

Chapter Four

** Please note that this chapter has not been revised for the 2002 edition of the WCPD Guidelines.

DISEASES OF GREENHOUSE CROPS

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GENERAL DISEASE CONTROL METHODS FOR GREENHOUSE CROPS

Several major cultural practices to control diseases should be integrated into all greenhouse management programs. These serve both to prevent and 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 a compromise between those that favour plant growth and those that favour disease development. Careful attention to such detail helps to prevent the onset and spread of diseases and may reduce the need for an expensive eradication program.

a. Damping-off, root and stem rots

- 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 quintozone (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.
- 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.
- provide adequate bottom heat where appropriate.

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

- avoid overcrowding and placing plants in damp, shady locations.
- do not sprinkle foliage, particularly in late afternoon or evening.
- take cuttings from healthy plants only and disinfect 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 overfertilizing, especially with nitrogen.
- take cuttings off dry plants only.
- do not use wet mulches.
- space plants to 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.
- disinfect 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, 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)

- 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.

- Remove dead and dying leaves and flowers from the greenhouse. Dispose of off site or in a covered compost area.
- Keep walks and the surfaces of beds and benches clean, including free of algae.
- Control weeds in and around greenhouses.
- Hang up the ends of hoses.
- 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.
- Use a foot bath with Chemprocide (PCP 13148).
- Keep traffic flows from clean to dirty, i.e. do not go into the greenhouse after working at the cull pile.
- 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 disinfectant such as bleach, Chemprocide (PCP 13148). Disinfectants are toxic so follow all safety precautions and directions on the label. 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 BCMAFF Greenhouse Vegetable Clean-Up Factsheet 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°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°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°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 (°C)	Time (min.)
Weeds (most)	70-80	15
Insects & mites	60-70	20
Bacteria (most)	60	10
<i>Fusarium</i>	57	30
<i>Botrytis</i>	55	15
Nematodes	55	15
<i>Rhizoctonia</i>	52	30
<i>Sclerotinia</i>	50	5
<i>Pythium</i>	46	40

Most undesirable organisms can be eliminated, under ideal conditions, by 60°C for 30 min. Above 82°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 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

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, hilichrysum, 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.

GROWERS SHOULD EXERCISE EXTREME CAUTION TO MINIMIZE HEALTH RISKS WHEN USING SOIL FUMIGANTS. An effective gas mask **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 should be carefully followed.

c. Other Methods of Soil Treatment

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 source to reach 82°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°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 (DOM) or captan can be mixed into the soil to control damping-off.

Prevent recontamination of treated soil by disease-causing organisms by disinfecting 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, Equipment, Irrigation Line and Structural Sanitation

Benches and equipment should be disinfected regularly as part of every green house 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 Chemproicide (PCP 13148) or bleach. 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 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 hydrochlorite	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.

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" for information on using slow-sand filtration which has been quite effective in grower trials. Another potential technique is the addition of biocontrol agents to nutrient solutions but this application requires further research and registration of microbials. cDNA probes have been developed by Dr. Andre Levesque, when he was with AAFC, Summerland to identify species of *Pythium* and *Phytophthora* in nutrient solutions. Commercialization of this technology is underway.

AFRICAN VIOLET (*Saintpaulia ionantha*)

DAMPING-OFF

See bedding plants, DAMPING-OFF AND ROOT ROT on page 14.

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.

Chemical: Chlorothalonil (COM) DU; fenhexamid (COM) WDG; iprodione (COM) WP. Limitations: As per label.

Notes: Apply chlorothalonil when foliage and blossoms are dry and when greenhouse temperatures do not exceed 24°C. When applying iprodione, use tepid water to prepare the spray mixture. Phytotoxicity may occur if cold water is used. Repeated use of benomyl or 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 cichoracearum

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 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.

Chemical: Etridiazole + indole butyric acid (DOM) SN; metalaxyl (COM) GR. Limitations: As per label.

ALSTROMERIA

DAMPING-OFF

See bedding plants, DAMPING-OFF AND ROOT ROT on page [14](#).

GRAY MOLD

See bedding plants, GRAY MOLD on page [15](#).

ANEMONE CORONARIA

DAMPING-OFF

See bedding plants, DAMPING-OFF AND ROOT ROT on page [14](#).

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 15.

AZALEA (*Rhododendron* spp.)**DAMPING-OFF**

See bedding plants, DAMPING-OFF AND ROOT ROT on page 14.

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) DU; iprodione (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.

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: Thiophanate-methyl (COM) WP. Limitations: as per label.

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: *Streptomyces griseoviridis* Strain K61 (COM) WP.

Chemical: Oxine benzoate (DOM) SN; iprodione (COM) WP; fosetyl-Al (COM) WDG; quitozene (COM) DU, WP; captan (COM) WP; etridiazole (COM) WP, EC; etridiazole + indolebutyric acid (DOM) SN; metalaxyl (COM) GR.

Limitations: Iprodione is safe for use on celosia and salvia only. Check tolerance to iprodione on a few plants before large scale use. Metalaxyl is registered for use on african violet, carnation, chrysanthemum, geranium and gloxinia only. Fosetyl-Al is registered for use on azalea, begonia, celosia, geranium, impatiens, petunia, salvia and vinca.

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

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.

Chemical: Chlorothalonil (COM) DU, F; fenhexamid (COM) WDG; iprodione (COM) WP; copper complex (COM) WP; thiophanate-methyl (COM) WP. Limitations: As per label.

Notes: Apply chlorothalonil only when foliage surface is 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

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 [57](#).

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) WP for begonia and New Guinea impatiens; thiophanate-methyl (COM) WP for begonia and cineraria. Limitations: As per label.

BEGONIA (*Begonia* spp.)**DAMPING-OFF**

See bedding plants, DAMPING-OFF AND ROOT ROT on page [14](#).

FOLIAR NEMATODE

Aphelenchoides fragariae, *A. 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: Chlorothalonil (COM) DU; fenhexamid (COM) WDG; iprodione (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. Repeated use of iprodione may induce resistance in *Botrytis* to the fungicide.

IMPATIENS NECROTIC SPOT

See BEDDING PLANTS, Impatiens Necrotic Spot on page 15.

POWDERY MILDEW

Erysiphe cichoracearum

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

Resistant Cultivars: None.

Chemical: Thiophanate-methyl (COM) WP; copper complex (COM) WP. 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.

Chemical: Fosetyl-Al (COM) WDG; quintozone (COM) DU, WP; captan (COM) WP; etridiazole (COM) EC.
Limitations: As per label.

Notes: Quintozone is only effective against *Rhizoctonia*. Fosetyl-Al, etridiazole and captan will control *Pythium* and *Phytophthora*. *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 carotovora 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.

Resistant Cultivars: None.

Chemical: None.

DAMPING-OFF

Cultural: See bedding plants, DAMPING-OFF AND ROOT ROT on page 14.

Resistant Cultivars: None.

Chemical: Captan + carbaryl (DOM). Limitations: As per label.

DRY ROT

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°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 ROTS

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.

Chemical: Formaldehyde (COM) LI hot water treatment. Do not use on tulips, they will be damaged. Benomyl (DOM) WP; captan (COM) WP; captan + carbaryl (DOM) DU. Limitations: As per label.

GRAY MOLD

Botrytis spp. See bedding plants, GRAY MOLD on page 15 and BULB LEAF SPOTS on page 21.

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: Captan (COM) WP; chlorothalonil (COM) F; iprodione (COM) WP for Botrytis. 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 'General Disease Control Methods for Greenhouse Crops' on page 6.

References:

1. 1999 Floriculture Production Guide, BCMAFF.

POWDERY MILDEW

See Bedding plants, POWDERY MILDEW on page 16.

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: Chlorothalonil (COM) DU, fenhexamid (COM) WDG. Limitations: As per label.

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

CARNATION (*Dianthus caryophyllus*)

ALTERNARIA BLIGHT

Alternaria dianthi and *A. dianthicola*

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

Resistant Cultivars: None.

Chemical: Chlorothalonil(COM). Limitations: As per label.

Notes: Captan (COM) WP is registered for control of Alternaria blight of carnation, but is not specifically labelled 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 14.

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) DU, F; fenhexamid (COM) DU, F; 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°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: None.

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: *Streptomyces giseoviridis* strain K61 (COM) WP. Limitations: as per label.

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

Notes: Quintozene is only effective against *Rhizoctonia*.

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).

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.

CHRISTMAS CACTUS

ROOT ROT

See Bedding Plants, DAMPING-OFF AND ROOT ROT, page 14.

CHRYSANTHEMUM (*Chrysanthemum* spp.)

DAMPING-OFF

See bedding plants, DAMPING-OFF AND ROOT ROT on page 14.

FOLIAR NEMATODE

Aphelenchoides fragariae and *A. 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: Dichloran (COM) WP; chlorothalonil (COM) F, DU; fenhexamid (COM) WDG; thiophanate-methyl (COM) WP; iprodione (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 15.

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. Limitations: As per label.

ROOT and STEM ROT

Fusarium spp., *Rhizoctonia solani*, and *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) WP. Limitations: As per label.

Chemical: Quintozene (COM) DU, WP, Etridiazole (COM) EC, and Metalaxyl (COM) GR. Limitations: As per label.

Notes:

1. Quintozene is only effective against *Rhizoctonia*.

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 sp., *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: *Streptomyces griseoviridis* Strain K61 (COM) WP. Limitations: As per label.

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 Agriculture and Agri-Food Canada, and B.C. Ministry of Agriculture, Fisheries and Food bulletin, October, 1993.

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: Chlorothalonil (COM) DU, F; fenhexamid (COM) WDG; thiophanate-methyl (COM) WP; iprodione (COM) WP. Limitations: As per label.

Notes: Apply chlorothalonil when foliage and blossoms are dry and when greenhouse temperatures do not exceed 24°C. 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 15.

POWDERY MILDEW*Erysiphe cichoracearum***Cultural:** Refer to 'General Disease Control Methods for Greenhouse Crops' at the beginning of this chapter.**Resistant Cultivars:** None.**Chemical:** Thiophanate-methyl (COM) WP. Limitations: As per label.**COLEUS (*Coleus* spp.)****DAMPING-OFF**

See bedding plants, DAMPING-OFF AND ROOT ROT on page 14.

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) TA, DU; fenhexamid (COM) WDG. Limitations: As per label.**Notes:** Apply chlorothalonil only when foliage and blossom surfaces are dry, and when greenhouse temperatures do not exceed 24°C.**IMPATIENS NECROTIC SPOT**

See BEDDING PLANTS, Impatiens necrotic spot on page 15.

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°/24°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.

Resistant Cultivars: None.

Chemical: None.

References:

1. Diener, T.O. 1987. Chapter 12, Cucumber pale fruit *in* The viroids, T.O. Diener (ed).
2. Dorst, H.J.M. van, and Peters, D. 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 germinability. 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. Limitation: As per label.

Chemical: Propamocarb hydrochloride (COM) L; thiram (COM) WP. Limitations: As per label. Propamocarb hydrochloride will only control *Pythium*.

Notes: *Pythium* can also cause root rot in mature plants (see under root rot on page 14).

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'.

Biological: *Streptomyces griseoviridis* Strain K61 (COM) WP. Limitation: As per label.

Chemical: None.

References:

1. 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.
2. 1996-97 Greenhouse Vegetable Production Guide, BCMAFF.
3. Punja, Z.K. 1999. Fusarium rot and stem rot of greenhouse cucumbers. Greenhouse vegetable factsheet, 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 humidities are 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 (scraper) and applying a fungicide paste of iprodione (COM) WP. Avoid full venting when outside temperatures are less than 15°C. Cool air 'dropping' from roof vents creates a climate that favours establishment of the disease.

Resistant Cultivars: None.

Chemical: Iprodione (COM) WP; ferbam (COM) WG (see Notes).

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

Notes: The U.S. has a zero tolerance for Rovral residues. Ferbam causes severe damage to English cucumber. Anilazine and benomyl which are registered for the control of certain other foliage diseases of greenhouse cucumbers, are also effective against gray mold. Repeated use of benomyl or iprodione may induce resistance in *B. cinerea* to the fungicide. Benomyl is harmful to predatory mites.

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.

Chemical: Benomyl (COM) WP + mancozeb (COM) WP; iprodione (COM) WP; myclobutanil (COM) WP stem sprays. Alternate between the recommended fungicides to avoid buildup of resistance.

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

Resistant Cultivars: None.

Chemical: None.

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

References:

1. Jarvis, W.R. and Barrie, S.D. 1988. Stem rot of greenhouse cucumbers caused by *Penicillium crustosum*. Plant Dis. 72:363.
2. Jarvis, W.R. 1989. Spotting the *Botrytis* look-alike. Grower (Lond.)III(14):16-19.
3. Pest Management Note 95-04. 1995. BCMAFF.

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. 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.

Chemical: Benomyl (COM) WP + mancozeb (COM) WP; sulphur (COM) WP; myclobutanil (COM) WP.

Limitations: Preharvest intervals - 14 days (benomyl + mancozeb); 1 day (sulphur); 2 days (myclobutanil).

Notes:

1. The development of resistance to benomyl by powdery mildew fungi has been reported. Repeated applications of benomyl may cause some phytotoxicity, and is harmful to predatory mites.
2. Benomyl is a spider mite ovicide.
3. Repeated application of sulphur may cause leaf injury. Avoid use during high temperatures (+29°C).

References:

1. Menzies, J.G. *et al.* 1991. Effects of soluble silicon on the parasitic fitness of *Sphaerotheca fuliginea* on *Cucumis sativus*. *Phytopathology* 81:84-88.
2. Kharbanda, P. and Howard, R. 1981. Identity and control of powdery mildew of greenhouse cucumbers in southern Alberta. *Can. J. Plant Pathol.* 3:115.

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 (1). Activated slow sand filtration will remove *Pythium* in recirculated nutrient solutions and 95% of *Fusarium* propagules (3).

Resistant Cultivars: None.

Chemical: Captan (COM) WP, propamocarb hydrochloride (COM) L or thiram (COM) WP may be applied as protective seed treatments. Limitations: As per label. Propamocarb hydrochloride will only control *Pythium*. Captan may cause phytotoxicity on some varieties; test first on a small batch.

Notes: On occasion, *Fusarium* may be carried on seed.

References:

1. 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.
2. Ehret, D. 1998. Personal communication. Pacific Agricultural Research Centre, Agassiz, B.C.
3. Ng, K. 1999. Personal communication. Ng Consulting, Vancouver, B. C.

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.

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

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.

Notes: Benomyl, which is registered on greenhouse cucumbers against gummy stem blight and powdery mildew, is also effective against stem and fruit rot.

CYCLAMEN (*Cyclamen indicum*)**CORM ROT***Erwinia carotovora*

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

Resistant Cultivars: None.

Chemical: Copper complex (COM) WP. 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: *Streptomyces griseoviridis* Strain K61 (COM) WP. Limitations: As per label.

Chemical: None.

Notes: 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). *Fusarium* spores spread easily in recirculated nutrient solutions.

References:

1. Personal communication. R. Copeman, 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: Chlorothalonil (COM) DU; copper complex (COM) WP; fenhexamid (COM) WDG; thiophanate- methyl (COM) WP; iprodione (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 [15](#).

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) LI; 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 14)

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) DU; iprodione (COM) WP; copper complex (COM) WP. Limitations: As per label.

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

Chemical: Copper complex (COM) WP 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 14)

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: *Streptomyces griseoviridis* Strain K61 (COM) WP. Limitations: As per label.

Chemical: Oxine benzoate (DOM) WP, metalaxyl (COM) GR. Limitations: As per label.

DAMPING-OFF

Pythium spp., *Rhizoctonia solani*

See bedding plants, DAMPING-OFF AND ROOT ROT on page 14.

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; chlorothalonil (COM) F, DU; copper complex (COM) WP; fenhexamid (COM) WDG; iprodione (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.

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.

RUST

Puccinia pelargonii-zonalis

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.

Notes:

1. 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.

GLOXINIA (*Sinninga 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: Chlorothalonil (COM) DU; fenhexamid (COM) WDG; iprodione (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.

DAMPING-OFF

See Bedding Plants, DAMPING-OFF AND ROOT ROT on page [14](#).

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.

IMPATIENS NECROTIC SPOT

See BEDDING PLANTS, Impatiens necrotic spot on page [15](#).

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) L; fenhexamid (COM) WDG. 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: Chlorothalonil (COM) DU, F; fenhexamid (COM) WDG; thiophanate-methyl (COM) WP. Limitations: As per label.

Notes: Apply chlorothalonil to foliage, and only when foliage is dry and when greenhouse temperatures do not exceed 24°C. Do not apply to plants in bloom.

POWDERY MILDEW

Erysiphe cichoracearum

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

Resistant Cultivars: None.

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

Notes: Apply chlorothalonil to foliage, and only when foliage is dry and when greenhouse temperatures do not exceed 24°C. Do not apply to plants in bloom.

ROOT ROT

Pythium spp.

See Bedding Plants, DAMPING-OFF AND ROOT ROT page 14.

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.

Chemical: Thiram (COM) WP as a protectant seed treatment; ferbam (COM) DU, WG may be applied to emerged seedlings. Limitations: Preharvest interval - 1 day (ferbam).

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.

Chemical: Fosetyl-al (COM) WDG. 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.

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

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.

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

TOMATO SPOTTED WILT

See tomato, TOMATO SPOTTED WILT on page 57.

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.

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) F, DU; fenhexamid (COM) WDG. 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: *Streptomyces griseoviridis* Strain K61 (COM) WP. Limitations: As per label.

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

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

PANSY (*Viola* spp.)**BLACK ROOT ROT**

Thielaviopsis basicola (see under BEDDING PLANTS, page 14)

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: *Streptomyces griseoviridis* Strain K61 (COM) WP. Limitations: As per label.

Chemical: None.

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

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:

1. 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 humidities 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 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. Limitations: As per label.

Chemical: Buy treated seed or apply thiram as a seed treatment. Limitations: As per label.

References:

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

FUSARIUM STEM ROT

Fusarium solani

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

Resistant Cultivars: None.

Chemical: None.

References:

1. 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. Reduce humidity and improve air circulation around the plants.

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.

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.

POINSETTIA (*Euphorbia pulcherrima*)

BLACK ROOT ROT

Thielaviopsis basicola (see under BEDDING PLANTS, page 14)

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) DU; thiophanate-methyl (COM) WP; copper complex (COM) L; fenhexamid (COM) WDG; iprodione (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 this fungicide.

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°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.

Chemical: Copper complex (COM) WP, myclobutanil (COM) WP.

Notes:

1. 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: *Streptomyces griseoviridis* Strain K61 (COM) WP. Limitations: As per label.

Chemical: Etridiazole (COM) WP, EC; quitozene (COM) WP, GR; etridiazole + indole butyric acid (DOM) SU; metalaxyl (COM), GR. Limitations: As per label.

Notes:

1. Etridiazole and metalaxyl are only effective against *Pythium*. Mixtures of benomyl + quitozene are reported to give good control of the entire poinsettia root rot complex (1).

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 ROT

See under BEDDING PLANTS, page 14.

GRAY MOLD

See under BEDDING PLANTS, page 15.

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 15.

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.

Chemical: Chlorothalonil (COM) SU; dicloran (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 15).

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; chlorothalonil (COM) DU; fenhexamid (COM) WDG; thiophanate-methyl (COM) WP; copper complex (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.

Chemical: Myclobutanil (COM) W; thiophanate-methyl (COM) WP; copper complex (COM) WP; microfine sulphur (COM) WP. Limitations: As per label.

SNAPDRAGON (*Antirrhinum majus*)**DAMPING-OFF**

See Bedding Plants, DAMPING-OFF AND ROOT ROT on page 14.

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: 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: Chlorothalonil (COM) DU; fenhexamid (COM) WDG. 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

Erysiphe cichoracearum

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

Resistant Cultivars: None.

Chemical: None.

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°C and not below 16°C at night.

Resistant Cultivars: Rust-resistant varieties are available.

Chemical: None.

STEM and ROOT ROT

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: *Streptomyces griseoviridis* Strain K61 (COM) WP. Limitations: As per label.

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

Notes: Etridiazole will only control *Pythium* and *Phytophthora*. Quintozenone alone will only control *Rhizoctonia* and *Sclerotinia*.

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. Minist. 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 litres of water on a 2-3 sprays/week basis. Avoid relative humidities 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. Mohyuddin, 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. Mohyuddin, 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

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. Limitations: As per label.

Chemical: Thiram (COM) WP, as a protectant seed treatment. Limitations: As per label.

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, SEPTORIA LEAF SPOT

Alternaria solani, *Septoria lycopersici*

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

Resistant Cultivars: None.

Chemical: Mancozeb (COM) WP.
Limitations: 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.

Chemical: None. See notes.

Notes: General sanitation and soil sterilization may reduce disease inoculum but will not prevent disease. Benomyl (0.5 g/L) has been observed to be partially effective in controlling the disease, but resistance may develop.

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.

Chemical: Iprodione (COM) WP; chlorothalonil (COM) DU; dicloran (COM) WP; benomyl + mancozeb (COM) WP.
Limitations: Benomyl is not to be applied to hydroponically grown greenhouse tomatoes. Preharvest intervals - 1 day (dicloran, chlorothalonil); 2 days (iprodione); 7 days (benomyl + mancozeb).

Notes: Some strains of *Botrytis* may be resistant to benomyl. It is advisable to alternate benomyl with other fungicides or to use benomyl + mancozeb.

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: Benomyl + mancozeb (COM) WP.

Limitations: Preharvest interval - 7 days (benomyl + mancozeb). Not to be used on hydroponically grown greenhouse tomatoes.

References:

1. Committee 1984. 1985-86 Greenhouse Vegetable Production Recommendations. Ont. Minist. Agric. Food Publ. 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 gm/100 liters. 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.

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.

Chemical: Myclobutanil (COM) WP; sulphur (COM) WP. Benomyl plus mancozeb or chlorothalonil as applied for Botrytis may also provide some control. Benomyl is not to be used on hydroponically grown greenhouse tomatoes.

Limitations: Preharvest interval - 3 days (myclobutanil); 1 day (sulphur).

References:

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

ROOT, STEM and FRUIT ROTS

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

Chemical: For *Botrytis*, use - anilazine (COM) WP; chlorothalonil (COM) DU; dicloran (COM) WP.

Limitations: Preharvest intervals - 1 day (anilazine, dichloran, chlorothalonil).

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 (1).

References:

1. 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.
2. 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.
3. Cho, J.J. *et al.* 1989. A multidisciplinary approach to management of tomato spotted wilt virus in Hawaii. Plant Dis. 73:375-383.
4. MacDonald, L. 1988. Tomato spotted wilt virus now in B.C. Pest Control Notes, B.C. Ministry of Agriculture and Fisheries.
5. 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.

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 (3,4).

References:

1. Committee. 1985-86 Greenhouse Vegetable Production Recommendations. Ont. Minist. Agric. Food Publ. 365.
2. Hiruki, C. 1977. Tomato mosaic disease and its control in the greenhouse. Agric. For. Bull. Univ. Alta., Edmonton 35: 6-8.
3. Stace-Smith, R. 1975. Virus control in greenhouse tomatoes. Can. Agric. 21(1):15-16.

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.

Chemical: Fumigate soil (preplant) with - chloropicrin (COM) LI; methyl bromide (RES) PS, LI; dazomet (COM) GR; 1,2 dichloropropene (COM) LI; metam sodium (COM) SN. Limitations: As per label.

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

References:

1. Committee, 1984. 1985-86 greenhouse vegetable production recommendations. Ont. Minist. Agric. Food Publ. 365.

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2. Fletcher, J.T. 1984. Diseases of Greenhouse Plants. Longman Group Ltd., London. 351 pp.
3. Forsberg, J.L. 1975. Diseases of Ornamental Plants Univ. Ill. Spec. Publ. 3 (rev.).
4. Hicock, H.W. and Olson, R.A. 1954. The toxicity to plants of wood preservatives and their solvents. Conn. Agric. Exp. Sta., Circ. 189.
5. Horst, K.P. 1979. Westcott's plant disease handbook, 4th ed. Van Nostrand Reinhold Company. New York, New York.
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15. Thompson, W.T. 1995. Agricultural Chemicals. III - Fumigants, growth regulators, repellents, and rodenticides (rev.). Thompson Publications, Fresno, Calif.
16. Thompson, W.T. 1997. Agricultural Chemicals. IV. Fungicides (Rev.). Thompson Publications, Fresno, Calif.
17. Koch, Christine. 1999. Floriculture Production Guide for Commercial Growers. B. C. Ministry of Agriculture Food and Fisheries.

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.

TABLE 1. Fungicides Registered for Use on Greenhouse Ornamentals

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
All crops	Damping-off	No-Damp	oxine benzoate	2.5% SN	3794
Bedding Plants	Gray mold or bud rot	Exotherm Termil	chlorothalonil	20% PO	16661
		Rovral	iprodione	50% WP	15213
	Damping-off (Rhizoctonia)	Rovral	iprodione	50% WP	15213
	Root, stem and crown rots and damping-off	Clean Crop Captan 80W	captan	80% WP	23190
		Clean Crop Captan 80W	captan	80% WP	10780
		Captan 80 WDG	captan	80% WDG	23691
Clean Crop Supra Captan		captan	80% WDG	24613	
Maestro 75DF		captan	75% DF	23350	
Maestro 80DF	captan	80% DF	26408		
No-Damp	oxine benzoate	2.5% SN	3794		
Root and stem rots and damping-off (Pythium, Phytophthora)	Truban	etridiazole	25% EC	12222	
	Subdue 2G	metalaxyl	2% GR	18818	
Stem rot (Rhizoctonia)	Terraclor	quintozene	75% WP	7251	
	Quintozene 75%	quintozene	75% WP	11425	
Greenhouse ornamentals	Gray mold	Decree 50 WDG	fenhexamid	50% WDG	26132
	Damping-off, root and stem rot, and wilt caused by <i>Fusarium</i>	Mycostop Biofungicide	Streptomyces griseoviridis Strain K61	10 cfu/g	26265
African violet	Gray mold or bud rot	Exotherm Termil Protectant	chlorothalonil	20% PO	16661
		Rovral	iprodione	50% WP	15213
	Damping off, Pythium root rot	Subdue 2G	metalaxyl	2% GR	18818
Root, stem and crown rots and damping-off	Subdue 2G	metalaxyl	2% GR	18818	
	Truban	etridiazole	25% EC	12222	
Aster	Powdery mildew, rust	Nova 40W	myclobutanil	40% WP	22399
Azalea	Gray mold or bud rot	Exotherm Termil Protectant	chlorothalonil	20% PO	16661
		Rovral	iprodione	50% WP	15213
	Pythium and Phytophthora	Aliette WDG	fosetyl-Al	80% WDG	24458

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Begonia	Gray mold or bud rot	Easout Turf & Ornamental Fungicide	thiophanate-methyl	70% WP	19465
		Exotherm Termil	chlorothalonil	20% PO	16661
		Rovral	iprodione	50% WP	15213

	Powdery mildew	Easout Turf & Ornamental Fungicide Phyton 27	thiophanate-methyl copper complex	70% WP 5.5%	19465 21699
	Root, stem and crown rots and damping-off , Pythium and Phytophthora	Aliette WDG Subdue 2G Truban	fosetyl-Al metalaxyl etridiazole	80% WDG 2% GR 25% EC	24458 18818 12222
	Root, stem and crown rots and damping-off	Clean Crop Captan 80W Clean Crop Captan 80W Captan 80 WDG Clean Crop Supra Captan Maestro 75 DF Maestro 80DF No-Damp	captan captan captan captan captan captan oxine benzoate	80% WP 80% WP 80% WDG 80% WDG 75% DF 80% DF 2.5% SN	23190 10780 23691 24613 23350 26408 3794
	Stem rot (Rhizoctonia)	Terraclor Quintozene 75%	quintozene quintozene	75% WP 75% WP	7251 11425
Bulbs	Damping-off, bulb rot	Greenleaf Bulb Dust Later's Bulb Dust Wilson's Bulb Dust	captan + carbaryl captan + carbaryl captan + carbaryl	5% + 5% DU 5% + 5% DU 5% + 5% DU	15389 12146 14852
		Clean Crop Captan 80W Clean Crop Captan 80W Captan 80 WDG Clean Crop Supra Captan Maestro 75DF Maestro 80DF	captan captan captan captan captan captan	80% WP 80% WP 80% WDG 80% WDG 75% DF 80% DF	23190 10780 23691 24613 23350 26408
		Fusarium bulb rot	Greenleaf Benomyl Later's Benomyl Wilson's Benomyl	benomyl benomyl benomyl	50% WP 50% WP 50% WP
	Nematodes	Clean Crop Formalin	formaldehyde	37 % LI	6998
	Sclerotinia bulb rot	Quintozene 75%	quintozene	75% WP	11425
	Calceolaria	Gray mold or bud rot	Exotherm Termil	chlorothalonil	20% PO

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Carnation	Alternaria leaf spot & branch rot	Daconil 2787	chlorothalonil	40.4% F	15724
	Gray mold or bud rot	Daconil 2787	chlorothalonil	40.4% FL	15724
		Easout Turf & Ornamental Fungicide	thiophanate-methyl	70% WP	19465
	Stem rot (Rhizoctonia)	Exotherm Termil	chlorothalonil	20% PO	16661
		Root, stem and crown rots and damping-off	Clean Crop Captan 80W Clean Crop Captan 80W Captan 80 WDG Clean Crop Supra Captan Maestro 75DF Maestro 80DF No-Damp	captan captan captan captan captan captan oxine benzoate	80% WP 80% WP 80% WDG 80% WDG 75% DF 80% DF 2.5% SN
Celosia	Damping-off	Rovral	iprodione	50% WP	15213
	Pythium, Phytophthora	Aliette WDG	fosetyl-Al	80% WDG	24458
Chrysanthemum	Gray mold or bud rot	Botran 75W	dicloran	75% WP	8772
		Daconil 2787	chlorothalonil	40.4% F	15724
	Powdery mildew	Easout Turf & Ornamental Fungicide	thiophanate-methyl	70% WP	19465
		Exotherm Termil	chlorothalonil	20% PO	16661
	Root, stem and crown rots and damping-off	Rovral	iprodione	50% WP	15213
		Root, stem and crown rots and damping-off	Clean Crop Captan 80W Clean Crop Captan 80W Captan 80 WDG Clean Crop Supra Captan Maestro 75DF Maestro 80DF No-Damp	captan captan captan captan captan captan oxine benzoate	80% WP 80% WP 80% WDG 80% WDG 75% DF 80% DF 2.5% SN
Root, stem and crown rots and damping-off (Pythium, Phytophthora)	Truban Subdue 2G	etrizazole metalaxyl	25% EC 2% GR	12222 18818	
Stem rot (Rhizoctonia)	Terraclor Quintozene 75%	quintozene quintozene	75% WP 75% WP	7251 11425	

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Chrysanthemum, cut	Powdery mildew, rust	Nova 40W	myclobutanil	40% WP	22399
Cineraria	Gray mold or bud rot	Easout Turf & Ornamental Fungicide Exotherm Termil Rovral	thiophanate-methyl chlorothalonil iprodione	70% WP 20% PO 50% WP	19465 16661 15213
	Powdery mildew	Easout Turf & Ornamental Fungicide	thiophanate-methyl	70% WP	19465
Coleus	Gray mold or bud rot	Exotherm Termil	chlorothalonil	20% PO	16661
	Root, stem and crown rots and damping-off	Clean Crop Captan 80W	captan	80% WP	23190
		Clean Crop Captan 80W	captan	80% WP	10780
		Captan 80 WDG	captan	80% WDG	23691
		Clean Crop Supra Captan	captan	80% WDG	24613
Maestro 75DF		captan	75% DF	23350	
Maestro 80DF		captan	80% DF	26408	
No-Damp	oxine benzoate	2.5% SN	3794		
Root, stem and crown rots and damping-off (Pythium, Phytophthora)	Truban Subdue 2G	etr Diazole metalaxyl	25% EC 2% GR	12222 18818	
Stem rot (Rhizoctonia)	Terraclor Quintozene 75%	quintozene quintozene	75% WP 75% WP	7251 11425	
Cyclamen	Gray mold or bud rot	Easout Turf & Ornamental Fungicide Exotherm Termil Rovral	thiophanate-methyl chlorothalonil iprodione	70% WP 20% PO 50% WP	19465 16661 15213
	Gray mold	Phyton 27	copper complex	5.5% L	21699
	Erwinia soft rot	Phyton 27	copper complex	5.5% L	21699
Fuchsia	Gray mold	Exotherm Termil Phyton 27 Rovral	chlorothalonil copper complex iprodione	20% PO 5.5% L 50% WP	16661 21699 15213

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Geranium	Blackleg	No-Damp Subdue 2G	oxine benzoate metalaxyl	2.5% SN 2% GR	3784 18818
	Gray mold or bud rot	Botran 75W Daconil 2787 Exotherm Termil Rovral	dicloran chlorothalonil chlorothalonil iprodione	75% WP 70% WP 20% PO 50% WP	8772 15724 16661 15213
	Gray mold	Phyton 27	copper complex	5.5% L	21699
	Root, stem and crown rots and damping-off	Clean Crop Captan 80W Clean Crop Captan 80W Captan 80 WDG Clean Crop Supra Captan Maestro 75DF Maestro 80DF No-Damp	captan captan captan captan captan captan oxine benzoate	80% WP 80% WP 80% WDG 80% WDG 75% DF 80% DF 2.5% SN	23190 10780 23691 24613 23350 26408 3794
	Root, stem and crown rots and damping-off (Pythium, Phytophthora)	Aliette WDG Truban Subdue 2G	fosetyl-Al etrizadiazole metalaxyl	80% WDG 25% EC 2% GR	24458 12222 18818
	Rust	Nova 40W	myclobutanil	40% WP	22399
	Stem rot (Rhizoctonia)	Terraclor Quintozene 75%	quintozene quintozene	75% WP 75% WP	7251 11425
	<i>Xanthomonas campestris</i>	Phyton 27	copper complex	5.5% L	21699
	Gerbera	Gray mold	Phyton 27	copper complex	5.5% L
Powdery mildew		Nova 40W	myclobutanil	40% WP	22399
Gloxinia	Gray mold or bud rot	Exotherm Termil Rovral	chlorothalonil iprodione	20% PO 50% WP	16661 15213
	Root , stem and crown rots and damping-off (Pythium , Phytophthora)	Truban Subdue 2G	etrizadiazole metalaxyl	25% EC 2% GR	12222 18818
	Root, stem and crown rots and damping-off	Clean Crop Captan 80W Clean Crop Captan 80W Captan 80 WDG Clean Crop Supra Captan Maestro 75DF Maestro 80DF No-Damp	captan captan captan captan captan captan oxine benzoate	80% WP 80% WP 80% WDG 80% WDG 75% DF 80% DF 2.5% SN	23190 10780 23691 24613 23350 26408 3794
	Stem rot (Rhizoctonia)	Terraclor Quintozene 75%	quintozene quintozene	75% WP 75% WP	7251 11425

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Hibiscus	Gray mold	Phyton 27	copper complex	5.5% L	21699
Hydrangea	Gray mold	Daconil 2787	chlorothalonil	40.4% F	15724
		Easout Turf & Ornamental Fungicide	thiophanate-methyl	70% WP	19465
		Exotherm Termil	chlorothalonil	20% PO	16661
	Powdery mildew	Easout Turf & Ornamental Fungicide	thiophanate-methyl	70% WP	19465
		Exotherm Termil	chlorothalonil	20% PO	16661
	Root , stem and crown rots and damping-off (Pythium , Phytophthora)	Truban Subdue 2G	etrifiazole metalaxyl	25% EC 2% GR	12222 18818
Root, stem and crown rots and damping-off	Clean Crop Captan 80W Clean Crop Captan 80W Captan 80 WDG Clean Crop Supra Captan Maestro 75DF Maestro 80DF No-Damp	captan captan captan captan captan oxine benzoate	80% WP	23190	
			80% WP	10780	
			80% WDG	23691	
			80% WDG	24613	
			75% DF	23350	
80% DF	26408				
2.5% SN	3794				
Stem rot (Rhizoctonia)	Terraclor Quintozone 75%	quintozone quintozone	75% WP	7251	
			75% WP	11425	
Lily	Gray mold or bud rot	Exotherm Termil	chlorothalonil	20% PO	16661
		Daconil 2787	chlorothalonil	40.4% F	15724
New Guinea impatiens	Gray mold, powdery mildew	Phyton 27	copper complex	5.5% L	21699
	Pythium and Phytophthora	Aliette WDG	fosetyl-Al	80% WDG	24458
Orchid	Gray mold	Phyton 27	copper complex	5.5% L	21699
Petunia	Gray mold	Daconil 2787	chlorothalonil	40.4% F	15724
	Pythium and Phytophthora	Aliette WDG	fosetyl-Al	80% WDG	24458
Poinsettia	Gray mold or bud rot	Easout Turf & Ornamental Fungicide	thiophanate-methyl	70% WP	19465
		Exotherm Termil	chlorothalonil	20% PO	16661
		Rovral	iprodione	50% WP	15213
	Gray mold	Phyton 27	copper complex	5.5% L	21699
	Powdery mildew	Nova 40W Phyton 27	myclobutanil copper complex	40% WP 5.5% L	22399 21699
Root, stem and crown rots and damping-off (Pythium, Phytophthora)	Subdue 2G Truban	metalaxyl etrifiazole	2% GR 25% EC	18818 12222	
Primula	Gray mold	Phyton 27	copper complex	5.5% L	21699

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Rose	Black spot	Botran 75W Exotherm Termil	dicloran chlorothalonil	75% WP 20% PO	8772 16661
	Gray mold or bud rot	Botran 75W Daconil 2787 Easout Turf & Ornamental Fungicide Exotherm Termil	dicloran chlorothalonil thiophanate-methyl chlorothalonil	75% WP 40.4% F 70% WP 20% PO	8772 15724 19465 16661
	Gray mold	Phyton 27	copper complex	5.5% L	21699
	Powdery mildew	Easout Turf & Ornamental Fungicide Nova 40W Phyton 27	thiophanate-methyl myclobutanil copper complex	70% WP 40% WP 5.5% WP	19465 22399 21699
Salvia	Damping-off	Rovral	iprodione	50% WP	15213
	Pythium and Phytophthora	Aliette WDG	fosetyl-Al	80% WDG	24458
Snapdragon	Gray mold or bud rot	Exotherm Termil	chlorothalonil	20% PO	16661
	Root, stem and crown rots and damping-off (Pythium , Phytophthora)	Truban Subdue 2G	etridiazole metalaxyl	25% EC 2% GR	12222 18818
	Root, stem and crown rots and damping-off	Clean Crop Captan 80W Clean Crop Captan 80W Captan 80 WDG Clean Crop Supra Captan Maestro 75DF Maestro 80DF No-Damp	captan captan captan captan captan captan oxine benzoate	80% WP 80% WP 80% WDG 80% WDG 75% DF 80% DF 2.5% SN	23190 10780 23691 24613 23350 26408 3794
	Stem rot (Rhizoctonia)	Terraclor Quintozene 75%	quintozene quintozene	75% WP 75% WP	7251 11425
Spathiphyllum	Gray mold	Phyton 27	copper complex	5.5% L	21699
	Pythium and Phytophthora	Aliette WDG	fosetyl-Al	80% WDG	24458
Tulip	Botrytis	Clean Crop Captan 80W Clean Crop Captan 80W Captan 80 WDG Clean Crop Supra Captan Maestro 75DF Maestro 80DF	captan captan captan captan captan captan	80% WP 80% WP 80% WDG 80% WDG 75% DF 80%DF	23190 10780 23691 24613 23350 26408
Vinca	Pythium, Phytophthora	Aliette WDG	fosetyl-Al	80% WDG	24458

TABLE 2. Fungicides Registered for Use on Greenhouse Vegetables

Host	Disease	Trade Name	Active Ingredient	Formulation	PCP#
Green house vegetables such as cucumber, tomato, lettuce.	Damping off, root and stem rot, and Wilt caused by <i>Fusarium</i>	Mycostop Biofungicide	<i>Steptomycetes griseoviridis</i> Strain K61	10 cfu/g	26265
Cucumber	Fusarium	Captan 75 Seed Protectant	captan	75% WP	6007
	Gray mold	Clean Crop Ferbam	ferbam	76% WG	20136
		Ferbam 76 WDG	ferbam	76% WG	20536
		Rovral	iprodione	50% WP	15213
	Gummy stem blight	Benlate + Manzate 200 Rovral Nova 40W	benomyl	50% WP	11062
			mancozeb	80% WP	10526
iprodione			50% WP	15213	
myclobutanil			40% WP	22399	
Powdery mildew	Benlate + Manzate 200 Kumulus DF	benomyl	50% WP	11062	
		mancozeb sulphur	80% WP 80% WG	10526 18836	
Pythium root diseases	Previcur N	propamocarb hydrochloride	722 g/L	26288	
Seed decay, seedling blight and damping-off	Thiram	thiram	75% WP	15933	
Lettuce	Downy mildew	Aliette (B. C. only)	fosetyl-Al	80% WDG	24458
	Gray mold	Clean Crop Ferbam Ferbam 76 WDG Rovral	ferbam	76% WG	20136
			ferbam	76% WG	20536
			iprodione	50% WP	15213
Sclerotinia drop	Rovral	iprodione	50% WP	15213	
Seed decay, seedling blight and damping-off	Thiram	thiram	75% WP	15933	
Pepper	Root, crown & stem rots and damping off	Captan 80W	captan	80% WP	23190
		Captan 80W	captan	80% WP	10780
Maestro 75F		captan	75% DF	23350	
Maestro 80DF		captan	80% DF	26408	
Seed decay, seedling blight and damping-off	Thiram	thiram	75% WP	15933	
Tomato	Bacterial canker	Clean Crop Copper Spray	copper oxychloride	50% WP	19146
		Guardsman Copper oxychloride	copper oxychloride	50% WP	13245
	Early blight, Septoria leaf spot	Manzate 200	mancozeb	80% WP	10526
	Gray leaf spot	Clean Crop Captan 50W	captan	50% WP	5371
	Gray mold	Clean Crop Ferbam Exotherm Termil Protectant Ferbam 76 WDG Rovral	ferbam	76% WG	20136
chlorothalonil			20% PO	16661	
ferbam iprodione			76% WG 50% WP	20536 15213	
Gray mold (stem rot)	Benlate ^(a) + Manzate 200	benomyl mancozeb	50% WP 80% WP	11062 10526	

^(a)Not registered for use on hydroponically grown greenhouse tomatoes.

Table 2. Fungicides Registered for Use on Greenhouse Vegetables con't

Tomato con't	Leaf mold	Benlate ^(a) + Manzate 200	benomyl mancozeb	50% WP 80% WP	11062 10526
	Powdery mildew	Barlett Microscopic Sulphur Nova 40 W	sulphur myclobutanil	92% WP 40% WP	873 22399
	Root, crown & stem rots and damping off	Captan 80W Captan 80W Maestro 75F Maestro 80DF	captan captan captan captan	80% WP 80% WP 75% DF 80% DF	23190 10780 23350 26408
	Root, stem and fruit rots (see Gray mold of tomato)				
	Seed decay, seedling blight and damping- off	Thiram	thiram	75% WP	15933

^(A)Not registered for use on hydroponically grown greenhouse tomatoes.

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	Active Ingredients	Spectrum of Control	Crops	Pre-Plant Interval (days)	PCP#
Telone C-17 Telone C-17-R	Chloropicrin + 1,3-dichloropropene (COM) LI	nematodes	lettuce, pepper, tomato, ornamentals	14+	16324 16323
BASF Basamid	Dazomet (COM) GR	fungi, weeds, nematodes (uncysted)	lettuce, pepper, eggplant, tomato, annual flower beds	10-40	15032
Telone II Telone II-B	1,3-dichloropropene (COM) LI, SN	nematodes	vegetables, ornamentals	14+	15893 13368
Methyl Bromide	Methyl Bromide (RES) LI	damping off organisms (<i>Fusarium</i> , <i>Pythium</i> , <i>Rhizoctonia</i>), insects, nematodes, weed seeds	ornamentals, vegetable transplants, compost, manure, topsoil	7	16495
Vorlex Plus	Methyl isothiocyanate + 1,3- dichloropropene + related chlorinated C3 hydrocarbons (COM) LI	damping-off, nematodes, weeds, wireworms	lettuce ornamentals tomato	7-14	18353
Vorlex Plus CP	Methyl isothiocyanate + 1,3- dichloropropene + chloropicrin (COM) LI	damping-off, nematodes, symphyllids, weeds, wilt, wireworms	lettuce ornamentals tomato	14	18354
Vapam	Metam-sodium (COM) SN	damping-off, nematodes, symphyllids, weeds, root rots	ornamentals vegetables	21-30	6453