) WP. Limitations, as per label.

Chemical: Copper complex (COM) SN; fenhexamid (COM) WG; iprodione (COM) WG, WP; thiophanate-methyl (COM) WP. Limitations: As per label.

Notes: Repeated use of iprodione may induce resistance in *Botrytis* to this fungicide.

References:

1. Benson, D. M. *et al*. 2002. The history and diseases of poinsettia, the Christmas flower. Online. Plant Health Progress doi:10.1094/PHP-2002-0212-01-RV.

MOSAIC

Poinsettia mosaic virus

Cultural: Propagate poinsettias from virus-free stock.

Resistant Cultivars: None.

Chemical: None.

Notes:

1. Symptoms are enhanced in plants grown at 20^{o}C or lower, but are generally mild or non-existent in plants grown at higher temperatures.

2. Virus-free poinsettias have been obtained from infected stocks by procedures involving heat therapy or tissue culture. However, virus-indexed poinsettias are apparently not currently available in commercial quantities.

References:

1. Chiko, A.W. 1983. Poinsettia mosaic virus in British Columbia. Plant Dis. 67: 427-428.

2. Pfannenstiel, M.A., Mintz, K.P., and Fulton, R.W. 1982. Evaluation of heat therapy of poinsettia mosaic and characterization of the viral components. Phytopathology 72: 252-254.

POWDERY MILDEW

Oidium sp.

Cultural: Check cuttings to ensure they do not have powdery mildew. If detected, remove infected leaves and place into bags at the site.

Resistant Cultivars: None.

Biological: *Bacillus subtilis* Strain QST 713 (COM) AS. Limiations: See label.

Chemical: Boscalid / pyraclostrobin (COM) WG; copper complex (COM) SN; myclobutanil (COM) WP; potassium bicarbonate (COM) DU; trifloxystrobin (COM) WG. Limitations: See label.

Notes: Use caution when applying fungicides when the bracts are fully developed.

ROOT AND STEM ROT

Rhizoctonia solani, *Pythium* spp., *Fusarium* spp., *Cylindrocladium* spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. Use a well-drained potting mix and avoid overwatering.

Resistant Cultivars: None.

Biological: *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP; *Gliocladium catenulatum* J1446 (COM) WP. Limitations: As per label.

Chemical: Captan (COM) WP; copper complex (COM) SN; etridiazole (COM) EC; folpet (COM) WP, WG; propamocarb hyrdrochloride (COM) AS; trifloxystrobin (COM) WG. Limitations: As per label.

Notes: Etridiazole is only effective against *Pythium*.

PRIMROSE (*Primula* spp.)

BACTERIAL LEAF SPOT

Pseudomonas primulae

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. Older leaves have been reported to be more susceptible.

Resistant Cultivars: Some varieties of Primula have been proven to be more susceptible than others.

Chemical: None.

Notes: Severe outbreaks can be curbed with copper fungicides.

DAMPING OFF AND ROOT AND STEM ROTS

Pythium spp., *Phytophthora* spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological:

Chemical: Metalaxyl-M & S (COM) EC. Limitations: As per label.

DOWNY MILDEW

Peronospora spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Dimethomorph (COM) WP. Limitations: As per label.

GRAY MOLD

Botrytis cinerea

See under BEDDING PLANTS, page 19.

Chemical: Copper complex (COM) SN; iprodione (COM) WP, WG. Limitations: See label.

RUST

Puccinia aristidae, Uromyces apiosporus

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: None.

VIRUS DISEASES

Cucumber Mosaic Virus (CMV), Impatiens Necrotic Spot Virus (INSV)

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. Remove and destroy infected plants. For CMV, control weeds and aphids that may harbor and spread the virus. For INSV, see under BEDDING PLANTS, Impatiens Necrotic Spot on page 19.

Resistant Cultivars: None.

Chemical: None.

ROSE (*Rosa* spp.)

BLACK SPOT

Diplocarpon rosae

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Bacillus subtilis* (COM) AS. Limitations: As per label

Chemical: Captan (COM) WP; chlorothalonil (COM) WG, SU; dicloran (COM) WP; thiophanate-methyl (COM) WP. Limitations: As per label.

Notes: Apply chlorothalonil only when foliage and blossom surfaces are dry, and when greenhouse temperatures do not exceed 24°C.

DOWNY MILDEW

Peronospora sparsa (see under BEDDING PLANTS, page 19).

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Dimethomorph (COM) WP. Limitations: As per label.

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Chlorothalonil (COM) WG, SU; copper complex (COM) SN; dicloran (COM) WP; fenhexamid (COM) WG; thiophanate-methyl (COM) WP. Limitations: As per label.

Notes: Apply chlorothalonil only when foliage and blossom surfaces are dry, and when greenhouse temperatures do not exceed 24°C.

POWDERY MILDEW

Sphaerotheca macularis

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Pseudozyma flocculosa* (COM) SU; *Bacillus subtilis* (COM) AS. Limitations: As per label.

Chemical: Copper complex (COM) SN; dodemorph acetate (COM) EC; myclobutanil (COM) WP; thiophanate-methyl (COM) WP; trifloxystrobin (COM) WG. Limitations: As per label.

ROOT AND STEM ROTS

Pythium spp., *Phytophthora* spp., *Rhizoctonia solani*

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: None.

Chemical: Captan (COM) WP, WG; propamocarb hydrochloride (COM) AS; trifloxystrobin (COM) WG. Limitations: As per label.

SNAPDRAGON (*Antirrhinum majus*)

DAMPING-OFF

See Bedding Plants, DAMPING-OFF AND ROOT ROT on page 18.

DOWNY MILDEW

Peronospora antirrhini

Cultural: Can be a problem under conditions of high humidity and where leaf tissue remains wet for prolonged periods. Control climate with temperature and ventilation.

Resistant Cultivars: None.

Chemical: Dimethomorph (COM) WP. Limitations: See label.

GRAY MOLD

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Gliocladium catenulatum* J1446 (COM) WP. Limitations: As per label.

Chemical: None.

POWDERY MILDEW

Erysiphe cichoracearum, Oidium spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Trifloxystrobin (COM) WG. Limitations: See Label

RUST

Puccinia antirrhini

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. Propagation from seed is preferable to the use of cuttings. The disease is also spread from plant to plant by insects, which carry the uredospores; the control of insects therefore helps to control rust. Since the uredospores germinate very rapidly at low temperatures, infection is most likely in cool conditions. It has been reported that rust can be controlled if the temperature of the greenhouse is kept above 21^{o}C and not below 16^{o}C at night.

Resistant Cultivars: Rust-resistant varieties are available.

Chemical: None.

STEM and CROWN and ROOT ROTS

Sclerotinia sclerotiorum, Fusarium spp., *Pythium* spp., *Rhizoctonia solani, Phytophthora* spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Coniothyrium minitans* CON/M/91-08 (COM) WG (Sclerotinia only); *Gliocladium catenulatum* J1446 (COM) WP; *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP. Limitations: As per label.

Chemical: Captan (COM) WG, WP; etridiazole (COM) WP, EC; metalaxyl-M & S (COM) EC; oxine benzoate (COM, DOM) SN. Limitations: As per label.

Notes: Etridiazole and metalaxyl will only control *Pythium* and *Phytophthora*. .

TOMATO (*Lycopersicon esculentum*)

BACTERIAL CANKER

Clavibacter michiganensis subsp. *michiganensis*

Cultural: Sow only hot water-treated seed. For hot water treatment of seed of doubtful status, place seed in a loose cheesecloth bag and soak in water at 50°C for 30 min. Treatment at 53°C may be carried out if the seed is planted within a few days. Use an accurate thermometer and keep the seed agitated during treatment. Spread seed out to dry immediately after treatment. Also follow a rigid schedule of sanitation throughout the season (refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter).

Resistant Cultivars: None.

Chemical: Copper oxychloride (COM) WP may be used as a foliar spray. Limitations: Preharvest interval - 1 day (copper oxychloride). A copper fungicide applied to the area of outbreak may help reduce the disease, however preventative applications of copper-containing fungicides have not been effective in controlling the disease in field studies (1).

References:

1. Hudgins, E. 2000. Bacterial Canker of Greenhouse Tomatoes. BCMAFF factsheet.

2. Maitland, A. E. 1976. Bacterial canker of tomato. Ont. Ministry Agric. Food, Factsheet 76-014.

BLOSSOM-END ROT

Physiological

Cultural: Maintain a steady rate of plant growth. Avoid wide fluctuations in soil water, soil compaction, and air temperature. Increase root zone temperature at night. Make sure calcium levels are between 150 to 200 ppm in the nutrient solution. In soil or soil based media, calcium levels should be maintained between 200 to 300 ppm based on the water extraction method. In soilless media, rockwool and NFT, the electrical conductivity should be around 2.0 millisiemens/cm when air temperature is above 26°C. If BER has already appeared, remove the fruit. Reduce carbon dioxide and temperature to avoid vigorous fruit growth. Remove leaves at the bottom of the plant. This will remove sites of calcium accumulation that compete with the fruit. Spray developing trusses with calcium chloride or calcium nitrate at 100 to 200 g/100 L of water on a 2-3 sprays/week basis. Avoid relative humidity above 80% in the greenhouse. Avoid high nitrogen levels when plants are small.

Resistant Cultivars: None.

Chemical: None.

Notes: Blossom-end rot may be a serious problem on tomatoes grown in peat moss.

References:

1. Mayodan, M. 1985. Personal Communication. Alberta Tree Nursery and Hort. Centre, Edmonton, Alta.

BLOTCHY RIPENING

Physiological and tobacco mosaic virus.

Cultural: Provide adequate space per plant, e.g., 0.3 to 0.4 m². Control tobacco mosaic virus (see page 57). Maintain relatively high soil potassium levels. In hydroponic culture, increase potassium levels to 400 to 500 ppm (2). Keep greenhouse temperatures as low as possible during hot weather. Avoid heavy de-leafing. Increase leaf canopy on plants in June. Maintain 18-20 leaves per plant.

Resistant Cultivars: None.

Chemical: None.

References:

1. Mayodan, M. 1983. Personal communication. Alta. Hort. Res. Center, Brooks, Alta.
2. Piedrahita, O. 1984. Tomato fruit disorders. Ont. Minist. Agric. Food, Factsheet 84-051.
3. Stace-Smith, R. 1975. Virus control in greenhouse tomatoes. Can. Agric. 21(1): 15-16.
4. 1996-97 Greenhouse Vegetable Production Guide, BCMAFF.

DAMPING-OFF, ROOT ROT

Pythium spp., *Rhizoctonia solani*, *Phytophthora spp.*, *Fusarium spp.*

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Gliocladium catenulatum* J1446 (COM) WP; *Streptomyces griseoviridis* Strain K61 (COM) WP; *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP. Limitations: As per label.

Chemical: Captan (COM) WP, WG; oxine benzoate (COM) SN; propamocarb hydrochloride (COM). Limitations: See labels.

DIDYMELLA STEM AND FRUIT ROT

Didymella lycopersici

Cultural: Remove any infected plant and burn. Do not handle or cut lesions. Minimize water splashing around affected areas. Follow other cultural control practices discussed on 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: None.

References:

1. Wright, R.G. 1983. Didymella stem and fruit rot of tomato. ADAS leaflet 560, Ministry of Agriculture, Fisheries and Food, U.K.
2. 1996-97 Greenhouse Vegetable Production Guide, BCMAFF.

EARLY BLIGHT, LATE BLIGHT, SEPTORIA LEAF SPOT

Alternaria solani, Septoria lycopersici, Phytophthora infestans

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Chemical: Copper oxychloride (COM) WP; mancozeb (COM) WG, WP.
Limitations: As per label. Preharvest interval - 7 days (mancozeb).

Notes: Attempt to keep new growth covered with protectant sprays and dusts.

FUSARIUM CROWN and ROOT ROT

Fusarium oxysporum f. sp. *radicis-lycopersici*

Cultural: Use resistant cultivars. Graft onto resistant rootstock varieties, B82.864. Removal of the first fruit of a heavily infected plant will allow the plant to recover with relatively little loss thereafter. The mounding of soil or a soil-peat mixture around the base of the stem of infected plants to a height of 20-30 cm allows the growth of adventitious roots. These roots generally remain disease free and allow the plants to recover.

Resistant Cultivars: Apollo, B8-864 (pink fruited), Cobra (red fruited), CR-6 (pink), 83W186, Furon (red), Farao (red), Larma (red), Match, Red Giant (red), Trust (red), Vicores (red), W1601 (red), 1627, and 518. Consult seed companies.

Biological: *Streptomyces griseoviridis* Strain K61 (COM) WP; *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP. Limitations: As per label.

Chemical: None. See notes.

Notes: General sanitation and soil sterilization may reduce disease inoculum but will not prevent disease.

References:

1. 1986-87 Greenhouse Vegetable Production Guide, BCMAFF.

2. Jarvis, W.R. 1976. Fusarium crown and root rot in greenhouse tomatoes. Canadex 257. 635.

GRAY LEAF SPOT

Stemphylium solani

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Chemical: Captan (COM) WP.
Limitations: Preharvest interval - 2 days (captan).

Notes: Maneb, mancozeb, and chlorothalonil are reported to be effective against gray leaf spot.

GRAY MOLD (STEM ROT)

Botrytis cinerea

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. If detected early, disease areas on the stem may be cleaned by removing with a knife (scrape) and applying a paste of iprodione.

Resistant Cultivars: None.

Biological: *Streptomyces griseoviridis* Strain K61 (COM) WP; *Gliocladium catenulatum* J1446 (COM) WP. Limitations: As per label.

Chemical: Dicloran (COM) WP; fenhexamid (COM) WG; ferbam (COM) WG; iprodione (COM) WG, WP; boscalid/pyraclostrobin (COM) WG; pyrimethanil (COM) SU.
Preharvest intervals - 1 day (dicloran, fenhexamid); 2 days (iprodione). Limitations: As per label.

References:

1. Utkhede, R. et al. 2001. Effects of biological and chemical treatments on *Botrytis* stem canker and fruit yield of tomato under greenhouse conditions. Can. J. Plant Pathol. 23: 253-259.

LEAF MOLD

Cladosporium fulvum

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: Ontario Red 775, Ontario Pink 774, and Buffalo.

Intermediate: Dombito and Laura. Use varieties with C5 resistance for western Canada.

Chemical: None.

References:

1. Committee 1984. 1985-86 Greenhouse Vegetable Production Recommendations. Ont. Min. Agric. Food Pub. 365.

MAGNESIUM DEFICIENCY

Physiological - Inadequate availability of magnesium.

Cultural: Rotate plantings to new beds. Apply magnesium sulphate (Epsom salts) to the soil at 1 kg/100 m² or to the leaves once as a spray at 25 g/100 L. In greenhouses where the problem has occurred on previous crops, magnesium sprays should be applied even before the symptoms occur.

Resistant Cultivars: None.

Chemical: None.

Notes: High potassium levels in the soil may induce magnesium deficiency.

PEPINO MOSAIC

Pepino Mosaic Virus

Cultural: Practice prevention methods based on strict greenhouse sanitation and hygiene excluding all off site tomatoes and prohibiting visitor access to crop. Ensure that workers have a separate uniform including footwear that is only for greenhouse use. Follow an intensive, year end greenhouse clean up to prevent virus carry over to new crop. Dip hands and tools in undiluted skim milk (at least 3.5% protein). Disinfect tools and greenhouse surfaces.

Resistant Cultivars: None.

Chemical: None.

References:

1. Ferguson, G. 2003. Management of pepino mosaic virus in greenhouse tomato. Ontario Ministry of Agriculture and Food factsheet http://www.omafra.gov.on.ca/english/crops/facts/01-017.htm (accessed Feb 10, 2012).

PITH NECROSIS

Pseudomonas corrugata

Cultural: Remove and destroy infected plants. Low night temperatures, high humidity, and high nitrogen levels appear to contribute to disease development.

Resistant Cultivars: None.

Chemical: None.

POWDERY MILDEW

Erysiphe sp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: None.

Biological: *Bacillus subtilis* Strain QST 713 (COM) WP. Limitations, as per label

Chemical: Myclobutanil (COM) WP; potassium bicarbonate (COM) DU; Sulphur (COM) WP; boscalid/pyraclostrobin (COM) WG; garlic (COM) WP.
Preharvest interval - 3 days (myclobutanil) with no more than 2 applications per crop cycle. Limitations: As per label.

References:

1. BCMAFF. 1996-97 Greenhouse Vegetable Production Guide.

2. Ehret, D.L. *et al*. 2002. Foliar applications of fertilizer salts inhibit powdery mildew on tomato. Can. J. Plant Pathol. 24: 437-444.

ROOT, STEM and FRUIT ROTS

Colletotrichum coccodes, Sclerotinia sclerotiorum, Rhizoctonia solani, Pyrenochaeta lycopersici, Botrytis cinerea, Pythium spp., *Phytophthora* spp., *Fusarium* spp.

Cultural: Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter. Consider soilless culture as an alternative to soil in severe recurring cases. Avoid rotating tomatoes with lettuce or cucumbers when *S. sclerotiorum* is present.

Resistant Cultivars: None.

Biological: *Streptomyces griseoviridis* Strain K61 (COM) WP; *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP. Limitations: As per label.

Chemical: None.

References:

1. BCMAFF. 1996-97 Greenhouse Vegetable Production Guide.

2. Nielsen, C.J. *et al*. 2006. Efficacy of biosurfactants in the management of *Phytophthora capsici* on pepper in recirculating hydroponic systems. Can. J. Plant Path. 28: 450-460.

TOMATO SPOTTED WILT

Tomato spotted wilt virus

Cultural: Use disease-free propagation stock. Control weeds in and around the greenhouse as they can harbour TSWV. The use of 'double doors' in greenhouses may be useful in preventing the entry of thrips. Use indicator plants. Petunias such as 'Calypso', 'Summer Madness' and 'Super Blue Magic' are good indicator plants for INSV and TSWV infections.

Resistant Cultivars: None.

Chemical: None.

Notes: Use recommended methods to control the western flower thrips vector of TSWV (2).

References:

1. Allen, W.R. and Broadbent, A.B. 1986. Transmission of tomato spotted wilt virus in Ontario greenhouses by *Frankliniella occidentalis*. Can. J. Plant Pathol. 8: 33-38.

2. Best, R.J. 1968. Tomato spotted wilt virus *in* Advances in Virus Research. Smith, K.M. and Lauffer, K.M. (eds.) Vol. 13: 65-145. Academic Press, New York, New York.

3. Bitterlich, I. and MacDonald, L. 1993. The prevalence of tomato spotted wilt virus in weeds and crops in Southwestern B.C. Can. Plant Dis. Surv. 73(2): 137-142.

4. Cho, J.J. *et al.* 1989. A multidisciplinary approach to management of tomato spotted wilt virus in Hawaii. Plant Dis. 73: 375-383.

5. MacDonald, L. 1988. Tomato spotted wilt virus now in B.C. Pest Control Notes, B.C. Ministry of Agriculture and Fisheries.

VIRUS DISEASES

Tobacco mosaic virus (TMV), potato virus X (PVX), cucumber mosaic virus (CMV)

Cultural: TMV - Use 1-year-old seed. Spray seed flats with skim milk the evening before pricking out. Do not smoke or handle any form of tobacco in tomato greenhouses. Dry heating of seeds at 70°C for 3 days inactivates the virus within the seed-coat (1).

PVX - Avoid handling potatoes before working in tomatoes.

CMV - Control weeds and aphids that may harbor and spread the virus.

Follow other cultural control practices outlined under 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: Use only resistant cultivars. Bruinsma 493, Dombito, Laura, Ohio CR-6, Ohio MR-13, Ohio Hybrid 7, Ontario Pink 774, Ontario Red 775, B8-864, Buffalo. Consult your seed companies.

Chemical: To destroy surface-borne TMV on tomato seed, soak seed for 20 min. in 10% trisodium phosphate. Rinse thoroughly in clean water and dry.

Notes: Inoculation of tomato seedlings with a mild strain of TMV may confer protection against severe strains (3).

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WILT

Verticillium spp., *Fusarium oxysporum* f. sp. *lycopersici*

Cultural: Rotate tomatoes with cucumbers. Follow other cultural control practices given under 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.

Resistant Cultivars: **Verticillium wilt** - Bruinsma 493, Bruinsma 732, Buffalo, Laura, Ohio CR-6, Ohio Hybrid 7, B8-864. Consult seed companies.
Fusarium wilt - Dombito (not recommended because it is highly susceptible to Fusarium crown and root rot), Laura, Buffalo, B8-864.

Biological: For Fusarium root diseases, *Streptomyces griseoviridis* Strain K61 (COM) WP and *Trichoderma harzianum* Rifai strain KRL-AG2 (COM) GR, WP are labeled and may offer some preventive disease suppression. Limitations: As per label.

Chemical: Fumigate soil (preplant) with - chloropicrin (COM) SN; methyl bromide (RES) PS, LI; dazomet (COM) GR; 1,3 dichloropropene (COM) SN; metam sodium (COM) SN. Limitations: As per label.

Notes: Methyl bromide soil fumigant does not appear to be effective against *Verticillium* (1).

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APPENDIX I. Fungicides Registered for Use Against Diseases of Greenhouse Crops in Canada.

NOTE: ***The following is a guide only. Always read the label before using a product. Check label for applicability on a specific crop.***

TABLE 1. General Fungicide Registrations for Use on Greenhouse Ornamentals

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
All crops	Damping-off	No-Damp	oxine benzoate	3.2% SN	3794, 11880
		Rootshield HC Rootshield Granules	*Trichoderma harzianum* Rifai strain KRL-AG2	1×10^7 cfu/g WP 1×10^7 cfu/g GR	27115 27116
	Damping-off, root, crown and stem rot and wilt	Mycostop Biofungicide	*Streptomyces griseoviridis* strain K61	1×10^6 cfu/g GR	26265
Bedding Plants	Alternaria leaf spot	ZeroTol	hydrogen peroxide	27% SN	29508
	Damping-off (Rhizoctonia)	Rovral WP Rovral WDG Rootshield HC Rootshield Granules Prestop (suppression only)	iprodione iprodione *Trichoderma harzianum* Rifai strain KRL-AG2 *Gliocladium catenulatum* J1446	50% WP 50% WG 1×10^7 cfu/g WP 1×10^7 cfu/g GR 2×10^8 cfu/g WP	15213 24709 27115 27116 28820
	Damping-off	No-Damp Prestop (suppression only)	oxine benzoate *Gliocladium catenulatum* J1446	3.2% SN 2×10^8 cfu/g WP	3794, 11880 28820
	Gray mold or bud rot	Decree 50 WDG Rovral WP Rovral WDG Prestop (suppression only)	fenhexamid iprodione iprodione *Gliocladium catenulatum* J1446	50% WG 50% WP 50% WG 2×10^8 cfu/g WP	26132 15213 24709 28820
	Root, stem and crown rots and damping-off	Captan 80WP Captan 80 WDG Supra Captan 80 WDG Maestro 80DF	captan captan captan captan	80% WP 80% WG 80% WG 80% WG	9582 23691 24613 26408
	Root and stem rots and damping-off (*Pythium*, *Phytophthora*)	Truban Truban Chipco Aliette Ornamental Aliette WP Aliette Ornamental Subdue MAXX Rootshield HC* Rootshield Granule* Prestop (suppression only)	etridiazole etridiazole fosetyl AL fosetyl AL fosetyl AL metalaxyl-M & S-isomer *Trichoderma harzianum* Rifai strain KRL-AG2 *Gliocladium catenulatum* J1446	25% EC 30% WP 80% WG 80% WP 80% WP 240 g/L EC 1×10^7 cfu/g WP 1×10^7 cfu/g GR 2×10^8 cfu/g WP	12222 11460 27557 24564 28585 27055 27115 27116 28820
	Damping off and root rot caused by Pythium & Rhizoctonia	Prestop (suppression only)	*Gliocladium catenulatum* J1446	2 x 10^8 cfu/g WP	28820
	Powdery mildew	Compass 50WG	trifloxystrobin	50% WG	27527
		Milstop	potassium bicarbonate	85% DU	28095
	Root rot (*Rhizoctonia*)	Compass 50WG	trifloxystrobin	50% WG	27527
	Rhizoctonia aerial blight	ZeroTol	hydrogen peroxide	27% SN	29508
	Xanthomonas leaf spot	ZeroTol	hydrogen peroxide	27% SN	29508
Bulbs	Damping-off, bulb rot	Wilson's Bulb Dust	captan + carbaryl	5% + 5% DU	14852
		Captan 80WP Captan 80 WDG Supra Captan 80 WDG Captan 50W Captan 50WP Maestro 80DF Rootshield HC Rootshield Granules	captan captan captan captan captan captan *Trichoderma harzianum* Rifai strain KRL-AG2	80% WP 80% WG 80% WG 50% WP 50% WP 80% WG 1×10^7 cfu/g WP 1×10^7 cfu/g GR	9582 23691 24613 14823 4559 26408 27115 27116
	Fusarium bulb rot	Rootshield HC	*Trichoderma harzianum* Rifai strain KRL-AG2	1×10^7 cfu/g WP	27115
	Nematodes	Formalin	formaldehyde	37 % LI	6998
	Sclerotinia bulb rot	Quintozene 75% Quintozene (Terraclor) 75WP Quintozene 75WP	quintozene quintozene quintozene	75% WP 75% WP 75% WP	11425 7251 27416
Bulbs and Corms	Bulb rot, damping off	Wilson's Bulb dust	carbaryl + captan	5% + 5% DU	14852

*Rootshield is not labeled for Phytophthora control.

TABLE 1. General Fungicide Registrations for Use on Greenhouse Ornamentals (continued)

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Foliage Plants	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX Truban Truban	metalaxyl-M & S-isomer etridiazole etridiazole	240 g/L EC 25% EC 30% WP	27055 12222 11460
	Various leafspots and blights (see label)	Daconil 2787 Flowable	chlorothalonil	40.4% SU	15724
Greenhouse ornamentals	Gray mold	Decree 50 WDG	fenhexamid	50% WG	26132
	Damping-off, root and crown rot, and wilt caused by *Fusarium*	Mycostop Biofungicide Rootshield HC Rootshield Granules	*Streptomyces griseoviridis* Strain K61 *Trichoderma harzianum* Rifai strain KRL-AG2	1×10^6 cfu/g GR 1×10^7 cfu/g WP 1×10^7 cfu/g GR	26265 27115 27116
	Damping-off, root, crown and stem rot and wilt caused by *Pythium*	Mycostop Biofungicide	*Streptomyces griseoviridis* Strain K61	1×10^6 cfu/g GR	26265
	Leafspots and blights, various (see label)	Daconil 2787 Flowable	chlorothalonil	40.4% SU	15724
	Root and stem rot and wilt caused by *Phytophthora*	Mycostop Biofungicide	*Streptomyces griseoviridis* Strain K61	1×10^6 cfu/g GR	26265
	Phytophthora and *Pythium*	Aliette WP Aliette Ornamental Chipco Aliette Ornamental	fosetyl AL fosetyl AL fosetyl AL	80% WP 80% WP 80% WP	24564 28585 27557
	Powdery mildew (various species)	Compass 50WG	trifloxystrobin	50% WG	27527
		Milstop	potassium bicarbonate	85% DU	28095
	Root rot (*Rhizoctonia*)	Compass 50WG	trifloxystrobin	50% WG	27527
Greenhouse potted ornamentals	Powdery mildew	Senator 70WP 1 Senator 70WP Senator 70WP WSB1	thiophanate-methyl thiophanate-methyl thiophanate-methyl	70% WP 70% WP 70% WP	12279 25343 27297
	Botrytis	Senator 70WP 1 Senator 70WP Senator 70WP WSB	thiophanate-methyl thiophanate-methyl thiophanate-methyl	70% WP 70% WP 70% WP	12279 25343 27297
	Leafspots	Senator 70WP 1 Senator 70WP Senator 70WP WSB1	thiophanate-methyl thiophanate-methyl thiophanate-methyl	70% WP 70% WP 70% WP	12279 25343 27297
	Stem, crown & root rots caused by Fusarium and Rhizoctonia	Senator 70WP 1 Senator 70WP Senator 70WP WSB1	thiophanate-methyl thiophanate-methyl thiophanate-methyl	70% WP 70% WP 70% WP	12279 25343 27297
	Various leafspots and blights (see label)	Daconil 2787 Flowable	chlorothalonil	40.4% SU	15724

TABLE 2. Fungicides Registered for Use on Greenhouse Ornamentals.

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
African Daisy	Powdery mildew	Milstop	potassium bicarbonate	85% DU	28095
African violet (*Saintpaulia ionantha*)	Gray mold or bud rot	Rovral WP Rovral WDG Decree 50WDG Prestop (suppression only)	iprodione iprodione fenhexamid *Gliocladium catenulatum* J1446	50% WP 50% WG 50% WG 2×10^8 cfu/g WP	15213 24709 26132 28820
	Damping off, Pythium root rot	Rootshield HC Rootshield Granules Previcur N Prestop (suppression only)	*Trichoderma harzianum* Rifai strain KRL-AG2 propamocarb hydrochloride *Gliocladium catenulatum* J1446	1×10^7 cfu/g WP 1×10^7 cfu/g GR 722 g/L 2×10^8 cfu/g WP	27115 27116 26288 28820
	Root, stem and crown rots and damping-off	Truban Rootshield HC* Rootshield Granules* Prestop (suppression only)	etridiazole *Trichoderma harzianum* Rifai strain KRL-AG2 *Gliocladium catenulatum* J1446	25% EC 1×10^7 cfu/g WP 1×10^7 cfu/g GR 2×10^8 cfu/g WP	12222 27115 27116 28820
	Root rot (*Phytophthora*)	Previcur N Prestop (suppression only)	propamocarb hydrochloride *Gliocladium catenulatum* J1446	722 g/L 2×10^8 cfu/g WP	26288 28820
	Downy mildew	Acrobat 50WP	dimethomorph	50% WP	27700

*Rootshield is not labeled for Phytophthora control.

TABLE 2. Fungicides Registered for Use on Greenhouse Ornamentals (continued)

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Ageratum	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX Truban	metalaxyl-M & S-isomer etridiazole	240 g/L EC 30% WP	27055 11460
Aglaonema	Leaf Spot	Rhapsody ASO	*Bacillus subtilis* - QST 713 strain	1×10^9 CFU/g SU	28627
Algerian Ivy	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX	metalaxyl-M & S-isomer	240 g/L EC	27055
Aloe Vera	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
Alstromeria	Gray mold (*Botrytis*)	Phyton 27	copper complex	5.5% SN	21699
Alyssum	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Truban Truban Prestop (suppression only)	etridiazole etridiazole *Gliocladium catenulatum* J1446	25% EC 30% WP 2×10^8 cfu/g WP	12222 11460 28820
	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
	Downy mildew	Acrobat 50WP	dimethomorph	50% WP	27700
	Gray mold (Botrytis)	Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820
Aptenia	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
Artemesia / Artemisia	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX	metalaxyl-M & S-isomer	240 g/L EC	27055
Aster	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX Truban	metalaxyl-M & S-isomer etridiazole	240 g/L EC 30% WP	27055 11460
	Powdery mildew	Nova 40W	myclobutanil	40% WP	22399
	Rust	Nova 40W	myclobutanil	40% WP	22399
	Botrytis flower blight	Captan 50WP	captan	50% WP	4559
Azalea (*Rhododendron* spp.)	Gray mold or bud rot	Rovral WP Rovral WDG	iprodione iprodione	50% WP 50% WG	15213 24709
	Pythium and *Phytophthora*	Aliette WDG Aliette WP Chipco Aliette Ornamental Rootshield HC* Rootshield Granules*	fosetyl-Al fosetyl-AL fosetyl-AL *Trichoderma harzianum* Rifai strain KRL-AG2	80% WG 80% WP 80% WP 1×10^7 cfu/g WP 1×10^7 cfu/g GR	24458 24564 27557 27115 27116
		Previcur N	propamocarb hydrochloride	722 g/L AS	26288
	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
	Cylindrocladium	Phyton 27	copper complex	5.5% SN	21699
	Stem rot of cuttings	Captan 50W Captan 80 WDG Folpan 50WP (Folpet) Folpan 80 WDG	captan captan folpet folpet	50% WP 80% WG 50% WP 80% WG	14823 23691 15654 27733
	Damping off/rot of cuttings	Maestro 80DF Supra Captan 80 WDG Captan 50WP	captan captan captan	80% WG 80% WG 50% WP	26408 24613 4559
	Downy mildew	Acrobat 50WP	dimethomorph	50% WP	27700
Balsam	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Truban	etridiazole	30% WP	11460
Bee Balm (*Monarda*)	Powdery mildew	Milstop Phyton 27 Rhapsody ASO	potassium bicarbonate copper complex *Bacillus subtilis* - QST 71 strain	85% DU 5.5% SN 1×10^9 CFU/g SU	28095 21699 28627

*Rootshield is not labeled for Phytophthora control.

TABLE 2. Fungicides Registered for Use on Greenhouse Ornamentals (continued)

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Begonia (*Begonia* spp.)	Gray mold or bud rot	Senator 70 WP1	thiophanate-methyl	70% WP	12279
		Senator 70WP	thiophanate-methyl	70% WP	25343
		Senator 70WP WSB1	thiophanate-methyl	70% WP	27297
		Rovral WP	iprodione	50% WP	15213
		Rovral WDG	iprodione	50% WG	24709
	Powdery mildew	Senator 70 WP1	thiophanate-methyl	70% WP	12279
		Senator 70WP	thiophanate-methyl	70% WP	25343
		Senator 70WP WSB1	thiophanate-methyl	70% WP	27297
		Phyton 27	copper complex	5.5% SN	21699
		Compass 50WG	trifloxystrobin	50% WG	27527
	Root, stem and crown rots and damping-off , *Pythium* and *Phytophthora*	Truban	etridiazole	30% WP	11460
		Aliette WP	fosetyl AL	80% WP	24564
		Chipco Aliette Ornamental	fosetyl AL	80% WG	27557
		Aliette WDG	fosetyl AL	80% WG	24458
		Aliette Ornamental	fosetyl AL	80% WP	28585
		Subdue MAXX	metalaxyl-M & S-isomer	240 g/L EC	27055
		Rootshield HC*	*Trichoderma harzianum* Rifai strain KRL-AG2	1×10^7 cfu/g WP	27115
		Rootshield Granules*		1×10^7 cfu/g GR	27116
	Root, stem and crown rots and damping-off	Captan 80WP	captan	80% WP	9582
		Captan 80 WDG	captan	80% WG	23691
		Supra Captan 80 WDG	captan	80% WG	24613
		Maestro 80DF	captan	80% WG	26408
		No-Damp	oxine benzoate	2.5% SN	3794
		Senator 70 WP1	thiophanate-methyl	70% WP	12279
		Senator 70WP	thiophanate-methyl	70% WP	25343
		Senator 70WP WSB1	thiophanate-methyl	70% WP	27297
		Rootshield HC	*Trichoderma harzianum* Rifai strain KRL-AG2	1×10^7 cfu/g WP	27115
		Rootshield Granules		1×10^7 cfu/g GR	27116
	Stem rot (*Rhizoctonia*)	Senator 70 WP1	thiophanate-methyl	70% WP	12279
		Senator 70WP	thiophante-methyl	70% WP	25343
		Senator 70WP WSB1	thiophanate-methyl	70% WP	27297
	Bulb rot, damping off	Wilson's Bulb dust	captan + carbaryl	5% + 5% DU	14852
		Captan 50WP	captan	50% WP	4559
		Captan 50W	captan	50% WP	14823
		Captan 80WDG	captan	80% WG	23691
		Supra Captan 80WDG	captan	80% WG	24613
	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
	Downy mildew	Acrobat 50WP	dimethomorph	50% WP	27700
Blue Daze	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
Brachycome	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
Caladium	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX	metalaxyl-M & S-isomer	240 g/L EC	27055
	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
Calendula	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Truban	etridiazole	25% EC	12222
		Truban	etridiazole	30% WP	11460
Carnation (*Dianthus* sp.)	Alternaria leaf spot & branch rot	Daconil 2787 Flowable	chlorothalonil	40.4% SU	15724
		Daconil Ultrex	chlorothalonil	82.5% WG	28354
	Heterosporium echinulatum	Phyton 27	copper complex	5.5% SN	21699
	Leaf spot	Captan 50WP	captan	50% WP	4559
	Gray mold or bud rot	Daconil 2787 Flowable	chlorothalonil	40.4% SU	15724
		Daconil Ultrex	chlorothalonil	82.5% WG	28354
		Senator 70 WP1	thiophanate-methyl	70% WP	12279
		Senator 75WP	thiophanate-methyl	70% WP	25343
		Senator 70WP WSB1	thiophanate-methyl	70% WP	27297
	Root, stem and crown rots and damping-off	Captan 80WP	captan	80% WP	9582
		Captan 80 WDG	captan	80% WG	23691
		Supra Captan 80 WDG	captan	80% WG	24613
		Maestro 80DF	captan	80% WG	26408
		No-Damp	oxine benzoate	2.5% SN	3794
		Senator 70 WP1	thiophanate-methyl	70% WP	12279
		Senator 70WP	thiophanate-methyl	70% WP	25343
		Senator 70WP WSB1	thiophanate-methyl	70% WP	27297
		Rootshield HC	*Trichoderma harzianum* Rifai strain KRL-AG2	1×10^7 cfu/g WP	27115
		Rootshield Granules		1×10^7 cfu/g GR	27116

*Rootshield is not labeled for Phytophthora control.

TABLE 2. Fungicides Registered for Use on Greenhouse Ornamentals (continued)

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Carnation (continued)	Stem rot (*Rhizoctonia*)	Senator 70 WP1	thiophanate-methyl	70% WP	12279
		Senator 70WP	thiophanate-methyl	70% WP	25343
		Senator 70WP WSB1	thiophanate-methyl	70% WP	27297
	Carnation rust	HRC Liquid	oxycarboxin	5% LI	10878
	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
	Downy mildew	Acrobat 50WP	dimethomorph	50% WP	27700
	Damping off/rot of cuttings	Maestro 80DF	captan	80% WG	26408
		Supra Captan 80 WDG	captan	80% WG	24613
		Captan 50WP	captan	50% WP	4559
	Stem rot of cuttings	Captan 50W	captan	50% WP	14823
		Captan 80 WDG	captan	80% WG	23691
	Damping off & root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX	metalaxyl-M & S-isomer	240 g/L EC	27055
		Truban	etridiazole	30% WP	11460
Cast Iron Plant	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
Catnip	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
Celosia	Damping-off	Rovral WP	iprodione	50% WP	15213
		Rovral WDG	iprodione	50% WG	24709
		Rootshield HC	*Trichoderma harzianum* Rifai strain KRL-AG2	1×10^7 cfu/g WP	27115
		Rootshield Granules		1×10^7 cfu/g GR	27116
	Pythium, *Phytophthora*	Aliette WDG	fosetyl-AL	80% WG	24458
		Aliette WP	fosetyl AL	80% WP	24564
		Chipco Aliette Ornamental	fosetyl AL	80% WG	27557
		Aliette Ornamental	fosetyl AL	80% WP	28585
		Rootshield HC*	*Trichoderma harzianum* Rifai strain KRL-AG2	1×10^7 cfu/g WP	27115
		Rootshield Granules*		1×10^7 cfu/g GR	27116
	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Truban	etridiazole	25% EC	12222
		Truban	etridiazole	30% WP	11460
	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
	Sclerotinia sclerotiorum	Contans WG	*Coniothyrium minitans* CON/M/91-08	1×10^9 cfu/g 5.3% WG	29066
Chrysanthemum (*Chrysanthemum* spp.)	Gray mold or bud rot Botrytis flower blight	Botran 75W	dicloran	75% WP	8772
		Daconil 2787 Flowable	chlorothalonil	40.4% SU	15724
		Daconil Ultrex	chlorothalonil	82.5% WG	28354
		Rovral WP	iprodione	50% WP	15213
		Rovral WDG	iprodione	50% WG	24709
		Senator 70 WP1	thiophanate-methyl	70% WP	12279
		Senator 70WP	thiophanate-methyl	70% WP	25343
		Senator 70WP WSB1	thiophanate-methy	70% WP	27297
		Captan 50WP	captan	50% WP	4559
	Powdery mildew	Nova 40W	myclobutanil	40% WP	22399
		Senator 70 WP1	thiophanate-methyl	70% WP	12279
		Senator 70WP	thiophanate-methyl	70% WP	25343
		Senator 70WP WSB1	thiophanate-methy.	70% WP	27297
	Root, stem and crown rots and damping-off	Captan 80WP	captan	80% WP	9582
		Captan 80 WDG	captan	80% WG	23691
		Supra Captan 80 WDG	captan	80% WG	24613
		Maestro 80DF	captan	80% WG	26408
		No-Damp	oxine benzoate	2.5% SN	3794
		Senator 70 WP1	thiophanate-methyl	70% WP	12279,
		Senator 70WP	thiophanate-methyl	70% WP	25343
		Senator 70WP WSB1	thiophanate-methyl	70% WP	27297
		Rootshield HC	*Trichoderma harzianum* Rifai strain KRL-AG2	1×10^7 cfu/g WP	27115
		Rootshield Granules		1×10^7 cfu/g GR	27116
		Compass 50WG	trifloxystrobin	50% WG	27527
	Root, stem and crown rots and damping-off, *Pythium* and *Phytophthora*	Subdue MAXX	metalaxyl-M & S-isomer	240 g/L EC	27055
		Truban	etridiazole	25% EC	12222
		Truban	etridiazole	30% EC	11460
		Rootshield HC*	*Trichoderma harzianum* Rifai strain KRL-AG2	1×10^7 cfu/g WP	27115
		Rootshield Granules*		1×10^7 cfu/g GR	27116

*Rootshield is not labeled for Phytophthora control.

TABLE 2. Fungicides Registered for Use on Greenhouse Ornamentals (continued)

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Chrysanthemum (*Chrysanthemum* spp.) (continued)	Stem rot (*Rhizoctonia*)	Senator 70 WP1 Senator 70WP Senator 70WP WSB1	thiophanate-methyl thiophanate-methyl thiophanate-methyl	70% WP 70% WP 70% WP	12279, 25343 27297
	Damping off/rot of cuttings	Captan 50WP Maestro 80DF Supra Captan 80 WDG	captan captan captan	50% WP 80% WG 80% WG	4559 26408 24613
	Stem rot of cuttings	Captan 50W Captan 80 WDG	captan captan	50% WP 80% WG	14823 23691
	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
	Rust	Nova 40W	myclobutanil	40% WP	22399
	Mycosphaerella ray blight	Daconil 2787 Flowable Daconil Ultrex	chlorothalonil chlorothalonil	40.4% SU 82.5% WG	15724 28354
	Septoria leafspot	Daconil Ultrex Daconil 2787 Flowable	chlorothalonil chlorothalonil	82.5% WG 40.4% SU	28354 15724
		Captan 50WP	captan	50% WP	4559
	Downy mildew	Acrobat 50WP	dimethomorph	50% WP	27700
Chrysanthemum, cut	Powdery mildew, rust	Nova 40W	myclobutanil	40% WP	22399
	Sclerotinia sclerotiorum	Contans WG	*Coniothyrium minitans* CON/M/91-08	1×10^9 cfu/g 5.3%WG	29066
Cineraria (*Senecio cruentus*)	Gray mold or bud rot	Rovral WP Rovral WDG	iprodione iprodione	50% WP 50% WG	15213 24709
Coleus (*Coleus* spp.)	Root, stem and crown rots and damping-off	Captan 80WP Captan 80 WDG Supra Captan 80 WDG Maestro 80DF No-Damp No-Damp Rootshield HC Rootshield Granules	captan captan captan captan oxine benzoate oxine benzoate *Trichoderma harzianum* Rifai strain KRL-AG2	80% WP 80% WG 80% WG 80% WG 3.2% SN 3.2% SN 1×10^7 cfu/g WP 1×10^7 cfu/g GR	9582 23691 24613 26408 11880 3794 27115 27116
	Root, stem and crown rots and damping-off , *Pythium* and *Phytophthora*	Subdue MAXX Truban Rootshield HC* Rootshield Granules*	metalaxyl-M etridiazole *Trichoderma harzianum* Rifai strain KRL-AG2	240 g/L EC 30% WP 1×10^7 cfu/g WP 1×10^7 cfu/g GR	27055 11460 27115 27116
	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
Cosmos	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
	Powdery mildew	Compass 50WG	trifloxystrobin	50% WG	27527
Cyclamen (*Cyclamen indicum*)	Gray mold or bud rot	Rovral WP Rovral WDG	iprodione iprodione	50% WP 50% WG	15213 24709
	Gray mold	Phyton 27	copper complex	5.5% SN	21699
	Erwinia soft rot	Phyton 27	copper complex	5.5% SN	21699
	Root Rot (*Pythium* & *Phytophthora*)	Previcur N	propamocarb hydrochloride	722 g/L AS	26288
Daffodil	Damping off / bulb rot	Captan 50WP Captan 50W Captan 80WDG Supra Captan 80WDG	captan captan captan captan	50% WP 50% WP 80% WG 80% WG	4559 14823 23691 24613
	Nematodes (bulb dip)	Formalin	formaldehyde	37% SN	6998
	Sclerotinia bulb rot	Quintozene 75% Quintozene (Terraclor) 75WP Quintozene 75WP	quintozene quintozene quintozene	75% WP 75% WP 75% WP	11425 7251 27416
Dahlia	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Truban Truban	etridiazole etridiazole	25% EC 30% WP	12222 11460
	Bulb rot, damping off Botrytis flower blight	Wilson's Bulb dust Captan 50W Captan 50WP Captan 80WP Captan 80 WDG Supra Captan 80 WDG Maestro 80DF	carbaryl + captan captan captan captan captan captan captan	5% + 5% DU 50% WP 50% WP 80% WP 80% WG 80% WG 80% WG	14852 14823 4559 9582 23691 24613 26408
	Sclerotinia sclerotiorum	Contans WG	*Coniothyrium minitans* CON/M/91-08	1×10^9 cfu/g 5.3%WG	29066

*Rootshield is not labeled for Phytophthora control.

TABLE 2. Fungicides Registered for Use on Greenhouse Ornamentals (continued)

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Daisy	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
	Mycosphaerella ray blight	Daconil 2787 Flowable Daconil Ultrex	chlorothalonil chlorothalonil	40.4% SU 82.5% WG	15724 28354
	Septoria leafspot	Daconil 2787 Flowable Daconil Ultrex	chlorothalonil chlorothalonil	40.4% SU 82.5% WG	15724 28354
	Powdery mildew	Milstop	potassium carbonate	85% LI	28095
	Botrytis flower blight (Grey mould)	Daconil Ultrex	chlorothalonil	82.5% WG	28354
Daisy (Shasta)	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX	metalaxyl-M & S-isomer	240 g/L EC	27055
Day Lily	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
	Leaf spot	Rhapsody ASO	*Bacillus subtilis* - QST 713 strain	1×10^9 CFU/g SU	28627
Delphinium	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
	Sclerotinia sclerotiorum	Contans WG	*Coniothyrium minitans* CON/M/91-08	1×10^9 cfu/g 5.3%WG	29066
	Leaf spot	Rhapsody ASO	*Bacillus subtilis* - QST 713 strain	1×10^9 CFU/g SU	28627
Dusty Miller	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
	Alternaria leaf spot	Phyton 27	copper complex	5.5% SN	21699
	Downy mildew	Acrobat 50WP	dimethomorph	50% WP	27700
Dwarf Ivy	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
Easter Lily	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Truban	etridiazole	30% EC	11460
English Ivy	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX	metalaxyl-M & S-isomer	240 g/L EC	27055
	Xanthomonas leaf spot (suppression)	ZeroTol	hydrogen peroxide	27% SN	29508
Foliage Plants	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX Truban Truban	metalaxyl-M & S-isomer etridiazole etridiazole	240 g/L EC 25% EC 30% WP	27055 12222 11460
	Various leafspots and Blights (see label)	Daconil 2787 Flowable Daconil Ultrex	chlorothalonil chlorothalonil	40.4% SU 82.5% WG	15724 28354
Foxglove (*Digitalis* spp.)	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX Truban	metalaxyl-M & S-isomer etridiazole	240 g/L EC 30% WP	27055 11460
Freesia	Gray mold (*Botrytis*)	Phyton 27	copper complex	5.5% SN	21699
Fuchsia (*Fuchsia* hybrids)	Gray mold or bud rot	Rovral WP Rovral WDG Phyton 27	iprodione iprodione copper complex	50% WP 50% WG 5.5% SN	15213 24709 21699
Gaillardia	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX	metalaxyl-M & S-isomer	240 g/L EC	27055

*Rootshield is not labeled for Phytophthora control.

TABLE 2. Fungicides Registered for Use on Greenhouse Ornamentals (continued)

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Geranium (*Pelargonium* spp.)	Blackleg	No-Damp	oxine benzoate	3.2% SN	11880
		No-Damp	oxine benzoate	3.2% SN	3794
	Downy mildew	Acrobat 50WP	dimethomorph	50% WP	27700
	Gray mold or bud rot	Botran 75W	dicloran	75% WP	8772
		Daconil 2787 Flowable	chlorothalonil	40.4% SU	15724
		Daconil Ultrex	chlorothalonil	82.5% WG	28354
		Rovral WP	iprodione	50% WP	15213
		Rovral WDG	iprodione	50% WG	24709
	Gray mold / Botrytis leaf blight	Phyton 27	copper complex	5.5% SN	21699
		Decree 50WDG	fenhexamid	50% WG	26132
		Rhapsody ASO	*Bacillus subtilis* – QST 713 strain	1×10^9 CFU/g SU	28627
		Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820
	Powdery mildew	Nova 40W	myclobutanil	40% WP	22399
		Compass 50WG	trifloxystrobin	50% WG	27527
	Root, stem and crown rots and damping-off	Captan 80 WDG	captan	80% WG	23691
		Supra Captan 80 WDG	captan	80% WG	24613
		Maestro 80DF	captan	80% WG	26408
		No-Damp	oxine benzoate	3.2% SN	11880
		No-Damp	oxine benzoate	3.2% SN	3794
		Rootshield HC	*Trichoderma harzianum* Rifai strain KRL-AG2	1×10^7 cfu/g WP	27115
		Rootshield Granules		1×10^7 cfu/g GR	27116
		Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820
	Root, stem and crown rots and damping-off , *Pythium* and *Phytophthora*	Aliette WDG	fosetyl-Al	80% WG	24458
		Aliette WP	fosetyl AL	80% WP	24564
		Chipco Aliette Ornamental	fosetyl AL	80% WG	27557
		Aliette Ornamental	fosetyl AL	80% WP	28585
		Subdue MAXX	metalaxyl-M & S-isomer	240 g/L EC	27055
		Truban	etridiazole	25% EC	12222
		Rootshield HC*	*Trichoderma harzianum* Rifai strain KRL-AG2	1×10^7 cfu/g WP	27115
		Rootshield Granules*		1×10^7 cfu/g GR	27116
		Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820
		Previcur N	propamocarb hydrochloride	722 g/L AS	26288
	Rust	Nova 40W	myclobutanil	40% WP	22399
		Daconil 2787 Flowable	chlorothalonil	40.4% SU	15724
		Daconil Ultrex	chlorothalonil	82.5% WG	28354
	Xanthomonas campestris	Phyton 27	copper complex	5.5% SN	21699
		Rhapsody ASO	*Bacillus subtilis* – QST 713 strain	1×10^9 CFU/g SU	28627
Gerbera	Gray mold	Phyton 27	copper complex	5.5% SN	21699
	Downy mildew	Acrobat 50WP	dimethomorph	50% WP	27700
	Powdery mildew	Nova 40W	myclobutanil	40% WP	22399
		Actinovate SP	*Streptomyces lydicus* – strain WYEC 108	1.0×10^7 CFU/g SP	28672
	Root Rot (*Pythium* & *Phytophthora*)	Previcur N	propamocarb hydrochloride	722 g/L AS	26288
Gladiolus	Curvularia leaf/flower spot	Daconil Ultrex	chlorothalonil	82.5% WG	28354
		Daconil 2787 Flowable	chlorothalonil	40.4% SU	15724
	Botrytis leaf/flower spot	Daconil Ultrex	chlorothalonil	82.5% WG	28354
		Daconil 2787 Flowable	chlorothalonil	40.4% SU	15724
	Damping off / Bulb Rot	Captan 50WP	captan	50% WP	4559
		Captan 50W	captan	50% WP	14823
		Captan 80WDG	captan	80% WG	23691
		Supra Captan 80WDG	captan	80% WG	24613
	Nematodes (bulb dip)	Formalin	formaldehyde	37% SN	6998

*Rootshield is not labeled for Phytophthora control.

TABLE 2. Fungicides Registered for Use on Greenhouse Ornamentals (continued)

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Gloxinia (*Sinningia speciosa*)	Gray mold or bud rot	Rovral WP Rovral WDG	iprodione iprodione	50% WP 50% WG	15213 24709
	Root, stem and crown rots and damping-off , *Pythium* and *Phytophthora*	Subdue MAXX Truban Rootshield HC* Rootshield Granules*	metalaxyl-M & S-isomer etridiazole *Trichoderma harzianum* Rifai strain KRL-AG2	240 g/L EC 25% EC 1×10^7 cfu/g WP 1×10^7 cfu/g GR	27055 12222 27115 27116
	Root, stem and crown rots and damping-off	Captan 80WP Captan 80 WDG Supra Captan 80 WDG Maestro 80DF No-Damp No-Damp Rootshield HC Rootshield Granules	captan captan captan captan oxine benzoate oxine benzoate *Trichoderma harzianum* Rifai strain KRL-AG2	80% WP 80% WG 80% WG 80% WG 3.2% SN 3.2% SN 1×10^7 cfu/g WP 1×10^7 cfu/g GR	9582 23691 24613 26408 11880 3794 27115 27116
Hens & Chickens (flowering)	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
Hibiscus (*Hibiscus syriacus*)	Gray mold	Phyton 27	copper complex	5.5% SN	21699
Hollyhock	Rust	Daconil 2787 Flowable Daconil Ultrex	chlorothalonil chlorothalonil	40.4% SU 82.5% WG	15724 28354
Hosta	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
Hydrangea (*Hydrangea macrophylla*)	Gray mold or bud rot	Botran 75W Senator 70 WP1 Senator 70WP Senator 70WP WSB1	dicloran thiophanate-methyl thiophanate-methyl thiophanate-methyl	75% WP 70% WP 70% WP 70% WP	8772 12279 25343 27297
	Root, stem and crown rots and damping-off, *Pythium* and *Phytophthora*	Truban Rootshield HC* Rootshield Granules*	etridiazole *Trichoderma harzianum* Rifai strain KRL-AG2	25% EC 1×10^7 cfu/g WP 1×10^7 cfu/g GR	12222 27115 27116
	Root, stem and crown rots and damping-off	Captan 80WP Captan 80 WDG Supra Captan 80 WDG Maestro 80DF No-Damp No-Damp Rootshield HC Rootshield Granules	captan captan captan captan oxine benzoate oxine benzoate *Trichoderma harzianum* Rifai strain KRL-AG2	80% WP 80% WG 80% WG 80% WG 3.2% SN 3.2% SN 1×10^7 cfu/g WP 1×10^7 cfu/g GR	9582 23691 24613 26408 11880 3794 27115 27116
	Powdery mildew	Milstop Phyton 27	potassium bicarbonate copper complex	85% DU 5.5% SN	28095 21699
	Cercospora and Septoria leafspots	Daconil 2787 Flowable** Daconil Ultrex**	chlorothalonil chlorothalonil	40.4% SU 82.5% WG	15724 28354
	Rust	Daconil 2787 Flowable** Daconil Ultrex**	chlorothalonil chlorothalonil	40.4% SU 82.5% WG	15724 28354
Hypoestes	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
Impatiens	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX Truban	metalaxyl-M & S-isomer etridiazole	240 g/L EC 30% WP	27055 11460
	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
	Botrytis	Rovral WP Rovral WDG	iprodione iprodione	50% WP 50% WG	15213 24709
	Pythium & *Phytophthora*	Aliette WP Aliette WDG Chipco Aliette Ornamental Aliette Ornamental	fosetyl AL fosetyl AL fosetyl AL fosetyl AL	80% WP 80% WG 80% WG 80% WP	24564 24458 27557 28585
	Downy mildew	Acrobat 50WP	dimethomorph	50% WP	27700
	Powdery mildew	Pristine WG	boscalid / pyraclostrobin	25.2% / 12.8% WG	27985

*Rootshield is not labeled for Phytophthora control.

** Hydrangea – foliage only

TABLE 2. Fungicides Registered for Use on Greenhouse Ornamentals (continued)

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Iris (African/Siberian)	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
	Botrytis blossom blight	Daconil 2787 Flowable Daconil Ultrex	chlorothalonil chlorothalonil	40.4% SU 82.5% WG	15724 28354
	Didymellina leafspot	Daconil 2787 Flowable Daconil Ultrex	chlorothalonil chlorothalonil	40.4% SU 82.5% WG	15724 28354
	Bulb rot, damping off	Captan 80WP Captan 80 WDG Supra Captan 80 WDG Captan 50W Captan 50WP Maestro 80DF Wilson's Bulb dust	captan captan captan captan captan captan carbaryl + captan	80% WP 80% WG 80% WG 50% WP 50% WP 80% WG 5% + 5% DU	9582 23691 24613 15823 4559 26408 14852
	Bulb Rot (Sclerotinia)	Quintozene (Terraclor) 75WP Quintozene 75WP Quintozene 75% WP	quintozene quintozene quintozene	75% WP 75% WP 75% WP	7251 27416 11425
	Nematodes (bulb dip)	Formalin	formaldehyde	37% SN	6998
Kalanchoe	Gray mold	Phyton 27 Rovral WP Rovral WDG	copper complex iprodione iprodione	5.5% SN 50% WP 50% WG	21699 15213 24709
Leatherhead Fern	Anthracnose	Rhapsody ASO	*Bacillus subtilis* - QST 713 strain	1×10^9 CFU/g SU	28627
Lily (*Lilium* spp.)	Gray mold or bud rot	Daconil 2787 Flowable Daconil Ultrex	chlorothalonil chlorothalonil	40.4% SU 82.5% WG	15724 28354
	Sclerotinia sclerotiorum	Contans WG	*Coniothyrium minitans* CON/M/91-08	1×10^9 cfu/g 5.3% WG	29066
Liriope	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
Lisianthus	*Sclerotinia sclerotiorum*	Contans WG	*Coniothyrium minitans* CON/M/91-08	1×10^9 cfu/g 5.3%WG	29066
Marigold	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX Truban Truban Prestop (suppression only)	metalaxyl-M & S-isomer etridiazole etridiazole *Gliocladium catenulatum* J1446	240 g/L EC 25% EC 30% WP 2×10^8 cfu/g WP	27055 12222 11460 28820
	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
	Grey mold (*Botrytis*)	Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820
Moonflower	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
New Guinea impatiens	Gray mold	Phyton 27	copper complex	5.5% SN	21699
	Powdery mildew	Phyton 27	copper complex	5.5% SN	21699
	Pythium and *Phytophthora*	Aliette WDG Aliette WP Chipco Aliette Ornamental Aliette Ornamental Rootshield HC* Rootshield Granules*	fosetyl-Al fosetyl AL fosetyl AL fosetyl AL *Trichoderma harzianum* Rifai strain KRL-AG2	80% WG 80% WP 80% WG 80% WP 1×10^7 cfu/g WP 1×10^7 cfu/g GR	24458 24564 27557 28585 27115 27116
	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
Orchid	Gray mold	Phyton 27	copper complex	5.5% SN	21699
Pansy	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX Truban Truban Prestop (suppression only)	metalaxyl-M & S-isomer etridiazole etridiazole *Gliocladium catenulatum* J1446	240 g/L EC 25% EC 30% WP 2×10^8 cfu/g WP	27055 12222 11460 28820
	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
	Downy mildew	Acrobat 50WP	dimethomorph	50% WP	27700
	Gray mold (Botrytis)	Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820

* Rootshield is not labeled for Phytophthora control.

TABLE 2. Fungicides Registered for Use on Greenhouse Ornamentals (continued)

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Petunia	Gray mold	Daconil 2787 Flowable	chlorothalonil	40.4% SU	15724
		Daconil Ultrex	chlorothalonil	82.5% WG	28354
		Decree 50WDG	fenhexamid	50% WG	26132
		Rhapsody ASO	*Bacillus subtilis* – QST 713 strain	1×10^9 CFU/g SU	28627
		Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820
	Pythium and *Phytophthora*	Aliette WDG	fosetyl-Al	80% WG	24458
		Aliette WP	fosetyl AL	80% WP	24564
		Chipco Aliette Ornamental	fosetyl AL	80% WG	27557
		Aliette Ornamental	fosetyl AL	80% WP	28585
		Rootshield HC*	*Trichoderma harzianum* Rifai strain KRL-AG2	1×10^7 cfu/g WP	27115
		Rootshield Granules*		1×10^7 cfu/g GR	27116
		Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820
	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX	metalaxyl-M & S-isomer	240 g/L EC	27055
		Truban	etridiazole	25% EC	12222
		Truban	etridiazole	30% WP	11460
		Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820
	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
	Phytophthora blight (foliar phase only)	Daconil 2787 Flowable	chlorothalonil	40.4% SU	15724
		Daconil Ultrex	chlorothalonil	82.5% WG	28354
	Powdery mildew	Pristine WG	boscalid / pyraclostrobin	25.2% / 12.8% WG	27985
Phlox	Powdery mildew	Milstop	potassium bicarbonate	85% DU	28095
		Phyton 27	copper complex	5.5% SN	21699
		Rhapsody ASO	*Bacillus subtilis* – QST 713 strain	1×10^9 CFU/g SU	28627
	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX	metalaxyl-M & S-isomer	240 g/L EC	27055
	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
	Downy mildew	Acrobat 50WP	dimethomorph	50% WP	27700
Photinia	Powdery mildew	Compass 50WG	trifloxystrobin	50% WG	27527
Pinks (Dianthus)	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX	metalaxyl-M & S-isomer	240 g/L EC	27055
		Truban	etridiazole	25% EC	12222
		Truban	etridiazole	30% WP	11460
	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
	Heterosporium echinulatum	Phyton 27	copper complex	5.5% SN	21699
	Downy mildew	Acrobat 50WP	dimethomorph	50% WP	27700
Poinsettia (*Euphorbia pulcherrima*)	Gray mold or bud rot	Rovral WP	iprodione	50% WP	15213
		Rovral WDG	iprodione	50% WG	24709
		Senator 70 WP1	thiophanate-methyl	70% WP	12279
		Senator 70WP	thiophanate-methyl	70% WP	25343
		Senator 70WP WSB1	thiophanate-methyl	70% WP	27297
	Gray mold / Botrytis blight	Phyton 27	copper complex	5.5% SN	21699
		Decree 50WDG	fenhexamid	50% WG	26132
		Rhapsody ASO	*Bacillus subtilis* – QST 713 strain	1×10^9 CFU/g SU	28627
		Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820
	Powdery mildew	Nova 40W	myclobutanil	40% WP	22399
		Phyton 27	copper complex	5.5% SN	21699
		Milstop	potassium bicarbonate	85% DU	28095
		Rhapsody ASO	*Bacillus subtilis* – QST 713 strain	1×10^9 CFU/g SU	28627
		Compass 50WG	trifloxystrobin	50% WG	27527

* Rootshield is not labeled for Phytophthora control.

TABLE 2. Fungicides Registered for Use on Greenhouse Ornamentals (continued)

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Poinsettia (*Euphorbia pulcherrima*) (continued)	Root, stem and crown rots and damping-off , *Pythium* and *Phytophthora*	Truban	etridiazole	30% EC	11460
		Rootshield HC*	*Trichoderma harzianum*	1×10^7 cfu/g WP	27115
		Rootshield Granules*	Rifai strain KRL-AG2	1×10^7 cfu/g GR	27116
		Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820
		Previcur N	Propamocarb hydrochloride	722 g/L AS	26288
	Rhizoctonia root rot	Phyton 27	copper complex	5.5% SN	21699
		Compass 50WG	trifloxystrobin	50% WG	27527
	Scab	Phyton 27	copper complex	5.5% SN	21699
	Pythium root rot	Folpan 50 WP (Folpet)	folpet	50% WP	15654
		Folpan 80 WDG	folpet	80% WG	27733
		Previcur N	propamocarb hydrochloride	722 g/L AS	26288
	Erwinia soft rot (of cuttings)	Phyton 27	copper complex	5.5% SN	21699
Portulaca	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Truban	etridiazole	30% WP	11460
Primula	Gray mold	Phyton 27	copper complex	5.5% SN	21699
		Rovral WP	iprodione	500 g/kg WP	15213
		Rovral WDG	iprodione	500 g/kg WG	24709
	Downy mildew	Acrobat 50WP	dimethomorph	50% WP	27700
Primrose (*Primula* spp.)	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX	metalaxyl-M & S-isomer	240 g/L EC	27055
Prostrate Rosemary	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX	metalaxyl-M & S-isomer	240g/L EC	27055
Rabbit's Foot Fern	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
Rose (*Rosa* spp.)	Black spot	Daconil 2787 Flowable	chlorothalonil	40.4% SU	15724
		Daconil Ultrex	chlorothalonil	82.5% WG	28354
		Botran 75W	dicloran	75% WP	8772
		Senator 70WP 1	thiophanate-methyl	70% WP	12279
		Senator 70WP	thiophanate-methyl	70% WP	25343
		Senator 70WP WSB1	thiophanate-methyl	70% WP	27297
		Rhapsody ASO	*Bacillus subtilis* – QST 713 strain	1×10^9 CFU/g SU	28627
		Captan 50WP	captan	50% WP	4559
	Gray mold or bud rot Botrytis flower blight	Daconil 2787 Flowable	chlorothalonil	40.4% SU	15724
		Daconil Ultrex	chlorothalonil	82.5% WG	28354
		Botran 75W	dicloran	75% WP	8772
		Senator 70 WP 1	thiophanate-methyl	70% WP	12279
		Senator 70WP	thiophanate-methyl	70% WP	25343
		Senator 70WP WSB1	thiophanate-methyl	70% WP	27297
		Captan 50WP	captan	50% WP	4559
	Gray mold	Phyton 27	copper complex	5.5% SN	21699
		Decree 50WDG	fenhexamid	50% WG	26132
	Powdery mildew	Phyton 27	copper complex	5.5% WP	21699
		Meltatox	dodemorph-acetate	384g/L EC	11798
		Nova 40W	myclobutanil	40% WP	22399
		Rhapsody ASO	*Bacillus subtilis* – QST 713 strain	1×10^9 CFU/g SU	28627
		Senator 70 WP 1	thiophanate-methyl	70% WP	12279
		Senator 70WP	thiophanate-methyl	70% WP	25343
		Senator 70WP WSB1	thiophanate-methyl	70% WP	27297
		Sporodex L	*Pseudozyma flocculosa*	1.3% SU	27161
		Compass 50WG	trifloxystrobin	50% WG	27527
	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527

* Rootshield is not labeled for Phytophthora control.

TABLE 2. Fungicides Registered for Use on Greenhouse Ornamentals (continued)

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Rose (*Rosa* spp.) (continued)	Damping-off & fungus root diseases	Captan 50WP Captan 50WP Captan 80WP Maestro 80DF Supra Captan 80 WDG	captan captan captan captan captan	50% WP 50% WP 80% WP 80% WG 80% WG	4559 14823 9582 26408 24613
	Downy mildew	Acrobat 50WP	dimethomorph	50% WP	27700
	Root Rot (*Pythium* & *Phytophthora*)	Previcur N	propamocarb hydrochloride	722 g/L AS	26288
Salvia	Damping-off	Rovral WP Rovral WDG	iprodione iprodione	50% WP 50% WG	15213 24709
	Powdery mildew	Compass 50WG	trifloxystrobin	50% WG	27527
	Gray mold (Botrytis)	Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820
	Pythium and *Phytophthora*	Aliette WDG Aliette WP Chipco Aliette Ornamental Aliette Ornamental Rootshield HC* Rootshield Granules* Prestop (suppression only)	fosetyl-Al fosetyl AL fosetyl AL fosetyl AL *Trichoderma harzianum* Rifai strain KRL-AG2 *Gliocladium catenulatum* J1446	80% WG 80% WP 80% WG 80% WP 1×10^7 cfu/g WP 1×10^7 cfu/g GR 2×10^8 cfu/g WP	24458 24564 27557 28585 27115 27116 28820
	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX Truban Truban Prestop (suppression only)	metalaxyl-M & S-isomer etridiazole etridiazole *Gliocladium catenulatum* J1446	240 g/L EC 25% EC 30% WP 2×10^8 cfu/g WP	27055 12222 11460 28820
	Sclerotinia sclerotiorum	Contans WG	*Coniothyrium minitans* CON/M/91-08	1×10^9 cfu/g 5.3%WG	29066
Snapdragon (*Antirrhinum majus*)	Root, stem and crown rots and damping-off , *Pythium* and *Phytophthora*	Subdue MAXX Truban Truban Rootshield HC* Rootshield Granules* Prestop (suppression only)	metalaxyl-M & S-isomer etridiazole etridiazole *Trichoderma harzianum* Rifai strain KRL-AG2 *Gliocladium catenulatum* J1446	240 g/L EC 25% EC 30% WP 1×10^7 cfu/g WP 1×10^7 cfu/g GR 2×10^8 cfu/g WP	27055 12222 11460 27115 27116 28820
	Root, stem and crown rots and damping-off	Captan 80WP Captan 80 WDG Supra Captan 80 WDG Maestro 80DF No-Damp No-Damp Rootshield HC Rootshield Granules	captan captan captan captan oxine benzoate oxine benzoate *Trichoderma harzianum* Rifai strain KRL-AG2	80% WP 80% WG 80% WG 80% WG 3.2% SN 3.2% SN 1×10^7 cfu/g WP 1×10^7 cfu/g GR	9582 23691 24613 26408 11880 3794 27115 27116
	Sclerotinia rot	Contans WG	*Coniothyrium minitans* CON/M/91-08	1×10^9 cfu/g 5.30%WG	29066
	Downy mildew	Acrobat 50WP	dimethomorph	50% WP	27700
	Powdery mildew	Compass 50WG (suppression only)	trifloxystrobin	50% WG	27527
	Gray mold (*Botrytis*)	Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820
	Root Rot (*Pythium* & *Phytophthora*)	Previcur N	propamocarb hydrochloride	722 g/L AS	26288
Spathiphyllum	Gray mold	Phyton 27	copper complex	5.5% SN	21699
	Pythium and *Phytophthora*	Aliette WDG Aliette WP Chipco Aliette Ornamental Aliette Ornamental Rootshield HC* Rootshield Granules*	fosetyl-Al fosetyl AL fosetyl AL fosetyl AL *Trichoderma harzianum* Rifai strain KRL-AG2	80% WG 80% WP 80% WP 80% WP 1×10^7 cfu/g WP 1×10^7 cfu/g GR	24458 24564 27557 28585 27115 27116
	Cylindrocladium	Phyton 27	copper complex	5.5% SN	21699
	Downy mildew	Acrobat 50WP	dimethomorph	50% WP	27700

TABLE 2. Fungicides Registered for Use on Greenhouse Ornamentals (continued)

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Statice	Leaf blights (Anthracnose/ Cercospora/ Alternaria / Botrytis)	Daconil Ultrex Daconil 2787 Flowable	chlorothalonil chlorothalonil	82.5% WG 40.4% SU	28354 15724
Stock	Downy mildew	Acrobat 50WP	dimethomorph	50% WP	27700
Stokesia	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Truban	etridiazole	30% WP	11460
Sweet Pea	*Botrytis* (on cut flowers)	Phyton 27	copper complex	5.5% SN	21699
Tulip	Botrytis	Captan 80WP Captan 80 WDG Supra Captan 80 WDG Maestro 80DF	captan captan captan captan	80% WP 80% WG 80% WG 80% WG	9582 23691 24613 26408
		Captan 50WP Captan 50W	captan captan	50% WP 50% WP	4559 14823
	Bulb rot (caused by Sclerotinia)	Quintozene (Terraclor) 75WP Quintozene 75WP Quintozene 75% WP	quintozene quintozene quintozene	75% WP 75% WP 75% WP	7251 27416 11425
	Bulb rot, damping off	Captan 50W Wilson's Bulb dust	captan carbaryl + captan	50% WP 5% + 5% DU	14823 14852
		Captan 50WP	captan	50% WP	4559
	Nematodes (bulb dip)	Formalin	formaldehyde	37% SN	6998
Verbena	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora*)	Subdue MAXX Truban Truban	metalaxyl-M & S-isomer etridiazole etridiazole	240 g/L EC 25% EC 30% WP	27055 12222 11460
	Rhizoctonia root rot	Compass 50WG	trifloxystrobin	50% WG	27527
	Powdery mildew	Phyton 27 Compass 50WG	copper complex trifloxystrobin	5.5% SN 50% WG	21699 27527
	Downy mildew	Acrobat 50WP	dimethomorph	50% WP	27700
Vinca	*Pythium* and *Phytophthora*	Aliette WDG Aliette WP Chipco Aliette Ornamental Aliette Ornamental Rootshield HC* Rootshield Granules*	fosetyl-Al fosetyl AL fosetyl AL fosetyl AL *Trichoderma harzianum* Rifai strain KRL-AG2	80% WG 80% WP 80% WG 80% WP 1×10^7 cfu/g WP 1×10^7 cfu/g GR	24458 24564 27557 28585 27115 27116
	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora)*	Truban Truban Subdue MAXX	etridiazole etridiazole metalaxyl-M & S-isomer	25% EC 30% WP 240g/L EC	12222 11460 27055
Zinnia	Damping-off and root and stem rot (caused by *Pythium* and *Phytophthora)*	Truban Truban Subdue MAXX	etridiazole etridiazole metalaxyl-M & S-isomer	25% EC 30% WP 240 g/L EC	12222 11460 27055
	Powdery mildew	Daconil 2787 Flowable Daconil Ultrex	chlorothalonil chlorothalonil	40.4% SU 82.5% WG	15724 28354
	Sclerotinia sclerotiorum	Contans WG	*Coniothyrium minitans* CON/M/91-08	1×10^9 cfu/g 5.3%WG	29066

*Rootshield is not labeled for Phytophthora control.

TABLE 3. Fungicides Registered for Use on Greenhouse Vegetables.

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Greenhouse vegetables such as cucumber, tomato, pepper	Damping off, root and stem rot, and Wilt caused by *Fusarium*	Mycostop Biofungicide Prestop (suppression only)	*Streptomyces griseoviridis* Strain K61 *Gliocladium catenulatum* J1446	1×10^6 cfu/g GR 2×10^8 cfu/g WP	26265 28820
	Powdery mildew	Milstop	potassium bicarbonate	85% DU	28095
	Rot rot (*Pythium*)	Previcur N Prestop (suppression only)	propamocarb hydrochloride *Gliocladium catenulatum* J1446	722 g/L 2×10^8 cfu/g WP	26288 28820
Green house vegetables such as cucumber, tomato, lettuce.	Botrytis (Gray mold)	Ferbam 76 WDG Ferbam 76 WDG Prestop (suppression only)	ferbam ferbam *Gliocladium catenulatum* J1446	76% WG 76% WG 2×10^8 cfu/g Wp	20136 20536 28820
Greenhouse cucumber and tomato	Pythium, Rhizoctonia, Fusarium root rot	Rootshield HC Rootshield Granules	*Trichoderma harzianum* Rifai strain KRL-AG2	1×10^7 cfu/g WP 1×10^7 cfu/g GR	27115 27116
	Gray mold	Ferbam 76 WDG Ferbam 76 WDG	ferbam ferbam	76% WG 76% WG	20136 20536
	Powdery Mildew	Milstop Nova 40W	potassium bicarbonate myclobutanil	85% DU 40% WP	28095 22399
	Damping off, root & crown rot caused by Pythium	Mycostop Biofungicide Prestop (suppression only)	*Streptomyces griseoviridis* Strain K61 *Gliocladium catenulatum* J1446	1×10^6 cfu/g GR 2×10^8 cfu/g WP	26265 28820
Greenhouse tomato and pepper	Root and stem rot and Wilt caused by Phytophthora	Mycostop Biofungicide	*Streptomyces griseoviridis* Strain K61	1×10^6 cfu/g GR	26265
Cucumber (*Cucumus sativus*)	Downy mildew	Tanos 50DF	famoxadone + cymoxanil	25% WG + 25% WG	27435
	Damping-off (*Pythium* & *Rhizoctonia*)	Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820
	Fusarium	Rootshield HC Rootshield Granules Prestop (suppression only)	*Trichoderma harzianum* Rifai strain KRL-AG2 *Gliocladium catenulatum* J1446	1×10^7 cfu/g WP 1×10^7 cfu/g GR 2×10^8 cfu/g WP	27115 27116 28820
	Gray mold	Ferbam 76 WDG Ferbam 76 WDG Rovral WP Rovral WDG Prestop (suppression only)	ferbam ferbam iprodione iprodione *Gliocladium catenulatum* J1446	76% WG 76% WG 50% WP 50% WG 2×10^8 cfu/g WP	20136 20536 15213 24709 28820
	Gummy stem blight	Rovral WP Rovral WDG Nova 40W Manzate 200 WP Prestop (suppression only) Pristine WG (suppression only)	iprodione iprodione myclobutanil mancozeb *Gliocladium catenulatum* J1446 boscalid / pyraclostrobin	50% WP 50% WG 40% WP 80% WP 2×10^8 cfu/g Wp 25.2% / 12.8% WG	15213 24709 22399 10526 28820 27985
	Powdery mildew	Nova 40W Milstop Sporodex L Kumulus DF Microscopic sulphur Serenade Max Switch 62.5 WG Pristine WG (suppression only) Influence WP	myclobutanil potassium bicarbonate *Pseudozyma flocculosa* sulphur sulphur *Bacilus subtilis* – QST 713 strain cyprodinil / fludioxonil boscalid / pyraclostrobin garlic	40% WP 85% DU 1.3% SU 80% WG 92% WP $7.3\ 10^9$ CFU/g WP 37.5% / 25.0% WG 25.0% / 12.8% 70.1% WP	22399 28095 27161 18836 14653 28549 28189 27985 29667
	Pythium root diseases *Pythium* spp.	Previcur N Rootshield HC Rootshield Granules Ridomil Gold 480EC Prestop (suppression only)	propamocarb hydrochloride *Trichoderma harzianum* Rifai strain KRL-AG2 metalaxyl-M & S-isomer *Gliocladium catenulatum* J1446	722 g/L SN 1×10^7 cfu/g WP 1×10^7 cfu/g GR 480 g/L EC 2×10^8 cfu/g Wp	26288 27115 27116 25384 28820
	Seed decay, seedling blight and damping-off	No-Damp No-Damp Rootshield HC Rootshield Granules	oxine benzoate oxine benzoate *Trichoderma harzianum* Rifai strain KRL-AG2	3.2% SN 3.2% SN 1×10^7 cfu/g WP 1×10^7 cfu/g GR	11880 3794 27115 27116
	Damping off and root & crown rot caused by *Pythium*	Mycostop Biofungicide Prestop (suppression only)	*Streptomyces griseoviridis* Strain K61 *Gliocladium catenulatum* J1446	1×10^6 cfu/g GR 2×10^8 cfu/g WP	26265 28820
	Damping off, root & crown rot and wilt caused by *Fusarium*	Mycostop Biofungicide Prestop (suppression only)	*Streptomyces griseoviridis* Strain K61 *Gliocladium catenulatum* J1446	1×10^6 cfu/g GR 2×10^8 cfu/g WP	26265 28820

TABLE 3. Fungicides Registered for Use on Greenhouse Vegetables (continued)

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Lettuce (*Lactuca sativa*)	Downy mildew	Aliette WDG (B. C. only)	fosetyl-Al	80% WG	24458
		Aliette WP (B.C. only)	fosetyl AL	80% WP	24564
		Aliette Systemic WDG (B.C. only)	fosetyl AL	80% WG	27688
		Serenade Max	*Bacilus subtilis* – QST 713 strain	7.3×10^9 CFU/g WP	28549
	Gray mold	Ferbam 76 WDG	ferbam	76% WG	20136
		Ferbam 76 WDG	ferbam	76% WG	20536
		Rovral WP	iprodione	50% WP	15213
		Rovral WDG	iprodione	50% WG	24709
		Decree 50 WDG	fenhexamid	50% WG	26132
		Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820
	Sclerotinia drop	Rovral WP	iprodione	50% WP	15213
		Rovral WDG	iprodione	50% WG	24709
		Serenade Max	*Bacilus subtilis* – QST 713 strain	7.3×10^9 CFU/g WP	28549
	Seed decay, seedling blight and damping-off	No-Damp	oxine benzoate	3.2% SN	11880
		No-Damp	oxine benzoate	3.2% SN	3794
	Powdery mildew	Serenade Max	*Bacilus subtilis* – QST 713 strain	7.3 x 10^9 CFU/g WP	28549
		Pristine WG	boscalid / pyraclostrobin	25.5% / 12.8% WG	27985
	Damping-off (*Pythium* & *Rhizoctonia*)	Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820
Pepper (*Capsicum* spp.)	Powdery mildew	Nova 40W	myclobutanil	40% WP	22399
		Microscopic Wettable Sulphur	sulphur	92% WP	00873
		Milstop	potassium bicarbonate	85% DU	28095
		Actinovate SP	*Streptomyces lydicus* – WYEC 108 strain	1.0×10^9 CFU/g	28672
		Serenade Max	*Bacilus subtilis* – QST 713 strain	7.3×10^9 CFU/g WP	28549
		Pristine WG	boscalid / pyraclostrobin	25.0% / 12.8% WG	27985
	Root, crown & stem rots and damping off	Captan 50WP	captan	50% WP	4559
		Captan 80WP	captan	80% WP	9582
		Captan 80WDG	captan	80% WG	23691
		Supra Captan 80 WDG	captan	80% WG	24613
		Maestro 80DF	captan	80% WG	26408
	Seed decay, seedling blight and damping-off	No-Damp	oxine benzoate	3.2% SN	11880
		No-Damp	oxine benzoate	3.2% SN	3794
	Root and stem rot and wilt caused by *Phytophthora*	Mycostop Biofungicide	*Streptomyces griseoviridis* Strain K61	1×10^6 cfu/g GR	26265
	Damping off, root & crown rot and wilt caused by *Fusarium*	Mycostop Biofungicide	*Streptomyces griseoviridis* Strain K61	1×10^6 cfu/g GR	26265
		Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820
	Damping off (*Pythium*)	Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820
	Bacterial spot (greenhouse seedlings for transplant)	Coppercide WP	copper hydroxide	50% WP	16047
		Kocide 101	copper hydroxide	50% WP	14417
	Root rot (*Pythium*)	Previcur N	propamocarb hydrochloride	722 g/L	26288
Tomato (*Lycopersicon esculentum*)	Bacterial canker	Copper Spray	copper oxychloride	50% WP	19146
		Guardsman Copper Oxychloride	copper oxychloride	50% WP	13245
	Early blight, late blight, Septoria leaf spot	Manzate 200 WP	mancozeb	80% WP	10526
		Manzate DF	mancozeb	75% WG	21057
		Manzate Pro-Stick	mancozeb	75% WG	28217
		Guardsman Copper Oxychloride	copper oxychloride	50% WP	13245
	Damping off, root & crown rot and wilt caused by *Fusarium*	Mycostop Biofungicide	*Streptomyces griseoviridis* Strain K61	1×10^6 cfu/g GR	26265
	Root and stem rot and Wilt caused by *Phytophthora*	Mycostop Biofungicide	*Streptomyces griseoviridis* Strain K61	1×10^6 cfu/g GR	26265
	Damping off, root & crown rot caused by *Pythium*	Mycostop Biofungicide	*Streptomyces griseoviridis* Strain K61	1×10^6 cfu/g GR	26265
	Damping-off (*Pythium* & *Rhizoctonia*)	Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820
	Seed decay, seedling blight and damping-off	No-Damp	oxine benzoate	3.2% SN	11880
		No-Damp	oxine benzoate	3.2% SN	3794
		Rootshield HC*	*Trichoderma harzianum* Rifai strain KRL-AG2	1×10^7 cfu/g WP	27115
		Rootshield Granules*		1×10^7 cfu/g GR	27116

TABLE 3. Fungicides Registered for Use on Greenhouse Vegetables (continued)

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Tomato (*Lycopersicon esculentum*) (continued)	Bacterial spot (greenhouse seedlings for transplant)	Coppercide WP	copper hydroxide	50% WP	16047
		Kocide 101	copper hydroxide	50% WP	14417
	Stem canker (Botrytis)	Botran 75W	dicloran	75% WP	8772
			Streptomyces griseoviridis Strain K61		
	Gray mold	Decree 50WDG	fenhexamid	50% WG	26132
		Ferbam 76 WDG	ferbam	76% WG	20136
		Ferbam 76 WDG	ferbam	76% WG	20536
		Rovral WP	iprodione	50% WP	15213
		Rovral WDG	iprodione	50% WG	24709
		Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820
		Pristine WG	boscalid / pyraclostrobin	25.2% / 12.8% WG	27985
		Scala SC	pyrimethanil	400 g/L SU	29975
	Powdery mildew	Bartlett Microscopic Wettable Sulphur	sulphur	92% WP	00873
		Nova 40 W	myclobutanil	40% WP	22399
		Milstop	potassium bicarbonate	85% DU	28095
		Serenade Max	*Bacilus subtilis* – QST 713 strain	7.3×10^9 CFU/g WP	28549
		Pristine WG (suppression only)	boscalid / pyraclostrobin	25.2% / 12.8%	27985
		Influence WP	garlic	70.1% WP	29667
	Root, crown & stem rots and damping off	Captan 50W	captan	50% WP	4559
		Captan 80WP	captan	80% WP	9582
		Captan 80WDG	captan	80% WG	23691
		Supra Captan 80 WDG	captan	80% WG	24613
		Maestro 80DF	captan	80% WG	26408
		Rootshield HC*	*Trichoderma harzianum* Rifai strain KRL-AG2	1×10^7 cfu/g WP	27115
		Rootshield Granules*		1×10^7 cfu/g GR	27116
	Root rot (*Pythium*)	Previcur N	propamocarb hydrochloride	722 g/L	26288
Pumpkin	Powdery mildew	Milstop	potassium bicarbonate	85% DU	28095
Misc vegetables (including cauliflower, broccoli & herbs)	Damping-off (*Pythium* & *Rhizoctonia*)	Prestop (suppression only)	*Gliocladium catenulatum* J1446	2×10^8 cfu/g WP	28820
Strawberry	*Botrytis cinerea* (suppression)	Rootshield HC	*Trichoderma harzianum* Rifai strain KRL-AG2	1×10^7 cfu/g WP	27115
		Actinovate SP	*Streptomyces lydicus* – WYEC 108 strain	1.0×10^9 CFU/g	28672
	Powdery mildew (suppression)	Actinovate SP	*Streptomyces lydicus* – WYEC 108 strain	1.0×10^9 CFU/g	28672

*Rootshield is not labeled for Phytophthora control.

APPENDIX II. Soil Fumigants and Nematicides Registered for Use in Greenhouses in Canada.

NOTE: The following is a guide only. Always read the label before using a product.

Fumigant/ Nematicide	PCP#	Active Ingredients	Spectrum of Control	Crops	Pre-Plant Interval (days)
Telone C-17	16324	chloropicrin + 1,3-dichloropropene (COM) SN	nematodes	lettuce, pepper, tomato, ornamentals, vegetables	14+
Basamid Granular	15032	dazomet (COM) GR	fungi, weeds, nematodes (uncysted)	lettuce, pepper, eggplant, tomato, annual flower beds, vegetable seedbeds,	10-40
Telone II	15893	1,3-dichloropropene (COM) SN	nematodes	vegetables, ornamentals	14+
Methyl Bromide Meth-O-Gas	16495 9564	methyl bromide (RES) LI	damping off organisms (*Fusarium, Pythium, Rhizoctonia*), insects, nematodes, weed seeds	ornamentals, vegetable transplants, compost, manure, topsoil	7
Vapam	6453 29128	metam-sodium (COM) SN	damping-off, nematodes, symphylids, weeds, root rots	ornamentals vegetables	21-30