

Chapter 10

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BUCKWHEAT (*Fagopyrum esculentum*)

BOTRYTIS ROT

Botrytis cinerea

Cultural: Practice a rotation with cereals, corn, or grasses to reduce disease incidence. Avoid fababeans, field beans and lentils in the rotation. Follow cultural practices that avoid a dense planting.

Resistant Cultivars: None.

Chemical: None.

Notes: Pathogen is seed-borne (1,3) and overwinters in crop residue and soil.

References:

1. Mills, J.T. and Wallace, H.A.H. 1971. Microflora of buckwheat seed, changes in storage and effects of seed treatments on seedling emergence. Can. Plant Dis. Surv. 51: 154-158.
2. Morrall, R.A.A. and McKenzie, D.L. 1975. Diseases of specialty crops in Saskatchewan: I. Notes on buckwheat and sunflower 1972-1973. Can. Plant Dis. Surv. 55: 69-72.
3. Savitskiy, K.A. 1970. Grechika [Buckwheat]. Moscow: 'Kolos', 312 pp.

DOWNY MILDEW

Peronospora ducometi

Cultural: Plant populations that allow good air circulation and fast drying of the leaves should help reduce severity of the disease. The disease is seedborne; if possible plant seed from mildew-free crops. Planting buckwheat seed when soil temperature is 20°C or above may reduce the incidence of downy mildew.

Resistant Cultivars: None (see Notes).

Chemical: None.

Notes: Intermediate to good resistance is available and attempts to transfer this resistance to advanced research germplasm are being made.

SEED ROT, SEEDLING BLIGHT and ROOT ROT

Fusarium spp. and *Rhizoctonia solani*

Cultural: Practice a crop rotation with cereals, corn or grasses. Avoid pulses, vegetables, and potatoes in the rotation.

Resistant Cultivars: None.

Chemical: Treat seed with fludioxonil (COM) SN.

References:

1. Morrall, R.A.A. and McKenzie, D.L. 1975. Diseases of specialty crops in Saskatchewan: I. Notes on buckwheat and sunflower 1972-1973. *Can. Plant Dis. Surv.* 55: 69-72.

OTHER DISEASES

The following diseases are currently of minor importance and/or are diseases for which no practical control measures are currently recommended:

Aster Yellows (aster yellows phytoplasma)

Sclerotinia Stem Rot (*Sclerotinia sclerotiorum*)

CANARYSEED (*Phalaris canariensis*)**LEAF MOTTLE**

Septoria triseti

Cultural: A crop rotation of at least two years between canaryseed crops should reduce disease build up. Avoid planting seed harvested from heavily infected crops.

Resistant Cultivars: None

Chemical: Foliar application of propiconazole (COM) EC. Refer to minor use label (Tilt 250E) for details.

Notes:

1. Leaf mottle is most destructive during wet growing seasons and is capable of reducing yield, quality and bushel weight.
2. *Septoria triseti* has also been reported on *Agrostis* and *Koeleria* species in North and South America.

References:

1. Berkenkamp, B., G.D. Jespersen and J. Bissett. 1989. Leaf mottle, a new disease of canarygrass caused by *Septoria triseti* Speg. *Plant Dis.* 73: 859.

OTHER DISEASES

The following diseases of canaryseed are currently of minor importance and/or are diseases for which no practical control measures are currently recommended:

Anthraxnose (*Colletotrichum graminicola*)

Common Root Rot (*Cochliobolus sativus*, *Fusarium* spp.)

Ergot (*Claviceps purpurea*)

Fusarium head blight (*Fusarium* spp.)

Spot Blotch (*Cochliobolus sativus*)

CARAWAY (*Carum carvi*) & CORIANDER (*Coriandrum sativum*)

BLOSSOM BLIGHT

Ascochyta sp., *Aureobasidium*-like sp., *Botrytis cinerea*, *Sclerotinia sclerotiorum*, *Fusarium* spp., *Alternaria alternata*

Cultural: Use clean seed and a diverse crop rotation to reduce disease severity.

Chemical: None.

Notes:

1. Blossom blight is most severe when crop canopies are dense and prolonged wet conditions occur during flowering. Symptoms include browning and death of growing tips, flowers, and umbels, and extensive dieback of shoots. Seed may become infected and discolored; weight and germinability may be reduced. The pathogens are seed and residue-borne.

References:

1. Duczek, L.J. and Slinkard A.E. 2003. Blight of caraway in Saskatchewan from 2000 to 2002. Can. Plant Dis. Surv. 83: 101-102.
2. Duczek, L.J. and Slinkard, A.E. 2003. Blight of coriander in Saskatchewan from 2000 to 2002 with notes on anise, cumin and dill. Can. Plant Dis. Surv. 83: 115-116.
3. Bailey, K.L., Gossen, B.D., Gugel, R. and Morrall, R.A.A. (Editors). 2003. Diseases of Field Crops in Canada. Canadian Phytopathological Society, Saskatoon, SK. 290 pp. (Page 260).

OTHER DISEASES

The following diseases are currently of minor importance (MI) and/or are disease for which no practical control (NC) measures are currently recommended:

Aster Yellows (aster yellows phytoplasma)

Sclerotinia Stem Rot (*Sclerotinia sclerotiorum*)

Seed Rot, Seedling Blight and Root Rot (*Fusarium* spp., *Rhizoctonia solani*, *Pythium* spp., *Botrytis cinerea*, *Alternaria* spp.)

Chemical: Fludioxonil (COM) SN is registered as a seed treatment in caraway and coriander to protect against *Fusarium* and *Rhizoctonia* species.

CHICKPEA (*Cicer arietinum*)

ASCOCHYTA BLIGHT

Ascochyta rabiei

Cultural: Use disease-free seed (see Note 1). Where possible chickpeas should not be grown more than once every four years on the same field. This will minimize the risk of re-infection from crop residues. Plant as far as possible from the previous year's chickpea fields, because crop residues could be an important source of windblown spores. Rolling is not recommended for chickpea because of the potential to damage plants and spread infection.

Resistance Rating:

Chickpea Type	Variety	Ascochyta Blight Disease Rating	Leaf Type
Kabuli	Amit (B-90), CDC Frontier	Fair	Fern
	CDC ChiChi, CDC Chico, CDC Yuma	Poor	Fern
	CDC Diva, CDC Xena, Dwelley, Evans, Sanford	Very Poor	Unifoliate
Desi	CDC Anna, CDC Cabri, CDC Desiray, Myles, CDC Nika	Fair	Fern

Referenced from “*Varieties of Grain Crops 2005*, Saskatchewan Agriculture, Food and Rural Revitalization”

Chemical: Treat seed with carbathiin + thiabendazole (COM) LI or fludioxonil + metalaxyl-M (COM) LI. Foliar application of chlorothalonil (COM) SU, pyraclostrobin (COM) EC, azoxystrobin (COM) SU and/or boscalid (COM) WG. Recent research has shown that foliar fungicide application should commence at the seedling to pre-flower stage to delay the onset of disease, which may mean applying fungicide prior to the detection of symptoms. Monitor crop for further disease development and plan subsequent fungicide applications based on cultivar susceptibility, disease severity and the weather forecast.

Limitations: Chlorothalonil - preharvest interval is 48 days; do not make more than 3 applications per season. Maintain high water volumes for coverage of canopy. Boscalid - preharvest interval is 21 days; do not make more than 2 applications per season. Pyraclostrobin - preharvest interval is 30 days. Azoxystrobin - preharvest interval is 15 days. Do not make more than 2 applications of strobiluron fungicides per season to prevent the development of fungicide resistance in the pathogen population. Use high water volumes to ensure good coverage, i.e. 20 g/acre or 90 L/acre.

Notes:

1. An agar plate test can be carried out by seed laboratories accredited to conduct ascochyta tests.

References:

1. Armstrong, C. L., Chongo, G., Gossen, B. D. and Duczek, L. J. 2001. Mating type distribution and incidence of the teleomorph of *Ascochyta rabiei* (*Didymella rabiei*) in Canada. *Can. J. Plant Pathol.* 23: 110-113.
2. Armstrong-Cho, C.L., Gossen, B.D. and Chongo, G. 2004. Impact of continuous or interrupted leaf wetness on infection of chickpea by *Ascochyta rabiei*. *Can. J. Plant Pathol.* 26: 134-141.
3. Ascochyta blight of chickpea: 2004 Guidelines for Fungicide Applications. Prepared by the Saskatchewan Ascochyta Blight Response Team. Available on the following website: <http://www.agr.gov.sk.ca> or on CD ROM (Call: 306-787-5297)
4. Chang, K.F., Hwang, S.F, Howard, R.J., Turnbull G.D. and S.F. Blade. 2003. Occurrence of ascochyta blight and root rot diseases on chickpea in Alberta in 2001 and 2002. 2003. *Can. Plant Dis. Surv.* 83: 103- 104.5. Chongo, G. and Gossen, B.D. 2002. Effect of plant age on resistance to *Ascochyta rabiei* in chickpea. *Can. J. Plant Pathol.* 23: 358-363.
6. Chongo, G., Buchwaldt, L. and Gossen, B.D. 2003. Widespread occurrence of ascochyta blight on chickpea in Saskatchewan in 2000. *Can. Plant Dis. Surv.* 83: 105-106.
7. Chongo, G., Banniza, S., Warkentin, T., Morrall, R.A.A., Pearse, P.G. Armstrong-Cho, C. and Vail, S. 2003. Survey of ascochyta blight and other diseases of chickpea in Saskatchewan in 2002. *Can. Plant Dis. Surv.* 83: 107-110.
8. Chongo, G., Buckwaldt, L., Gossen, B.D., Lafond, G., May, W.E., Johnson, D. and Hogg, T. 2003. Foliar fungicides to manage ascochyta blight in chickpea in Canada. *Can. J. Plant. Pathol.* 25: 135-142.

9. Chongo, G., Gossen, B.D, Buchwaldt, L., Adhikari, T. and Rimmer, S.R. 2003. Genetic diversity of *Ascochyta rabiei* in Western Canada. Plant Dis. 88:4-10.
10. Gossen, B.D. and Miller, P.R. 2004. Survival of *Ascochyta rabiei* in chickpea residue on the Canadian prairies. Can. J. Plant Pathol. 26: 142-147.
11. Morrall, R.A.A., Carriere, B., Pearse, C. Schmeling, D. and Thomson, L. 2003. Seed-borne pathogens of chickpea in Saskatchewan in 2002. Can. Plant Dis. Surv. 83:111-113.
12. Morrall, R.A.A., Carriere, B., Pearse, C. Schmeling, D. and Thomson, L. 2004. Seed-borne pathogens of chickpea, lentil and pea in Saskatchewan in 2003. Can. Plant Dis. Surv. 84:109-110.

SEED ROT and SEEDLING BLIGHT

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

Cultural: Avoid deep planting into cool, wet soils. Use clean seed with good germination..

Resistant Cultivars: None. Kabuli types are very susceptible to seed rot by *Pythium* spp.

Chemical: Treat seed with carbathiin + thiabendazole (COM) LI; fludioxonil (COM) SN. Seed treatment with metalaxyl (COM) SU will protect against *Pythium* spp. only.

References:

1. Chang, K.F., Hwang, S.F, Howard, R.J., Turnbull G.D. and Blade, S.F. 2003. Occurrence of ascochyta blight and root rot diseases on chickpea in Alberta in 2001 and 2002. Can. Plant Dis. Surv. 83: 103-104.
2. Chang, K.F. Hwang, S.F., Gossen, B.D., Turnbull, G.D., Howard, R.J. and Blade, S.F. 2004. Effects of soil temperature, seeding depth, and seeding date on rhizoctonia seedling blight and root rot of chickpea. Can. J. Plant Sci. 84: 901-907.
3. Hwang, S.F., Gossen, B.D., Chang, K.F., Turnbull, G.D., Howard, R.J., and Blade, S.F. 2003. Etiology and impact of rhizoctonia seedling blight and root rot of chickpea on the Canadian Prairies. Can. J. Plant Sci. 83: 959-967.
4. Morrall, R.A.A., Carriere, B., Pearse, C., Schmeling, D. and L. Thomson. 2004. Seed-borne pathogens of chickpea, lentil and pea in Saskatchewan in 2003. Can. Plant. Dis. Surv. 84: 109-110.

OTHER DISEASES

The following diseases of chickpea are currently of minor importance (MI) and/or are diseases for which no practical control measures are currently recommended (NC):

Gray Mould Stem and Pod Rot (*Botrytis cinerea*) MI

Sclerotinia White Mould (*Sclerotinia sclerotiorum*) MI

Chemical: Foliar application of boscalid (COM) WG for control of both gray mould (*Botrytis*) and white mould (*Sclerotinia*). Apply at the beginning of flowering. Apply a second time 7-14 days later if disease persists or weather conditions are favourable for disease development. Preharvest interval is 21 days; do not make more than 2 applications per season.

Pink Seed (*Erwinia rhapontici*) - MI/NC. Refer to FIELD PEA, PINK SEED.

CORN (*Zea mays*)

COMMON SMUT

Ustilago maydis

Cultural: Follow a 2-year minimum crop rotation, using broadleaf special crops. Avoid injuring plants during cultivation. Maintain balanced soil fertility; particularly avoid high nitrogen. Where practical, remove and destroy galls as soon as possible after detection.

Resistant Cultivars: Current field corn hybrids have adequate resistance to common smut.

Chemical: None.

EAR and KERNEL ROTS

Diplodia maydis, *Fusarium* spp., *Gibberella zeae*, *Aspergillus* spp., *Penicillium* spp.

Cultural: Maintain balanced soil fertility. Harvest grain when mature and store initially at a moisture level below 18% for ears and 15% for shelled grain at temperatures of 4-10°C. Do not rotate corn with wheat or other cereals susceptible to *Fusarium* head blight.

Resistant Cultivars: Choose varieties from recommended hybrids.

Chemical: None.

Notes: *Aspergillus* and *Penicillium* are important storage rot pathogens. Mouldy corn, particularly if *Fusarium*, *Aspergillus*, and *Penicillium* spp. are involved, may contain harmful levels of mycotoxins, notably aflatoxin, zearalenone, and ochratoxin.

References:

1. Scott, P.M. 1973. Mycotoxins in stored grain, feeds and other cereal products. Pp. 343-365 in Sinha, R.N. and Muir, W.E. (eds.) Grain storage: part of a system. A.V.C. Publishing Co., Westport, Conn.
2. Sutton, J.C. 1982. Epidemiology of wheat head blight and corn ear rot caused by *Fusarium graminearum*. Can. J. Plant Pathol. 4: 195-209.

HEAD SMUT

Sphacelotheca reiliana

Cultural: Head smut is accentuated by stress conditions on the seedling plant, e.g., soil compaction, low soil fertility, low soil temperatures. Rotate corn with other crops and do not plant corn for several years in contaminated fields. Spores are known to survive in animals and are readily distributed in manure (1).

Resistant Cultivars: Choose resistant hybrids.

Chemical: Treat seed with carbathiin + thiram (COM) SU. Limitations: As per label. Seed treatment will not control soil-borne inoculum.

References:

1. Edgington, L.V. and Lynch, K. 1981. Head smut of corn - decisions to make. Can. J. Plant Pathol. 3: 273-276.

2. Lynch, K.V. *et al.* 1980. Head smut, a new disease of corn in Ontario. Can. J. Plant Pathol. 2: 176-178.

HOLCUS SPOT

Pseudomonas syringae pv. *syringae*

Cultural: Rotate with broadleaf special crops. Maintain a high level of potassium. Inoculum carryover can occur on corn and sorghum refuse and on susceptible grass hosts such as green foxtail.

Resistant Cultivars: None.

Chemical: None.

Notes: Holcus spot only occurs occasionally in Canada and is usually not severe. *Pseudomonas syringae* pv. *syringae* has a wide host range that includes many herbaceous and woody ornamental plants. Seed transmission is not confirmed in corn but can occur in sorghum.

ROOT and STALK ROTS

Diplodia maydis, *Fusarium* spp., *Pythium* spp.

Cultural: Rotate for at least 1 year excluding cereals and grasses. Excessively high plant populations cause stress on individual plants increasing stalk rot and lodging. Maintain a balanced soil fertility based on soil tests. High levels of nitrogen and low levels of potassium increase risk of stalk rot. Control stalk-boring insects to reduce the number of disease infection sites. Harvest fields with more than 10-15% stalk rot early to reduce lodging problems.

Resistant Cultivars: None.

Chemical: None.

Notes: *Fusarium moniliforme* and *F. graminearum* may also infect ears, kernels, and seedlings. (See EAR and KERNEL ROTS)

SEED ROT and SEEDLING BLIGHT

Diplodia maydis, *Fusarium* spp., *Penicillium* spp., *Pythium* spp., other seed decay fungi.

Cultural: Follow a crop rotation that avoids cereals and grasses for three years. Delay seeding until soil temperature is above 10°C. Avoid planting in poorly drained soils. Follow recommended practices for fertilizer and herbicide applications.

Resistant Cultivars: None.

Chemical: Treat seed with - captan (COM) SU, WP; captan + diazinon (COM) WP; carbathiin + thiram (COM) SU; fludioxonil (COM) SN; fludioxonil + metalaxyl-M (COM) SU; mancozeb (COM) WP; metalaxyl (COM) SU; and thiram (COM) WP.

Limitations: Do not use treated seed for food or feed.

Notes: The most important organisms causing seedling blights are species of *Pythium*. *Aspergillus* appears to be more important as an ear rot or storage rot pathogen.

OTHER DISEASES

The following diseases of corn are currently of minor importance and are diseases for which no practical control measures are currently recommended:

Rust (*Puccinia sorghi*)

Northern Leaf Blight (*Setosphaeria turcica*)

QUARANTINE DISEASES

The following diseases of corn do not occur at present or are of limited distribution in Canada and are subject to quarantine regulations:

Goss' Wilt (Leaf Freckles) (*Corynebacterium nebraskiensis*)

DILL (*Anethum graveolens*)

BLIGHT

Phoma anethi

Cultural: Use a 3-year crop rotation. Use seed from disease-free fields. Turn under stubble and plant fields distant from previous year's fields to prevent infection from the air-borne spores.

Resistant Cultivars: None.

Chemical: Treat seed with fludioxonil (COM) SN to protect against seed decay and seedling blight.

References:

1. Duczek, L.J. and Slinkard, A.E. 2003. Blight of coriander in Saskatchewan from 2000 to 2002 with notes on anise, cumin and dill. Can. Plant Dis. Surv. 83: 115-116.

OTHER DISEASES

The following disease of dill is currently of minor importance and/or is a disease for which no practical control measures are currently recommended:

White Mould (*Sclerotinia sclerotiorum*)

Aster Yellows (aster yellows phytoplasma)

FABABEAN (*Vicia faba*)

ANTHRACNOSE

Colletotrichum truncatum

Cultural: Avoid growing fababeans after lentils in areas where the disease is present. Follow a crop rotation of 4 years.

Resistant Cultivars: None.

Chemical: None.

CHOCOLATE SPOT

Botrytis fabae, Botrytis cinerea

Cultural: Follow a crop rotation of 4 years between successive crops of fababeans and avoid buckwheat in the rotation. Use seed from disease-free fields.

Resistant Cultivars: None.

Chemical: None.

LEAF and POD SPOT

Ascochyta fabae

Cultural: Follow a crop rotation of 4 years between successive crops of fababeans. Use disease-free seed.

Resistant Cultivars: None.

Chemical: Apply foliar fungicide pyraclostrobin (COM) EC at the beginning of flowering or the onset of disease symptoms. Apply a second application 10-14 days later if disease persists or weather conditions are favourable for disease development. Preharvest interval of 30 days; do not make more than 2 applications per season.

References:

1. Kharbanda, P.D. and Bernier, C.C. 1979. Effectiveness of seed and foliar applications of fungicides to control ascochyta blight of fababeans. Can. J. Plant Sci. 59: 661-666.

MOSAIC

Bean yellow mosaic virus (BYMV)

Cultural: Other legumes are susceptible to this virus; therefore, avoid planting fababeans in close proximity to established fields of forage legumes.

Resistant Cultivars: None.

Chemical: None.

Notes:

1. BYMV symptoms may be confused with herbicide injury, which also causes chlorosis and leaf distortion.
2. A mild strain causing leaf mosaic and a severe strain causing mosaic and stem necrosis have been recognized in Manitoba (2).

RUST

Uromyces viciae-fabae

Cultural: A crop rotation of at least 2 years between fababean crops should reduce disease build-up.

Resistant Cultivars: None.

Chemical: None.

Notes: All isolates of *U. viciae-fabae* collected from native species of *Vicia* and *Lathyrus* infected fababean, pea and lentil, suggesting that native legumes may be important in the epidemiology of rust on these crops (1).

References:

1. Conner, R.L. and Bernier, C.C. 1982. Host range of *Uromyces viciae-fabae*. *Phytopathology* 72: 687-689.

SEED ROT, SEEDLING BLIGHT and ROOT ROT

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

Cultural: Follow a crop rotation that does not include fababeans or other legumes more than once in 4 years. Plant in well-drained soil.

Resistant Cultivars: None.

Chemical: None.

References:

1. Lamari, L. and Bernier, C.C. 1985. Etiology of seedling blight and root rot of fababean (*Vicia faba*) in Manitoba. *Can. J. Plant Pathol.* 7: 139-145.
2. Rashid, K.Y. and Bernier, C.C. 1993. Genetic diversity among isolates of *Rhizoctonia solani* and sources of resistance in *Vicia faba*. *Can. J. Plant Pathol.* 15: 23-28.3.

OTHER DISEASES

The following diseases of fababeans are currently of minor importance and/or are diseases for which no practical control measures are recommended:

Alternaria Leaf Spot (*Alternaria alternata*)

Aster Yellows (aster yellows phytoplasma)

Powdery Mildew (*Microsphaera penicillata* var. *ludens*)

Chemical: Apply pyraclostrobin (COM) EC at the beginning of flowering or the onset of disease.

Sclerotinia Stem Rot (*Sclerotinia sclerotiorum*)

FIELD BEAN (*Phaseolus vulgaris*)

ANTHRACNOSE

Colletotrichum lindemuthianum

Cultural: Follow a 3-year crop rotation to reduce carry-over of pathogen on infected crop debris. Sow disease-free seed grown in semi-arid regions where the pathogen is less likely to occur. Turn under crop residue. Avoid cultivating or entering bean fields during wet weather to prevent spreading infection.

Resistant Cultivars: Use resistant cultivars. Most resistant cultivars available in Canada carry race specific resistance genes.

Chemical: Treat seed with captan + diazinon + thiophanate-methyl (COM) DU; fludioxonil + metalaxyl-M (COM) SU; carbathiin + thiram (COM) SU. Apply foliar spray of tribasic copper sulfate (COM) WP when plants are 15 cm tall as a protectant and repeat at 7-14 day intervals depending on disease pressure. Apply foliar fungicide pyraclostrobin (COM) EC or azoxystrobin (COM) SU at the beginning of flowering; apply a second application 10-14 days later if disease persists or weather conditions are favourable for disease development.

Limitations: Tribasic copper sulphate - preharvest interval is 1 day. Pyraclostrobin - preharvest interval is 30 days. Azoxystrobin - preharvest interval is 15 days. Do not make more than 2 applications of strobilurin fungicides per season.

Notes:

1. Anthracnose is an important disease of beans in Ontario and in the states of North Dakota, Michigan and New York; it is an important disease in southern Manitoba, however not a problem in Saskatchewan or Alberta.
2. Plant quarantine regulations require that all seed imported into Canada be treated with a registered fungicide to restrict the spread of new races of the pathogen.
3. Most current recommendations suggest that beans are not responsive to Rhizobium inoculation and are best grown with applied fertilizer.

References:

1. Tu, J.C. 1982. Effect of temperature on incidence and severity of anthracnose on white bean. *Plant Dis.* 66: 781-783.

BACTERIAL WILT

Curtobacterium flaccumfaciens pv. *flaccumfaciens*

Cultural: Little is known at this time about control measures for this disease. Use disease-free seed and rotate fields to non-susceptible crops (see Note 1).

Resistant Cultivars: None.

Chemical: None.

Notes:

1. Bacterial wilt is a new disease of bean in Western Canada but recent surveys indicate it is widespread in Alberta and Saskatchewan dry bean crops (1,2,3). Bacterial wilt is highly seed-borne and infected seed may exhibit yellow, orange, or purplish discoloration depending on the pigment in the pathogen strain. Seedlings that develop from infected seed produce wilted and shriveled primary leaves with deep green or brown green discoloration. Plants that survive past the trifoliate stage have reduced seed yield and are likely to produce infected seed. The pathogen can survive on seed for over 25 years.

References:

1. Huang, H.C., Erickson, R.S. and Hsieh, T.F. 2004. Bacterial wilt and pink seed of dry bean in Western Canada in 2002. *Can. Plant Dis. Surv.* 84:88-89.
2. Huang, H.C, Hsieh, T.F. and Erickson, R.S. 2003. Distribution of new seed-borne diseases of dry bean in Alberta and Saskatchewan. *Can. Plant Dis. Surv.* 83: 90-91.
3. Hsieh, T.F., Huang, H.C., Erickson, R.S., Yanke, L.J. and Mundel, H.H. 2002. First report of bacterial wilt of common bean caused by *Curtobacterium flaccumfaciens* in Western Canada. *Plant Dis.* 86: 1275.
4. Bailey, K.L., Gossen, B.D., Gugel, R. and Morrall, R.A.A. (Editors). 2003. *Diseases of Field Crops in Canada.* Canadian Phytopathological Society, Saskatoon, SK. 290 pp.

COMMON BLIGHT, FUSCOUS BLIGHT, HALO BLIGHT, and BROWN SPOT

Xanthomonas phaseoli, *X. phaseoli* var. *fuscans*, *Pseudomonas syringae* pv. *phaseolicola*, *P. syringae* pv. *syringae*

Cultural: Use pathogen free seed. Bury crop debris. Avoid successive plantings of beans. Bacteria survive on the stubble for about 2 years, but do not survive very long in soil. Avoid working in bean fields during wet weather, or when dew is on the plants.

Resistant Cultivars: All bean cultivars are susceptible to common blight and halo blight..

Chemical: Apply foliar spray of tribasic copper sulphate (COM) WP; copper hydroxide (COM) WP. Apply first application when plants are 15 cm as protectant, re-apply at 7-10 day intervals.

References:

1. 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.
2. Yager, L., Conner, R.L., McLaren, D.L., and Groom, M. 2004. Diseases of field bean in Manitoba in 2003. Can. Plant Dis. Surv. 84: 90-91..

RUST

Uromyces appendiculatus

Cultural: Follow a crop rotation that allows a minimum of 3 years between successive crops of beans. After harvest, turn under all bean refuse as completely as possible.

Resistant Cultivars: None.

Chemical:

1. Apply propiconazole (COM) EC at first sign of disease and second application 14-21 days later if disease pressure continues. Preharvest interval is 28 days; do not make more than 2 applications per season.
2. Apply a foliar spray of pyraclostrobin (COM) EC at the beginning of flowering; apply a second application 10-14 days later if diseases persists or weather conditions are favourable for disease development. Preharvest interval is 30 days; do not make more than 2 applications per season.

SEED ROT, SEEDLING BLIGHT and ROOT ROT

Fusarium solani f.sp. *phaseoli*, *Pythium* spp., *Rhizoctonia solani*

Cultural: Rotate beans with non-host crops such as corn, wheat, barley or alfalfa to reduce *Pythium*, and avoid sugar beets and potatoes to reduce *Rhizoctonia solani*. Include beans in rotation only once every 5 years. Planting into soil in which the top 15 cm is at least 16°C and contains adequate moisture should help reduce the incidence of infection by these pathogens.

Resistant Cultivars: None.

Chemical: Treat seed with captan (COM) SU; captan + diazinon (COM) WP; captan + diazinon + thiophanate methyl (COM) WP; carbathiin + thiram (COM) SU; fludioxonil (COM) SN; fludioxonil + metalaxyl-M (COM) LI; metalaxyl (COM) SU; thiram (COM) WP. Limitations: As per label.

References:

1. Hagedorn, D.J. and Rand, R.E. 1979. Research for integrated control of bean root rot. Pp. 425-430 in B. Schippers and W. Gams (eds.). Soil-borne plant pathogens. Academic Press Inc., London.
2. Yager, L., Conner, R.L., McLaren, D.L. and Groom M. 2004. Diseases of field bean in Manitoba in 2003. Can. Plant Dis. Surv. 84: 90-91.

STEM ROT (WHITE MOULD)

Sclerotinia sclerotiorum

Cultural: Rotate to cereals, corn and grasses, crops that are immune. Allow at least 4 years between the susceptible crops buckwheat, canola/rapeseed, mustard, safflower, sunflower, fababeans, lentils, peas and other legumes in the rotation. Space plants to allow for good air circulation. Apply only the recommended amount of fertilizer to avoid excess canopy development. Avoid irrigation procedures that prolong excessive moisture levels at the soil surface 10 days prior to and during flowering.

Resistant Cultivars: None. See notes.

Chemical: Apply the following as sprays - boscalid (COM) WG (Note 2); thiophanate-methyl (COM) WP; vinclozolin (COM) EG. Refer to product labels for details.

Limitations: As per label. Preharvest interval - 14 days (benomyl, thiophanate-methyl); 21 days (boscalid); 45 days (vinclozolin). Do not feed treated foliage to livestock.

Notes:

1. Cultivars with an erect growth habit are generally less prone to white mould because of lower humidity levels in the plant canopy.
2. An application of boscalid should occur in a preventative manner in dry beans for optimum control. A second application should be made if conditions continue to favour disease progression.
3. The USA no longer allows importation of dry bean treated with vinclozolin. Growers whose crops are destined for the USA should avoid the use of this product.

References:

1. Huang, H.C. and Erickson, R.S. 2000. Survey of diseases of dry bean in southern Alberta in 1999. Can. Plant Dis. Surv. 80: 73-74.
2. Yager L., Conner, R.L., McLaren, D.L. and Groom, M. 2004. Diseases of field bean in Manitoba in 2003. Can. Plant Dis. Surv. 84: 90-91.

VIRUS DISEASES

Bean yellow mosaic virus (BYMV), Bean common mosaic virus (BCMV)

Cultural: Avoid locating fields adjacent to sweet clover and other clovers as spread of BYMV can occur from these crops via aphids. Do not plant seed from fields that were infected the previous year. BYMV is not seed-borne; BCMV is carried in the seed.

Resistant Cultivars: Refer to provincial guides for resistant cultivars.

Chemical: None.

Notes: Pedigreed seed may not be completely free from bean common mosaic virus.

OTHER DISEASES

The following diseases are currently of minor importance (MI) and/or are diseases for which no practical control (NC) measures are currently recommended:

Gray Mould (*Botrytis cinerea*)

Pink Seed (*Erwinia rhapontici*) Refer to FIELD PEA, PINK SEED

FIELD PEA (*Pisum sativum*)

BACTERIAL BLIGHT

Pseudomonas syringae pv. *pisi*

Cultural: Use a 4-year crop rotation and turn under infected crop debris. This disease is highly seed-borne so do not use seed from crops in which bacterial blight was present. Avoid pivot irrigation as this increases the spread of disease in the field.

Resistant Cultivars: None.

Chemical: None.

Notes:

1. Bacterial blight incidence is usually low, but can be destructive in wet seasons and especially in crops damaged by hail.

References:

1. Chongo, G., Banniza, S., Warkentin, T., and R.A.A. Morrall. 2003. Disease survey in field pea in Saskatchewan in 2002. Can. Plant Dis. Surv. 83: 124-125.

DOWNY MILDEW

Peronospora viciae

Cultural: Practice extended rotations and/or remove or till under infected crop debris. Use seed produced in areas of low rainfall.

Resistant Cultivars: None.

Chemical: None (see Note 2).

Notes:

1. This disease only causes losses in cool wet years and is of little importance in the prairies. Oospores can survive 10-15 years in the soil. This disease is serious when seed or soil is heavily infested, leading to systemic infections that cause plant stunting and death.
2. Products containing metalaxyl may be applied to harvested seed destined for export. Consult with the importer to establish what rates are used on the crop in their country.

LEAF and POD SPOT

Ascochyta pisi

Cultural: Use management practices as outlined for mycosphaerella blight.

Resistant Cultivars: Cultivars are not evaluated for reaction to this pathogen.

Chemical: None.

Notes: *A. pisi* has not been considered a problem in western Canada for many years. However, high levels of seed infection by *A. pisi* have been detected in samples from southern Saskatchewan in recent years.

MYCOSPHAERELLA BLIGHT, FOOT ROT

Mycosphaerella pinodes, *Phoma medicaginis* var. *pinodella*

Cultural: Use seed from disease-free fields if possible (see Note 1). Peas should not be grown more frequently than once every 5 years as chlamydozoospores can survive in soil up to 5 years. Turn under crop refuse as soon as possible after harvest and control volunteer seedlings soon after emergence in the fall. Locate new plantings as far as possible from the previous year's fields.

Resistant Cultivars: Some cultivars are more tolerant than others to damage caused by mycosphaerella blight and thus do not respond as much to fungicide application. Refer to provincial guides for disease ratings. Advanced cultivars are evaluated in co-op trials for their reaction to this disease.

Chemical: Apply seed treatments if seed with a high level of infection is used. Use captan (COM) LI, thiram (COM) WP, fludioxonil (COM) SN, fludioxonil + metalaxyl (COM) LI, or carbathiin + thiram (COM) LI (Note 2). Foliar application of chlorothalonil (COM) SU, pyraclostrobin (COM) EC, and/or azoxystrobin (COM) SU. Apply first application at early flowering and apply a second time 10-14 days later if disease conditions persist or if weather conditions are favourable for disease development.

Limitations: Chlorothalonil - preharvest interval is 32 days ; do not make more than 3 applications per season. Pyraclostrobin - preharvest interval is 30 days. Azoxystrobin - preharvest interval is 15 days. Do not make more than 2 applications of strobiluron fungicides per season to prevent the development of fungicide resistance in the pathogen population.

Notes:

1. If in doubt about the quality of a seed lot, have an agar plate test carried out by an accredited laboratory.
2. Viability of *Rhizobium* seed inoculum may be reduced by fungicide seed treatment (7).

References:

1. Banniza, S. and Vandenberg A. 2003. The influence of plant injury on development of *Mycosphaerella pinodes* in field pea. *Can. J. Plant Pathol.* 25:304-311.
2. Chang, K.F., Bowness, R., Hwang, S.F., Turnbull, G.D., Howard, R.J. and Blade S.F. 2004. The occurrence of field pea diseases in central and southern Alberta in 2004. *Can. Plant. Dis. Surv.* 84:104-106.
3. Chongo, G. Banniza, S., Warkentin, T., and R.A.A. Morrall. 2003. Disease survey in field pea in Saskatchewan in 2002. 83:124-125.
4. Hu, S. *et al.* 2002. Survey of powdery mildew and ascochyta blight on field pea in central Alberta in 2001. *Can. Plant Dis. Surv.* 82: 112-113.
5. McLaren, D.L. Conner R.L., Yager, L. and Groom, M. 2004. Diseases of field pea in Manitoba in 2003. *Can. Plant Dis. Surv.* 84: 107-108.

6. Morrall, R.A.A., Carriere, B., Pearse, C. Schmeling, D. and Thomson L. 2004. Seed-borne pathogens of chickpea, lentil and pea in Saskatchewan in 2003. *Can. Plant Dis. Surv.* 84: 109-110.
7. Rennie, R.J. *et al.* 1985. The effect of seed-applied pesticides on growth and N₂ fixation in pea, lentil and fababean. *Can. J. Plant Sci.* 65: 23-28.
8. Warkentin, T. D. *et al.* 1996. Fungicidal control of *Ascochyta* blight of field pea. *Can. J. Plant Sci.* 76: 67-71.
9. Xue, A.G. *et al.* 1996. Genotypic variability in seedborne infection of pea by *Mycosphaerella pinodes* and its relation to foliar disease severity. *Can. J. Plant Pathol.* 18: 370-374.
10. Xue, A.G. *et al.* 1997. Effect of timings of inoculation with *Mycosphaerella pinodes* on yield and seed infection of field pea. *Can. J. Plant Sci.* 77: 685-689.
11. Xue, A.G. and Warkentin, T.D. 2001. Partial resistance to *Mycosphaerella pinodes* in field pea. *Can. J. Plant Sci.* 81: 535-540.
12. Yager, L., Conner, R.L. and McLaren, D.L. 2003. Diseases of field pea in Manitoba in 2002. *Can. Plant Dis. Surv.* 83: 128- 129.

PINK SEED

Erwinia rhapontici

Cultural: None recommended at this time.

Resistant Cultivars: None.

Chemical: None.

Notes:

1. The economic impact of pink seed is probably limited. Infected seed are shriveled and turn a bright carmine red, similar to the colour of some seed treatments. The colour is a diffusible pigment produced by most strains of the pathogen and the pink discoloration may also be evident on pods or other plant structures in the field. Pink seed may result in dockage during seed cleaning and grading. The pathogen likely invades the plant late in the season via wounds from insect or mechanical damage. The incidence of pink seed is greater in seasons with above-normal rainfall.

References:

1. Huang, H.C., Hsieh, T.F. and Erickson, R.S. 2003. Distribution of new seed-borne diseases of dry bean in Alberta and Saskatchewan. *Can. Plant Dis. Surv.* 83: 90-91.
2. Bailey, K.L., Gossen, B.D., Gugel, R. and Morrall, R.A.A (Editors). 2003. *Diseases of Field Crops in Canada*. Canadian Phytopathological Society, Saskatoon, SK. 290 pp.

POWDERY MILDEW

Erysiphe pisi

Cultural: Follow a crop rotation that includes peas or other legumes only once every 4 years. Turn under crop refuse. Locate new plantings distant from previous year's fields. Seed early and/or plant early maturing cultivars to escape the disease.

Resistant Cultivars: Resistance to powder mildew is conferred by at least two genes so resistance has been rated 'very good' for many cultivars. Consult provincial lists for cultivars with resistance to powdery mildew.

Chemical: Apply foliar application of sulphur (COM) DF at the first appearance of disease and repeat at 7-10 day intervals as necessary. Apply foliar application of pyraclostrobin (COM) EC at the onset of symptoms and a second application 10-14 days later if the disease persists.

Limitations: Sulphur - preharvest interval is 1 day; use minimum of 45 L/acre water volume. Pyraclostrobin - preharvest interval is 30 days; do not make more than 2 applications per season.

References:

1. Chang, K.F., Bowness, R., Hwang, S.F., Turnbull, G.D., Howard, R.J. and Blade, S.F. 2004. The occurrence of field pea diseases in central and southern Alberta in 2003. *Can. Plant Dis. Surv.* 84 :104-106.
2. Hu, S. *et al.* 2002. Survey of powdery mildew and ascochyta blight on field pea in central Alberta in 2001. *Can. Plant Dis. Surv.* 82: 112-113.
3. McLaren, D.L., Conner, R.L., Yager, L. and Groom, M. 2004. Diseases of field pea in Manitoba in 2003. *Can. Plant Dis. Surv.* 84:107-108.
4. Tiwari, K.R., Warkentin, T.D., Penner, G.A and Menzies, J.G. 1999. Studies on the winter survival of *Erysiphe pisi* in Manitoba. *Can. J. Plant Pathol.* 21: 159-164.
5. Yager, L., Conner, R.L. and McLaren, D.L. 2003. Diseases of field pea in Manitoba in 2002. *Can. Plant Dis. Surv.* 83: 128-129.

SEED ROT, SEEDLING BLIGHT AND ROOT ROT

Fusarium solani f. sp. *pisi*, *Rhizoctonia solani*, *Pythium* spp., *Aphanomyces euteiches*.

Cultural: Include pea in rotation only once every 4 years. Avoid other pulse crops in the rotation. Do not use pea seed that is mechanically damaged or has low germination due to seed-borne disease. Select well drained fields as excessive soil moisture favours root rot. Avoid compacting the soil.

Resistant Cultivars: None.

Chemical: Treat seed with - captan (COM) SU; captan + diazinon (COM) WP; carbathiin + thiram (COM) SU; fludioxonil (COM) SN; fludioxonil + metalaxyl-M (COM) LI; metalaxyl (COM) SU; thiram (COM) WP. Limitations: As per label.

Notes:

1. The effectiveness of seed treatments is questionable on poor quality seed, but seed treatment can substantially improve establishment of seed that has been damaged during handling e.g. at seeding, or seed infected by *Mycosphaerella pinodes* (see references), or in cool soils that lead to delayed seedling emergence.
2. Viability of *Rhizobium* seed inoculum may be reduced by fungicide seed treatment.

References:

1. Chang, K.F, Howard R.J., Briant, M.A., Burke, D.A., and Taillieu, S. 2000. The occurrence of mycosphaerella blight, powdery mildew, and root rot of field pea in southern Alberta in 1999. *Can. Plant Dis. Surv.* 80: 104-106.
2. Hwang, S.F, Chang, K.F., Howard, R.J., Deneka, B.A. and Turnbull, G.D. 1995. Decrease in incidence of *Pythium* damping-off of field pea by seed treatment with *Bacillus* spp. and metalaxyl. *J. Plant Dis. Prot.* 103: 31-41.
3. Hwang, S.F., Gossen, B.D., Chang, K.F., Turnbull, G.D. and Howard, R.J. 2001. Effect of seed damage and metalaxyl seed treatment on *pythium* seedling blight and seed yield of field pea. *Can. J. Plant Sci.* 81: 509- 519.

4. Hwang, S.F., Gossen, B.D., Turnbull, G.D., Howard R.J., and Thomas, A.G. 2000. Seeding date, temperature, and seed treatment affect pythium seedling blight of field pea. *Can. J. Plant Pathol.* 22: 392-399.
5. McLaren, D.L., Conner, R.L., Yager, L. and Groom, M. 2004. Diseases of field peas in Manitoba in 2003. *Can. Plant Dis. Surv.* 84: 107-108.
6. Morrall, R.A.A. 1986. Evaluation of fungicide treatments on field pea seed of low quality - 1986. Pg. 229 *in* Pesticide Research Report, Agriculture Canada, Ottawa.
7. Rennie, R.J. *et al.* 1985. The effect of seed-applied pesticides on growth and N₂ fixation in pea, lentil and faba bean. *Can. J. Plant Sci.:* 65: 23-28.
8. Wang, H., Hwang, S.F., Chang, K.F., Turnbull, G.D. and Howard, R.J. 2000. Diseases of field pea in eastcentral Alberta in 1999. *Can. Plant Dis. Surv.* 80: 107-109.
9. Yager, L. and Conner, R.L. 2003. Diseases of field pea in Manitoba in 2002. *Can. Plant Dis. Surv.* 83: 128- 129.
10. Yager, L., Conner R.L. and McLaren, D.L. 2003. Diseases of field pea in Manitoba in 2002. *Can. Plant Dis. Surv.* 83: 128-129.

STEM and POD ROT

Sclerotinia sclerotiorum

Cultural: Rotate to cereals and other non-broadleaf crops. Control broadleaf weeds and volunteers of susceptible crops.

Resistant Cultivars: None.

Chemical: None.

VIRUS DISEASES

Pea mosaic virus, pea enation mosaic virus, pea streak virus, pea seed-borne mosaic virus, bean yellow mosaic virus, alfalfa mosaic virus and red clover vein mosaic virus.

Cultural: Destroy volunteer plants in fall or early spring. Locate pea plantings away from fields of other legumes such as alfalfa and clovers to prevent secondary spread of viruses by aphids to peas.

Resistant Cultivars: None.

Chemical: None.

Notes: Indexing pea germplasm for pea seed-borne mosaic virus (PSbMV) has eradicated it from the breeding program at the Agriculture & Agri-Food Canada Research Centre, Morden, MB. Recent research results indicate that at present most field pea cultivars registered in Canada do not possess a serious potential for high amplification of PSbMV in the seed. PSbMV was found to be transmitted in lentil seed at rates of 32 - 44% (1).

References:

1. Hampton, R.O. and Muehlbauer, F. J. 1977. Seed transmission of pea seed-borne mosaic virus in lentils. *Plant Dis. Rep.* 61: 235-238.

OTHER DISEASES

The following diseases of field pea are currently of minor importance and/or are diseases for which no practical control measures are currently recommended (NC):

Anthracnose (*Colletotrichum pisi*) NC

Leaf Blotch (*Septoria pisi*) NC

Leaf Spot (*Alternaria alternata*) NC

Rust (*Uromyces viciae-fabae*) NC

GINSENG (*Panax quinquefolium*)

ALTERNARIA BLIGHT

Alternaria panax, *Alternaria alternata*

Cultural: Follow recommended seeding rates, avoid high plant densities which reduce air movement and increase relative humidity which promote disease. Irrigate early in the day so leaves have the opportunity to dry off in the morning. Avoid using high levels of fertilizer or manure that promote excessive leaf growth that is more susceptible to disease and reduces the ability of fungicides to penetrate the crop canopy. Avoid moving equipment through the garden when the leaves are wet as *Alternaria* spores can be spread by the movement of equipment and people.

Resistant Cultivars: None.

Chemical: Mancozeb(COM) DG, WP - apply at 2 week intervals; iprodione (COM) WP - alternate with other fungicides to avoid resistance; anilazine (COM) WP - apply at first sign of disease and follow with 2 subsequent sprays at 4 week intervals. Anilazine may cause injury if applied improperly or in adverse weather conditions; chlorothalonil (COM) SU - start applications when disease threatens and repeat at 7-10 day intervals.

Limitations: Preharvest interval: 14 days (chlorothalonil); 30 days (anilazine, iprodione, mancozeb). Make no more than 3 applications of iprodione or anilazine per season. Do not apply chlorothalonil or mancozeb more than 6 times per season.

Notes: Good fungicide coverage is essential for controlling this disease. Calibrate your sprayer. Use a dye to determine the efficacy of your application if necessary. More frequent applications may be necessary in the spring following emergence until the plants are fully expanded.

References:

1. BC Ministry of Agriculture & Food. 2003. Ginseng Production Guide for Commercial Growers. 176 pp. (http://www.agf.gov.bc.ca/speccrop/ginseng/ginseng_production_guide.htm)
2. Chang, K.F., Howard, R.J., Blade, S.F., and Hwang, S.F. 1999. Foliar and root rot diseases of ginseng in Alberta in 1998. Can. Plant Dis. Surv. 79: 123-125.

BOTRYTIS BLIGHT

Botrytis cinerea

Cultural: Avoid dense plantings or excessive fertilization that promotes the growth of leaves. Dense plant canopies and continued leaf wetness enhance disease development

Resistant Cultivars: None.

Chemical: Chlorothalonil (COM) SU. Start applications when disease threatens and repeat at 7-10 day intervals.

Limitations: Maximum of 6 applications per year. Do not apply within 14 days of harvest.

References:

1. BC Ministry of Agriculture & Food. 2003. Ginseng Production Guide for Commercial Growers. 176 pp. (http://www.agf.gov.bc.ca/speccrop/ginseng/ginseng_production_guide.htm)

DAMPING-OFF of SEEDS and YOUNG SEEDLINGS

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

Cultural: Avoid heavy soils and low, wet sites. Prolonged cool and wet soils promote the damping-off problem especially in the spring as plants emerge. Avoid thick straw mulch, which keeps the soil cool and wet and increases the risk of damping-off and root diseases, as well as reduces the ability of fungicides to penetrate into the soil. Choosing sites that were not used for alfalfa in previous year can reduce the risk of damping-off and root rot by *Rhizoctonia solani*. Preparing the site, and leaving it fallow for the year preceding planting will also reduce the potential for damping-off and root rots. Avoid excessive chemical fertilizer or manure, which favours lush growth and increases the susceptibility to diseases.

Resistant Cultivars: None.

Chemical: For the control of *Rhizoctonia* seedling blight: use azoxystrobin (COM) SU – maximum of 2 applications per season and a pre-harvest interval of 24 months; or, quintozene (COM) WP - maximum of 1 application per season and pre-harvest interval of 24 months (Note 1). For the control of *Pythium* blight: metalaxyl-M (COM) EC – maximum of 3 applications per season and pre-harvest interval of 9 days.

Notes:

1. PCNB [Quinto zene 75 WP (COM) WP] remains registered for use on ginseng, but its use is no longer recommended due to issues with chemical residues. Quintozone applied at label rates in the year of planting only may result in residues over tolerance in the roots at harvest. Root residues resulting from Quintozone use have recently resulted in trade barriers in Asia and the United States.
2. No other root crops are to be grown for a minimum of one year following the harvest of a ginseng garden that was treated with quitozene.

References:

1. BC Ministry of Agriculture & Food. 2003. Ginseng Production Guide for Commercial Growers. 176 pp. (http://www.agf.gov.bc.ca/speccrop/ginseng/ginseng_production_guide.htm)
2. Chang, K.F., Howard, R.J., Blade, S.F., and Hwang, S.F. 1999. Foliar and root rot diseases of ginseng in Alberta in 1998. Can. Plant Dis. Surv. 79: 123-125.

NEMATODE DISEASES

Pratylenchus penetrans, *Meloidogyne* spp.

Cultural: Select nematode-free sites for ginseng gardens. Because the host range of root knot nematodes includes many plants besides ginseng, soil from prospective garden sites should be tested for nematodes. Consult your extension agent for labs offering nematode assay services. Like other soil-borne diseases, contaminated equipment, boots, and tools can spread root knot nematodes. Soil fumigation before planting is recommended when over 100 nematodes/100 cc of soil are found.

Resistant Cultivars: None.

Chemical: None.

References:

1. BC Ministry of Agriculture & Food. 2003. Ginseng Production Guide for Commercial Growers. 176 pp. (http://www.agf.gov.bc.ca/speccrop/ginseng/ginseng_production_guide.htm)
2. Parke, J.L. and Shotwell, K.M. 1989. Diseases of Cultivated Ginseng. University of Wisconsin-Madison. 16 pp.

PHYTOPHTHORA ROOT ROT and FOLIAR BLIGHT

Phytophthora cactorum.

Cultural: Avoid poorly drained sites, heavy clay soils and orchard land. Avoid driving heavy machinery on wet soil. Ridge the beds to improve drainage, and design the beds to utilize the contours of the land to prevent low spots in the troughs where water will accumulate. Use seed from Phytophthora foliar blight free gardens.

Resistant Cultivars: None.

Chemical: Metalaxyl (COM) GR; metalaxyl-M (COM) GR, EC. Only 3 applications/year. The first application is pre-emergence in the spring, the second six weeks later, and the third six weeks later. Metalaxyl (COM) EC pre-emergence in spring only. Fosetyl-AI (COM) WG, WP. No more than 5 applications/year. Apply first application at full emergence. Final application should be made when foliage is still green.

Limitations: Preharvest interval: 9 days (metalaxyl); 31 days (fosetyl-AI).

Notes: Some strains of Phytophthora are now insensitive to metalaxyl, i.e., it no longer controls the disease. Over application increases the chance for these strains to develop. Follow the label.

References:

1. BC Ministry of Agriculture & Food. 2003. Ginseng Production Guide for Commercial Growers. 176 pp. (http://www.agf.gov.bc.ca/speccrop/ginseng/ginseng_production_guide.htm)
2. Parke, J.L. and Shotwell, K.M. 1989. Diseases of Cultivated Ginseng. University of Wisconsin-Madison. 16 pp.

RHIZOCTONIA DISEASE/TIP OVER

Rhizoctonia solani.

Cultural: Keep the shade cloth off as long as possible in the spring prior to plant emergence to allow the soil to warm up in the spring. Clean equipment, tools and footwear after working in infested gardens.

Resistant Cultivars: None.

Chemical: For the control of *Rhizoctonia* seedling blight: use azoxystrobin (COM) SU – maximum of 2 applications per season and a pre-harvest interval of 24 months; or, quintozene (COM) WP - maximum of 1 application per season and pre-harvest interval of 24 months (Note 1).

Notes:

1. PCNB [Quintozene 75WP (COM) WP] remains registered for use on ginseng, but its use is no longer recommended due to issues with chemical residues. Quintozenes applied at label rates in the year of planting only may result in residues over tolerance in the roots at harvest. Root residues resulting from Quintozenes use have recently resulted in trade barriers in Asia and the United States.
2. No other root crops are to be grown for a minimum of one year following the harvest of a ginseng garden that was treated with quintozene.

References:

1. BC Ministry of Agriculture & Food. 2003. Ginseng Production Guide for Commercial Growers. 176 pp. (http://www.agf.gov.bc.ca/speccrop/ginseng/ginseng_production_guide.htm)
2. Parke, J.L. and Shotwell, K.M. 1989. Diseases of Cultivated Ginseng. University of Wisconsin-Madison. 16 pp.

OTHER DISEASES

The following diseases are currently of minor importance (MI) and/or are diseases for which no practical control (NC) measures are currently recommended.

Disappearing Root Rot/ Rusty Root (*Cylindrocarpon destructans*) NC.

Sclerotinia White Mould (*Sclerotinia sclerotiorum*) MI/NC.

Stromatinia Rot (*Stromatinia panacis*) MI/NC.

Verticillium Wilt (*Verticillium albo-atrum*, *Verticillium dahliae*) MI/NC.

HEMP (*Cannabis sativus*)

HEMP CANKER

Sclerotinia sclerotiorum

Cultural: Rotate to cereals and other non-broadleaf crops. Allow at least four years between susceptible crops such as buckwheat, canola/rapeseed, fababeans, lentils, mustard, peas, sunflower, soybeans and safflower. Control broadleaf weeds and volunteers of susceptible crops.

Resistant cultivars: None

Chemical: None

OTHER DISEASES

The following diseases are currently of minor importance (MI) and/or are diseases for which no practical control (NC) measures are currently recommended.

Gray Mould (*Botrytis cinerea*)

Yellow Leaf Spot (*Septoria cannabis*)

LENTIL (*Lens culinaris*)

ANTHRACNOSE

Colletotrichum truncatum

Cultural: Practice a rotation of at least 4 years between lentil crops and control volunteer lentil plants and wild vetch in the rotation. This disease is highly destructive under warm, wet conditions especially when short rotations have been used. The use of disease free seed is desirable.

Resistant Cultivars: CDC Redberry, CDC Robin, CDC Viceroy, CDC Rouleau. Resistance is to Race 1 only (see Note 2).

Chemical: Apply foliar fungicides chlorothalonil (COM) SU, mancozeb (COM) WG, pyraclostrobin (COM) EC, and/or azoxystrobin (COM) SU. Apply at early flower or the onset of disease and additional applications 10-14 days later if disease persists or weather conditions are favourable for disease development.

Limitations: Preharvest intervals: chlorothalonil - 48 days; mancozeb - 35 days; pyraclostrobin - 30 days; azoxystrobin - 15 days. Do not make more than 3 applications of mancozeb, 2 applications of chlorothalonil or 2 applications of either strobiluron fungicide per season.

Notes:

1. Anthracnose of lentil is now widespread in all lentil growing regions of Manitoba and Saskatchewan (1).
2. At least 2 races of the pathogen have been identified in western Canada.

References:

1. Buchwaldt, *et al.* 1996. Windborne dispersal of *Colletotrichum truncatum* and survival in infested lentil debris. *Phytopathology* 86: 1193-1198
2. Chongo, G. *et al.* 1999. Control of anthracnose in lentil using partial resistance and fungicide applications. *Can. J. Plant Pathol.* 21: 16-22.
3. Chongo, G., and Bernier, C.C. 2000. Effects of host, inoculum concentration, wetness duration, growth stage and temperature on anthracnose of lentil. *Plant Disease* 84: 544-548.
4. Chongo, G *et al.* 2002. Infection process of *Colletotrichum truncatum* in partially resistant and susceptible lentil genotypes. *Can. J. Plant Pathol.* 24: 81-85.
5. Chongo, G., Banniza, S., and Morrall, R.A.A. 2003. Diseases of lentil in Saskatchewan in 2002. *Can. Plant Dis. Surv.* 83: 119-120.
6. Morrall, R.A.A. *et al.* 2003. Seed-borne pathogens of lentil in Saskatchewan in 2002. *Can. Plant Dis. Surv.* 83: 121-123
7. Morrall, R.A.A *et al.* 2004. Seed-borne pathogens of chickpea, lentil and pea in Saskatchewan in 2003. *Can. Plant Dis. Surv.* 84: 109-110.

ASCOCHYTA BLIGHT

Ascochyta lentis

Cultural: Use only disease-free seed in areas of higher moisture and low levels in dryer areas (see Note 1). Practice a crop rotation of at least 4 years. Loss of quality from seed discoloration from this disease continues to increase after swathing, particularly if moist weather prevails (2,5). Turn under crop refuse soon after harvest (3,4). Control volunteer seedlings and avoid planting lentil adjacent to the previous year's lentil field (8).

Resistant Cultivars: CDC Blaze, CDC Glamis, CDC Grandora, CDC Milestone, CDC Plato, CDC Redberry, CDC Redcap, CDC Redwing, CDC Robin, CDC Rouleau, CDC Sovereign, CDC Vantage, CDC Viceroy.

Chemical: Use seed treatments of carbathiin + thiabendazole (COM) LI, metalaxyl-M + fludioxonil (COM) LI. Apply foliar fungicides chlorothalonil (COM) SU, mancozeb (COM) WG, pyraclostrobin (COM) EC, azoxystrobin (COM) SU, and/or boscalid (COM) WG. Apply at early flower or the onset of disease and make additional applications 10-14 days later if disease persists or weather conditions are favourable for disease development.

Limitations: Preharvest intervals: chlorothalonil - 48 days; mancozeb - 35 days; pyraclostrobin - 30 days; azoxystrobin - 15 days; boscalid - 21 days. Do not make more than 3 applications of mancozeb, 2 applications of chlorothalonil or boscalid, or 2 applications of either strobiluron fungicide per season.

Notes:

1. Have seed tested at an accredited laboratory for presence of *Ascochyta*.
2. *Ascochyta lentis* does not infect pea, fababean or chickpea.
3. Growers with a crop adjacent to the previous year's lentil residue should inspect the edge of the crop for disease and apply fungicide to edge of field if disease symptoms appear; and/or harvest the edge separately if it is much more heavily infested than the remainder.

References:

1. Ahmed, S. and Morrall, R.A.A. 1996. Field reactions of lentil lines and cultivars to isolates of *Ascochyta fabae* f. sp. *lentis*. Can. J. Plant Pathol. 18: 362-369.
2. Chongo, G., Banniza, S., and Morrall, R.A.A. 2003. Diseases of lentil in Saskatchewan in 2002. Can. Plant Dis. Surv. 83: 119-120.
3. Gossen, B.D. 2001. Impact of burial and survival of *Ascochyta lentis* on lentil residue. Can. J. Plant Pathol. 23: 146-148.
4. Gossen, B.D. and Derksen, D.A. 2003. Impact of tillage and crop rotation on ascochyta blight (*Ascochyta lentis*) of lentil. Can. J. Plant Sci. 83: 411-415.
5. Gossen, B.D. and Morrall, R.A.A. 1984. Seed quality loss at harvest due to *Ascochyta* blight of lentil. Can. J. Plant Pathol. 6: 233-237.
6. Morrall, R.A.A. 1997. Evolution of lentil diseases over 25 years in western Canada. Can. J. Plant Pathol. 19: 197-207.
7. Morrall, R.A.A. *et al.* 2003. Seed-borne pathogens of lentil in Saskatchewan in 2002. Can. Plant Dis. Surv. 83: 121-122.
8. Pederson, E.A. and Morrall, R.A.A. 1994. Effect of nonhost and fungicide-treated barriers on horizontal spread of ascochyta blight of lentil. Can. J. Plant Pathol. 16: 317-325.

BOTRYTIS STEM and POD ROT (GRAY MOULD)

Botrytis cinerea

Cultural: Include lentil in rotation only once every 4 years. Using wide row spacing may help to maintain ventilation in the canopy and non-conductive conditions for disease development.

Resistant Cultivars: None.

Chemical: Apply foliar spray of boscalid (COM) WG at the beginning of flowering and make second application 7-14 days later if disease persists or weather conditions are favourable for disease development. It is not known whether seed treatments to control seedling blight induced by *Botrytis* have an effect on late season stem and pod rot.

Limitations: Preharvest interval: boscalid - 21 days. Do not make more than 2 applications of boscalid per season.

References:

1. Anderson, K.L, Buckwaldt, L., Congo, G., Gossen, B.D., Morrall, R.A.A, and Pearse, P.G. 2000. Diseases of lentil in Saskatchewan in 1999. *Can. Plant. Dis. Surv.* 80: 96-98.
2. Huang, H.C. and Erickson, R.S. 2000. Survey of diseases of lentil in southern Alberta in 1999. *Can. Plant Dis. Surv.* 80: 99-100.
3. Morrall, R.A.A. 1997. Evolution of lentil diseases over 25 years in western Canada. *Can. J. Plant Pathol.* 19: 197-207.
4. Morrall, R.A.A. *et al.* 2001. Seed-borne pathogens of lentil in Saskatchewan in 2000. *Can. Plant Dis. Surv.* 81: 126-129.
5. Morrall, R.A.A. *et al.* 2004. Seed-borne pathogens of chickpea, lentil and pea in Saskatchewan in 2003. *Can. Plant Dis. Surv.* 84: 109-110.

SEED ROT, SEEDLING BLIGHT and ROOT ROT

Fusarium spp., *Fusarium avenaceum*, *Rhizoctonia solani*, *Botrytis cinerea*, *Pythium* spp. and *Sclerotinia sclerotiorum*

Cultural: Include lentil in rotation only once every 4 years. Do not use lentil seed that has a high level of *Botrytis* or *Sclerotinia* infection.

Resistant Cultivars: None.

Chemical: Use seed treatments containing carbathiin + thiabendazole (COM) LI; carbathiin + thiram (COM) LI; fludioxonil (COM) SN; or metalaxyl-M + fludioxonil (COM) LI. Metalaxyl (COM) SU will protect zero tannin lentils against *Pythium*.

References:

1. Anderson, K.L, Buckwaldt, L., Congo, G., Gossen, B.D., Morrall, R.A.A, and Pearse, P.G. 2000. Diseases of lentil in Saskatchewan in 1999. *Can. Plant. Dis. Surv.* 80: 96-98.
2. Huang, H.C. and Erickson, R.S. 2000. Survey of diseases of lentil in southern Alberta in 1999. *Can. Plant Dis. Surv.* 80: 99-100.
3. Hwang, S.F. *et al.* 1994. Etiology and severity of fusarium root rot of lentil in Alberta. *Can. J. Plant Pathol.* 16: 295-303.
4. Hwang, S.F., Gossen, B.D., Turnbull, G.D., Chang, K.F., Howard, R.J., and Thomas, A.G. 2000. Effect of temperature, seeding date, fungicide seed treatment and inoculation with *Fusarium avenaceum* on seedling survival, root rot severity and yield of lentil. *Can. J. Plant Sci.* 80: 899-907.
5. Morrall, R.A.A. *et al.* 1997. Evolution of lentil diseases over 25 years in western Canada. *Can. J. Plant Pathol.* 19: 197-207.

SCLEROTINIA STEM and POD ROT

Sclerotinia sclerotiorum

Cultural: Rotate to cereals, corn and grasses. Allow at least 4 years between susceptible crops such as buckwheat, canola/rapeseed, faba bean, lentil, mustard, pea, safflower, soybean and sunflower. Control broadleaved weeds and volunteers of susceptible crops.

Resistant Cultivars: None.

Chemical: Apply foliar spray of boscalid (COM) WG at the beginning of flowering and make second application 7-14 days later if disease persists or weather conditions are favourable for disease development.

Limitations: Preharvest interval: boscalid - 21 days. Do not make more than 2 applications of boscalid per season.

References:

1. Anderson, K.L. *et al.* 2000. Diseases of lentil in Saskatchewan 1999. Can. Plant Dis. Surv. 80: 96-97.
2. Morrall R.A.A. *et al.* 2004. Seed-borne pathogens of chickpea, lentil and pea in Saskatchewan in 2003. Can. Plant Dis. Surv. 84: 109-110.

OTHER DISEASES

The following diseases of lentils are currently of minor importance (MI) and/or are diseases for which no practical control measures are currently recommended (NC):

Pink Seed (*Erwinia rhapontici*) MI, NC. Refer to FIELD PEA, PINK SEED.

Powdery mildew (*Microsphaera* spp.)

Reference: Banniza, S., Parmelee, J.A., Morrall, R.A.A., Tulla, A. and Beauchamp, C.J. 2004. First record of powdery mildew in lentil in Canada. Can. Plant Dis. Surv. 84: 102-103.

Septoria Leaf Spot (*Septoria* sp.)

Note: This disease may be confused with ascochyta blight, but symptoms usually occur only on the lower leaves.) MI, NC

Stemphylium Blight (*Stemphylium* sp.) NC

Virus Diseases (pea seed-borne mosaic virus). (See Ref. 1, under FIELD PEA, VIRUS DISEASES) MI

PEPPERMINT (*Mentha piperita*, *M. aquatica* x *M. spicata*)

The following diseases of peppermint are currently of minor importance and/or are diseases for which no practical control measures are currently recommended.

Powdery Mildew (*Erysiphe cichoracearum*)

Verticillium Wilt (*Verticillium albo-atrum*, *V. dahliae*)

SORGHUM (*Sorghum bicolor*)

BACTERIAL LEAF SPOT (HOLCUS SPOT)

Pseudomonas syringae

Cultural: Follow a crop rotation that avoids corn, Sudan grass, and foxtail millet. Control susceptible weeds such as green foxtail. Use seed from disease-free fields as the bacterium is seed-borne. Destroy infected stubble by plowing under after harvest and avoid planting near infected fields of previous season.

Resistant Cultivars: None.

Chemical: None.

SEED ROT and SEEDLING BLIGHT

Fusarium spp., *Penicillium* spp.

Cultural: Sow seed in warm moist soil.

Resistant Cultivars: None.

Chemical: None.

SPEARMINT (*Mentha spicata*)

The following diseases of spearmint are currently of minor importance and/or are diseases for which no practical control measures are currently recommended.

Powdery Mildew (*Erysiphe cichoracearum*)

Rust (*Puccinia menthae*)

Verticillium Wilt (*Verticillium albo-atrum*, *V. dahliae*)

SOYBEAN (*Glycine max*)

BACTERIAL BLIGHT, BACTERIAL PUSTULE

Pseudomonas glycinea, *Xanthomonas phaseoli* var. *sojensis*

Cultural: Use disease-free seed. Follow 2-year minimum crop rotation as bacteria may overwinter in diseased leaves. Do not cultivate or enter fields when plants are wet with dew or rain.

Resistant Cultivars: None.

Chemical: None.

DOWNY MILDEW

Peronospora manshurica

Cultural: The pathogen overwinters as oospores in infected leaves and on seeds. Sow seed from uninfected fields. Plow under soybean residue. Avoid successive soybean plantings or following soybeans with beans.

Resistant Cultivars: None.

Chemical: None.

SCLEROTINIA STEM ROT

Sclerotinia sclerotiorum

Cultural: Rotate to cereals, corn and grasses, crops that are immune. Allow at least 4 years between susceptible crops such as buckwheat, canola/rapeseed, fababean, lentil, mustard, pea, safflower, soybean and sunflower. Control broadleaved weeds and volunteers of susceptible crops.

Resistant Cultivars: None.

Chemical: None.

SEED ROT and SEEDLING BLIGHT

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

Cultural: None.

Resistant Cultivars: None.

Chemical: Seed treatment with - captan (COM); captan + diazinon (COM) DU, SU; carbathiin + thiram (COM) SU; fludioxonil (COM) SN; metalaxyl (COM) SU; metalaxyl-M + fludioxonil (COM) LI; thiram (COM) WP (see Notes).

Limitations: As per label.

Notes: *Rhizobium japonicum* applied on seed was compatible with thiram and carbathiin but not with captan (1). Studies show that granular inoculant applied in soil is not affected by these fungicides (2).

References:

1. Curley, R.L. and Burton, J.C. 1975. Compatibility of *Rhizobium japonicum* with chemical seed protectants. *Agron. J.* 67: 807-808.
2. Rennie, R.J. and Dubetz, S. 1984. Effect of fungicides and herbicides on nodulation and N₂ fixation in soybean fields lacking indigenous *Rhizobium japonicum*. *Agron. J.* 76: (May-June) 451-454.

OTHER DISEASES

The following diseases of soybean are currently of minor importance (MI) and/or are diseases for which no practical control (NC) measures are currently recommended:

Root Rots (*Rhizoctonia solani*, *Fusarium solani*, *Phytophthora sojae*)

SUGAR BEET (*Beta vulgaris*)

DAMPING-OFF, BLACK LEG

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

Cultural: Sow sugar beets early into a firm, moist seed bed.

Resistant Cultivars: None.

Chemical: Treat seed with - captan (COM) SU; captan + methoxychlor (COM) SU; metalaxyl (COM) SU; thiram (COM) WP. Limitations: As per label.

Notes: *Phoma betae* may also cause a leaf spot and storage rot of sugar beet.

References:

1. Bardin, S.D. and Huang, H.C. 2001. Survey of damping-off diseases of sugar beet in southern Alberta in 2000. *Can. Plant Dis. Surv.* 81: 136-137.

LEAF SPOT

Cercospora beticola

Cultural: Use a crop rotation of 3 years. Turn under crop refuse. Locate new fields at least 100 m from those infected the previous year.

Resistant Cultivars: None.

Chemical: Spray foliage with - copper hydroxide (COM) WP; mancozeb (COM) DF, WP; metiram (COM) WG, WP; and/or pyraclostrobin (COM) EC. Apply pyraclostrobin at the onset of disease to control *Cercospora* leaf spot and powdery mildew.

Limitations: Preharvest intervals - 1 day (copper hydroxide); 21 days (mancozeb, metiram); 7 days (pyraclostrobin). Do not feed crop refuse treated with maneb, mancozeb, or metiram, to livestock.

Notes:

1. Since the disease rarely occurs in Western Canada, chemical control is seldom required.

SUGAR BEET CYST NEMATODE

Heterodera schachtii

Cultural: Use a crop sequence that includes sugar beet or crucifers only once in 4 years. Control cruciferous weeds. Avoid canola or mustard in rotations that include sugar beets or red beets.

Resistant Cultivars: None.

Chemical: None.

Notes: Sugar beet fields in Alberta are monitored annually for *H. schachtii* and those found to be infested are removed from production.

References:

1. Hawn, E.J., *et al.* 1964. Control of the sugar-beet nematode in Alberta. Agric. Can., Publ. 1216. 4 pp.
2. Snow, J.G. and Hill, A.W. 1976. Alberta sugar beet bulletin. 21. Can. Sugar Factories Co., Lethbridge, AB.

OTHER DISEASES

The following diseases of sugar beet are currently of minor importance and/or are diseases for which no practical control measures are currently recommended:

Powdery Mildew (*Erysiphe polygoni*) - apply foliar spray of pyraclostrobin (COM) EC at the first sign of disease.
Storage Rot (*Penicillium* spp., *Phoma betae*, *Rhizopus* spp., *Erwinia* spp., *Botrytis* spp., and *Fusarium* spp.)

GENERAL REFERENCES

1. Allen, D.J. and J.M Lenne (Eds.) 1998. The Pathology of Food and Pasture Legumes. CAB International, New York. 750 pp.
2. Bailey, K.L., Gossen, B.D., Gugel, R., and Morrall, R.A.A. (Editors). 2003. Diseases of Field Crops in Canada. Canadian Phytopathological Society, Saskatoon, SK. 290 pp.
3. Frederiksen, Richard, A. *et al.* (Eds.) 2000. Compendium of sorghum diseases (2nd ed.). Am. Phytopathol. Soc., St. Paul, Minn. 78 pp.
4. Hall, Robert (Ed.). 1991. Compendium of bean diseases. Am. Phytopathol. Soc., St. Paul, Minn. 73 pp.
5. Hartman, G.L. *et al* (Eds.). 1999. Compendium of soybean diseases (4th ed.). Am. Phytopathol. Soc., St. Paul, Minn. 100 pp.
6. Howard, R.J., J.A. Garland, W.L. Seaman, (Eds). 1994. Diseases and Pests of Vegetable Crops in Canada. The Canadian Phytopathological Society and the Entomological Society of Canada. Ottawa, Ontario. 554 pp.
7. Kraft, J.M, Pflieger F.L. 2001. Compendium of pea diseases and pests (2nd ed.). Am. Phytopathol. Soc., St. Paul, Minn. 67 pp.
8. White, D.G. (Ed.). 1999. Compendium of Corn Diseases (3rd ed.). Am. Phytopathol. Soc., St. Paul, Minn. 78 pp.
9. Whitney, E.D. *et al.* 1986. Compendium of beet diseases and insects. Am. Phytopathol. Soc., St. Paul, Minn. 76 pp.

APPENDIX 1. FOLIAR FUNGICIDES REGISTERED FOR USE ON SPECIAL CROPS

Crop	Disease	Active Ingredient	Trade Name	Formulation	PCP#
Canaryseed	Leaf mottle	propiconazole	Tilt 250E	250 g/L EC	19346
Chickpea	Ascochyta blight	azoxystrobin	Quadris	250 g/L EC	26153
		boscalid	Lance	70% WG	27495
		chlorothalonil	Bravo 500	500 g/L SU	15723
		pyraclostrobin	Headline EC	250 g/L EC	27322
	White mould, gray mould	boscalid	Lance	70% WG	27495
Corn	Rust, Leaf blight	propiconazole	Tilt 250E Propiconazole 250E	250 g/L EC 250 g/L EC	19346 24029
Faba bean	Ascochyta leaf and pod spot	pyraclostrobin	Headline EC	250 g/L EC	27322
Field Bean	Anthracnose	azoxystrobin	Quadris	250 g/L EC	26153
		pyraclostrobin	Headline EC	250 g/L EC	27322
		tribasic copper sulphate	Copper 53W	53% WP	9934
	Common blight/ Halo blight	tribasic copper sulphate	Copper 53W	53% WP	9934
		copper hydroxide	Kocide 101 Parasol	50% WP 50% WP	14417 24671
	Powdery mildew	pyraclostrobin	Headline EC	250 g/L EC	27322
	Rust	propiconazole	Tilt 250E	250 g/L EC	19346
		pyraclostrobin	Headline EC	250 g/L EC	27322
	Stem Rot/White mould	benomyl ¹	Benlate	50% WP	11062, 24678
		boscalid	Lance	70% WG	27495
		thiophanate methyl	Senator	70% WP	25343
		vinclozolin	Ronilan EG	50% WG	24894
Field Pea	Mycosphaerella blight	azoxystrobin	Quadris	250 g/L EC	26153
		chlorothalonil	Bravo 500	500 g/L SU	15723
		pyraclostrobin	Headline EC	250 g/L EC	27322
	Powdery mildew	pyraclostrobin	Headline EC	250 g/L EC	27322
		sulphur	Kumulus DF	80% WG	18836

APPENDIX 1. FOLIAR FUNGICIDES REGISTERED FOR USE ON SPECIAL CROPS (continued)

Crop	Disease	Active Ingredient	Trade Name	Formulation	PCP#
Lentil	Anthracnose, Ascochyta blight	azoxystrobin	Quadris	250 g/L EC	26153
		boscalid (not anthracnose)	Lance	70% WG	27495
		chlorothalonil	Bravo 500	500 g/L SU	15723
		mancozeb	Dithane DG	75% WG	20553
		pyraclostrobin	Headline EC	250 g/L EC	27322
	White mould, gray mould	boscalid	Lance	70% WG	27495
Sugar beet	Leaf spot	copper hydroxide	Kocide 101 Parasol WP	50% WP 50% WP	14417 24671
		mancozeb	Dithane M-45 Dithane WSP Manzate 200 DF Penncozeb	80% WP 80% WP 75% DF 80% WP	8556 23655 21057 25396
		metiram	Polyram DF	80% WG	20087
		pyraclostrobin	Headline EC	250 g/L EC	27322
	Powdery mildew	pyraclostrobin	Headline EC	250 g/L EC	27322

APPENDIX II. FUNGICIDES REGISTERED FOR USE ON GINSENG

Fungicides	PCP#	Alternaria Blight	Botrytis Blight	Phytophthora Root Rot	Phytophthora Foliar Blight	Rhizoctonia Crown Rot	Damping-off
anilazine							
Dyrene Solupak	22090	x					
azoxystrobin							
Quadris	26153					x	x (Rhizoctonia)
chlorothalonil							
Bravo 500	15723	x	x				
fosetyl-AI							
Aliette WDG	24458 27688			x	x		
Aliette WP	24564			x	x		
iprodione							
Rovral WP	15213	x					
Rovral WDG	24709	x					
mancozeb							
Dithane DG	20553	x					
Dithane F-45	20552	x					
Dithane WSP	23655	x					
Manzate 200 DF	21057	x					
Penncozeb 75 DF	25397	x					
Penncozeb 80WP	25396	x					
metalaxyl							
Ridomil 2G	24037			x			
Ridomil 240EC	17274			x			
metalaxyl-M							
Ridomil Gold 480EC	25384			x			x (Pythium)
Ridomil Gold 1 G	26612			x			
PCNB							
Quintozene 75WP	7251					x	x (Rhizoctonia)

APPENDIX III. SEED TREATMENTS REGISTERED FOR USE ON SPECIAL CROPS

Seed Treatment	PCP#	Seed Rot & Seedling Blight							Seed-borne Diseases		
		Corn	Chick-pea	Field Bean	Field Pea	Lentil	Soybean	Sugar Beets	Bean Anthracnose	Corn Head Smut	Lentil/ Chickpea Ascochyta
captan											
Captan Flowable	12028	X		X	X		X	X			
captan + diazinon											
Agrox B-2	26956	X		X	X		X				
Agrox CD	26957	X		X	X		X				
captan + diazinon + thiophanate methyl											
DCT Dual Purpose	14986			X					X		
carbathiin + thiram											
Anchor	18788				X	X	X				
Vitaflo 280	11423	X		X	X	X	X			X	
carbathiin + thiabendazole											
Crown	23430		X			X					X
Fludioxonil											
Maxim 480 FS	27001	X	X	X	X	X	X				
fludioxonil + metalaxyl-M											
Maxim XL	27071	X									
Apron Maxx RTA	27577		X	X	X	X	X		X		
mancozeb											
Dithane M-22	4818							X			
Dithane M-45	12215	X									
Manzate 200	10526	X									
metalaxyl											
Allegiance FL	26674	X	X	X	X	X	X	X			
Apron FL	26674	X	X	X	X	X	X	X			
Apron XL LS	25585	X			X	X	X	X			
thiram											
Thiram 75WP	15933	X		X	X		X	X			

APPENDIX 1. FOLIAR FUNGICIDES REGISTERED FOR USE ON SPECIAL CROPS

Crop	Disease	Active Ingredient	Trade Name	Formulation	PCP#
Canaryseed	Leaf mottle	propiconazole	Tilt 250E	250 g/L EC	19346
Chickpea	Ascochyta blight	azoxystrobin	Quadris	250 g/L EC	26153
		boscalid	Lance	70% WG	27495
		chlorothalonil	Bravo 500	40.4% SU	15723
		pyraclostrobin	Headline EC	250 g/L EC	27322
	White mould, gray mould	boscalid	Lance	70% WG	27495
Corn	Rust, Leaf blight	propiconazole	Tilt 250E Topas 250E Propiconazole 250E	250 g/L EC 250 g/L EC 250 g/L EC	19346 24030 24029
Dill	Dill Blight	Benomyl ¹	Benlate	50% WP	11062 24678
Field Bean	Anthracnose	azoxystrobin	Quadris	250 g/L EC	26153
		pyraclostrobin	Headline EC	250 g/L EC	27322
		tribasic copper sulphate	Copper 53W	53% WP	9934
	Common blight	tribasic copper sulphate	Copper 53W	53% WP	9934
		copper hydroxide	Kocide 101 Parasol	50% WP 50% WP	14417 24671
	Halo blight	copper hydroxide	Kocide 101 Parasol	50% WP 50% WP	14417 24671
	Powdery mildew	pyraclostrobin	Headline EC	250 g/L EC	27322
	Rust	propiconazole	Tilt 250E	250 g/L EC	19346
		pyraclostrobin	Headline EC	250 g/L EC	27322
	Stem Rot/White mould	boscalid	Lance	70% WG	27495
		thiophanate methyl	Easout Senator	70% WP 70% WP	12279 25343
		vinclozolin	Ronilan EG	50% WG	24894
	Field Pea	Mycosphaerella blight	azoxystrobin	Quadris	250 g/L EC
chlorothalonil			Bravo 500	40.4% SU	15723
pyraclostrobin			Headline EC	250 g/L EC	27322
Powdery mildew		pyraclostrobin	Headline EC	250 g/L EC	27322
		sulphur	Kumulus DF	80% WG	18836

APPENDIX 1. FOLIAR FUNGICIDES REGISTERED FOR USE ON SPECIAL CROPS
(continued)

Crop	Disease	Active Ingredient	Trade Name	Formulation	PCP#
Lentil	Anthracnose, Ascochyta blight	azoxystrobin	Quadris	250 g/L EC	26153
		boscalid (not anthracnose)	Lance	70% WG	27495
		chlorothalonil	Bravo 500	40.4% SU	15723
		mancozeb	Dithane DG	75% WG	20553
		pyraclostrobin	Headline EC	250 g/L EC	27322
	White mould, gray mould	boscalid	Lance	70% WG	27495
Sugar beet	Leaf spot	copper hydroxide	Kocide 101 Parasol WP	50% WP 50% WP	14417 24671
		mancozeb	Dithane M-45 Manzate WSP Manzate 200 DF Penncozeb	80% WP 80% WP 75% DF 80% WP	8556 23655 21057 25396
		metiram	Polyram 80W Polyram DF	80% WP 80% WG	14825 20087
		pyraclostrobin	Headline EC	250 g/L EC	27322
	Powdery mildew	pyraclostrobin	Headline EC	250 g/L EC	27322

APPENDIX II. FUNGICIDES REGISTERED FOR USE ON GINSENG

Fungicides	PCP#	Alternaria Blight	Botrytis Blight	Phytophthora Root Rot	Phytophthora Foliar Blight	Rhizoctonia Crown Rot	Damping-off
anilazine							
Dyrene Solupak	22090	x					
azoxystrobin							
Quadris*	26153					x	x (Rhizoctonia)
chlorothalonil							
Bravo 500	15723	x	x				
fosetyl-AI							
Aliette WDG	24458			x	x		
Aliette WP	24564			x	x		
iprodione							
Rovral WP	15213	x					
Rovral WDG	24709	x					
mancozeb							
Dithane DG	20553	x					
Dithane F-45	20552	x					
Dithane M-45	8556	x					
Dithane WSP	23655	x					
Manzate 200 DF	21057	x					
Penncozeb 75 DF	25397	x					
Penncozeb 80WP	25396	x					
metalaxyl							
Ridomil 2G	24037			x			x (Pythium)
Ridomil 240EC	17274			x			x (Pythium)
metalaxyl-M							
Ridomil Gold 480EC	25384			x			x (Pythium)
PCNB							
Quintozene 75WP	7251 1142					x	x (Rhizoctonia)

APPENDIX III. SEED TREATMENTS REGISTERED FOR USE ON SPECIAL CROPS

Seed Treatment	PCP#	Seed Rot & Seedling Blight								Seed-borne Diseases		
		Corn	Chick-pea	Field Bean	Field Pea	Lentil	Soybean	Sugar Beets	Spices	Bean Anthrac-nose	Cron Head Smut	Lentil/ Chickpea Ascochyta
captan												
Captan Flowable	12028	X		X	X		X	X				
captan + diazinon												
Agrox B-2	26956	X		X	X		X					
Agrox CD	26957	X		X	X		X					
captan + diazinon + thiophanate methyl												
DCT Dual Purpose	14986			X						X		
captan + methoxychlor												
Captan 30-Mehtoxychlor 3	12029	X		X			X	X				
carbathiin + thiram												
Anchor	18788						X					
Vitaflo 280	11423	X		X	X	X	X				X	
carbathiin + thiabendazole												
Crown	23430		X			X						X
fludioxonil												
Maxim 480 FS	27001	X	X	X	X	X	X					
fludioxonil + metalaxyl-M												
Apron Maxx RTA	27577		X	X	X	X	X		X	X		
Maxim XL	27071	X										
mancozeb												
Dithane M-22	4818							X				
Dithane M-45	12215	X										
Manzate 200	10526	X										
metalaxyl												
Allegiance FL	26674	X	X	X	X	X	X	X				
Apron FL	26674	X	X	X	X	X	X	X				
metalaxyl-M												
Apron XL LS	25585	X			X	X	X	X				
thiram												
Thiram 75WP	15933	X		X	X		X	X				