## Chapter Twelve

# DISEASES OF VEGETABLE CROPS

# ASPARAGUS (*Asparagus officinalis*)

## CROWN ROT and SEEDLING BLIGHT

*Fusarium* spp.

**Cultural**: Plant disease-free crowns if possible. Rotate infested fields with grasses or cereals (1).

**Resistant cultivars**: None.

**Intermediate**: Jersey Giant, Lucullus 234 and 328.

**Chemical**: If disease-free soil is not available for growing seedlings, fumigate seedbed with methyl bromide 98% LI (RES) or other soil fumigant according to usual procedures (see chapter 4, under General Disease Control Methods for Greenhouse Crops). Dip plants in benomyl (COM) WP prior to transplanting. Sodium chloride will suppress crown and root rot symptoms (4). Limitations: As per label.

**Notes**: In Washington and Oregon, seed-borne inoculum is controlled through the use of a 2,000 ppm benomyl seed soak for 24 hr at room temperature followed by 10 min at 55ºC. In Ontario, a sodium hypochlorite seed treatment is recommended.

**References**:


1. Cohen, S.I. and Heald, F.D. 1941. A wilt and root rot of asparagus caused by *Fusarium oxysporum*. Plant Dis. Rep. 25: 503-509.

2. Damicone, J.P. and Manning, W.J. 1984. Frequency and pathogenicity of *Fusarium* spp. isolated from first year asparagus grown from transplants. Plant Disease 69: 413-416.

3. Damicone, J.P. *et al.* 1981. Benomyl in acetone eradicates *Fusarium moniliforme* and *F. oxysporum* from asparagus seed. Plant Disease 65: 892-893.

4. Elmer, W.H. 1992. Suppression of Fusarium crown and root rot of asparagus with sodium chloride. Phytopathology 82: 97-104.

5. Elmer, W.H. *et al.* 1996. Epidemiology and management of the diseases causal to asparagus decline. Plant Dis. 80: 117-125.

6. Stephens, E.T. *et al.* 1989. Evaluation of asparagus species for resistance to *Fusarium oxysporum* f. sp. *asparagi* and *F. moniliforme.* HortScience 24: 365-368.


## RUST

*Puccinia asparagi*

**Cultural**: Avoid areas having poor air circulation. Cut or destroy all volunteers around fence lines, etc. Grow only resistant cultivars. Irrigate early in the day so that plants do not remain wet overnight.

**Resistant Cultivars**: None.

**Intermediate**: Jersey Centennial, Jersey Giant, Viking, UC-157.

**Susceptible**: Mary Washington, WSU-1.

**Chemical**: After harvesting has been completed for the year but before disease normally appears, spray fern growth every 10-14 days as required with metiram (COM) WG or zineb (COM) WP (3). Apply propiconazole (COM) EC as soon as fern growth begins at 14 to 21 day intervals, maximum of three applications per season. Apply myclobutanil (COM) WP postharvest to ferns, maximum of 5 applications per season.

**Limitations**: As per labels. Do not apply to spears to be cut.

**Notes**: Use of resistant cultivars is usually sufficient.

**References**:

1. Hepler, P.R. *et al.* 1957. Inheritance of resistance to asparagus rust in Illinois; its causal agent and control. Ill. Agric. Exp. Sta., Bull. 607: 1-47.

2. Johnson, D.A. and Lunden, J.D. 1992. Effect of rust on yield of susceptible and resistant asparagus cultivars. Plant Dis. 76: 84-86.

3. Linn, M.B. and Lubani, K.R. 1958. Zineb as a protective fungicide for the control of asparagus rusts. Plant Dis. Rep. 42: 669-672.

## PURPLE SPOT

*Stemphylium vesicarium (Pleospora allii)*

**Cultural**: Avoid introducing the disease by using treated seed (see fusarium wilt) or crowns from a disease-free field. Incorporate or burn crop refuse at end of season to reduce overwintering (1).

**Resistant Cultivars**: None.

**Intermediate**: Jersey Giant

**Susceptible**: Mary Washington

**Chemical**: Zineb used for control of rust reduces the level of disease on ferns but is not registered for use on spears.

**References**:

1. Johnson, D.A. 1990. Effect of crop debris management on severity of stemphylium purple spot of asparagus. Plant Disease 74: 413-415.

2. Johnson, D.A. and Lunden, J.D. 1986. Effects of woundings and wetting duration on infection of asparagus by *Stemphylium vesicarium*. Plant Disease 70: 419-420.

3. Lacy, M.L. 1982. Purple spot: A new disease of young asparagus spears caused by *Stemphylium vesicarium.* Plant Disease 66: 1198-1200.

4. Menzies, S.A. *et al.* 1984. Asparagus: Stemphylium leafspot. New Zealand Commercial Grower 3: 37.

# BEANS (snap) (*Phaseolus vulgaris*)

## ANTHRACNOSE

*Colletotrichum lindemuthianum* (= *Glomerella lindemuthiana*, perfect state)

**Cultural**: The use of clean seed; rotation for 2-3 years with nonhost crops (i.e. cereals and corn) to reduce initial inoculum from infested debris.

**Resistant Cultivars**: Few cultivars are resistant to all the major races (Alpha, gamma, delta, kappa and lambda).

**Chemical**: Clean Crop Copper 53W (tribasic copper sulphate) 53% WP (COM) - as needed to keep plants covered. Seed treatment for white beans: captan + diazinon + thiophanate-methyl (COM) WP (see note). Limitations: As per labels.

**Note**: DCT Dual Purpose (captan + diazinon + thiophanate-methyl) will not control anthracnose if seed is severely infected.

**References**:

1. Goth, R.W. and Zaumeyer, W.J. 1965. Reactions of bean varieties to four races of anthracnose. Plant Dis. Rept. 49: 815-818.

2. Hall, R. Ed. 1994. Compendium of Bean Diseases. APS Press., St. Paul, Mn., USA. 73 pp.

3. Howard, R.J., Garland, J.A. and Seaman, W.L. (Eds.) 1994. Diseases and Pests of Vegetable Crops in Canada. The Canadian Phytopathological Society and Entomological Society of Canada. 554 pp.

## BACTERIAL BLIGHT, FUSCOUS BLIGHT, HALO BLIGHT

*Xanthomonas campestris* pv. *phaseoli*, *Pseudomonas syringae* pv. *phaseolicola*

**Cultural**: Use only disease-free seed (3) produced in blight-free areas of the Western United States if possible. Plow under crop refuse promptly after harvest. Follow a 3-year rotation out of beans. Do not work in fields when foliage is wet. Avoid sprinkler irrigation.

**Resistant Cultivars**: Extensive lists of resistant cvs. are available but are of little use unless the exact identity of the pathogen has been determined (1,2).

**Chemical**: Tribasic copper sulfate (COM, DOM) WP; cupric hydroxide (COM) WP (see note 1). For control of bacterial blight in breeders seed only - streptomycin sulfate (COM) WP (PCP# 10305, registration expires December 31, 2001).

**Limitations**: Preharvest interval - 1 day (tribasic copper sulphate, cupric hydroxide). Do not use streptomycin on beans for food or fodder.

**Notes**:

1. Chemical control is not practical except for small seed plots or other special situations.

**References**:


1. Burkholder, W.H. and Bullard, E.T. 1946. Varietal susceptibility of beans to *Xanthomonas phaseoli* var. *fuscans*. Plant Dis. Rep. 30: 446-448.

2. Goth, R.W. and Zaumeyer, W.J. 1965. Reactions of bean varieties to four races of anthracnose. Plant Dis. Rep. 49: 815-818.

3. Mackie, W.W. *et al.* 1945. Production in California of snap bean seed free from blight and anthracnose. Calif. Agric. Exp. Sta., Bull. 689: 1-23.

4. Ntahimpera, N. *et al.* 1996. Anthracnose development in mixtures of resistant and susceptible dry bean cultivars. Phytopathology 86: 668-673.

5. Tu, J.C. 1994. Occurrence and characterization of the alpha-Brazil race of bean anthracnose (*Colletotrichum lindemuthianum*) in Ontario. Can. J. Plant Pathol. 16: 129-131.

6. Wallen, V.R. and Galway, D.A. 1979. Effective management of bacterial blight of field beans in Ontario - a 10 year program. Can. J. Plant Pathol. 1: 42-46.

7. Webster, D.M. *et al.* 1983. Bacterial blights of snapbeans and their control. Plant Dis. 67: 935-940.


## DRY ROOT ROT

*Fusarium solani* f.sp. *phaseoli*

**Cultural**: In fields where root rot is known to be a problem, cultivate and fertilize to obtain maximum growth. Plow down crop refuse promptly after harvest. Follow long rotation with wheat, other cereals, or grasses (2, 3).

**Resistant Cultivars**: Cultivars range from very susceptible to very resistant with most of the common cvs. being intermediate (1).

**Chemical**: Apply captan (COM) WG as a seed bed treatment, worked into upper 7.5 to 10 cm of soil before planting. Limitations: As per label.

**References**:


1. Boomstra, A.G. *et al.* 1977. New sources of Fusarium root rot resistance in *Phaseolus vulgaris* L. J. Amer. Soc. Hort. Sci. l02: 182-185.

2. Maier, C.R. 1968. Influence of nitrogen nutrition on Fusarium root rot of pinto beans and on its suppression by barley straw. Phytopathology 58: 620-625.

3. Miller, D.E. and Burke, D.W. 1974. Influence of soil bulk density and water potential on *Fusarium solani* f. sp. *phaseoli* root rot of beans. Phytopathology 64: 526-529.


## GRAY MOLD

*Botrytis cinerea*

**Cultural**: Maintain air circulation through good weed control and avoid dense, lush growth. Avoid long periods of overhead irrigation particularly during flowering.

**Resistant Cultivars**: None.

**Chemical**: Iprodione (COM) as per label recommendation applied when 30 and 50% of blossoms have opened. Thorough coverage is essential for control. Vinclozolin (COM) WG as per label recommendation at early bloom and full bloom (BC only).

**Limitations**: Preharvest intervals - iprodione: apply at bloom only; 20 days: (vinclozolin). Do not apply more than 3 kg/ha of Ronilan DF (vinclozolin) per season.

**Notes**: Alternation of iprodione with other fungicides is recommended to minimize the risk of fungicide resistance. Benomyl (COM) WP and dicloran (COM) WP are also registered for gray mold, but provide limited control in most areas.

**References**:

1. Gabrielson, R.L. *et al.* 1971. Field control of white and gray molds of beans in Western Washington. Plant Dis. Rep. 55: 234-238.

2. Sweeney, M.E. and Ormrod, D.J. 1983. Fungicide applications for the control of grey and white molds of snapbeans. Pp. 229 *in* Pesticide Research Report. ECPUA, Ottawa.

## MOSAICS

Bean Common Mosaic Virus, Bean Yellow Mosaic Virus

**Cultural**: If common mosaic is a problem, select resistant cultivars. Avoid bean yellow mosaic by planting beans at least 0.5 km from sweet, crimson or red clover and gladioli, which may carry the virus (3).

**Resistant Cultivars**: Most cultivars of snap and dry beans now commonly grown are resistant to common mosaic (2).

**Chemical**: None.

**Notes**: Aphid control may reduce rate of spread.

**References**:

1. Hampton, R.O. 1975. The nature of bean yield reduction by bean yellow and bean common mosaic viruses. Phytopathology 65: 1342-1346.

2. Zaumeyer, W.J. and Meiners, J.P. 1975. Disease resistance in beans. Ann. Rev. Phytopathol. 13: 313-334.

3. Zaumeyer, W.J. and Thomas, H.R. 1957. A monographic study of bean diseases and methods for their control. U.S. Dep. Agric., Bull. 868: 90-107.

## PYTHIUM DAMPING-OFF AND PHYTOPHTHORA ROOT ROT

*Pythium* spp; *Phytophthora* spp..

**Cultural**: Sow seed as shallowly as possible into a well-drained, warm and moist but not wet soil. Bean crops should be rotated with grains or pasture crops rather than vegetable crops.

**Resistant Cultivars**: None.

**Chemical**: Apply metalaxyl (COM) EC at planting to the seed furrow. Treat seed with captan (COM) SU. Apply captan (COM) WG as a seed bed treatment, worked into upper 7.5 to 10 cm of soil before planting

**Limitations**: As per label. Apply metalaxyl only once per year during seeding. Seed treated by the slurry of captan should not be bagged or stacked until it has dried. A colourant must be added to captan to colour seed.

**References**:

1. Adegbola, M.O.K. and Hagedorn, D.J. 1970. Host resistance and pathogen virulence in Pythium blight of bean. Phytopathology 60: 1477-1479.

2. Hall, R. Ed. 1994. Compendium of bean diseases. APS Press. St. Paul, MN, USA. 73 pp.

3. Howard, R.J., Garland, J.A. & Seaman, W.L. 1994. Diseases and Pests of Vegetable Crops in Canada: An Illustrated Compendium. Can. Phytopath. Soc. and Ent. Soc. Canada. Ottawa, Canada, 554 pp.

## RUST

*Uromyces appendiculatus* (syn. *Uromyces phaseoli*)

**Cultural**: Plow under crop refuse after harvest. Follow a 3-year rotation with non-legume crops. Disinfest used posts and stakes in commercial formalin 1:30 or lime sulphur 1:10 (2).

**Resistant Cultivars**: Most bush beans are resistant; most popular pole beans are susceptible although some are resistant to certain races.

**Chemical**: Where early infections occur use of sulphur (COM, DOM) WP dusts or sprays at 7-day intervals up to blossoming may be warranted.

**Limitations**: Preharvest interval - 1 day (sulphur).

**References**:

1. Stavely, J.R. 1984. Pathogenic specialization in *Uromyces phaseoli* in the United States and rust resistance in beans. Plant Dis. 68: 95-99.

2. Zaumeyer, W.J. and Thomas, H.R. 1957. A monographic study of bean diseases and methods for their control. U.S. Dep. Agric., Tech. Bull. 868: 34-42.

## STEM ROT (WHITE MOLD)

*Sclerotinia sclerotiorum*

**Cultural**: Avoid dense foliage by restricting nitrogen fertility and moisture levels. Rotate with non-susceptible crops such as beets, onions, spinach, corn, cereals, and grasses (1, 2).

**Resistant Cultivars**: None.

**Chemical**: Benomyl (COM) WP at full bloom or a split application at first and full bloom. Thorough coverage of blossoms is essential (4). Thiophanate-methyl (COM) WP applied during early stages of bloom prior to rows closing in (white beans only). Iprodione (COM) WG, WP can be used. Vinclozolin (COM) WG is registered for white mold and as used for gray mold in British Columbia will also control white mold (3). Dicloran (COM) WP is registered for control of sclerotinia on beans.

**Limitations**: Preharvest interval - 2 days (dicloran); 14 days (benomyl); 20 days (vinclozolin). Do not feed treated crop refuse to livestock.

**Notes**: Chlorothalonil [Bravo] and thiophanate-methyl [Senator] are registered for use only on dry (field) beans (see Field Beans in Chapter 10) (5). Dicloran (Botran) is registered for use on snap beans, dry beans and pole beans (BC only).

**References**:

1. Gabrielson, R.L. *et al.* 1971. Field control of white and gray molds of beans in Western Washington. Plant Dis. Rep. 55: 234-238.

2. Natti, J.J. 1979. Epidemiology and control of bean white mold. Phytopathology 61: 669-674.

3. Ormrod, D.J., Sweeney, M.E. and Brookes, V.R. 1993. Efficacy of single applications of fungicides at 10% bloom against gray and white mold of snapbeans. Pesticide Research Report. ECPUA Ottawa.

4. Sweeney, M.E. and Ormrod, D.J. 1983. Fungicide applications for the control of grey and white mold of snapbeans. Pp. 229 *in* Pesticide Research Report. ECPUA, Ottawa

5. Tu, J.C. 1983. Efficacy of iprodione against alternaria black pod and white mold of white beans. Can. J. Plant Pathol. 5: 133-135.

# BEET (*Beta vulgaris)*

See SUGAR BEET, in Chapter 10.

# BROAD BEAN (*Vicia fabae*)

See FABABEAN, in Chapter 10.

# BROCCOLI, BRUSSELS SPROUTS, CABBAGE, CAULIFLOWER (*Brassica oleracea*)

## BLACKLEG

*Leptosphaeria maculans* (imperfect state *Phoma lingam*)

**Cultural**: Use clean seed or hot water-treated seed (see Black rot on this page). Eradicate cruciferous weeds. Use a 4-year crop rotation with non-cruciferous crops. Maintain good soil drainage.

**Resistant Cultivars**: None.

**Chemical**: Seed treatment with carbathiin-thiram-lindane (COM) is registered for use.

**Notes**: Carbathiin-thiram-lindane seed treatment for damping-off will also help to control seed-borne blackleg.

**References**:

1. Gabrielson, R.L. *et al.* 1977. Fungicidal eradication of seed-borne *Phoma lingam* of crucifers. Plant Dis. Rep. 61: 118-121.

2. Kharbanda, P.D. 1992. Performance of fungicides to control blackleg of canola. Can. J. Plant Path. 14: 169-176.

3. Petrie, A. and Vanterpool, T.C. 1974. Infestation of crucifer seed in Western Canada by the blackleg fungus *Leptosphaeria maculans*. Can. Plant Dis. Survey 54: 119-123.

## BLACK ROT

*Xanthomonas campestris* pv. *campestris*

**Cultural**: Use clean seed or seed soaked in water at 50°C for 25 min. for cabbage and Brussels sprouts and 15 min. for cauliflower or broccoli. This treatment may reduce germination. Use a 2-year rotation out of crucifers in production fields (1). Use a 3-year rotation in the transplant bed. This is important since most spread of the disease occurs in the seed bed.

**Resistant Cultivars**: King Cole and Roundup cabbage are said to be highly tolerant. See seed catalogue descriptions for additional resistant cultivars.

**Chemical**: Seed may be treated with Streptomycin 17 (COM) WP. Soak seed in 500 ppm solution for 60 minutes. Read label for additional instructions. Limitations: See label for handling precautions.

**References**:

1. Lockhart, C.L. *et al.* 1976. Control of *Xanthomonas campestris* in Brussels sprouts with hot water and Aureomycin seed treatment. Can. Plant Dis. Survey 56: 63-66.

2 Schaad, N.W. 1989. Detection of *Xanthomonas campestris* pv. *campestris* in crucifers. Pp. 68-75 *in* Saettler, A.W. *et al*. Detection of Bacteria in Seed and other Planting Material. APS Press, St. Paul, MN. 122 pp.

3. Williams, P.H. 1980. Black rot: a continuing threat to world crucifers. Plant Dis. 64: 736-742.

4. Kocks, C.G. and Zadoks, J.C. 1996. Cabbage refuse piles as sources of inoculum for black rot epidemics. Plant Dis. 80: 789-792.

## CLUBROOT

*Plasmodiophora brassicae*

**Cultural**: Plant seed in soil known to be free of clubroot. Where plants are to be set out rather than seeded direct, be sure the seed bed is free of clubroot or thoroughly fumigated before seeding (see Notes). Plant early in well drained soils. Where clubroot is known to occur, rotate with other than cole crops at least 3 out of every 4 years. In light sandy soils, thoroughly disk-in hydrated lime at 4.5 tonnes/ha at least 6 weeks before planting. Finely ground limestone at 10 tonnes/ha one year prior to planting is preferable (2,6). The pH of the soil must be raised above 7.0 for this treatment to be effective. This is not practical on muck soils (3). Do not over-fertilize. Use a soil test to determine nutritional requirements.

**Resistant Cultivars**: Cabbage - Badger Shipper, Richelain; broccoli - B 150 MC, Oregon CR1 (See note 3).

**Chemical**: While it is not a general recommendation because of the high cost and marginal control achieved, quintozene 75% WP (COM) is still registered for use. On the light sandy soils where experience has shown it to be effective, it may be applied as a transplanting drench. For cauliflower only, apply Agral 90 as a drench at planting for control. See label for directions (4).

**Limitations**: Quintozene is registered as a transplant treatment only.

**Notes**:

1. Clubroot is normally a problem only in acidic soils.

2. Lime should never be added to seed beds as it will mask symptoms.

3. Cultivar resistance (1) depends on the race(s) of clubroot present in the field. Badger Shipper cabbage and B 150 MC broccoli are resistant to race 6, the predominant race in B.C. Oregon CR1 broccoli is resistant to clubroot races 1, 4, and 6. Richelain cabbage has multi-race resistance.

4. Recent research has included solarization with and without chemicals; pre and post planting applications of calcium cyanamide; and biological control including the use of trap crops to stimulate spore germination.

**References**:

1 Campbell, R.N. *et al.* 1985. Factors related to control of clubroot of crucifers in the Salinas Valley of California. Phytopathol. 75: 665-670.

2. Chiang, M.S. and Crete, R. 1972. Screening crucifers for germplasm resistance to clubroot *Plasmodiophora brassicae*. Can. Plant Dis. Surv. 52: 45-50.

3. Dobson, R.L. *et al.* 1983. Effects of lime particle size and distribution and fertilizer formulation on clubroot disease caused by *Plasmodiophora brassicae*. Plant Dis. 67: 50-52.

4. Edgington, L.V. *et al.* 1986. Use of surfactants to control clubroot in cauliflower, 1986. Pesticide Research Report, ECPUA, Ottawa.

5. Myers, D.F. and Campbell, R.N. 1985. Lime and the control of clubroot of crucifers: effects of pH, calcium, magnesium and their interactions. Phytopathology 75: 670-673.

6 Sweeney, M.E. and Ormrod, D.J. 1986. Evaluation of soil fumigants for the control of clubroot and weeds in cole crop seedbeds. Pesticide Research Report, ECPUA, Ottawa.

## DOWNY MILDEW

*Peronospora parasitica*

**Cultural**: Rotate to noncruciferous plants. Use good field sanitation including destruction of mustard weeds. Avoid heavy seeding, over-watering, and the application of water after 3 p.m. Plow in crop remains as soon as harvest is complete. Obtain good soil coverage of plowed refuse to ensure early breakdown of crop remains.

**Resistant Cultivars**: A number of broccoli varieties with resistance are now available. Consult your seed supplier.

**Very Susceptible**: Waltham 29 broccoli.

**Chemical**: In the seed bed, spray seedlings at germination and repeat twice a week until transplanted, with zineb (COM) WP or chlorothalonil (COM) SU. In the field, after transplanting or direct seeding, use chlorothalonil (1, 3). Tribasic copper sulphate (COM, DOM) is also registered for use. For broccoli and bok choy only, apply fosetyl-Al (COM) WG up to 5 applications per season.

**Limitations**: As per label. Preharvest interval - 7 days (chlorothalonil, fosetyl-Al, zineb); 1 day (tribasic copper sulphate).

**References**

1. Natti, J.J. 1957. Control of downy mildew of broccoli with antibiotics and fungicides. Plant Dis. Res. 41: 780-788.

2. Natti, J.J. 1958. Resistance of broccoli and other crucifers to downy mildew. Plant Dis. Rep. 42: 656-662.

3. Natti, J.J. 1959. Control of downy mildew of broccoli with fungicide and fungicide-streptomycin combination sprays. Plant Dis. Rep. 43: 735-740.

## GRAY LEAF SPOT

*Alternaria brassicae*

**Cultural**: Rotate with non-cruciferous crops on a 4 or 5 year cycle and use clean seed or hot water-treated seed (see BLACK ROT on page 11). Eradicate cruciferous weeds.

**Resistant Cultivars**: None.

**Chemical**: In the seed bed, spray seedlings, at germination and repeat twice a week until transplanted, with zineb (COM) WP or chlorothalonil (COM) SU. In the field, after transplanting or direct seeding use chlorothalonil. Tribasic copper sulphate (COM, DOM) WP is also registered, but some formulations are not registered for use on broccoli. Apply iprodione (COM) WG, WP 1-2 days prior to tying of cauliflower or 7 to 14 days before harvest for cabbage.

**Limitations**: Preharvest interval: 7 days (chlorothalonil, zineb); 1 day (tribasic copper sulphate); 5 days for cauliflower, 7 days for cabbage (iprodione).

**References**:

1. Changsri, W. and Weber, G.F. 1963. Three *Alternaria* species pathogenic on certain cultivated crucifers. Phytopathology 53: 643-648.

## SCLEROTINIA ROT (DROP or WATERY SOFT ROT)

*Sclerotinia sclerotiorum*

**Cultural**: Rotate with more resistant crops such as grasses, cereals, beets, onions, spinach, or corn. Plant in well-drained soil. Use plant spacing that will allow good air circulation among plants. Practice good field sanitation (remove and destroy diseased plants). Disinfest storage bins before harvest using copper sulphate at 1 kg/50 liters of water as a spray. Storage area must be allowed to dry before storing produce.

**Resistant Cultivars**: None.

**Chemical**: None.

## SOFT ROT

*Erwinia* spp., *Pseudomonas* spp.

**Cultural**: Avoid bruising plants in cultivation and harvesting (1). Use plant and row spacing that will allow good air circulation (5). Prolonged overhead irrigation sets may increase the likelihood of water-soaking the plant tissue, thus favoring bacterial infection. Control root maggots, slugs, and chewing insects. Avoid excess nitrogen (2). Avoid frost injury (6). Disinfest storages with copper sulphate at 1 kg/50 liters of water or other disinfestants. Storage area must be allowed to dry before storing produce. Avoid warm, humid storage conditions.

**Resistant Cultivars**: Chinese cabbage lines CC-14-1, CC-18-2, C3-26, C3-27, C3-28 and C3-29.

**Chemical**: None.

**Notes**: Tribasic copper sulphate (COM, DOM) WP used for fungal diseases will also reduce bacterial infections in the field. Do not use surfactants with sprays applied during weather conducive to bacterial rots. When the cuticular wax is damaged by surfactants, water soaking and bacterial infection of the plant tissue increases.

**References**:

1. Burton, C.L. 1971. Bacterial soft rot and black spot disease of Bok Choy (Chinese chard). Plant Dis. Rep. 55: 1037-1039.

2. Farmer, L.J. *et al.* 1971. A firm head rot of broccoli. Plant Dis. Rep. 55: 1136.

3. Ren, J.P. *et al.* 2001. CC-14-1 and CC-18-2 progenies of Chinese cabbage derived from somatic hybridization for resistance to bacterial soft rot. Hort Science 36: 990-991.

4. Ren, J.P. and Dickson, M.H. 2001. Release of Chinese cabbage lines derived from recurrent selection for resistance to soft rot disease. HortScience 36: 992-994.

5. Smith, M.A. and Ramsey, G.B. 1956. Bacterial zonate spot of cabbage. Phytopathology 46: 210-213.

6. Sumner, D.R. 1972. Effect of freezing injury on head rot and spot of cabbage. Phytopathology 62: 322-325.

## SPROUT ROT OF BRUSSELS SPROUTS

Cause unknown (*Rhizoctonia* spp. and *Cladosporium* spp. associated)

**Cultural**: Use good field sanitation practices. Harvest as soon as sprouts are ready.

**Resistant Cultivars**: None. Jade Cross is very susceptible.

**Chemical**: None.

## WIRESTEM, DAMPING OFF

*Rhizoctonia solani*, *Pythium* spp.

**Cultural**: Delay planting as long as possible to avoid cold, wet soils that favor disease development. Avoid excessive irrigation. Grow seedlings for transplanting in fumigated seed beds. Reduce seeding rate in seed beds to allow

air circulation around plants.

**Resistant Cultivars**: None.

**Chemical**: Regardless of whether the seed is hot-water treated, it should be dusted before seeding with thiram (COM) WP or treated with carbathiin + thiram + gamma BHC. Limitations: As per label.

**Notes**: It has been observed that seedbed drenches with zineb (COM) WP or chlorothalonil (COM) SU for control of downy mildew also reduce wirestem incidence.

### YELLOWS

*Fusarium oxysporum* f. sp. *conglutinans*

**Cultural**: To avoid introducing this disease to new areas, do not purchase transplants from areas where the disease is known to occur. The disease is not known to occur in Western Canada.

**Resistant Cultivars**: Most modern cabbage cvs. are resistant (see commercial vegetable seed catalogues). No radish cvs. show much resistance.

**Chemical**: None.

**Notes**: Resistance in cabbage cvs. is of two types. Type A is uniformly resistant at all temperature ranges. Type B is resistant only at lower temperatures (1,2).

**References**:

1. Armstrong, G.M. and Armstrong, J.K. 1952. Physiologic races of the *Fusarium* causing wilts of the Cruciferae. Phytopathology 42: 255-257.

2. Armstrong, G.M. and Armstrong, J.K. 1966. Races of *Fusarium oxysporum* f.sp. *conglutinans*, "race 4", new race; and a new host for race 1, Lychnis chalcedonica. Phytopathology 56: 525-530.

3. Bosland, P.W. *et al.* 1988. Influence of soil temperature on the expression of yellows and wilt of crucifers by *Fusarium oxysporum*. Plant Disease 72: 777-780.

## CARROT (*Daucus carota*)

### ASTER YELLOWS

Aster yellows phytoplasma

**Cultural**: Isolate carrot plantings from forage legume fields and rough weedy areas where leafhoppers abound. Remove affected plants as soon as detected, if practical.

**Resistant Cultivars**: None known (1).

**Tolerant Cultivars:** Scarlet Nantes, Royal Chantenay, Gold King (1).

**Chemical**: None (see Notes).

**Notes**: Control of the leafhopper vector has reduced disease in some areas. For small scale organic growers, the use of straw mulch may be as effective as an insecticide spray program (2).

**References**:

1. Gabelman, W.H. 1995. Field evaluation and selection for resistance to aster yellows. *In*: Carrot Country, pp. 10-18, 1995.

2. Harvey, G.E.R. and Schroeder, W.T. 1949. The yellows disease of carrot. N.Y. Agric. Exp. Sta., Geneva, Bull. 737, 29 pp.

3. Setiawan, D.P. and Ragsdale, D.W. 1987. Use of aluminum foil and oat-straw mulches for controlling aster leafhopper, *Macrosteles fascifrons* and aster yellows in carrot. Great Lakes Entomologist 20: 103-109.

## BLACK ROOT ROT

*Chalara elegans (Thielaviopsis basicola)*

**Cultural**: Rotate carrot fields with beets, cereals or cole crops. Avoid legumes. Seed late in fields with a history of the disease. Wounding during and after harvest is necessary for infection to occur. Carrots harvested during warm weather should be cooled as quickly as possible. Keep carrots cool and not too damp after harvest. The discoloration is most severe when carrots are held in polyethylene bags at or near room temperature.

**Resistant Cultivars**: None.

**Intermediate**: Six Pence, Sprinter, Paramount

**Susceptible**: Golden State, Cimmaron, A-Plus

**Chemical**: None.

**Notes**: Chlorination in the range of 100 ppm NaOCl buffered to pH 7 in the hydro-cooling and final rinse water reduces infection. Cleaning and disinfesting conveyer belts in the sorting and packaging lines reduces inoculum levels. Anything that reduces post-harvest injury will reduce infection.

**References**:

1. Punja, Z.K. and Gaye, M.M. 1993. Influence of postharvest handling practices and dip treatments on development of black root rot on fresh market carrots. Plant Disease 77: 989-995.

## CAVITY SPOT

*Pythium* spp.

**Cultural**: Select fields with good drainage or improve drainage where possible. Avoid heavy irrigations which might cause temporary waterlogging of the soil. If carrots are to be left in the field late in the fall, select only the best drained fields for cropping. Carrots grown on high narrow ridges have less cavity spot than when grown on wide beds. Avoid fields with a past history of cavity spot. For early plantings, use cultivars with some resistance.

**Resistant Cultivars**: None.

**Intermediate**: Panther, Six Pak, Six Pak II, Caropride, Fannia, Navajo, Carochoice (ranked high to low)

**Variable**: Eagle, Nathlie, Paramount.

**Chemical**: Ridomil 2G (metalaxyl) applied in the seed furrow.
**Limitations**: As per label. Only recommended where there is a high likelihood of cavity spot.

**References**:

1. Benard, D. and Punja, Z.K. 1995. Role of *Pythium* species in cavity spot development on carrots in British Columbia. Can. J. Plant Pathol. 17: 31-45.

2. Vivoda, E. *et al.* 1991. Factors affecting the development of cavity spot of carrot. Plant Dis. 75: 519-522.

## RUSTY ROOT (LATERAL ROOT DIEBACK)

*Pythium* spp.

**Cultural**: Lateral root dieback does not normally occur in fields where carrots have not been grown previously. Avoid seeding carrots repeatedly in the same field; rotate with onions or other suitable crops. Avoid heavy seeding rates; precision seeding at a spacing of 3 cm is ideal. In fields with a high risk based on disease history, seed on raised beds particularly for the early crops when periods of prolonged wet weather can be expected.

**Resistant Cultivars**: Spartan Premium, Spartan Delight, Spartan Fancy, Six-Pak, Six-Pak II.

**Intermediate**: Chancellor, Grenadier, Spartan, Spartan Classic, Spartan Winner.

**Susceptible**: Gold Pak.

**Highly Susceptible**: Hicolor.

**Chemical**: None.

**References**:

1. Davis, R.M. and Nunez, J.J. 1993. Influence of soil temperature and microflora on the incidence of *Pythium* induced root rot and dieback of carrot. Phytopathol. 83: 1345.

2. Fushtey, S.G. and Filman, C.C. 1968. An early wilt and rusty root problem in carrots at the Bradford Marsh. Can. Plant Dis. Surv. 48: 150.

3. Liddell, C.M., Davis, R.M. and Nunez, J.J. 1989. Association of *Pythium* spp. with carrot root dieback in the San Joaquin Valley of California. Plant Dis. 73: 246-249.

4. McElroy, F.D. *et al.* 1971. Dieback of carrot roots caused by *Pythium debaryanum*. Phytopathology 61: 586-587.

5. Mildenhall, J.P. *et al.* 1971. *Pythium* brown root and forking of muck-grown carrots. Plant Dis. Rep. 55: 536-540.

6. Pratt, R.G. and Mitchell, J.E. 1973. A new species of *Pythium* from Wisconsin and Florida isolated from carrots. Can. J. Bot. 51: 333-339.

## LEAF SPOT, LEAF BLIGHT

*Alternaria dauci, Cercospora carotae*

**Cultural**: Rotate to an unrelated crop for several years. Practice good field sanitation (3).

**Resistant Cultivars**: None.

**Chemical**: In areas where leaf spots are a problem, apply about five sprays, starting in late July, using chlorothalonil (COM, DOM) SU, metiram (COM) WG, tribasic copper sulphate (COM, DOM) WP, mancozeb (COM), zineb (COM) WP or maneb (COM) WP (1, 4).

**Limitations**: Preharvest interval - 1 day (chlorothalonil & tribasic copper sulphate); 5 days ( maneb); 7 days (zineb, metiram, mancozeb) .

**Notes**: Neither of these fungi will sporulate below 15°C. *Alternaria* is seed-borne so the use of disease-free seed is an important preventive measure.

**References**:


1. Carisse, O. and Kushalappa, A. 1990. Development of an infection model for *Cercospora carotae* on carrot based on temperature and leaf wetness duration. Phytopathology 80: 1233-1238.

2. Kushalappa, A.C. 1989. Forecasting incidence thresholds of cercospora blight in carrots to initiate fungicide applications. Plant Dis. 73: 979-983.

3. Weber, P.V.V. *et al*. 1954. Fungicidal control of alternaria blight of carrots. Phytopathology 44: 112.

4. Thomas, H.R. 1943. *Cercospora* blight of carrots. Phytopathology 33: 114-115.

5. Slingsby, K. and McKeen, C.D. 1970. Leaf spot *Alternaria dauci* (Kühn) Groves and Skolko. P. 237 *in* Pesticide Research Report. CCPUA, Ottawa.


## RUBBERY ROOT

*Phytophthora cactorum, P. porri*

**Cultural**: This disease occurs primarily on growing carrot roots and its appearance in storage depends upon infection in the field (see Notes). Excessive soil moisture is necessary for infection to take place. Providing adequate drainage or harvesting the carrots as soon as they mature reduces the incidence of the disease (2). Storages should be well ventilated.

**Resistant Cultivars**: None.

**Chemical**: None.

**Notes**: *P. porri* can infect carrots in the field and in 0°C storage. *P. cactorum* infects only in the field.

**References**:

1. Ito, H.H. 1983. *Phytophthora porri* from stored carrots in Alberta. Mycologia 75: 747-751.

2. Rader, W.E. 1952. Diseases of stored carrots in New York State. Cornell Univ. Agric. Exp. Sta., Bull. 889: 35-38.

3. Stelfox, D. and Henry, A.W. 1978. Occurrence of rubbery brown rot of stored carrots in Alberta. Can. Plant Dis. Survey 58: 87-91.

## SCLEROTINIA ROT

*Sclerotinia sclerotiorum*

**Cultural**: Rotate with resistant crops (i.e., beets, onions, spinach, cereals, corn, or grasses) for 2 years before planting susceptible crops (i.e. beans, lettuce, parsnips, cole crops, cucumbers, and celery). Harvest before excessively wet conditions in fall (1). If feasible, flood land with water for a minimum of 30 days to kill the overwintering fungus. Copper sulphate at 1 kg/50 liters of water may be used as a spray to disinfest storages. Storage areas must be allowed to dry before storing produce. Avoid the use of floating row covers on crops grown in fields known to have a high *Sclerotinia* potential. Harvested roots should be cooled as quickly as possible. Storage at 0°C will help to reduce disease development in storage.

**Resistant Cultivars**: None.

**Chemical**: Benomyl (COM) WP may be applied to canning carrots. Follow label instructions.
**Limitations**: Do not apply more often than three times per season nor within 15 days of harvest.

**References**:

1. Finlayson, J.E., *et al.* 1989. Infection of carrots by *Sclerotinia sclerotiorum*. Can. J. Plant Pathol. 11: 242-246.

2. Finlayson, J.E., *et al.* 1989. Electrolyte leakage and storage decay of five carrot cultivars in response to infection by *Sclerotinia sclerotiorum*. Can. J. Plant Pathol. 11: 313-316.

3. Rader, W.E. 1952. Diseases of stored carrots in New York State. Cornell Univ. Agric. Exp. Sta., Bull. 889: 10-14.

## SOFT ROT

*Botrytis cinerea, Erwinia carotovora, Alternaria dauci*

**Cultural**: Handle the crop carefully to avoid wounds. Cull during harvest if rots are present. Allow crop to dry before storing. Store at 0-1°C and 90-95% relative humidity (2). Copper sulphate at 1 kg/50 L of water may be used as a spray to disinfest storages. Storage areas must be allowed to dry before storing produce (1).

**Resistant Cultivars**: None.

**Chemical**: None.

**References**:

1. Dye, D. W. 1953. Control of soft rot in carrots during transit and in storage. N.Z. J. Sci. Tech. A. 34: 465-467.

2. Rader, W.E. 1952. Diseases of stored carrots in New York State. Cornell Univ. Agric. Exp. Sta., Bull. 889: 7-10.

# CELERY (*Apium graveolens* var. *dulce*)

## ASTER YELLOWS

Aster yellows phytoplasma

**Cultural**: Avoid growing susceptible crops such as celery near forage legumes or other areas where leafhopper populations are high. Control weeds around perimeter of field.

**Resistant Cultivars**: None.

**Chemical**: None.

**Notes**: Rough, weedy headlands may be sprayed for leafhopper control. Before spraying any forage crop with an insecticide, check to be sure that the product is registered for use on the crop.

## BACTERIAL BLIGHT

*Pseudomonas syringae* pv. *apii*

**Cultural**: Use disease-free transplants. Keep irrigation to a minimum and apply water early in the morning so leaves can dry during the day. Work in crops only when foliage is dry and always work uninfected fields first. Turn under infested crop residues immediately after harvest.

**Chemical**: None. See notes.

**Notes**: Copper oxychloride (COM, DOM) applied for late blight control during mild, humid weather should help to deter the spread of bacterial blight.

## BLACK HEART

Physiological

**Cultural**: In the greenhouse, keep humidity and night temperature low. In the field avoid heavy applications of fertilizers with a high salt index and maintain uniform soil moisture. Apply calcium nitrate at 1.0-2.0 kg or calcium chloride at 0.5-1.0 kg/100 L water every 7-10 days to the foliage during periods when disease threatens, especially during cloudy yet warm weather.

**Resistant Cultivars**: None.

**Chemical**: None.

## EARLY BLIGHT, LATE BLIGHT

*Cercospora apii, Septoria apii*

**Cultural** Clean and disinfest greenhouse flats and cold frames between crops. Turn under crop refuse promptly after harvest. Follow a 2-year rotation. Use disease-free seed or seed that is more than 2 years old or has been immersed in water at 48°C for 30 min.

**Resistant Cultivars**: None.

**Chemical**: Begin fungicide spray or dust schedule in the greenhouse or seed bed and continue in the field using chlorothalonil (COM, DOM) SU; anilazine (COM) WP (1, 2); copper oxychloride or tribasic copper sulphate (COM, DOM); folpet (DOM); thiram (COM) WP; or one of maneb, mancozeb, zineb or metiram (COM).

**Limitations**: Preharvest interval - 1 day (copper oxychloride, tribasic copper sulphate); 7 days (chlorothalonil, folpet, thiram); 14 days (maneb, mancozeb, zineb, metiram). If anilazine is used less than 7 days before harvest, wash and trim produce before packing.

**References**:

1. Berger, R.D. 1975. Disease incidence and infection rates of *Cercospora apii* in plant spacing plots. Phytopathology 65: 485-487.

2. Lacy, M.L. 1974. Efficacy of two spray adjuvants in fungicidal protection of celery against septoria leaf spot. Plant Dis. Rep. 58: 232-234.

3. Paulus, A.O. *et al.* 1974. Control of septoria leaf spot of celery. Calif. Agric. 28(9): 14.

4. Sheridan, J.E. 1968. Conditions for infection of celery by *Septoria apiicola.* Plant Dis. Rep. 52: 142-145.

## FUSARIUM YELLOWS

*Fusarium oxysporum* f.sp. *apii*

**Cultural**: Avoid the movement of plants or soil from other farms or areas where the disease occurs. Start seedlings in soilless media or fumigated soil and plant in fields where the disease has not occurred previously. Avoid moving soil from infested to clean fields.

**Resistant Cultivars**: Bishop, Deacon, Matador, Picador, Starlet, Tendercrisp, Utah 52-70HK, Ventura, Vicar.

**Very Susceptible**: Utah 52-70R, Florida 683, Summit.

**Chemical**: None.

**References**:

1. Cerkauskas, R.F. and Chiba, M. 1991. Soil densities of *Fusarium oxysporum* f.sp. *apii* race 2 in Ontario, and the association between celery cultivar resistance and photocarcinogenic furocoumarins. Can. J. Plant Pathol. 13: 305-314.

2. Elmer, W.H. *et al.* 1986. Evaluation of celery germ plasm for resistance to *Fusarium oxysporum* f. sp. *apii* race 2 in Michigan. Plant Disease 70: 416-419.

3. Gaye, M.M. *et al.* 1991. Occurrence of Fusarium yellows of celery in southwestern British Columbia and evaluation of cultivars for disease tolerance. Can. J. Plant Pathol. 13: 88-92.

4. Opgenorth, D.C. and Endo, R.M. 1985. Additional sources of resistance to race 2 of *Fusarium oxysporum* f. sp. *apii*. Plant Dis. 69: 882-884.

## SOFT ROT

*Erwinia carotovora*

**Cultural**: Soft rot follows bruising, freezing, insect injury and black heart, a physiological disease. Control in the field is almost impossible but post-harvest losses may be greatly reduced by harvesting celery quickly and putting it into cold storage promptly.

**Resistant Cultivars**: None.

**Chemical**: None.

**Notes**: Celery plants contain photocarcinogenic furocoumarins which reach high levels in decaying tissue. Farm workers harvesting celery should always wear protective clothing to prevent skin contact with plant sap, especially in sunny weather.

**References**:

1. Cerkauskas, R.F. and Chiba, M. 1990. Association of phoma canker with photocarcinogenic furocoumarins in parsnip cultivars. Can. J. Plant Pathol. 12: 349-357.

2. Wimalajeewa, D.L.S. 1976. Studies on bacterial soft rot of celery in Victoria. Australian J. Exp. Agric. and Animal Husb. 16: 915-920.

# CORN (*Zea mays*)

See Corn, in Chapter 10, Special Field Crops.

# CUCUMBER, MELON, PUMPKIN, SQUASH
# (*Cucumis* spp. & *Cucurbita* spp.)

## ANGULAR LEAF SPOT

*Pseudomonas lachrymans*

**Cultural**: Use disease-free seed grown in a dry area if possible. Turn under crop refuse promptly after harvest. Follow a 3-year crop rotation. Do not work in crop when foliage is wet.

**Resistant Cultivars**: Gemini, Pioneer cucumbers. Other disease-resistant cultivars are listed in commercial seed catalogues.

**Chemical**: At first sign of disease, apply tribasic copper sulfate (COM, DOM), copper oxychloride (COM, DOM) WP and for cucumbers only, copper hydroxide (COM). Repeat at weekly intervals or as required.

**Limitations**: Preharvest interval - 1 day (tribasic copper sulfate, copper hydroxide, copper oxychloride).

**References**:

1. Hopkins, D.L. and Schenck, N.C. 1972. Bacterial leaf spot of watermelon caused by *Pseudomonas lachrymans*. Phytopathology 62: 542-545.

## BACTERIAL WILT

*Erwinia tracheiphila*

**Cultural**: Control cucumber beetles in and around fields especially for the first 3 to 5 weeks after emergence or transplanting. Destroy vines after harvest.

**Resistant Cultivars**: Country Fair, Calypso (pickling), H19 Little Leaf (1).

**Chemical**: Copper oxychloride (COM). Spray at 7 day intervals.
**Limitations**: Preharvest interval - 1 day (copper oxychloride).

**References**:

1. Hudelson, B.D. *et al.* 2000. Disease-resistant vegetables for the home garden. University of Wisconsin-Extension. #A3110., 26 pp.

## DAMPING-OFF

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

**Cultural**: Use steamed or fumigated soil (see chapter 4, under General Disease Control Methods for Greenhouse Crops) or synthetic mix for starting seedlings for transplanting. Avoid seeding in cold, wet soil.

**Resistant Cultivars**: None.

**Chemical**: Treat seed with thiram (COM) WP. **Limitations:** As per label.

## LEAF SPOT

*Alternaria* spp., *Ulocladium* spp.

**Cultural**: Maintain optimum growing conditions. Turn under crop refuse after harvest. Follow a rotation of at least 2 years.

**Resistant Cultivars**: Gurney's Burpless, Wisconsin SMR 18, Wisconsin SMR 58 (5).

**Chemical**: If leaf spot appears early in season on muskmelon or cucumber apply fungicide every 7-10 days (1, 2). Use benomyl + mancozeb (COM) WP, copper oxychloride (COM) WP, anilazine (COM) WP, mancozeb (COM) DF, WG, or zineb (COM) WP.

**Limitations**: Preharvest interval - 1 day (copper oxychloride); 3 days (anilazine); 5 days (mancozeb, zineb); 14 days (benomyl + mancozeb).

**References**:

1. Stevenson, W.R. 1975. Indiana muskmelon fungicide trial results. No. 130 *in* Fungicide and Nematicide Tests - Results of 1975. Amer. Phytopathol. Soc., Publ. 31.

2. Kantzes, J. 1976. Fungicide evaluation for control of cantaloupe foliar diseases. No. 147 *in* Fungicide and Nematicide Tests - Results of 1976. Amer. Phytopathol. Soc., Publ. 32.

3. Vakalounakis, D.J. 1990. *Alternaria alternata* f. sp. *cucurbitae*, the cause of a new leaf spot disease of melon (*Cucumis melo*). Ann. Appl. Biol. 117: 507-513.

4. Zitter, T.A. and L.W. Hsu. 1990. A leaf spot of cucumber caused by *Ulocladium cucurbitae* in New York. Plant Dis. 74: 824-827.

5. Hudelson, B.D. *et al.* 2000. Disease-resistant vegetables for the home garden. University of Wisconsin-Extension. #A3110., 26 pp.

## SCAB, ANTHRACNOSE

*Cladosporium cucumerinum, Colletotrichum orbiculare*

**Cultural**: Use disease-free seed. Turn under crop refuse promptly after harvest. Follow a 3-year rotation.

**Resistant Cultivars**: Gemini, Pioneer, and SMR cucumber cvs. are resistant to scab. Consult commercial seed catalogues for additional resistant cvs.

**Chemical**: Follow the alternaria leaf spot spray program or use: captan (cucumbers only) (COM) DF, WG; chlorothalonil (COM, DOM) SU; folpet (anthracnose only) (COM, DOM) WP; tribasic copper sulphate (COM, DOM) WP; zineb (COM) WP.

**Limitations**: Preharvest interval - 1 day (chlorothalonil, folpet, tribasic copper sulphate); 2 days (captan); 5 days (benomyl + mancozeb, zineb).

**References**:

1. Emmatty, D.A. *et al.* 1975. Yield response of resistant and susceptible cucumber cultivars to scab infection. Hortscience 10: 619.

### WILT

*Fusarium* spp.

**Cultural**: Use disease-free seed. Start plants in steamed or fumigated soil mix. Avoid fields where the disease is known to occur (1). Baby Bear (pumpkin) (2).

**Resistant Cultivars**: Numerous resistant cultivars are listed in commercial vegetable seed catalogues.

**Chemical**: None.

**References**:

1. Maloy, O.C. *et al.* 1974. Fusarium wilt of muskmelon in Washington. Plant Dis. Rep. 58: l0-12.

2. Wessel-Beaver, L. 1999. Pumpkin: pp. 938-984. *In*: Wehner, T.C. (ed.), Vegetable Cultivar Descriptions for North America List 25, 1999. HortScience 34(6): 957-1012.

## LETTUCE (*Lactuca sativa*)

### BACTERIAL DISEASES

*Erwinia carotovora*, *Pseudomonas* spp., *Xanthomonas* spp.

**Cultural**: Avoid overcrowding and overwatering. Do not sprinkler irrigate close to harvest. Harvest promptly when mature and cool to 1°C immediately.

**Resistant Cultivars**: Ithaca is the most tolerant of the popular iceberg type cultivars grown in B.C.

**Chemical**: None.

**References**:

1. Patterson, C.L. *et al*. 1986. Economically important diseases of lettuce. Plant Dis. 70: 982-987.

### DOWNY MILDEW

*Bremia lactucae*

**Cultural**: Seed late plantings in fields with good drainage and air circulation. Maintain good weed control. Deep plough diseased crop residues.

**Resistant Cultivars**: For late seedings where downy mildew may be a problem, use Valverde, Calmar, Target or Alpha. (3). Other resistant cvs are Esmeralda, Nevada, Nancy, Ruby Tuffles, Salad Bibb, Sierra, Sunfire and Tania (2).

**Chemical**: Spray every 7-10 days with fosetyl-Al (COM) WG, WP or zineb (COM) WP, or apply metalaxyl + mancozeb (COM) WP every 14 days after thinning in enough water to wet all foliage thoroughly. Apply metalaxyl before mildew appears.

**Limitations**: Preharvest interval - 7 days (fosetyl-Al); 10 days (zineb); 14 days (metalaxyl + mancozeb). Do not apply metalaxyl more than three times per crop.

**References**:

1. Fletcher, J.T. 1976. *Bremia lactucae,* oospores, sporangia dissemination and control. Ann. Appl. Biol. 84: 294-298.

2. Hudelson, B.D. *et al.* 2000. Disease-resistant vegetables for the home garden. University of Wisconsin-Extension. #A3110., 26 pp.

3. Scherm, H. *et al.* 1995. Field evaluation of fungicide spray advisories against lettuce downy mildew (*Bremia lactucae*) based on measured or forecast morning leaf wetness. Plant Dis. 79: 511-516.

4. Zink, F.W. and Duffus, J.E. l975. Reaction of downy mildew resistant lettuce cultivars to infection by turnip mosaic virus. Phytopathology 65: 243-245.

## FUNGAL ROTS

*Botrytis cinerea, Rhizoctonia solani, Sclerotinia sclerotiorum*

**Cultural**: Turn under crop residues promptly after harvest. Avoid poorly drained fields and overcrowded planting. Discard heads with any trace of infection at harvest. Cool to 1°C promptly after harvest.

**Resistant Cultivars**: None.

**Chemical**: For grey mould control, apply iprodione (COM) WG, WP. Maximum 4 applications per year at 7 day intervals between sprays.
For sclerotinia drop control, apply dicloran (COM) WP two times per year. Make a second application as a foliar spray at the rosette stage.
For lettuce drop, apply vinclozolin (COM) WG at early to mid bloom (30-50%) with a second application 7-14 days later at full bloom if the disease persists.

**Limitations**: Preharvest interval - 3 days (vinclozolin); 4 days (iprodione); 14 days (dicloran). Apply vinclozolin up to a maximum of four times per year.

**References**:

1. Paterson, C.L. and Grogan, R.G. 1985. Differences in epidemiology and control of lettuce drop caused by *Sclerotinia minor* and *S. sclerotiorum*. Plant Dis. 69: 766-770.

2. Subbarao, K.V. *et al.* 1996. Effects of deep plowing on the distribution and density of *Sclerotinia minor* sclerotia and lettuce drop incidence. Plant Dis. 80: 28-33.

### PYTHIUM STUNT AND DAMPING-OFF

*Pythium* spp.

**Cultural**: None.

**Resistant Cultivars**: None.

**Chemical**: Apply metalaxyl (COM) G at time of planting. Ensure product is applied evenly with the seed in the seed furrow.

**Limitations**: Do not use on transplanted lettuce. Only one application per year.

## ONION (*Allium cepa*)

### BASAL ROT

*Fusarium oxysporum* f.sp. *cepae*

**Cultural**: Avoid planting sets and transplants in new land that is to be used for onion production as several diseases including basal rot may be introduced in this way. Follow a long rotation. Control onion maggots. Avoid injury to bulbs during cultivation, harvesting, and storage.

**Resistant Cultivars**: Cultivars differ in susceptibility, but the disease is not serious enough in most areas to warrant the use of resistant cultivars.

**Tolerant Cultivars**: Bullet, Criterion, Duration, Endurance, Frontier, Gibralter, Legacy, North Star, Number 6404, Number 8911, Vaquero (1).

**Chemical**: None.

**References:**

1. Havey, M.J. 1999. Onion: pp. 961 - 968. *In*: Wehner, T.C. (ed.), Vegetable Cultivar Descriptions for North America List 25, 1999. HortScience 34(6): 957 - 1012.

### DOWNY MILDEW

*Peronospora destructor*

**Cultural**: Avoid planting spring-seeded onions in the vicinity of overwintered onions or onions grown from sets. Prevent growth of onions on cull piles. Follow a rotation of at least 2 years. Avoid poorly drained fields with poor air circulation.

**Resistant Cultivars**: There are no suitable resistant storage onions, although there are marked differences in susceptibility of green bunching onions. Resistant cultivars include Southport White Globe (1), Feast and Red Cross (2).

**Tolerant Cultivars:** Dragon Eye, Eskimo, Express Yellow, Hi-Ball, Hi-Keeper, Keep Well, Kodiac (1022), Norstar, Red Cross, Top Keeper, Tough Ball. (1)

**Chemical**: Begin fungicide applications 1 June for crops grown from sets or transplants and 1 July for spring-seeded

crops (3) or when advised by IPM scout (4). Use copper oxychloride (COM, DOM) WP; fosetyl-Al (COM) WG; mancozeb (COM) DF (for dry bulb onions only); or zineb (COM) WP. For fosetyl-Al apply a maximum of 5 applications per season. Apply metalaxyl + mancozeb (COM) WP before disease appears, and every 7 to 14 days up to three times per season.

**Limitations**: Preharvest interval - 1 day (copper oxychloride); 7 days (fosetyl-Al, zineb, metalaxyl + mancozeb); 10 days (mancozeb).

**References**:


1. Havey, M.J. 1999. Onion: pp. 961 - 968. *In*: Wehner, T.C. (ed.), Vegetable Cultivar Descriptions for North America List 25, 1999. HortScience 34(6): 957 - 1012.

2. Hudelson, B.D. *et al*. 2000. Disease-resistant vegetables for the home garden. University of Wisconsin-Extension. #A3110., 26 pp.

3. Kaliciak, H. and Ormrod, D.J. 1977. Fungicide applications for the control of downy mildew, blast, and purple blotch. Pp. 315-316 *in* Pesticide Research Report. CCPUA, Ottawa.

4. Jesperson, G.D. and Sutton, J.C. 1987. Evaluation of a forecaster for downy mildew of onion (*Allium cepa* L.). Crop Protection 6: 95-103.

5. Sigurdson, L.S. and Ormrod, D.J. 1984. Fungicide applications for the control of downy mildew in green bunching onions. P. 290 *in* Pesticide Research Report, ECPUA, Ottawa.


## LEAF BLIGHT (BLAST)

*Botrytis squamosa*

**Cultural**: Avoid high rates of seeding. Avoid high rates of nitrogen fertilizer.

**Resistant Cultivars**: Frontier, Norstar, Red Cross, Tokyo Long White, Wolf (2).

**Tolerant Cultivars**: Dragon Eye, Eskimo, Express Yellow, Hi-Ball, Hi-Keeper, Keep Well, Norstar, Red Cross, Top Keeper, Tough Ball (1).

**Chemical**: Begin iprodione (COM) WG, WP; anilazine (COM) WP mancozeb (COM) DF, WG or chlorothalonil (COM) SU; zineb (COM) WP sprays when advised by IPM scout or in mid-June. Alternate with downy mildew sprays. For green bunching onions, only chlorothalonil, or zineb may be used.

**Limitations**: Preharvest interval - 15 days (iprodione for dry bulb onions only); 1 day (copper oxychloride); 7 days (zineb, chlorothalonil for dry bulb onion); 10 days (mancozeb); 14 days (chlorothalonil for green bunching onion). Chlorothalonil should not be used more than 3 times on bulb onions or 5 times on green bunching onions.

**Notes**: Use of a spray program to control downy mildew will help to control leaf blight. Several blight prediction programs have been developed (4, 5).

**References**:


1. Havey, M.J. 1999. Onion: pp. 961 - 968. In: Wehner, T.C. (ed.), Vegetable Cultivar Descriptions for North America List 25, 1999. HortScience 34(6): 957 - 1012.

2. Hudelson, B.D. *et al.* 2000. Disease-resistant vegetables for the home garden. University of Wisconsin-Extension. #A3110., 26 pp.

3. Kaliciak, H. and Ormrod, D.J. 1977. Fungicide applications for the control of onion downy mildew, blast, and purple blotch. Pp. 315-316 *in* Pesticide Research Report. CCPUA, Ottawa.

4. Sutton, J.C. 1990. Epidemiology and management of botrytis leaf blight of onion and gray mold of strawberry: a comparative analysis. Can. J. Plant Path. 12: 100-110.

5. Vincelli, P.C. and Lorbeer, J.W. 1989. Blight-Alert: A weather based predictive system for timing fungicide applications on onion before infection periods of *Botrytis squamosa*. Phytopathology 79: 493-498.


## NECK ROT

*Botrytis aclada*, other *Botrytis* spp.

**Cultural**: Grow early maturing, tight-necked cultivars. Seed as early as possible. Avoid late growth by restricting nitrogen and water after early August. Do not lift bulbs until two-thirds of the tops are down. Dry in the field for 8-18 days followed by additional drying in storage (1). Supplemental heat may be required for the first 10-14 days to facilitate curing (3). If heat is to be used for curing, it should be applied immediately after the onions are put into storage. Do not exceed 35°C or prolong the curing period for more than 14 days. Reduce storage temperature to 0-4°C and less than 70% RH after the initial curing period.

**Resistant Cultivars**: None.

**Tolerant Cultivars:** Dragon Eye, Eskimo, Express Yellow, Frontier (T-400), Hi-Ball, Hi-Keeper, Keep Well, Norstar, Red Cross, Top Keeper, Tough Ball. (1)

**Chemical**: None.

**Notes**:

1. Downy mildew sprays may reduce neck rot by encouraging proper maturity of bulbs.

2. Seed-borne *B. allii* may be an important source of neck rot in Europe (3). Onion seed grown in desert areas of North America is not usually affected.

**References**:


1. Havey, M.J. 1999. Onion: pp. 961 - 968. *In*: Wehner, T.C. (ed.), Vegetable Cultivar Descriptions for North America List 25, 1999. HortScience 34(6): 957 - 1012.

2. Gunkel, W.E. *et al.* 1973. Recent developments on artificial heating - a method of control of botrytis neck rot in bulk stored onions. Dep. Agric. Eng. Plant Pathol., Cornell Univ., Unpublished.

3. Maude, R.B. and Presley, A.H. 1977. Neck rot (*Botrytis allii*). Seed-borne infection and its relationship to the disease in the onion crop. Ann. Appl. Biol. 86: 163-180.

4. Vaughan, E.K. *et al.* 1964. Effects of field curing practices, artificial drying, and other factors in the control of neck rot in stored onions. Oreg. State Univ., Tech. Bull. 77.

## PINK ROOT

*Phoma terrestris (Pyrenochaeta terrestris), Fusarium* spp.

**Cultural**: In fields where the disease is not known to occur, do not introduce transplants or sets from fields where it does occur. Follow long rotations in heavily infested fields. Lettuce, celery, beets, potatoes, and rutabagas are suitable rotation crops. The fungus can survive on the roots of cereal crops. Encourage rapid growth in infested fields through generous use of fertilizer and irrigation.

**Resistant Cultivars**: 157 cultivars are listed by Harvey (4). Among them the best resistant cultivars are: Majestic (AX 1507), NuMex Bolo, NuMex Centric, NuMex Crispy, NuMex Dulce, NuMex Jose, Jose Fernandez, NuMex Mesa, Numex Starlite, NuMex Sundial, NuMex Sunlite, NuMex Suntop, NuMex Sweetpak, Rio Verde PRR (RCSX 948) (4), NuMex Chaco and NuMex Snowball (2, 3).

**Chemical**: None.

**Notes**: Preplant fumigation is effective on mineral soils.

**References**:


1. Awuah, R.T. and Lorbeer J.W. 1989. A procedure for isolating *Pyrenochaeta terrestris* from onion roots. Ann. Appl. Biol. 114: 205-208.

2. Cramer, C.S. and Corgan, J.N. 2001. “NuMex Chaco” onion. HortScience 36: 1337-1338.

3. Cramer, C.S. and Corgan, J.N. 2001. “NuMex Snowball” onion. HortScience 36: 1339-1340.

4. Havey, M.J. 1999. Onion: pp. 961 - 968. *In*: Wehner, T.C. (ed.), Vegetable Cultivar Descriptions for North America List 25, 1999. HortScience 34(6): 957 - 1012.

5. Thornton, M.K. and Mohan, S.K. 1996. Response of sweet spanish onion cultivars and numbered hybrids to basal rot and pink root. Plant Dis. 80: 660-663.


## SMUT

*Urocystis magica*

**Cultural**: In areas where smut does not occur, avoid introduction of transplants or sets from areas where the disease does occur. Clean equipment when moving from smut-infested fields to new fields. In heavily infested fields, transplants can be set out safely as only the seedling stage is susceptible to infection.

**Resistant Cultivars**: Bulb-type - None; Green bunching type (*A. fistulosium*) cv. Beltsville Bunching (4, 5).

**Chemical**: In fields having more than 1% infection the last year that onions were grown, control measures are required (1, 4). Use one or more of the following: formalin (COM) SN (37% active at 7-14 L in 1,000-2,000 L of water/ha) applied as a drench with the seed; carbathiin + thiram (COM) DU [Pro-Gro] seed treatment applied with a sticker to raw seed before any other coating; thiram (COM) WP.

**Limitations**: Formalin may cause seedling injury under certain weather conditions, particularly on lighter soils.

**Notes**: Efficacy of carbathiin seed treatment is improved significantly by the use of methylcellulose sticker (2). To prepare, sprinkle Methocel A15 powder into hot (80-90$^{o}$C) water and mix until particles are thoroughly dispersed and wetted. Add cold water to give a final concentration of 2% methylcellulose, and refrigerate

overnight to dissolve the particles. Add methylcellulose solution to seed at a rate of 65 mL/kg of seed and shake in a suitable container until seed is uniformly wetted. Then add the fungicide in small amounts with shaking to obtain uniform distribution on the seed.

**References**:


1. Crete, R. *et al.* 1973, 1974, 1975. Pesticide Research Report. CCPUA, Ottawa.

2. Littley, E. and Rahe, J.E. 1982. Comparison of two seed treatments and two methylcellulose stickers for smut control. P. 244 *in* Pesticide Research Report. ECPUA, Ottawa.

3. Ormrod, D.J. *et al*. 1976, 1977. Pesticide Research Report. CCPUA. Ottawa.

4. Stevenson, F.J. and Jones, H.A. 1953. Some sources of resistance in crop plants. P. 211 *in* Plant Diseases. U.S. Dep. Agric., Yearb. Agric.

5. Utkhede, R.S. and Rahe, J.E. 1980. Screening world onion germplasm collection and commercial cultivars for resistance to smut. Can. J. Plant Sci. 60: 157-161.


## WHITE ROT

*Sclerotium cepivorum*

**Cultural**: In areas where the disease does not occur, do not introduce transplants or sets from areas where it does occur. To prevent field-to-field and farm-to-farm spread, clean equipment after leaving an infested field before entering a clean field. Dispose of infected culls in such a way that they will not be returned to fields where onions are to be grown. Avoid seeding onions in fields where white rot occurred the last time onions were grown. Flooding fields reduces survival of sclerotia, but take steps to prevent movement of flood waters from infested to clean fields (1, 2).

**Resistant Cultivars**: There are no resistant cultivars yet available although resistance related to inability to stimulate sclerotial germination is known within the genus *Allium* (2). Hudelson *et al.* listed cv. Norstar as resistant (4).

**Chemical**: If onions must be grown in infested soil, the following treatments may reduce losses: for seeded onions on mineral soils, broadcast dicloran (COM) WP and rotovate to a depth of 4 cm, 1-2 weeks before seeding (see Note 2); for transplants, apply dicloran in the furrow at planting (3,4). **Limitations**: As per label.

**Notes**:

1. The broadcast treatment is not considered to be very effective as white rot infection can occur throughout the growing season.

2. Before seeding dicloran-treated areas to a sensitive crop such as spinach or lettuce, plow to a depth of 20 cm and cross disc.

**References**:


1. Banks, E. and Edgington, L.V. 1989. Effects of integrated control of the onion white rot pathogen in organic soils. Can. J. Plant Path. 11: 268-272.

2. Brix, H.D. and Zinkernagel, V. 1992. Screening for resistance of *Allium* species to *Sclerotium cepivorum* with special reference to non-stimulatory resistance. Plant Pathology 41: 308-316.

3. Coley-Smith, J.R. 1959. Studies of the biology of *Sclerotium cepivorum* Berk. III. Host range, persistence and viability of sclerotia. Ann. Appl. Biol. 47: 511-518.

4. Hudelson, B.D. *et al.* 2000. Disease-resistant vegetables for the home garden. University of Wisconsin-Extension. #A3110., 26 pp.

5. Locke, S.B. 1968. Experimental control of onion white rot by means of soil chemicals. Plant Dis. Rep. 52: 272-276.

6. Maloy, O.C. and Machtmes, R. 1974. Control of onion white rot by furrow and root dip application of fungicides. Plant Dis. Rep. 58: 6-9.

7. Utkhede, R.S. and Rahe, J.E. 1982. Interactions of antagonist and pathogen in biological control of onion white rot. Phytopathology 73: 890-893.

# PARSNIP (*Pastinaca sativa*)

## CANKER

*Itersonilia pastinacae, Phoma complanata*

**Cultural**: This disease is common in wet seasons. Grow in well-drained soils. Rotate fields. Grow varieties with rounded rather than broad shouldered crowns.

**Resistant Cultivars**: Gladiator is resistant to *Itersonilia*. All American and Hollow Crown Improved were resistant to *Phoma* (1).

**Chemical**: Apply chlorothalonil (COM) SU in mid-August and carry through the wet fall weather in BC.
**Limitations**: Pre-harvest interval - 7 days (chlorothalonil). Do not apply more than 7 times per season.

**Notes**:

1. Control of carrot rust fly reduces canker as root infection usually begins at the crown or at points where carrot rust fly larvae have penetrated.

2. Where the leaf spot phase appears to be an important source of inoculum for root infection, a fungicide spray program such as that for foliar blights of carrots may be justified.

**References**:

1. Cerkauskas, R.F. 1986. Susceptibility of parsnip cultivars to canker caused by *Phoma camplanata*. Can. J. Plant Pathol. 8: 455-458.

2. Cerkauskas, R.F., and McGarvay, B.D. 1988. Fungicidal control of phoma canker of parsnip. Can. J. Plant Pathol. 10: 252-258.

3. Channon, A.G. 1963. Studies on parsnip canker. I. The causes of the disease. Ann. Appl. Biol. 51: 1-15.

4. Channon, A.G. 1963. Studies on parsnip canker. II. Observations on the occurrence of *Itersonilia pastinacae* and related fungi on the leaves of parsnips and in the air within parsnip crops. Ann. Appl. Biol. 51: 223-230.

5. Channon, A.G. 1964. Studies on parsnip canker. III. The effect of sowing date and spacing on canker development. Ann. Appl. Biol. 54: 63-70.

6. Channon, A.G. 1969. Infection of the flowers and seeds of parsnip by *Itersonilia pastinacae*. Ann. Appl. Biol. 64: 281-288.

7. Smith, P.R. 1966. Seed transmission of *Itersonilia pastinacae* in parsnip and its elimination by a steam-air treatment. Aust. J. Exp. Agric. Ani. Husb. 6: 441-444.

8. Smith, P.R. 1967. The survival in soil of *Itersonilia pastinacae* Channon, the cause of parsnip canker. Aust. J. Biol. Sci. 20:647-660.

# PEA (*Pisum sativum*)

## DOWNY MILDEW

*Peronospora viciae*

**Cultural**: Rotate crops to non-legumes for 2-3 years. Plant disease-free seed on well-drained land with good air circulation (1).

**Resistant Cultivars**: Green Arrow, Lincoln (3).

**Chemical**: Seed for export may be treated with metalaxyl (COM) SU.

**Limitations**: metalaxyl may not be used on pea seed to be planted in Canada.

**Notes**: Downy mildew of peas is of minor importance.

**References**:

1. Campbell, L. 1935. Downy mildew of peas caused by *Peronospora pisi*. Wash. Agr. Exp. Sta., Bull. 318. 42 pp.

2. Dixon, G.R. 1981. Downy mildews of peas and beans. Pp. 487-514 *in* Spencer, D.M. ed., The Downy Mildews. Academic Press. N.Y. 636 pp.

3. Hudelson, B.D. *et al*. 2000. Disease-resistant vegetables for the home garden. University of Wisconsin-Extension. #A3110., 26 pp.

## LEAF and POD SPOT, FOOT ROT, MYCOSPHAERELLA BLIGHT

*Ascochyta pisi, A. pinodella, Mycosphaerella pinodes, Phoma medicaginis* var. *pinodella*

**Cultural**: Rotate with crops other than peas for a minimum of 4 years. Do not include vetch in rotation. Use disease-free seed if possible. Remove diseased pea vines after harvest (3,4).

**Resistant Cultivars**: Fristo (Ascochyta race C) (2).

**Chemical**: None.

**References**:

1. Ali, S.M. *et al.* 1978. Selection of pea lines for resistance to pathotypes of *Ascochyta pinodes, A. pisi* and *Phoma medicaginis* var. *pinodella*. Aust. J. Agric. Res. 29: 841-849.

2. Gritton, E.T. 1999. Green Pea: pp. 968 - 971. In: Wehner, T.C. (ed.), Vegetable Cultivar Descriptions for North America List 25, 1999. HortScience 34(6): 957 - 1012.

3. Jones, L.K. 1927. Studies of the nature and control of blight, leaf spot, and foot rot of peas caused by species of *Ascochyta*. N.Y. Agric. Exp. Sta., Bull. 547. 46 pp.

4. Wallen, V.R. l974. Influence of three ascochyta diseases of peas on plant development and yield. Can. Plant Dis. Surv. 54: 86.

5. Wark, D.C. 1950. The inheritance of resistance to *Ascochyta pisi* in *Pisum sativum*. Aust. J. Agric. Res. 1: 382-390.

## POWDERY MILDEW

*Erysiphe polygoni*

**Cultural**: Destroy or plow under diseased crop debris. Rotate crops for several years. Seed early to avoid infection.

**Resistant Cultivars**: Aspen, Neptune (3); Dewdrop, Encore, Horison, Kalamo, Karisma, Laser, Mariner, Mendota, Opal, Oregon 605, Oregon Giant, Oregon Trail, Quantum, Scepter, Shield, Snowflake, Spartan, Super Sugar Snap, Tacoma, Tasman, Taxi, Turbo (2).

**Chemical**: Sulfur (DOM, COM) WP, WG. Repeat at 7 to 10 day intervals as necessary.
**Limitations**: Preharvest interval - 1 day.

**Notes**: Chemical control is not normally required.

**References**:

1. Dixon, G.R. 1978. Powdery mildews of vegetables and allied crops. III. Papilionaceae. A. Pea. Pp.502-506 *in* Spencer, D.M. ed., The Powdery Mildews. Academic Press. N.Y. 565 pp.

2. Gritton, E.T. 1999. Green Pea: pp. 968 - 971. In: Wehner, T.C. (ed.), Vegetable Cultivar Descriptions for North America List 25, 1999. HortScience 34(6): 957 - 1012.

3. Harland, S.C. 1948. Inheritance of immunity to mildew in Peruvian forms of *Pisum sativum.* Heredity: 263-269.

## ROOT ROT

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

**Cultural**: Peas should not be planted in the same soil more frequently than every fourth year. Plant in a well drained soil. Do not pack soil. Avoid over-irrigation. Destroy infested crop residues by deep plowing. Do not crowd plants. Drill in high-percentage phosphate fertilizer. Disc in up to 22.5 kg nitrogen/ha in fields where root rot has occurred and the weather is cold and wet.

**Resistant Cultivars**: Paint, Scepter (2), Bolero (4).

**Chemical**: None (see Note 2).

**Notes**:

1. Land where severe root rot has occurred should not be replanted to peas or broadbean (fababean) for 8-10 years (3).

2. Seed treatment fungicides used to control seed rot and damping-off will not control root rot in post-seedling plants.

**References**:

1. Basu, P.K. *et al.* 1973. Prevalence and severity of diseases of processing peas in Canada, 1970-71. Can. Plant Dis. Surv. 53: 49-57.

2. Gritton, E.T. 1999. Green Pea: pp. 968 - 971. *In*: Wehner, T.C. (ed.), Vegetable Cultivar Descriptions for North America List 25, 1999. HortScience 34(6): 957 - 1012.

3. Harper, F.R. 1983. Personal communication. Agric. Can. Res. Sta., Lethbridge.

4. Hudelson, B.D. *et al.* 2000. Disease-resistant vegetables for the home garden. University of Wisconsin-Extension. #A3110., 26 pp.

5. Tu, J.C. 1991. Response of cultivars and breeding lines to the disease complex of fusarium wilt and root rot of green peas in southwestern Ontario. Can Plant Dis. Surv. 71: 9-12.

## SEED ROT, DAMPING-OFF

*Pythium* spp., *Rhizoctonia solani*

**Cultural**: Avoid planting in cool, moist soil. Avoid excessive irrigation. Improve the texture of heavy soil.

**Resistant Cultivars**: None.

**Chemical**: Treat seed with captan (COM), SU or thiram (COM) WP. Seed for export may be treated with metalaxyl (COM) SU. Use inoculants after the chemical disinfectant and no earlier than 2 hours before planting (1).

**Limitations**: As per labels. Metalaxyl can only be applied to pea seed for export.

**Notes**: Processing pea seed is usually sold pretreated with a fungicide or fungicide-insecticide.

**References**:

1. McKeen, C.D. and Slingsby, K. 1974. Evaluation of chemical treatments to control seed rot of peas. Pp. 323-324 *in* Pesticide Research Report. CCPUA, Ottawa.

## WILT

*Fusarium oxysporum* f.sp. *pisi*

**Cultural**: Plant resistant cultivars (1, 2). Avoid infested fields. Plant disease-free seed in well drained soil. Rotate to other crops where fields are severely infested. Avoid planting peas in known infested areas within fields. Leave a generous border around the area. In newly developed infested spots, burn plants with a weed burner as soon as noticed, and definitely before harvest. Clean mobile viners before leaving the harvested field. Do not dump vines from one field in another field.

**Resistant Cultivars**: Race 2 - Array, Award, Bemol, Bravo, Citadel, Elegance, Epic, Hailey, Menuet, Opal, Podella, Princess, Renown, Talon, Targhee, Trump.
Races 5 & 6 - are important only in western Washington and southwest British Columbia: Aristagreen, Barok, Captain, Goal, Podella, Tasman, Valgreen (2).

**Chemical**: None.

**Notes**: **Race 1** - Most processing pea cvs. are resistant.
**Race 2** - A few resistant processing pea cvs. are available.
**Races 5 & 6** - Are important only in western Washington and southwest British Columbia.

**References**:

1. Armstrong, G.M. and Armstrong, J.K. 1974. Races of *Fusarium oxysporum* f. sp. *pisi*, causal agent of wilt of pea. Phytopathology 64: 849-857.

2. Gritton, E.T. 1999. Green Pea: pp. 968 - 971. *In*: Wehner, T.C. (ed.), Vegetable Cultivar Descriptions for North America List 25, 1999. HortScience 34(6): 957 - 1012.

3. Haglund, W.A. and Kraft, J.M. 1970. *Fusarium oxysporum* f.sp. *pisi*, Race 5. Phytopath. 60: l861-1862.

## VIRUSES

Pea enation virus, pea streak virus, pea seed-borne mosaic virus

**Cultural**: If possible, separate pea fields by at least 100 m from other leguminous crops and control aphids, the vectors for these viruses.

**Resistant Cultivars**: See seed catalogue descriptions for cultivar reactions to the different viruses.

**Chemical**: None.

# PEPPER (*Capsicum frutescens*)

## BLOSSOM-END ROT

See tomato, BLOSSOM-END ROT on page 43.

## SUNSCALD

Physiological

**Cultural**: Fruits not well protected from the sun by leaves are especially susceptible to sunscald. Any treatment that promotes luxuriant foliage reduces damage. Avoid varieties with upright fruits.

**Resistant Cultivars**: None.

**Chemical**: None.

**Notes**: Diseases causing loss of leaves, such as verticillium wilt, increase the severity of sunscald. Varieties with light-coloured fruits are less susceptible to damage than those with purple, black or brown fruits.

## VERTICILLIUM WILT

*Verticillium* sp.

**Cultural**: Seedlings should be grown in virgin or sterilized soil. Follow a 4-year rotation with crops other than potato, tomato or eggplant. Old crop remains should not be left on the field. The fungus may also be maintained from year to year by symptomless hosts (2).

**Resistant Cultivars**: Giant Szegedi.

**Chemical**: Treat seed with thiram (COM) WP. Limitations: As per label.

**Notes**: Flats used for growing seedlings should be disinfested.

**References**:

1. Hudelson, B.D. *et al*. 2000. Disease-resistant vegetables for the home garden. University of Wisconsin-Extension. #A3110., 26 pp.

2. Krikun, J. and C.C. Bernier. 1987. Infection of several crop species by two isolates of *Verticillium dahliae*. Can. J. Plant Pathol. 9: 241-245.

## VIRUS DISEASES

Cucumber mosaic virus (CMV), tobacco mosaic virus (TMV), tomato spotted wilt virus (TSWV - lettuce strain), impatiens necrotic spot virus (INSV formerly known as TSWV - impatiens strain).

**Cultural**: Maintain rigid weed control near plantings. Rogue infected plants early. Wash hands after handling TMV-infected plants. Controlling aphid and thrips vectors with insecticides may help reduce spread. Do not start transplants in greenhouses containing ornamentals which may be infected with TSWV or INSV.

**Resistant Cultivars**: CMV - Consul, Summer Sweet 5000. TMV - Yolo Wonder, Early California Wonder, Liberty Bell.

**Chemical**: None.

**Notes**: Cucumber mosaic virus is particularly prevalent in the B.C. Okanagan. Tobacco mosaic virus is uncommon but may appear if peppers are grown near tomatoes or if those handling young plants are smokers.

**References**:

1. Hudelson, B.D. *et al.* 2000. Disease-resistant vegetables for the home garden. University of Wisconsin-Extension. #A3110., 26 pp.

# RADISH (*Raphanus sativus*)

## BLACK ROOT

*Aphanomyces raphani*

**Cultural**: Grow only small globe-type cultivars as they are not seriously damaged. In new land, where the disease has not occurred, use hot-water-treated seed to avoid introducing the fungus. Diseased crop residues should be plowed under. Provide good soil drainage and follow a 4-year rotation.

**Resistant Cultivars**: Small globe-type cultivars show some field tolerance (3); Vintage (1).

**Chemical**: None

**Notes**: This disease has not been reported from the Prairie Provinces.

**References**:


1. Behling, J. 1999. Radish: p. 984. *In*: Wehner, T.C. (ed.), Vegetable Cultivar Descriptions for North America List 25, 1999. HortScience 34(6): 957 - 1012.

2. Sherf, A.F. 1959. Radish black root disease yields to chemical control. Union Carbide Chem. Co., New York, Sta. to Sta. Res. News 5(1).

3. Humaydan, H.S. *et al.* 1976. Resistance in radish to *Aphanomyces raphani* and *Rhizoctonia solani*. Plant Dis. Rep. 60: 156-160.


## DOWNY MILDEW

*Peronospora parasitica*

**Cultural**: Avoid planting radishes after radishes in the same year. Incorporate crop remains or remove from field after harvest to prevent carryover in diseased refuse, volunteers, and cruciferous weeds. Reduce density of plantings in the late summer to improve air circulation. Increase the phosphorus to potassium ratio of the fertilizer applied before late seedings.

**Resistant Cultivars**: Altabelle, Altaglobe, Tae-Baek.

**Chemical**: None.

**References**:


1. Channon, A.G. 1981. Downy mildew of brassicas. Pp. 321-339 *in* Spencer, D.M. ed., The Downy Mildews. Academic Press, London. 636 pp.

2. Hudelson, B.D. *et al.* 2000. Disease-resistant vegetables for the home garden. University of Wisconsin-Extension. #A3110, 26 pp.

3. Natti, J.J. 1958. Resistance of broccoli and other crucifers to downy mildew. Plant Dis. Rep. 42: 656-662.

4. Sherriff, C. and Lucas, J.A. 1990. The host range of isolates of downy mildew, *Peronospora parasitica* from *Brassica* crop species. Plant Pathol. 39: 77-91.

## YELLOWS

*Fusarium oxysporum* f.sp. *conglutinans*

**Resistant Cultivars**: Fuego (1), Vintage (2).

**References:**

1. Behling, J. 1999. Radish: p. 984. *In*: Wehner, T.C. (ed.), Vegetable Cultivar Descriptions for North America List 25, 1999. HortScience 34(6): 957 - 1012.

2. Hudelson, B.D. *et al*. 2000. Disease-resistant vegetables for the home garden. University of Wisconsin-Extension. #A3110., 26 pp.

# RHUBARB (*Rheum rhabarbarum*)

## LEAF SPOT, GRAY MOLD

*Ramularia rhei, Botrytis cinerea*

**Cultural**: Clean up crop refuse at the end of harvest by rotovating to encourage rapid breakdown.

**Resistant Cultivars**: None.

**Chemical**: Spray with captan (COM) DF, WG at weekly intervals.

**Limitations**: Pre-harvest interval - 1 day (captan).

**Notes**: Captan is registered for gray mold control only but the same spray schedule will control leaf spot.

**References**:

1. Ormrod, D.J. *et al.* 1985. Effect of fungicides on Ramularia leaf and stalk spot of rhubarb in coastal British Columbia. Can. Pl. Dis. Surv. 65: 29-30.

## VIRUS DISEASES

Turnip mosaic virus and others

**Cultural**: Obtain crowns for planting out from a source that is apparently free of virus and other diseases. Rogue out plants with obvious symptoms of dwarfing, mottling, or leaf reddening (1). Do not allow populations of black bean aphid or other aphids to build up in rhubarb plantings.

**Resistant Cultivars**: None.

**Chemical**: None.

**References**:

1. Stace-Smith, R. and Jacoli, G.G. 1967. A virus disease of rhubarb in British Columbia. Can. J. Bot. 45: 1059-1061.

# RUTABAGA (SWEDE TURNIP) (*Brassica napobrassica*)

## BLACKLEG, BLACK ROT

*Leptosphaeria maculans* (imperfect state *Phoma lingam*), *Xanthomonas campestris*, pv. *campestris*

**Cultural**: Use hot-water-treated seed (20 min. at 50°C). Follow a 2-year rotation with non-cruciferous crops for black rot or a 4- to 5-year rotation for black leg. Do not apply manure containing rutabaga refuse or diseased rutabagas to land intended for crucifer production. Avoid storing diseased roots. Clean and disinfest storages each spring (2).

**Resistant Cultivars**: None.

**Chemical**: Streptomycin 17 (COM) WP seed treatment may be used for control of seed-borne black rot and carbathiin-thiram-lindane (COM) SN may be used for blackleg.

**References**:

1. Bonman, J.M. *et al.* 1980. *Leptosphaeria maculans* on cabbage in Wisconsin. Plant Dis. 64: 326.

2. Walker, J.C. 1948. Diseases of cabbage and related plants. U.S. Dep. Agric., Farmers' Bull. 1439.

3. Williams, P.H. 1980. Black rot: a continuing threat to world crucifers. Plant Dis. 64: 736-742.

## CRATER ROT

*Rhizoctonia solani*

**Cultural**: Avoid injury to roots in the field and during harvest. Harvest under dry conditions if possible. Store close to 0°C and 90-95% RH. Disinfest storage bins before harvest (1).

**Resistant Cultivars**: None.

**Chemical**: None.

**Notes**: If it is necessary to grow on heavy, poorly drained soils, try to delay seeding until danger of cool, wet weather is past. This will reduce the amount of damping-off, wirestem and crater rot.

**References**:

1. Ramsey, G.B. and Smith, M.A. 1961. Market diseases of cabbage, cauliflower, turnips, cucumbers, melons, and related crops. U.S. Dep. Agric., Agric. Handb. 184: 9-10.

## SOFT ROT

*Erwinia carotovora*

**Cultural**: Avoid bruising roots in cultivation and harvesting. Harvest under dry conditions if possible. Store roots close to 0°C and 90-95% RH. Disinfest storage bins with a 2% copper sulphate solution or other disinfestant before harvest if storage rots have been a problem.

**Resistant Cultivars**: None.

**Chemical**: None.

**Notes**: *Erwinia* can infect cut surfaces and growth cracks. It is important to dry the roots promptly after trimming and washing. If that is not possible, the final rinse water should contain 100 ppm NaOCl buffered to pH 7.

## WATER CORE, BROWN HEART

Boron deficiency

**Cultural**: In light, sandy soils or where boron deficiency has occurred in the past, broadcast and disc in agricultural borax (11.4%) at 40 kg/ha or Tronabor (14.0%) at 30 kg/ha before planting. If deficiency occurs after planting, immediately apply Solubor (20.5%) or Borospray (20.5%) at 0.55 to 1.1 kg/ha as a 0.1% spray, using at least 1120 L of water/ha. In fields with a history of boron deficient crops, one or two foliar applications should be routinely applied.

**Resistant Cultivars**: None.

**Chemical**: None.

**Notes**: Fields to which boron has been applied should not be planted to beans or cucumbers the following year as both crops are extremely sensitive to boron.

## OTHER DISEASES

The following disease of rutabaga is currently of minor importance (MI).

**Surface Pitting**: This is a form of bacterial soft rot which is controlled by prompt drying after washing. (MI)

# SPINACH (*Spinacia oleracea*)

## DOWNY MILDEW

*Peronospora spinacea*

**Cultural**: If downy mildew is a recurring problem, consider using resistant cvs. Follow a 3-year or longer rotation. Use disease-free seed or treat seed with hot water (50°C for 25 min.). When growing successive crops, turn under refuse promptly after harvest. Avoid fields with poor air or soil drainage.

**Resistant Cultivars**:

Race 1 - Ambassador, Bolero, Bossanova, Carpo, Cello-Pak, Correnta, Eslivato, Fallgreen, Gladiator, Laron, Lina, Manta, Mazurka, Meridian, Murena, Nordic 4, Pacifica, Polka, Regency, Rhythm, Rico, Sassy, Sitra, Unipack 12, Unipack 151 (1).

Race 2 - Ambassador, Bolero, Bossanova, Carpo, Cello-Pak, Correnta, Eslivato, Fallgreen, Gladiator, Laron, Lina, Mazurka, Meridian, Murena, Nordic 4, Pacifica, Polka, Regency, Rhythm, Rico, Sassy, Sitra, Unipack 12, Unipack 151 (1).

Race 3 - Bolero, Bossanova,Carpo, Cello-Pak, Correnta, Gladiator, Laron, Lina, Manta, Mazurka, Meridian, Nordic 4, Pacifica, Polka, Regency, Rhythm, Rico, Sitra, Unipack 12, Unipack 151 (1).

Race 4 - Bolero, Bossanova, Cello-Pak, Nordic 4, Pacifica, Unipack 12, Unipack 151 (1).

**Chemical**: Use tribasic copper sulfate (DOM, COM) DU, WP (see Notes). **Limitations**: Preharvest interval - 1 day.

**Notes**: If a spray program becomes necessary, avoid applications close to harvest. These may result in a visible residue.

**References**:

1. Morelock, T. E. 1999. Radish: pp. 987 - 988. *In:* Wehner, T.C. (ed.), Vegetable Cultivar Descriptions for North America List 25, 1999. HortScience 34(6): 957 - 1012.

# TOMATO (*Lycopersicum esculentum*)

## ANTHRACNOSE

*Colletotrichum* spp.

**Cultural**: Turn under crop refuse after harvest. Follow a rotation of at least 3 years, that includes cereals and legumes.

**Resistant Cultivars**: There are a few commercial cvs. with useful resistance to anthracnose. Consult vegetable seed catalogues.

**Chemical**: A regular spray program may be a necessity in commercial tomato fields. About 1 June and every 7 to 14 days thereafter apply zineb (COM) WP, chlorothalonil (COM, DOM) SU, captan (DOM, COM) DF, DU, WG, mancozeb (COM) DF, SU, WG, copper oxychloride (DOM); tribasic copper sulphate (DOM, COM) WP, folpet (COM) WP, anilazine (COM) WP, metiram (COM) WP or benomyl + mancozeb (COM) WP.

**Limitations**: Preharvest interval - 1 day (chlorothalonil, tribasic copper sulphate, folpet); 2 days (captan); 3 days (anilazine); 5 days (zineb); 7 days (benomyl + mancozeb, mancozeb, metiram, copper oxychloride).

**References**:

1. Batson, W.E. and Roy, K.W. 1982. Species of *Colletotrichum* and *Glomerella* pathogenic to tomato fruit. Plant Dis. 66: 1153-1155.

2. Dillard, H.R. 1989. Effect of temperature, wetness duration and inoculum density on infection and lesion development of *Colletotrichum coccodes* on tomato fruits. Phytopathology 79: 1063-1066.

3. Fulling, B.A. *et al.* 1995. Integration of host resistance and weather-based fungicide scheduling for control of anthracnose of tomato fruit. Plant Dis. 79: 228-233.

4. Raid, R.N. and Pennypacker, S.P. 1987. Weeds as hosts for *Colletotrichum coccodes*. Plant Dis. 71: 643-646.

## BACTERIAL CANKER, BACTERIAL SPOT, BACTERIAL SPECK

*Clavibacter michiganensis* subsp. *michiganensis*, *Xanthomonas campestris* pv. *vesicatoria*, *Pseudomonas syringae* pv. *tomato*

**Cultural**: Use only hot water-treated (50°C for 25 min.), acid-treated or calcium hypochlorite treated seed (1), or disease-free transplants (see Notes). Grow seedlings in steamed or fumigated media in disinfected flats or pots. If any of the diseases appear in a crop, carefully remove the first infected plants, avoid methods of pruning, etc. that may spread disease from plant to plant, avoid sprinkler irrigation. Do not replant tomatoes or related plants for at least 2 years in a field where disease appeared.

**Resistant Cultivars**: Andino, Aztec, BOS 8033, BOS 8066, Condor, Grandstand 98, H2710, H8893, H9175, H9280, Hy 882, Hypeel 562, Isola, Maya, Nema 1201, Prairie Pastemaker, Prairie Schooner, Puebla, Red

Century 32, Salvador, Santa Fe, Spectrum 385, Spectrum 579, Stella, Super Marzano, Viva Italia (4).

**Chemical**: When bacterial spot threatens, apply copper hydroxide (COM) WP + mancozeb (COM) WP or cupric hydroxide + maneb (COM) WP at 7 to 10 day intervals.
**Limitations**: Pre-harvest interval: 1 day. Not registered for bacterial speck. Chemical control of these diseases in the field may not be practical or effective.

**Notes**: Buy disease-free transplants (bacterial canker is very severe in Georgia, a major supplier of transplants).

**References**:

1. Dhanvantari, B.N. 1989. Effect of seed extraction methods and seed treatments on control of tomato bacterial canker. Can. J. Plant Pathol. 11: 400-408.

2. Farley, J.D., and Miller, T.D., 1973. Spread and control of *Corynebacterium michiganense* in tomato transplants during clipping. Plant Dis. Rep. 57: 767-769.

3. Jones, J.B. *et al.* 1991. Diseases caused by bacteria. p. 25-30 *in* Compendium of Tomato Diseases. APS Press.

4. Scott, J. W. 1999. Tomato, pp. 999 - 1009. *In*: Wehner, T.C. (ed.), Vegetable Cultivar Descriptions for North America List 25, 1999. HortScience 34(6): 957 - 1012.

## BLOSSOM-END ROT

Physiological

**Cultural**: In acid soils, ensure adequate levels of calcium by adding lime or ground limestone well before planting. Maintain uniform soil moisture throughout the growing season (3). Avoid close cultivation. Apply 2.2 to 5.6 kg per ha of calcium chloride as a spray during fruit development (see Notes).

**Resistant Cultivars**: Earlibright (2).

**Chemical**: None.

**Notes**: Use the lower rate of calcium chloride where frequent applications are possible (1). Higher rates may cause injury to the leaves. Calcium nitrate may also be used. It is less damaging to the leaves but the extra nitrogen may not be desirable. While there are some differences in varietal susceptibility, they are not great enough to warrant selecting the varieties to grow on that basis.

**References**:

1. Halterlein, A.J. and Lambeth, V.N. l975. Effect of controlled release fertilizers on blossom-end rot incidence in *Lycopersicum esculentum* cv. Patio Hybrid. HortScience 10: 17-18.

2. Scott, J. W. 1999. Tomato, pp. 999 - 1009. *In*: Wehner, T.C. (ed.), Vegetable Cultivar Descriptions for North America List 25, 1999. HortScience 34(6): 957 - 1012.

3. Shaykewich, C.F. *et al.* 1971. Nutrition and blossom-end rot of tomatoes as influenced by soil water regime. Can. J. Plant Sci. 51: 505-511.

4. Tan, C.S. and B.N. Dhanvantari. 1985. Effect of irrigation and plant population on yield, fruit speck and blossom end rot of processing tomatoes. Can. J. Plant Sci. 65: 1011-1018.

## EARLY BLIGHT

*Alternaria solani*

**Cultural**: Plow under crop debris immediately after harvest. Follow a rotation that includes cereals and legumes. For staking tomatoes, disinfect stakes between crops. Control volunteer tomatoes and potatoes and solanaceous weeds such as nightshade.

**Resistant Cultivars**: All Star, Atlantic City, Big Beef, Butte, Cannery Row, Capitan, Carnival, Cisco, Colonial, Colusa, Condor, Corona, Duven, Eagle, Early Cascade, Early Goliath, EF 49, EF 50, EF 51, EF 52, Empire, Endura, Falcon, Fame, Famous Wisconsin 55, Floramerica, Florasette, Gardeners Choice, Goliath, Gilbraltor, H2710, H3044, H3302, H8773, H8892, H8893, H9175, H9280, H9382, Hawk, Heatwave, Heritage, Hunter, Husky Pink, Husky Red, Hy 337, Hy 882, Hybrid 922, Hypeel 219, Hypeel 287, Hypeel 696, Jack, Joker, Jubilee, Juliet, Keno, Leading Lady, Lemon Boy, Loteria, Lucky Draw, Lucky Lady, Majesty, Maxim PS, MH VF 789, Milagro, Mountain Fresh, Mountain Supreme, Nema 1201, Nema 1401, Pik Ripe 747 LSL, Pik Ripe 748 LSL, Pink Girl, Reno, Plum Daddy, Royal Red Cherry, Santiago, Shady Lady, Short Red Cherry, Silverado, Solimar, Sonar, Springfield, Stella, Sugar Daddy, Sunbeam, Sunbolt, Sunbrite, Sunglobe, Sunjay, Sunpride, Sweepstakes, Tango, Temprano, Tres Rios, Trojan, Vegas, Viva Italia. (1, 5)

**Chemical**: A regular spray program at 7 to 14-day intervals may be required in commercial tomato fields from early June for control of early blight. Apply captan (COM, DOM) DU, WG, chlorothalonil (COM, DOM) SU, mancozeb (COM) WP, benomyl + mancozeb (COM) WP, anilazine (COM) WP, maneb (COM) WP; metiram (COM) WG, tribasic copper sulphate (COM, DOM) DU, WP, copper oxychloride (COM, DOM) DU, WP, zineb (COM) WP, or ziram (COM) WP.

**Limitations**: Preharvest intervals - 1 day (chlorothalonil, copper oxychloride, tribasic copper sulphate, ziram); 2 days (captan); 3 days (anilazine); 5 days (zineb); 7 days (maneb, metiram, benomyl + mancozeb, mancozeb),.

**Notes**: Chlorothalonil and mancozeb also control anthracnose, late blight and other diseases. Differences in susceptibility of cultivars and breeding lines are known (2).

**References**:


1. Hudelson, B.D. *et al.* 2000. Disease-resistant vegetables for the home garden. University of Wisconsin-Extension. #A3110., 26 pp.

2. Maiero, M. *et al.* 1990. Genetic resistance to early blight in tomato breeding lines. HortScience 25: 344-346.

3. Pitblado, R.E. 1988. Development of a weather-timed fungicide spray program for field tomatoes. Can J. Plant Pathol. 10: 371 (abstr.).

4. Pitblado, R.E. and Hoste, E.O. 1976. Effect of Ethrel-Bravo combinations in field tomatoes. Pp. 320-322 *in* Pesticide Research Report. ECPUA, Ottawa.

5. Scott, J. W. 1999. Tomato, pp. 999 - 1009. *In*: Wehner, T.C. (ed.), Vegetable Cultivar Descriptions for North America List 25, 1999. HortScience 34(6): 957 - 1012.

## FUSARIUM WILT, VERTICILLIUM WILT, SOUTHERN BACTERIAL WILT, FUSARIUM CROWN & ROOT ROT

*Fusarium oxysporum* f.sp. *lycopersici, Verticillium dahliae, Pseudomonas solanacearum, Fusarium oxysporum* f.sp. *radicis-lycopersici.*

**Cultural**: In areas where any of these diseases do not occur, avoid introducing field grown seedlings for transplanting. Greenhouse grown seedlings using steamed or fumigated media and disinfected flats and pots are less likely to be infested. Follow a rotation in which members of the tomato-potato-pepper-eggplant group are not grown for at least 2 of 3 years (1, 2).

**Resistant Cultivars**: Most commercial cvs. have resistance to Fusarium (F) and or Verticillium (V) wilts. Scott lists 259 cvs resistant to Fol race 1, 167 to Fol race 2, and 242 to Vd race 2. The cultivars Hawk, Heatmaster, and Nahomi are resistant to bacterial wilt (4).

**Chemical**: Soil fumigation is effective in reducing inoculum levels in mineral soils.

**Notes**: Fusarium crown and root rot caused by *F. oxysporum* f.sp. *radicis-lycopersici* may be a problem in greenhouse grown transplants if the disease is present in the greenhouse.

**References**:


1. Brammall, R.A. and McKeown, A.W. 1989. An occurrence in Ontario of fusarium crown and root rot disease in field-grown processing tomatoes originating from multicelled tray transplants. Can. J. Plant Pathol. 11: 75-77.

2. Denby, L.G. 1963. Culture of field tomatoes in the southern interior of British Columbia. Agric. Can. Res. Sta., Summerland. Unnumbered Mimeo Publ.

3. Menzies, J.G., *et al.* 1990. Additions to the host range of *Fusarium oxysporum* f. sp. *radicis lycopersici*. Plant Dis. 74: 569-572.

4. Scott, J. W. 1999. Tomato, pp. 999 - 1009. In: Wehner, T.C. (ed.), Vegetable Cultivar Descriptions for North America List 25, 1999. HortScience 34(6): 957 - 1012.

5. Walker, J.C. 1971. Fusarium wilt of tomato. Am. Phytopath. Soc. Monog. 6.


## GRAY MOLD ROT

*Botrytis cinerea*

**Cultural**: Avoid situations resulting in high humidity. Do not use overhead sprinklers after 3 pm.

**Resistant Cultivars**: Florida MH-1. (1)

**Chemical**: At the fist appearance of the disease, spray anilazine (COM) WP or chlorothalonil (COM) SU. If wet weather prevails repeat every 14 days.

**Limitations**: Preharvest intervals: 1 day (chlorothalonil); 3 days (anilazine).

**References:**

1. Scott, J. W. 1999. Tomato, pp. 999 - 1009. *In*: Wehner, T.C. (ed.), Vegetable Cultivar Descriptions for North America List 25, 1999. HortScience 34(6): 957 - 1012.

## LATE BLIGHT

*Phytophthora infestans*

**Cultural**: Isolate tomato fields from potato fields and potato cull piles. Do not plant tomatoes after potatoes. Avoid excessive foliage. Do not sprinkler irrigate. Control volunteers and solanaceous weeds. With the presence of both the A2 and A1 mating types in Canada, sanitation and rotation will become necessary to reduce overwintering inoculum. Because oospores may be formed in foliage and vines, the prompt removal of diseased vines at the end of the season by whatever means are available may be useful if it is intended to use the same field for tomatoes or potatoes within the next few years. Areas which have not yet identified A2 should avoid importation of tomato transplants from the southern states where it is known to occur.

**Resistant Cultivars**: None.

**Chemical**: A regular spray program may be necessary in commercial tomato fields in areas where late blight occurs regularly. About 1 June and every 7-14 days thereafter apply mancozeb (COM) DF, WG, SU, metiram (COM) DF, chlorothalonil (COM, DOM) SU, zineb (COM) WP, copper oxychloride (DOM, COM) WP, or tribasic copper sulphate (DOM, COM) DU, WP.

**Limitations**: Preharvest interval - 1 day (chlorothalonil, copper oxychloride, tribasic copper sulphate); 5 days (zineb); 7 days (mancozeb, metiram).

**References**:

1. Fry, W.E. *et al.* 1993. Historical and recent migrations of *Phytophthora infestans*: chronology, pathways, implications. Plant Disease 77:653-661.

2. Tartier, L. and DeVaux, A. 1974. Control of late blight by different fungicides. Pp. 307-308 *in* Pesticide Research Report. CCPUA, Ottawa.

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1. Committee. 1985. Integrated pest management for cole crops and lettuce. University of California. Publ. 3307. 112 pp.

2. Committee. 1985. Integrated pest management for tomatoes. University of California. Publ. 3274. 105 pp.

3. Committee. 1998/99. Vegetable production recommendations. B.C. Minist. Agric. & Food.

4. Committee. 1995. Vegetable production recommendations. Ont. Minist. Agric., Food and Rural Affairs.

5. Committee. 1995. Pacific Northwest plant disease control handbook. Oreg. State Univ., Corvallis.

6. Dixon, G.R. 1981. Vegetable Crop Diseases. McMillan Publishers Ltd., London, U.K.

7. Hagedorn, Donald J. *et al.* 1984. Compendium of Pea Diseases. Am. Phytopathol. Soc, St. Paul, Minn. 57 pp.

8. Hall, R. *et al*. 1991. Compendium of bean diseases. Am. Phytopathol. Soc., St. Paul, Minn. 73 pp.

9. Howard, R.J., Garland, J.A. and Seaman, W.L. 1994. Diseases and Pests of Vegetable Crops in Canada: An Illustrated Compendium. Can. Phytopath. Soc. and Ent. Soc. Canada. 554 pp.

10. Jones, J.B. *et al.* 1991. Compendium of Tomato Diseases. Am. Phytopathol. Soc. St. Paul, Minn. 73 pp.

11. McKeen, C.D. 1972. Tomato diseases. Can. Dep. Agric. Publ. 1479.

12. McNab, A.A. *et al.* 1983. Identifying Vegetable Diseases. Pennsylvania State University, University Park, Pennsylvania.

13. Sherf, A.F. and MacNab, A.A. 1986. Vegetable diseases and their control. 2nd Ed. John Wiley & Sons, New York.

## APPENDIX I. Bactericides and fungicides registered for use on vegetable crops in Canada

| Active Ingredient | Trade Name | Formulation | Commercial/ Domestic | PCP # | Diseases Controlled |
|---|---|---|---|---|---|
| **ASPARAGUS:** | | | | | |
| benomyl[a] | Benlate 50W<br>Benlate Toss-N-Go | 50% WP<br>50% WP | C<br>C | 11062<br>24678 | *Fusarium*, *Rhizoctonia*, violet root rot |
| metiram | Polyram DF | 80% WG | C | 20087 | rust |
| myclobutanil | Nova 40W | 40% WP | C | 22399 | rust |
| propiconazole | Topas 250E | 250 g/L EC | C | 24030 | rust |
| zineb | Zineb 80W | 80% WP | C | 9318 | rust |
| **BEAN:** | | | | | |
| benomyl[a] | Benlate 50W<br>Benlate Toss-N-Go | 50% WP<br>50% WP | C<br>C | 11062<br>24678 | gray mold, white mold |
| captan | Captan Flowable | 30% SU | C | 12028,<br>24684 | seed treatment |
| | Supra Captan 80 WDG | 80% WG | C | 24613 | seedbed treatment |
| captan<br>+ diazinon<br>+ gamma BHC | Agrox B-3 Dual Purpose | 33.5% DU<br>11%<br>16.6% | C | 9505 | seed treatment |
| captan<br>+ diazinon<br>+ gamma BHC | Agrox D-L Plus,<br>Co-op DLC,<br>DLC Seed Treatment | 15% DU<br>15%<br>25% | C | 10896<br>13951<br>11451 | seed treatment |
| captan<br>+ diazinon<br>+ thiophanate-methyl | DCT Dual Purpose | 18% WP | C | 14986 | seed treatment, anthracnose |
| carbathiin<br>+ thiram | Vitaflo-280 | 14.9 % SU<br>13.2 % | C | 11423 | seed treatment |
| copper hydroxide | Kocide 101<br>Parasol | 50% WP<br>50% WP | C<br>C | 14417<br>24671 | bacterial blight |
| dicloran | Botran 75W | 75% WP | C | 8772 | white mold, gray mold |
| iprodione | Rovral<br>Rovral WDG | 50% WP<br>50% G | C | 15213<br>24709 | white mold, gray mold |
| metalaxyl | Ridomil 240EC | 240 g/L EC | C | 17274 | Pythium damping off, phytophthora root rot |
| metalaxyl-M | Ridomil Gold 480EC | 480 g/L EC | C | 25384 | Pythium damping off, phytophthora root rot |

[a] Products are coming off production December, 2001 and existing stocks will only be available until 2002.

| | | | | | |
|---|---|---|---|---|---|
| **BEAN: con't** | | | | | |
| sulphur | Later's Garden Sulfur | 90% WP | D | 5293 | powdery mildew |
| | Sulfur Dust | 92% DU | D | 19703 | powdery mildew, rust |
| | Safer's Natural Garden Fungicide | 0.40% RTU SU | D | 19061 | powdery mildew, rust |
| | CIL Mother Earth Garden Sulfur | 92% WP | D | 24180 | powdery mildew, rust |
| thiram | Thiram 75 W | 75% WP | C | 15933 | seed treatment |
| tribasic copper sulphate | Copper 53W<br>Basicop<br>Bordo | 53% WP<br>53% WP<br>53% WP | C<br>C<br>D | 9934<br>19003<br>17482 | anthracnose, downy mildew, bacterial leafspot |
| tribasic copper sulphate<br>+ carbaryl | Tomato & Vegetable Dust | 7% DU<br><br>+ 5% DU | D | 17424 | anthracnose, downy mildew, leafspot |
| vinclozolin | Ronilan DF | 50% WG | C | 22981 | gray mold, white mold |
| **BEET:** | | | | | |
| thiram | Thiram 75W | 75% WP | C | 15933 | seed treatment |
| tribasic copper sulphate | Copper 53W<br>Basicop<br>Bordo | 53% WP<br>53% WP<br>53% WP | C<br>C<br>D | 9934<br>19003<br>17482 | cercospora leafspot |
| tribasic copper sulphate<br>+ carbaryl | Tomato & Vegetable Dust | 7% DU<br><br>+ 5% DU | D | 17424 | cercospora leafspot |
| **BROCCOLI, BRUSSELS SPROUTS, CABBAGE, CAULIFLOWER:** | | | | | |
| captan | Supra Captan 80 WDG | 80% WG | C | 24613 | seedbed treatment |
| carbathiin<br>+ thiram<br>+ gamma BHC | Vitavax RS Flowable | 45 g/L SU<br>90 g/L<br>680 g/L | C | 15533 | seed treatment |
| chlorothalonil | Bravo 500 | 500 g/L SU | C | 15723 | alternaria leaf spot, downy mildew |
| fosetyl-Al | Aliette WDG | 80% WG | C | 24458 | downy mildew (broccoli and bok choy only) |
| iprodione | Rovral<br>Rovral WDG | 50% WP<br>50% WG | C<br>C | 15213<br>24709 | Alternaria leaf spots (cabbage and cauliflower only) |
| quintozene | Terraclor 75W<br>Quintozene 75 | 75% WP<br>75% WP | C<br>C | 7251<br>11425 | club root |
| streptomycin | Streptomycin 17 | 17% WP | C | 10305 | seed treatment for black rot |

| **BROCCOLI, BRUSSELS SPROUTS, CABBAGE, CAULIFLOWER** con't | | | | | |
|---|---|---|---|---|---|
| thiram | Thiram 75W | 75% WP | C | 15933 | seed treatment |
| tribasic copper sulphate | Copper 53W<br>Basicop | 53% WP<br>53% WP | C<br>C | 9934<br>19003 | downy mildew, black leafspot, gray leafspot |
| | Bordo | 53% WP | D | 17482 | downy mildew |
| tribasic copper sulphate + carbaryl | Tomato & Vegetable Dust | 7% DU<br>+ 5% DU | D | 17424 | downy mildew, black leafspot, gray leafspot |
| zineb | Zineb 80W | 80% WP | C | 9318, 14562 | downy mildew, black leafspot, gray leafspot |
| **CARROT:** | | | | | |
| benomyl[a] | Benlate 50W<br>Benlate Toss-N-Go | 50% WP<br>50% WP | C<br>C | 11062<br>24678 | white mold |
| chlorothalonil | Bravo 500 | 500 g/L SU | C | 15723 | early blight, late blight |
| chlorothalonil + carbaryl | Deecop Liquid Suspension | 180 g/L SU<br>+ 180 g/L SU | D | 13723 | early blight, late blight |
| mancozeb | Dithane DG | 75% WG | C | 20553 | leaf spots |
| | Manzate 200DF | 75% DF | C | 21057 | alternaria blight, cercospora leaf spot |
| maneb | Maneb 80WP | 80% WP | C | 25176 | Alternaria leaf spot, cercospora leaf spot |
| metalaxyl | Ridomil 2G | 2% G | C | 24037 | cavity spot |
| metiram | Polyram DF | 80% DF | C | 20087 | alternaria blight, cercospora blight |
| thiram | Thiram 75W | 75% WP | C | 15933 | seed treatment |
| tribasic copper sulphate | Copper 53W<br>Basicop | 53% WP<br>53% WP | C<br>C | 9934<br>19003 | cercospora leaf spot |
| | Bordo | 53% WP | D | 17482 | cercospora leaf spot |
| zineb | Zineb 80W | 80% WP | C | 9318, 14562 | alternaria blight, cersospora blight |
| **CELERY:** | | | | | |
| anilazine[b] | Dyrene 50W | 50% WP | C | 6731 | early blight, late blight, rhizoctonia |
| captan | Supra Captan 80 WDG | 80% WG | C | 24613 | seedbed treatment |
| chlorothalonil | Bravo 500 | 500 g/L SU | C | 15723 | early blight, late blight |
| chlorothalonil + carbaryl | Deecop Liquid Suspension | 180 g/L SU<br>+ 180 g/L SU | D | 13723 | early blight, late blight |

[a] Products are coming off production December, 2001 and existing stocks will only be available until 2002.

[b] Discontinued as of December 31, 2002. Growers have until December 31, 2005 to use up existing stocks.

| | | | | | |
|---|---|---|---|---|---|
| **CELERY:** con't | | | | | |
| copper oxychloride | Copper Oxychloride 50<br>Copper Spray | 50% WP<br>50% WP | C<br>C | 13245<br>19146 | early blight, late blight |
| | Copper Spray | 50% WP | D | 16140, 16637 | early blight, late blight |
| folpet | Folpet Rose & Garden | 50% WP | D | 15798 | early blight, late blight |
| mancozeb | Dithane DG | 75% WG | C | 20553 | early blight, late blight |
| | Manzate 200DF | 75% DF | C | 21057 | early blight, late blight |
| maneb | Maneb 80WP | 80% WP | C | 25176 | early blight, late blight |
| metiram | Polyram DF | 80% DF | C | 20087 | early blight, late blight |
| thiram | Thiram 75W | 75% WP | C | 15933 | early blight, late blight, rhizoctonia, damping-off, and also seed treatment |
| tribasic copper sulphate | Copper 53W<br>Basicop | 53% WP<br>53% WP | C<br>C | 9934<br>19003 | early blight, late blight |
| | Bordo | 53% WP | D | 17482 | early blight, late blight |
| tribasic copper sulphate<br>+ carbaryl | Tomato & Vegetable Dust | 7% DU<br><br>+ 5% DU | D | 17424, 23613 | early blight, late blight |
| tribasic copper sulphate<br>+ carbaryl | Deecop | 7% DU<br><br>5% | D | 14160 | |
| zineb | Zineb 80W | 80% WP | C | 9318, 14562 | early blight, late blight |
| **CUCUMBER:** See also Cucumbers, Melons, Pumpkins, Squash | | | | | |
| anilazine[b] | Dyrene 50W | 50% WP | C | 6731 | botrytis (see under Cucumbers, Melons, Pumpkins, Squash for additional diseases) |
| captan | Maestro 75DF<br>Maestro 80DF<br>Supra Captan 80WDG | 75% DF<br>80% DF<br>80% WG | C<br>C<br>C | 23350<br>26408<br>24613 | anthracnose, scab |
| copper hydroxide | Kocide 101<br>Parasol | 50% WP<br>50% WP | C | 14417<br>24671 | angular leaf spot |
| metalaxyl | Ridomil 240EC | 240 g/L EC | C | 17274 | Pythium damping-off |
| metalaxyl-M | Ridomil Gold 480EC | 480 g/L EC | C | 25384 | Pythium damping-off |

[b] Discontinued as of December 31, 2002. Growers have until December 31, 2005 to use up existing stocks.

| CUCUMBER, MELON, PUMPKIN, SQUASH: | | | | | |
|---|---|---|---|---|---|
| anilazine[b] | Dyrene 50W | 50% WP | C | 6731 | anthracnose, gummy stem blight, downy mildew, leaf spots (Alternaria and Cercospora) |
| benlate[a] + mancozeb | Benate 50W + Manzate 200 DF | 50% WP 80% DF | C C | 11062 21057 | alternaria leaf spot, anthracnose, downy mildew, gummy stem blight, powdery mildew, scab |
| | Benlate Toss-N-Go + Manzate 200 DF | 50% WP 80% DF | C C | 24678 21057 | |
| chlorothalonil | Bravo 500 | 500 g/L SU | C | 15723 | anthracnose, powdery mildew, scab |
| chlorothalonil + carbaryl | Deecop Liquid Suspension | 180 g/L SU + 180 g/L SU | D | 13723 | anthracnose, powdery mildew, scab |
| copper oxychloride | Copper Oxychloride 50 | 50% WP | C | 13245 | angular leaf spot, anthracnose, bacterial wilt, alternaria leaf spot, downy mildew, septoria leaf spot |
| | Copper Spray | 50% WP | C | 19146 | |
| | Copper Spray | 50% WP | D | 16140, 16637 | |
| folpet | Folpan | 50% WP | C | 15654 | anthracnose, downy mildew, powdery mildew |
| | Folpet Rose & Garden | 50% WP | D | 15798 | anthracnose, powdery mildew |
| mancozeb | Dithane DG Manzate 200DF | 75% WG 75% DF | C C | 20553 21057 | anthracnose, alternaria leaf spot, gummy stem blight, scab, downy mildew |
| thiram | Thiram 75W | 75% WP | C | 15933 | seed treatment |
| tribasic copper sulphate | Copper 53W | 53% WP | C | 9934 | angular leaf spot, anthracnose, downy mildew, scab |
| | Basicop | 53% WP | C | 19003 | |
| | Bordo | 53% WP | D | 17482 | |
| tribasic copper sulphate + carbaryl | Tomato & Vegetable Dust | 7% DU + 5% DU | D | 17424, 23613 | anthracnose, leaf spot, scab |
| tribasic copper sulphate + carbaryl | Deecop | 7% DU 5% | D | 14160 | angular leaf spot |
| zineb | Zineb 80W | 80% WP | C | 9318, 14562 | alternaria leaf spot, anthracnose, downy mildew, gummy stem blight, septoria leaf spot |

[b] Discontinued as of December 31, 2002. Growers have until December 31, 2005 to use up existing stocks.

| | | | | | |
|---|---|---|---|---|---|
| **ENDIVE:** | | | | | |
| metalaxyl-M + mancozeb | Ridomil Gold MZ | 4% WP<br>64% WP | C | 25379 | *Phytophthora* (post harvest root application) |
| **LETTUCE:** | | | | | |
| dicloran | Botran 75W | 75% WP | C | 8772 | sclerotinia drop |
| fosetyl-Al | Aliette WDG | 80% WG | C | 24458 | downy mildew |
| iprodione | Rovral<br>Rovral WDG | 50% WP<br>50% WG | C | 15213<br>24709 | gray mold |
| metalaxyl | Ridomil 2G | 2% GR | C | 24037 | *Pythium* damping-off, *Pythium* stunt |
| metalaxyl + mancozeb | Ridomil MZ 72 | 8% WP<br>64% WP | C | 17300 | downy mildew |
| thiram | Thiram 75W | 75% WP | C | 15933 | seed treatment |
| vinclozolin | Ronilan EG | 50% WG | C | 24894 | lettuce drop |
| zineb | Zineb 80W | 80% WP | C | 9318,<br>14562 | downy mildew |
| **ONION:** | | | | | |
| anilazine[b] | Dyrene 50W | 50% WP | C | 6731 | purple blotch, botrytis leaf blight |
| carbathiin + thiram | Pro-Gro | 30% DU<br>50% | C | 10959 | smut seed treatment |
| chlorothalonil | Bravo 500 | 500 g/L SU | C | 15723 | botrytis leaf blight |
| copper oxychloride | Copper Oxychloride 50<br>Copper Spray | 50% WP<br>50% WP | C<br>C | 13245<br>19146 | downy mildew |
| | Copper Spray | 50% WP | D | 16140,<br>16637 | |
| dicloran | Botran 75W | 75% WP | C | 8772 | white rot |
| fosetyl-Al | Aliette WDG | 80% WG | C | 24458 | downy mildew, purple blotch |
| iprodione | Rovral<br>Rovral WDG | 50% WP<br>50% WG | C<br>C | 15213<br>24709 | botrytis leaf blight, downy mildew |
| mancozeb | Dithane DG | 75% WG | C | 20553 | Botrytis leaf blight |
| | Manzate 200 DF | 75% DF | C | 21057 | botrytis leaf blight, downy mildew, purple blotch |
| metalaxyl + mancozeb | Ridomil MZ 72 | 8% WP<br>64% WP | C | 17300 | downy mildew |

[b] Discontinued as of December 31, 2002. Growers have until December 31, 2005 to use up existing stocks.

| | | | | | |
|---|---|---|---|---|---|
| **ONION: con't** | | | | | |
| thiram | Thiram 75W | 75% WP | C | 15933 | seed treatment |
| zineb | Zineb 80W | 80% WP | C | 9318, 14562 | botrytis leaf blight, downy mildew, purple blotch |
| **PARSNIP:** | | | | | |
| chlorothalonil | Bravo 500 | 500 g/L SU | C | 15723 | root canker |
| **PEA:** | | | | | |
| captan | Captan Flowable | 30% SU | C | 12028, 24684 | seed treatment |
| | Supra Captan 80 WDG | 80% WG | C | 24613 | seedbed treatment |
| metalaxyl<br>+ thiram<br>+ thiabendazole | Apron Combi FS | 140 g/L SU<br>60 g/L<br>72 g/L | C | 24288 for export only | ascochyta, downy mildew, damping-off |
| sulfur | Kumulus DF<br>Micro-Niasul<br><br>see BEAN for domestic products | 80% DF<br>92% WP | C<br>C | 18836<br>14713 | powdery mildew |
| thiram | Thiram 75W | 75% WP | C | 15933 | seed treatment |
| **PEPPER:** | | | | | |
| captan | Supra Captan 80WDG | 80% WG | C | 24613 | seedbed treatment |
| captan<br>+ carbaryl<br>+ malathion | Fruit Tree & Garden Spray | 10% WP<br>10%<br>5% | D | 09986 | most diseases |
| copper hydroxide | Kocide 101<br>Parasol | 50% WP<br>50% WP | C | 14417<br>24671 | bacterial spot |
| thiram | Thiram 75W | 75% WP | C | 15933 | seed treatment |
| tribasic copper sulphate | Copper 53W<br>Basicop | 53% WP<br>53% WP | C<br>C | 09934<br>19003 | early blight, late blight |
| | Bordo | 53% WP | D | 17482 | |
| tribasic copper sulphate<br>+ carbaryl | Tomato & Vegetable Dust | 7% DU<br><br>5% | D | 17424, 23613 | early blight, late blight |
| zineb | Zineb 80W | 80% WP | C | 9318, 14562 | anthracnose, early blight, late blight |
| **RADISH:** | | | | | |
| thiram | Thiram 75W | 75% WP | C | 15933 | seed treatment |

| | | | | | |
|---|---|---|---|---|---|
| **RHUBARB:** | | | | | |
| captan | Supra Captan 80 WDG | 80% WG | C | 24613 | gray mold |
| | Maestro 75DF<br>Maestro 80DF | 75% DF<br>80% DF | C<br>C | 23350<br>26408 | leaf rot |
| **RUTABAGA:** | | | | | |
| captan | Supra Captan 80 WDG | 80% WG | C | 24613 | seedbed treatment |
| carbathiin<br>+ gamma BHC<br>+ thiram | Cloak | 45 g/L SN<br>533 g/L<br>90 g/L | C | 22121 | seed treatment |
| propiconazole | Topas | 250 g/L EC | C | 24030 | powdery mildew |
| streptomycin | Streptomycin 17 | 17% WP | C | 10305 | seed treatment for black rot |
| **SPINACH:** | | | | | |
| thiram | Thiram 75W | 75% WP | C | 15933 | seed treatment |
| tribasic copper sulphate | Copper 53W<br>Basicop | 53% WP<br>53% WP | C<br>C | 09934<br>19003 | downy mildew, white rust |
| | Bordo | 53% WP | D | 17482 | |
| tribasic copper sulphate<br>+ carbaryl | Tomato & Vegetable Dust | 7% DU<br><br>5% | D | 17424,<br>23613 | downy mildew, white rust |
| **TOMATO:** | | | | | |
| anilazine[b] | Dyrene 50W | 50% WP | C | 6731 | anthracnose, botrytis, early blight, gray leaf spot, late blight, septoria leaf spot |
| benomyl[a] | Benlate 50W<br>Benlate Toss-N-Go | 50% WP<br>50% WP | C<br>C | 11062<br>24678 | septoria leaf spot |
| benlate[a] +<br>mancozeb | Benate 50W +<br>Manzate 200 DF<br><br>Benlate Toss-N-Go +<br>Manzate 200 DF | 50% WP<br>80% DF<br><br>50% WP<br>80% DF | C<br>C<br><br>C<br>C | 11062<br>21057<br><br>24678<br>21057 | anthracnose, early blight |
| captan | Supra Captan 80 WDG | 80% WG | C | 24613 | early blight, late blight, anthracnose, septoria leaf spot, gray leaf spot |
| | Maestro 75DF<br>Maestro 80DF | 75% DF<br>80% DF | C<br>C | 23350<br>26408 | anthracnose, septoria leaf spot |

[a] Products are coming off production December, 2001 and existing stocks will only be available until 2002.

[b] Discontinued as of December 31, 2002. Growers have until December 31, 2005 to use up existing stocks.

| **TOMATO:** con't | | | | | |
|---|---|---|---|---|---|
| captan<br>+ methoxychlor<br>+ rotenone | Golden Garden Dust | 5% DU<br>5%<br>0.75% | D | 17545,<br>17544 | anthracnose, early blight, gray leaf spot, septoria leaf spot, damping-off |
| captan<br>+ carbaryl<br>+ malathion | Fruit Tree & Garden Spray | 10% DU<br>10%<br>5% | D | 09986 | most diseases |
| chlorothalonil | Bravo 500 | 500 g/L SU | C | 15723 | anthracnose, Botrytis gray mold, early blight, late blight, Septoria leaf spot |
| chlorothalonil<br>+ carbaryl | Deecop Liquid Suspension | 180 g/L SU<br>+ 180 g/L SU | D | 13723 | anthracnose, early blight, late blight |
| copper hydroxide | Kocide 101<br>Parasol | 50% WP<br>50% WP | C | 14417<br>24671 | bacterial spot |
| | Kocide DF | 61.4% SG | C | 24538 | bacterial canker, septoria leaf spot, early blight, late blight |
| copper oxychloride | Copper Oxychloride 50<br>Copper Spray | 50% WP<br>50% WP | C<br>C | 13245<br>19146 | bacterial canker, early blight, late blight, septoria leaf spot |
| | Copper Spray | 50% WP | D | 16140,<br>16637 | |
| copper oxychloride<br>+ carbaryl | Tomato & Potato Dust | 7% DU<br><br>5% | D | 15391,<br>16106 | anthracnose, early blight, late blight, gray leaf spot |
| folpet | Folpan | 50% WP | C | 15654 | anthracnose |
| mancozeb | Dithane F-45 | 37% SU | C | 20552 | anthracnose, early blight, gray leaf spot, late blight |
| | Dithane DG<br>Manzate 200DF | 75% WG<br>75% DF | C<br>C | 20553<br>21057 | |
| maneb | Maneb 80WP | 80% WP | | 25176 | anthracnose, cladosporium leaf mold, septoria leaf spot, early blight, late blight |
| metiram | Polyram DF | 80% DF | C | 20087 | early blight, late blight, anthracnose, gray leaf spot, septoria leaf spot |
| thiram | Thiram 75 | 75% WP | C | 15933 | seed treatment |

| **TOMATO:** con't | | | | | |
|---|---|---|---|---|---|
| tribasic copper sulphate | Copper 53W<br>Basicop | 53% WP<br>53% WP | C<br>C | 09934<br>19003 | anthracnose, early blight, late blight, leaf mold, Septoria leaf spot |
| | Bordo | 53% WP | D | 17482 | |
| tribasic copper sulphate<br>+ carbaryl | Tomato & Vegetable Dust | 7% DU<br><br>5% | D | 17424,<br>23613 | anthracnose, early blight, late blight, Septoria leaf spot |
| tribasic copper sulphate<br>+ carbaryl | Deecop | 7% DU<br><br>5% | D | 14160 | early blight, late blight |
| zineb | Zineb 80W | 80% WP | C | 09318,<br>14562 | anthracnose, early blight, gray leaf spot, gray mold, late blight, leaf mold, septoria leaf spot |
| ziram | Ziram 85W | 85% WP | C | 14773 | anthracnose, early blight, late blight |