Updated March 2015

Chapter 8

DISEASES OF SPECIAL FIELD CROPS

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 seed-borne; if possible plant seed from mildew-free crops. Planting buckwheat seed when soil temperature is 20^{o}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., *Pythium* 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 (PCP# 27001 Maxim 480 FS) or difenoconazole + metalaxyl (COM) SU.

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. Apply at emergence of flag leaf.

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. Jesperson 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:

Anthracnose (*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: For coriander only: apply azoxystrobin (COM) EC prior to disease establishment. Only use 1 application per season and a preharvest interval of 21 days.

Notes: 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. 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).

2. Duczek, L.J. and Slinkard A.E. 2003. Blight of caraway in Saskatchewan from 2000 to 2002. Can. Plant Dis. Surv. 83: 101-102.

3. 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.

SEED ROT, SEEDLING BLIGHT AND ROOT ROT

(*Fusarium* spp., *Rhizoctonia solani*, *Pythium* spp., *Botrytis cinerea*, *Alternaria* spp.)

Chemical: fludioxonil (COM) SN PCP# 27001 is registered as a seed treatment in caraway and coriander to protect against *Fusarium* and *Rhizoctonia* species.

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)

References:

1. Hwang, S.F., Chang, K.F., and Howard, R.J. 1996. Yellows Diseases of Echinacea, Monarda and Caraway. AAFRD, Agdex 630-1, 4 pp.

2. Hwang, S.F., Chang, K.F., Howard, R.J., Gaudiel, R.G. and Wahab, M.N.J. 1997. A yellows disease of caraway (*Carum carvi* L.) in Canada associated with an unidentified phytoplasma. J. Plant Dis. Prot. 104: 166-172.

Sclerotinia Stem Rot (*Sclerotinia sclerotiorum*)

CHICKPEA (*Cicer arietinum*)

ASCOCHYTA BLIGHT

Ascochyta rabiei

Cultural: Use disease-free seed (see Notes). 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. Incorporation of infected residue into the soil can accelerate its breakdown and may be helpful following a severely infected crop. Rolling is not recommended for chickpea because of the potential to damage plants and spread infection.

Resistance Rating: Refer to current "Varieties of Grain Crops" publication, Saskatchewan Ministry of Agriculture, for resistance ratings.
http://www.agriculture.gov.sk.ca/Varieties_Grain_Crops (accessed April 12, 2012)

Chemical: Treat seed with carbathiin + thiabendazole (COM) SN or fludioxonil + metalaxyl-M (COM) SU.

Foliar application of azoxystrobin (COM) SU; azoxystrobin + chlorothalonil (COM) SU; boscalid (COM) WG; boscalid + pyraclostrobin (COM) WG; chlorothalonil (COM) SU; fluopyram + prothioconazole (COM) SU, fluxapyroxad + pyraclostrobin (COM) SU; penthiopyrad (COM) EC, prothioconazole (COM) SU; pyraclostrobin (COM) EC. 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. Boscalid - preharvest interval is 21 days; do not make more than 2 applications per season. Prothioconazole – preharvest interval is 7 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 strobilurin fungicides per season; do not apply sequentially; and apply as a tankmix with another chemistry if available (refer to Note 2). Use high water volumes to ensure good coverage.

Notes:

1. An agar plate test for seed-borne *Ascochyta* can be carried out by accredited seed testing laboratories.

2. Resistance to strobiluron fungicides has been identified in the *A. rabiei* pathogen in Saskatchewan, Alberta and North Dakota.

References:

1. Ahmed, H.U., Chang, K.F., Hwang, S.F., Gossen, B.D., Strelkov, S.E., and Turnbull, G.D. 2014. Baseline sensitivity and the population shifts of *Didymella rabiei* in chickpea to the QoI fungicide pyraclostrobin in Alberta, Canada. J. Plant Dis. Prot. 121: 164-170.

2. Ahmed, H.U., Chang, K.F., Hwang, S.F., Gossen, B.D., Howard, R.J., and Warkentin, T.D. 2006. Components of disease resistance in desi and kabuli chickpea varieties against ascochyta blight. Plant Pathol. J. 5: 336-342.

3. Ahmed, H.U., Chang, K.F., Hwang, S.F., Strelkov, S.E., and Turnbull, G.D. 2007. Pathogenic diversity of *Didymella rabiei* isolates from southern Alberta, Canada. J. Plant Dis. Prot. 114: 189-195.

4. Ahmed, H.U., Hwang, S.F., Gossen, B.D., Chang, K.F., Howard, R.J., Strelkov, S.E., and Turnbull, G.D. 2009. Adaptation to host (chickpea) genotype by isolates of *Didymella rabiei* following repeated cycles of infection. J. Plant Dis. Prot. 116: 177-181.

5. 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.

6. Armstrong-Cho, C., Chongo, G., Wolf, T., Hogg, T., Johnson, E., and S. Banniza. 2007. The effect of spray quality on ascochyta blight control in chickpea. Crop Protection. 27:700-709.

7. Chandirasekaran, R., *et al*. 2009. Improved sources of resistance to ascochyta blight in chickpea. Can. J. Plant Sci. 89:107-118.

8. Chang, K.F., Ahmed, H.U., Hwang, S.F., Gossen, B.D., Howard, R.J., Warkentin, T.D., Strelkov, S.E., and Blade, S.F. 2007. Impact of cultivar, row spacing and seeding rate on ascochyta blight severity and yield of chickpea. Can. J. Plant Sci. 87: 395-403.

9. Chang, K.F., Ahmed, H.U., Hwang, S.F., Gossen, B.D., Strelkov, S.E., Blade, S.F., and Turnbull, G.D. 2007. Sensitivity of field populations of *Ascochyta rabiei* to chlorothalonil, mancozeb and pyraclostrobin fungicides and effects of strobilurin fungicides on the progress of ascochyta blight of chickpea. Can. J. Plant Sci. 87: 937-944.

10. 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.

11. Gan, Y., Gossen, B.D., Li, L., Ford, G., and Banniza, S. 2007. Cultivar type, plant population and ascochyta blight in chickpea. Agron. J. 99: 1463-1470.

12. Gan, Y., Siddique, K.H.M., MacLeod, W.J., and P. Jayakumar. 2006. Management options for minimizing damage by ascochyta blight in chickpea. Field Crops Research 97: 121-134.

13. 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.

14. Pesticide Risk Reduction Program. 2010. Scouting and Management of Ascochyta Blight in Chickpea. Available at http://www.agriculture.gov.sk.ca/.

15. Tivoli, B., and S. Banniza. 2007. Comparison of the epidemiology of ascochyta blights in grain legumes. Eur. J. Plant Pathol. 119: 59-76.

GRAY MOULD STEM AND POD ROT

(*Botrytis cinerea*)

Cultural: Widen row spacing or lower seeding rates to improve air circulation in the crop.

Chemical: boscalid (COM) WG, penthiopyrad (COM) EC – Apply at the beginning of flowering, 7-14 later for the 2nd application.

Biological: Apply *Bacillus subtilis* (COM) SU when conditions become conducive to disease development. Repeat on 7 – 10 days intervals.

SCLEROTINIA WHITE MOULD

Sclerotinia sclerotiorum

Cultural: Conditions of high rainfall and dense crop canopy favour development of the disease.

Chemical: Foliar application of boscalid (COM) WG, fluopyram + prothioconazole (COM) SU, or fluxapyroxad + pyraclostrobin (COM) SU for control of 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 day; do not make more than 2 applications per season.

Biological: For suppression, apply *Bacillus subtilis* (COM) SU prior to or at early stage of disease development and repeat at 7 to 10 day intervals. Limitations: as per label.

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) SN; fludioxonil (COM) SN; fludioxonil + metalaxyl-M (COM) SU; thiabendazole + fludioxonil + metalaxyl-M (COM) SU; trifloxystrobin + metalaxyl (COM) SU; penflufen + trifloxystrobin + metalaxyl (COM) SU. Seed treatment with metalaxyl (COM) SU will protect against *Pythium* spp. only.

References:

1. 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.

2. 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.

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.

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):

Aster Yellows Phytoplasma MI/NC

Pink Seed (*Erwinia rhapontici*) - MI/NC. Refer to FIELD PEA, PINK SEED on page 26.

CORN (*Zea mays*)

COMMON SMUT

Ustilago maydis

Cultural: Follow a 2-year minimum crop rotation. 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.

References:

1. Desjardins, M.L., Heard, J., Kaminski, D.A. and Northover, P.R. 2007. 2006 Manitoba Crop Diagnostic Centre laboratory submissions. Can. Plant Dis. Surv. 87:20-26.

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^{o}C. Do not rotate corn with wheat or other cereals susceptible to Fusarium head blight.

Resistant Cultivars: Choose varieties from recommended hybrids.

Chemical: Apply prothioconazole (COM) SU once per season.

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. Sutton, J.C. 1982. Epidemiology of wheat head blight and corn ear rot caused by *Fusarium graminearum*. Can. J. Plant Pathol. 4: 195-209.

2. Warfield, C.Y., and Davis, R.M. 1996. Importance of the husk covering on the susceptibility of corn hybrids to Fusarium ear rot. Plant. Dis. 80: 208-210.

GOSS'S WILT (LEAF FRECKLES)

Clavibacter michaganensis subsp. *nebraskensis*

Cultural: Destruction or deep ploughing of infected debris immediately after harvest is recommended. Rotate crops and use resistant cultivars if available.

Resistant Cultivars: None. Disease severity can vary with cultivar. Consult the seed company for information regarding disease ratings on available cultivars. The dent corn inbred A632 and cultivars in which this and other related inbreds are used are known to be highly susceptible to the disease.

Chemical: None.

Notes:

1. This disease can cause a foliar blight or a systemic vascular wilt.

2. Infected residue is believed to be the main source of inoculum with infected seed playing a minor role in areas where the disease has already been established. Seed contamination can play a role in introduction of the disease to new areas (Ref 1).

References:

1. Biddle, J.A., D.C. McGee and E.J. Braun. 1990. Seed transmission of *Clavibacter michiganense* subsp. *nebraskense* in corn. Plant Dis. 74: 908-911.

2. Jackson, T.A., R.M. Harveson, and A.K. Vidaver. 2007. Reemergence of Goss's wilt and blight of corn to the central High Plains. Online. Plant Health Progress doi:10.1094/PHP-2007-0919-01-BR. http://www.plantmanagementnetwork.org/pub/php/brief/2007/goss/ (Accessed April 16, 2013)

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:

1. Holcus spot only occurs occasionally in Canada and is usually not severe.

2. *Pseudomonas syringae* pv. *syringae* has a wide host range that includes many herbaceous and woody ornamental plants.

3. 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 on page 11)

References:

1. Tamburic-Ilincic, L. and A.W. Schaafsma. 2009. The prevalence of *Fusarium* spp. colonizing seed corn stalks in southwestern Ontario, Canada. Can. J. Plant Sc. 89: 103-106.

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^{o}C. Avoid planting in poorly drained soils. Follow recommended practices for fertilizer and herbicide applications.

Resistant Cultivars: None.

Chemical: Treat seed with – azoxystrobin (COM) SU; captan (COM) SU, WP; captan + diazinon + thiophanate methyl (COM) WP; carbathiin + thiram (COM) SU; fludioxonil (COM) SN; fludioxonil + metalaxyl-M (COM) SU; mancozeb (COM) WP; metalaxyl (COM) SU; difenoconazole + metalaxyl (COM) SU; and thiram (COM) WP.
Limitations: As per label. azoxystrobin is for *Pythium* spp. and *Rhizoctonia*.

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:

Rust (*Puccinia sorghi*)

Chemical: Apply foliar fungicide penthiopyrad (COM) EC, propiconazole (COM) EC, azoxystrobin + propiconazole (COM) SU, prothioconazole (COM) SU or pyraclostrobin (COM) EC. Refer to labels for details.

Grey leaf spot (*Cercospora zeae-maydis*)

Chemical: Apply penthiopyrad (COM) EC prior to disease development and continue on a 7-14 days interval.

Northern Leaf Blight (*Setosphaeria turcica*)

Chemical: Apply foliar fungicide containing propiconazole (COM) EC, azoxystrobin + propiconazole (COM) SU or prothioconazole (COM) SU when disease first appears.

DILL (*Anethum graveolens*)

BLIGHT

Cercosporidium punctum (*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 PCP# 27001 to protect against seed decay and seedling blight.

References:

1. Callan, N.W. and Miller, J.B. 2001. Control of Dill Blight on Dill (*Anthemum graveolens* L.). The IR-4 Project. Online. http://ir4.rutgers.edu/FoodUse/PerfData/006.pdf (accessed April 16, 2013)

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.

OTHER DISEASES

The following diseases of dill are currently of minor importance and/or are diseases 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 fababean after lentil 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).

References:

1. Evans, I.R. 1973. Seed-borne bean yellow mosaic virus of fababeans in Canada. Can. Plant Dis. Surv. 53: 123-126.

2. Frowd, J.A. and Bernier, C.C. 1977. Virus diseases of fababeans in Manitoba and their effect on growth and yield. Can. J. Plant Sci. 57: 845-852.

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.

2. Sillero, J.C., Fondevilla, S., Davidson, J., Vaz Patto, M.C., Warkentin, T.D., Thomas, J., and Rubiales, D. 2006. Screening techniques and sources of resistance to rusts and mildews in grain legumes. Euphytica 147: 255-272.

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: Treat seed with thiabendazole + metalaxyl + fludioxonil (COM) SU.

References:

1. Chang, K.F., Conner, R.L., Hwang, S.F., Ahmed, H.U., McLaren, R.L., Gossen, B.D., and Turnbull, G.D. 2014. Effects of seed treatments and inoculum density of *Fusarium avenaceum* and *Rhizoctonia solani* on seedling blight and root rot of faba bean. Can. J. Plant Sci. 94: 693-700.

2. Chang, K.F., Conner, R., McLaren, D.L., Hwang, S.F., and Strelkov, S. 2010. Occurrence of faba bean root rot in Alberta and Manitoba in 2009. Can. Plant Dis. Surv. 90: 133-135.

3. 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.

4. 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.

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)

Fusarium Wilt (*Fusarium oxysporum*)

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*)

Chemical: Apply boscalid (COM) WG at 20-50% bloom; make 2nd application 7-14 days later.

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 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. If in doubt about the quality of a seedlot, have an agar plate test carried out by an accredited lab.

Resistant Cultivars: Use resistant cultivars. Many of the dry beans grown in western Canada are susceptible to the prevalent anthracnose race 73 (see Ref. 1).

Chemical: Treat seed with azoxystrobin (COM) SU; captan + diazinon + thiophanate-methyl (COM) WP; 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. Conner, R.L., Dongfang, Y., Balasubramanian, P., and Kiehn, F.A. 2005. Anthracnose resistant dry bean cultivars. Pulse Beat no. 44, Winter 2005: 30-31.

2. Conner, R.L., McAndrew, D.W., Kiehn, F.A., Chapman, S.R. and Froese, N.T. 2005. Effect of foliar fungicide application timing on the control of bean anthracnose in the navy bean 'Navigator'. Can. J. Plant Pathol. 26: 299-303.

3. Conner, R.L., McAndrew, D.W., Balasubramanian, P., Kiehn, F.A., and Dongfang, Y. 2006. Influence of growth habit, row spacing, and seed infection on bean anthracnose development. Can. J. Plant Pathol. 28: 411-418.

4. Dongfang, Y., Conner, R.L., Yu, K., Balasubramanian, P., Penner, W.C., and Yager, L.M. 2008. Identification of anthracnose genes in dry bean cultivars grown in Manitoba. Can. J. Plant Sci. 88: 771-781.

5. 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 Notes).

Resistant Cultivars: See Hsieh *et al*. J. Phytopathology 153: 245-249 and Mundel *et al*., Can. J. Plant Sci. 86: 1175-1177.

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).

2. 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 shrivelled 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.

3. The pathogen can survive on seed for over 25 years.

References:

1. 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.

2. Conner, R.L., Balasubramanian, P., Erickson, R.S., Huang, H.C. and Mündel, H.-H. 2008. Bacterial wilt resistance in kidney beans. Can. J. Plant Sci. 87: 405-412.

3. Erickson, R.S. and Balasubramanian, P.M. 2008. Survey of dry bean in southern Alberta in 2007. Can. Plant Dis. Surv. 88: 99-100.

4. 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.

5. Huang, H.C., Muendel, H.H., Erickson, R.S., Chelle, C.D., Balasubramanian, P.M., Kiehn, F. and Conner, R.L. 2007. Resistance of common bean (*Phaseolus vulgaris* L.) cultivars and germplasm lines to the purple variant of bacterial wilt (*Curtobacterium flaccumfaciens* pv. *flaccumfaciens*). Plant Pathol. Bull. 16: 91-95.

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

Xanthomonas axonopodis pv. *phaseoli, 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. The exception is

OAC Rex which is the first common bean resistant to common bacterial blight but this cultivar is intended for use in areas with greater than 2800 crop units (2).

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

References:

1. Gillard, C.L., Conner,R.L., Howard, R.J., Pauls, K.P., Shaw, L. and Taran, B. 2009. The performance of dry bean cultivars with and without common bacterial blight resistance in field studies across Canada. Can. J. Plant. Sc. 89: 405-410.

2. Michaels, T.E., Smith, T.H., Larsen, J., Beattie, A.D. and K.P. Pauls. 2006. OAC Rex common bean. Can. J. Plant Sci. 86: 733-736.

3. 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.

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

References:

1. Sillero, J.C., Fondevilla, S., Davidson, J., Vaz Patto, M.C., Warkentin, T.D., Thomas, J., and Rubiales, D. 2006. Screening techniques and sources of resistance to rusts and mildews in grain legumes. Euphytica 147: 255-272.

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^{o}C and contains adequate moisture should help reduce the incidence of infection by these pathogens.

Resistant Cultivars: None.

Chemical: Treat seed with azoxystrobin (COM) SU; captan (COM) SU; captan + diazinon (COM) WP; captan + diazinon + thiophanate methyl (COM) WP; carbathiin + thiram (COM) SU; fludioxonil (COM) SN; fludioxonil + metalaxyl-M (COM) SU; fludioxonil + metalaxyl-M + thiamethoxam (COM) SU; thiabendazole + metalaxyl + fludioxonil (COM) SU; trifloxystrobin + metalaxyl (COM) SU;

penflufen + trifloxystrobin + metalaxyl (COM) SU; metalaxyl (COM) SU; thiram (COM) WP. Limitations: As per label. Azoxystrobin is for control of Rhizoctonia.

References:

1. Conner, R.L., Hou, A., Balasubramanian, P., McLaren, D.L., Henriquez, M.A., Chang, K.F., and McRae, K.B. 2014. Reaction of dry bean cultivars grown in western Canada to root rot inoculation. Can. J. Plant Sci. 94: 1219-1230.

2. 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.

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), fluopyram + prothioconazole (COM) SU, thiophanate-methyl (COM) WP; or vinclozolin (COM) WG. Refer to product labels for details.

Limitations: As per label. Preharvest interval - 14 days (thiophanate-methyl); 21 days (boscalid); 45 days (vinclozolin).

Biocontrol: *Bacillus subtilis* (COM) SU or *Coniothyrium minitans* (COM) WG - Apply when conditions become conducive for disease development. Repeat on 7-10 days intervals.

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. Harikrishnan, R. and del Rio, L.E. 2005. Relationship between weather and white mold of dry bean in North Dakota. Phytopath. 95: S163.

2. Pynenburg, G., Sikkema, P., Robinson, D. and Gillard, C. 2011. The interaction of annual weed and white mold management systems for dry bean production in Canada. Can. J. Pl. Sci. 91: 587-598.

3. Saindon, G., Huang, H.C., and Kozub, G.C. 1995. White mold avoidance and agronomic attributes of upright common beans grown at multiple planting densities in narrow rows. J. Am. soc. Hortic. Sci. 120: 843-847.

4. Steadman, J.R. 1983. White mold – a serious yield-limiting disease of bean. Plant Dis. 67: 346-350.

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. OAC Rex is a white bean resistant to races 1 and 15 of common mosaic virus and is the first common bean cultivar resistant to common bacterial blight (1).

Chemical: None.

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

References:

1. Michaels, T.E., Smith, T.H., Larsen, J., Beattie, A.D. and K.P. Pauls. 2006. OAC Rex common bean. Can. J. Plant Sci. 86:733-736.

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*)

Chemical: Apply penthiopyrad (COM) EC prior to disease development and continue on a 7-14 day interval.

Biocontrol: *Bacillus subtilis* (COM) SU or *Coniothyrium minitans* (COM) WG - Apply when conditions become conducive for disease development. Repeat on 7-10 days intervals.

Pink Seed (*Erwinia rhapontici*) Refer to FIELD PEA, PINK SEED on page 26

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

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 theimporter to establish what rates are used on the crop in their country.

References:

1. Sillero, J.C., Fondevilla, S., Davidson, J., Vaz Patto, M.C., Warkentin, T.D., Thomas, J., and Rubiales, D. 2006. Screening techniques and sources of resistance to rusts and mildews in grain legumes. Euphytica 147: 255-272.

2. Chang, K.F., Hwang, S.F., Ahmed, H., Strelkov, S.E., Conner, R.L., Gossen, B.D., Bing, D.J., and Turnbull, G.D. 2013. Yield loss and management of downy mildew on field pea in Alberta, Canada. Crop Protection 46: 23-28.

3. Chang, K.F., Hwang, S.F., Turnbull, G.D., Liu, J.F., Strelkov, S.E., and Bing, D.J. 2009. Occurrence of downy mildew on filed pea in central Alberta in 2008. Can. Plant Dis. Surv. 89: 127-128.

4. Chang, K.F., Liu, J., Cao, T., Yang, Y., Fu, H., Turnbull, G.D., Hwang, S.F., Laflamme, P., Bing, D.J., and Strelkov, S.E. 2012. Occurrence of downy mildew on filed pea in central Alberta in 2009, 2010 and 2011. Can. Plant Dis. Surv. 92: 143-145.

5. Feng, J., Chang, K.F., Hwang, S.F., Strelkov, S.E., Conner, R.L., Gossen, B.D., McLaren, D.L., and Chen, Y.Y. 2012. Analysis of expressed sequence tags derived from pea leaves infected by *Peronospora viciae* f. sp. *pisi*. Ann. Appl. Biol. 161: 214-222.

6. Liu, J.-F., Cao, T., Chang, K.F., Hwang, S.F., and Strelkov, S.E. 2013. Virulence and diversity of *Peronospora viciae* f. sp. *pisi* in Alberta, Canada. Crop Protection 43: 18-26.

LEAF and POD SPOT

Ascochyta pisi

Cultural: Use management practice s as outlined for mycosphaerella blight.

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

Chemical: See MYCOSPHAERELLA BLIGHT.

Notes: *Ascochyta 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 chlamydospores 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: carbathiin + thiram (COM) SU, or fludioxonil + metalaxyl-M (COM) SU. Foliar application of chlorothalonil (COM) SU, fluxapyroxad + pyraclostrobin (COM) SU, penthiopyrad (COM) EC, pyraclostrobin (COM) EC, azoxystrobin (COM) SU, azoxystrobin + propiconazole (COM) SU, picoxystrobin (COM) SU and/or boscalid (COM) WG. 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. Boscalid – preharvest interval of 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 or 2 applications of boscalid 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.

References:

1. Ahmed, H.U. *et al*. 2015. Morphological characterization of fungi associated with the ascochyta blight complex and pathogenic variability of *Mycosphaerella pinodes* on field pea in central Alberta. The Crop Journal 3: 10-18.

2. 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.

3. Conner, R.L. *et al*. 2007. Influence of agronomic traits on the expression of tissue-specific resistance to mycosphaerella blight in field pea. Can. J. Plant Sci. 87: 157-165.

4. Conner, R.L. *et al*. 2012. Field assessment of partial resistance to mycosphaerella blight in *Pisum* subspecies accessions. Can. J. Plant Sci. 92: 289-296.

5. Gossen, B.D. *et al.* 2011. Managing the ascochyta blight complex on field pea in western Canada. Prairie Soils & Crops E-Journal 4: 135–141 Available at (http://www.prairiesoilsandcrops.ca/index.html).

6. Gossen, B.D. *et al.* 2010. Significance of seed infection on epidemics of mycosphaerella blight in field pea. Can. J. Plant Pathol. 32: 458-467.

7. Hwang, S.F., Chang, K.F., Conner, R.L., Gossen, B.D., and Turnbull, G.D. 2012. Plant age and timing of epidemic initiation affect mycosphaerella blight in field pea. J. Plant Dis. Prot. 119: 15-23.

8. Hwang, S.F. *et al*. 2006. Impact of seeding rate and depth on mycosphaerella blight and seed yield of field pea. Can. J. Plant Sci. 86: 845-853.

9. Su, H. *et al*. 2006. Assessment of yield loss caused by mycosphaerella blight in field peas in western Canada. J. Plant Dis. Prot. 113: 267-274.

10. Wang, H., *et al.* 2000. Characterization of *Ascochyta* isolates and susceptibility of pea cultivars to the ascochyta disease complex in Alberta. Plant Pathol. 49: 540-545.

11. Wang, T.F. *et al*. 2006. Lodging increases severity and impact of mycosphaerella blight on field pea. Can. J. Plant Sci. 86: 855-863.

12. Warkentin, T.D. *et al.* 1996. Fungicidal control of Ascochyta blight of field pea. Can. J. Plant Sci. 76: 67-71.

13. Zhang, R. *et al*. 2006. Genetic resistance to *Mycosphaerella pinodes* in 558 field pea accessions. Crop Sci. 46: 2409-2414.

PINK SEED

Erwinia rhapontici

Cultural: None recommended at this time. The pathogen can overwinter on infected crop debris.

Resistant Cultivars: None.

Chemical: None.

Notes:

1. The economic impact of pink seed is probably limited. Infected seed are shrivelled and turn a bright carmine red, similar to the colour of some seed treatments. The colour is due to 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.

2. Pink seed may result in dockage during seed cleaning and grading.

3. The pathogen likely invades the plant late in the season via wounds from insect or mechanical damage.

4. The incidence of pink seed is greater in seasons with above-normal rainfall.

References:

1. 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.

2. Huang, H.C., and Erickson, R.S. 2003. Overwintering of *Erwinia rhapontici*, causal agent of pink seed of pea, on the Canadian Prairies. Plant Pathol. Bull. 12:133-136

3. Huang, H.C., and Erickson, R S. 2004. Impact of pink seed of pea caused by *Erwinia rhapontici* in Canada. Plant Pathol. Bull. 13: 261-266.

4. Huang, H.C., Erickson, R.S., Mundell, H.H., Rasmussen, K.H., and Chelle, C.A. 2007. Distribution of seed-borne diseases of dry bean in southern Alberta in 2005. Can. Plant Dis. Surv. 87: 107-108.

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 a distance from previous year's fields. Seed early and/or plant early maturing cultivars to escape the disease.

Resistant Cultivars: 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) WG at the first appearance of disease and repeat at 7-10 day intervals as necessary. Apply foliar application of fluxapyroxad + pyraclostrobin (COM) SU, pyraclostrobin (COM) EC, azoxystrobin (COM) EC, propiconazole (COM) EC or azoxystrobin + propiconazole (COM) SU 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 / azoxystrobin - preharvest interval is 30 days; do not make more than 2 applications per season.

References:

1. Hwang, S.F., Zhang, X.R., Strelkov, S.E., Chang, K.F., Turnbull, G.D., and Vidmar, J. 2010. Effects of *Erysiphe pisi* on protein profiles and ribulose-1,5-bisphosphate carboxylase content in resistant and susceptible pea (*Pisum sativum* x *Pisum fulvum*) plants. J. Plant Dis. Prot. 117: 15-23.

2. Su, H., Hwang, S.F., Chang, K.F., Conner, R.L., Howard, R.J., Turnbull, G.D., and Blade, S.F. 2004. Differences in the growth stages of *Erysiphe pisi* on cultivars of field pea (*Pisum sativum* L.). J. Plant Dis. Prot. 111: 64-70.

3. Su, H., Hwang, S.F., Turnbull, G.D., Chang, K.F., Howard, R.J., Bjorklund, R., Buss, T., and Blade, S. 2002. Survey of powdery mildew and ascochyta blight on field pea in central Alberta in 2001. Can. Plant Dis. Surv. 82: 112-113.

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.

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; thiabendazole + metalaxyl + fludioxonil (COM) SU; fludioxonil + metalaxyl-M (COM) LI; trifloxystrobin + metalaxyl (COM) SU; penflufen + trifloxystrobin + metalaxyl (COM) SU; 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., Hwang, S.F., Ahmed, H., Gossen, B.D., Turnbull, G.D., and Strelkov, S.E. 2013. Management strategies to reduce losses caused by fusarium seedling blight of field pea. Can. J. Plant Sci. 93: 619-625.

2. Conner, R.L., Chang, K.F., Hwang, S.F., Warkentin, T.D., and McRae, K.B. 2013. Assessment of tolerance for reducing yield losses in field pea caused by Aphanomyces root rot. Can. J. Plant Sci. 93: 473-482.

3. Feng, J., Hwang, R., Chang, K.F., Hwang, S.F., Strelkov, S.E., Gossen, B.D., Conner, R.L., and Turnbull, G.D. 2010. Genetic variation in *Fusarium avenaceum* causing root rot on field pea. Plant Pathology 59: 845-852.

4. Hwang, S.F, Chang, K.F., Howard, R.J., Deneka, B.A., and Turnbull, G.D. 1996. 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.

5. 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.

6. Hwang, S.F., Gossen, B.D., Conner, R.L., Chang, K.F., Turnbull, Lopetinsky, K., and Howard, R.J. 2007. Management strategies to reduce losses caused by rhizoctonia seedling blight of field pea. Can. J. Plant Sci. 87: 145-155.

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8. Hwang, S.F., Howard, R.J., and Chang, K.F. 1995. Screening of field pea cultivars for resistance to fusarium root rot under field conditions in Alberta. Can. Pl. Dis. Surv. 75: 51-56.

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: Foliar application of fluxapyroxad + pyraclostrobin (COM) SU at the beginning of flowering; make second application 7-14 days later if disease persists or weather conditions are favourable for disease development.

Biological: Apply *Bacillus subtilis* (COM) SU when conditions become conducive to disease development. Repeat on 7 – 10 days intervals.

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 (MI) and/or are diseases for which no practical control measures are currently recommended (NC):

Anthracnose (*Colletotrichum pisi*)

Leaf Blotch (*Septoria pisi*) NC

Leaf Spot (*Alternaria alternata*) NC

Rust (*Uromyces viciae-fabae*) NC

Gray Mould (*Botrytis cinerea*) MI.

Chemical: Foliar application boscalid (COM) WG or penthiopyrad (COM) EC, – apply at the beginning of flowering; make second application 7-14 days later if disease persists or weather conditions are favourable for disease development. Do not make more than 2 applications per season and maintain a preharvest interval of 21 days.

Biological: Apply *Bacillus subtilis* (COM) SU when conditions become conducive to disease development. Repeat on 7 – 10 days intervals.

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 promoting 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) WG, WP - apply when disease first appears and make subsequent sprays at 2 week intervals; iprodione (COM) WP, WG – apply when disease first appears and make subsequent applications at monthly intervals; chlorothalonil (COM) SU - start applications when disease threatens and repeat at 7-10 day intervals.

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

Notes:

1. Good fungicide coverage is essential for controlling this disease. Calibrate your sprayer. Use a dye to determine the efficacy of your application if necessary.

2. 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 diseases of ginseng in Alberta in 1998. Can. Plant Dis. Surv. 79: 123-125.

3. Chang, K.F., Howard, R.J., Gaudiel, R.G., and Hwang, S.F. 1997. The occurrence of ginseng diseases in Alberta in 1996. Can. Plant Dis. Surv. 77: 78-80.

4. Hill, S. N., and Hausbeck, M. K. 2008. Evaluation of TOM-CAST in timing fungicide sprays for management of Alternaria blight on American ginseng. Plant Dis. 92:1611-1615.

BOTRYTIS BLIGHT

Botrytis cinerea

Cultural: Avoid dense plantings and excessive fertilization that promote leaf growth. 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. Fenhexamid (COM) WG - apply prior to disease establishment when conditions favour disease; repeat at 10-14 day intervals.

Limitations: Preharvest interval: 14 days (chlorothalonil); 0 days (fenhexamid). Do not apply more than 6 applications of chlorothalonil or 4 applications of fenhexamid per year.

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 and FUSARIUM ROOT ROT

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

Cultural: Avoid heavy soils and low, wet sites. Prolonged cool and wet soils promote damping-off 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 the previous year can reduce the risk of damping-off and root rot by *Rhizoctonia solani* and *Fusarium* spp. 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 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.
Seed treatment for Pythium damping-off –metalaxyl M & S isomer (COM) SU. For the control of *Pythium* blight: metalaxyl-M (COM) EC – maximum of 3 applications per season and pre-harvest interval of 9 days.

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., Gaudiel, R.G., Hwang, S.F., and Blade, S.F. 1998. Diseases of ginseng in Alberta in 1997. Can. Plant Dis. Surv. 78: 92-94.

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 bed s to utilize the contours of the land to prevent low spots in the troughs where water w ill accumulate. Use seed from Phytophthora foliar blight-free gardens.

Resistant Cultivars: None.

Chemical: Metalaxyl-M (COM) GR: broadcast first application in spring prior to emergence; repeat at 6 week intervals; do not make more than 3 applications per season; preharvest interval is 9 days. Metalaxyl-M (COM) EC: apply pre-emergence in spring only. Fosetyl-Al (COM) WG, WP: apply first application at full emergence; final application should be made when foliage is still green; make no more than 5 applications per year; preharvest interval is 31 days.

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 product 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: Apply azoxystrobin (COM) SU: first application in fall after seeding and before mulch application; make second application pre-emergence in spring. Maximum of 2 applications per season and a pre-harvest interval of 24 months.

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*)

Seedling Blights (*Pythium, Rhizoctonia, Fusarium* spp.)

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.

Resistant Cultivars: CDC Impala CL, CDC Imperial CL, CDC Maxim CL, CDC Redberry, CDC Robin, CDC Rosetown, CDC Rouleau, CDC Viceroy. Resistance is to Race Ct1 only (see Note 2).

Chemical: Apply foliar fungicides chlorothalonil (COM) SU, mancozeb (COM) WG, fluxapyroxad + pyraclostrobin (COM) SU, pyraclostrobin (COM) EC, and/or azoxystrobin + propiconazole (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 strobilurin 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 (Ct 0 and Ct1) 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. Wang, J. and Banniza, S. 2007. The infection process of two races (Ct0 and Ct1) of *Colletotrichum truncatum* on lentil. Can J. Plant Pathol. 29:220.

ASCOCHYTA BLIGHT

Ascochyta lentis

Cultural: Use only disease-free seed in areas of higher moisture and plant low levels of infected seed in dryer areas (see Note 1). Practice a crop rotation of at least 4 years. Loss of quality from seed discoloration from ascochyta continues to increase after swathing, particularly if moist weather

prevails. Turn under crop refuse soon after harvest. Control volunteer seedlings and avoid planting lentil adjacent to the previous year's lentil field.

Resistant Cultivars: Refer to *Varieties of Grain Crops 2012*, Saskatchewan Ministry of Agriculture: http://www.agriculture.gov.sk.ca/Varieties_Grain_Crops.

Chemical: Use seed treatments of carbathiin + thiabendazole (COM) SN, fluopyram + prothioconazole (COM) SU, metalaxyl-M + fludioxonil (COM) SU. Apply foliar fungicides chlorothalonil (COM) SU, penthiopyrad (COM) EC, mancozeb (COM) WG, fluxapyroxad + prothioconazole (COM) SU, pyraclostrobin (COM) SU, 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 strobilurin fungicide per season.

Notes:

1. Have seed tested at an accredited laboratory for presence of *Ascochyta lentis*.
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. Gossen, B.D. 2001. Impact of burial and survival of *Ascochyta lentis* on lentil residue. Can. J. Plant Pathol. 23: 146-148.
2. 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.
3. 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 limit disease development.

Resistant Cultivars: None.

Chemical: Apply foliar spray of boscalid (COM) WG or penthiopyrad (COM) EC 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 unlikely that seed treatments to control seedling blight induced by *Botrytis* have an effect on late season stem and pod rot.

Biological: Apply *Bacillus subtilis* (COM) SU when conditions become conducive to disease development. Repeat on 7 – 10 days intervals.

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

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) SN; carbathiin + thiram (COM) SU; fludioxonil (COM) SN; metalaxyl + fludioxonil (COM) SU; thiabendazole + metalaxyl + fludioxonil (COM) SU; trifloxystrobin + metalaxyl (COM) SU; penflufen + trifloxystrobin + metalaxyl (COM) SU; metalaxyl (COM) SU will protect zero tannin lentils against *Pythium*.

References:

1. Chang, K.F., Hwang, S.F., Gossen, B.D. Turnbull, G.D., Wang, H., and Howard, R.J. 2008. Effects of inoculum density, temperature, seeding depth, seeding date and fungicidal seed treatment on the impact of *Rhizoctonia solani* on lentil. Can. J. Plant Sci. 88: 799-809.

2. Hwang, S.F. *et al*. 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.

3. Hwang, S.F., Howard, R.J., Chang, K.F., Park, B., and Burnett, P.A. 1994. Etiology and severity of *Fusarium* root rot of lentil in Alberta. Can. J. Plant Pathol. 16: 295-303.

4. Wang, H., Chang, K.F., Hwang, S.F., Gossen, B.D., Turnbull, G.D., Howard, R.J., and Strelkov, S.E. 2006. Response of lentil cultivars to rhizoctonia seedling diseases in Canada. J. Plant Dis. Prot. 113: 219-223.

SCLEROTINIA STEM and POD ROT

Sclerotinia sclerotiorum

Cultural: Rotate to broadleaf crops. Allow at least 4 years between susceptible crops such as buckwheat, canola, beans, 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, fluopyram + prothioconazole (COM) SU or fluxapyroxad + pyraclostrobin (COM) SU 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.

Biological: Apply Contans WG (*Coniothyrium minitans*) or *Bacillus subtilis* (COM) SU when conditions become conducive to disease development. Repeat on 7 – 10 days intervals.

STEMPHYLIUM BLIGHT

Stemphylium botryosum

Cultural: The pathogen can be carried on infected seed as well as crop debris. Use disease free seed. Data on the value of crop rotation in managing the disease is not yet available. The disease can be severe in areas receiving high levels of rainfall late in the season.

Chemical: None.

References:

1. Mwakutuya, E. and Banniza, S. 2010. Influence of temperature and wetness periods on the development of Stemphylium blight on lentil. Plant Dis. 94: 1219-1224.

2. Mwakutuya, E. 2006. Epidemiology of stemphylium blight on lentil (*Lens culinaris*) in Saskatchewan. MSc.Thesis. University of Saskatchewan. http://library.usask.ca/theses/available/etd-04202006-174755/unrestricted/Edmore_thesis.pdf (accessed March 21, 2012)

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 on page 26.

Powdery mildew (*Microsphaera* spp.)

Chemical Spray propiconazole (COM) EC when 5% disease level occurred in the field. Followed by a second spray 14 days later.

Septoria Leaf Spot (*Septoria* sp.) MI, NC

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

Virus Diseases (pea seed-borne mosaic virus) MI. See Ref. 1, under FIELD PEA, VIRUS DISEASES page 29.

LUPIN (*Lupinus angustifolius*)

FUSARIUM SEEDLING BLIGHT and ROOT ROT

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

Cultural: To successfully grow narrow-leaved lupin, the crop should be planted in areas where high temperatures are not common in soils with low *Fusarium* concentrations.

References:

1. Chang, K.F., Hwang, S.F., Ahmed, H.U., Strelkov., S.E., Gossen, B.D., Turnbull, G.D., and Blade, S.F. 2014. Disease reaction to *Fusarium avenaceum* and yield losses in narrow-leafed lupin lines. Can. J. Plant Sci. 94: 1211-1218.

2. Chang, K.F., Hwang, S.F., Gossen, B.D., Howard, R.J., Lopetinsky, K., and Olson, M. 2005. First Report of *Rhizoctonia solani* AG-4 and AG-2-2 on *Lupinus angustifolius* in Canada. Plant Dis. 89: 685.

3. Chang, K.F., Hwang, S.F., Gossen, B.D., Strelkov, S.E., Turnbull, G.D., and Bing, D.J. 2011. Effect of seeding practices, temperature and seed treatments on fusarium seedling blight of narrow-leaved lupin. Can. J. Plant Sci. 91: 859-872.

4. Chang, K.F., Hwang, S.F., Lopetinsky, K., Olson, M., Bowness, R., Turnbull, G.D., Bing, D.J., and Howard, R.J. 2008. Occurrence of lupin diseases in central Alberta in 2007. Can Plant Dis. Surv. 88: 115-116.

5. Chang, K.F., Hwang, S.F., Lopetinsky, K., Olson, M., Bowness, R., Turnbull, G.D., Calpas, J., Bing, D.J., and Howard, R.J. 2006. Occurrence of lupine diseases in central Alberta in 2005. Can. Plant Dis. Surv. 86: 107-108.

6. Chang, K.F., Lopetinsky, K., Olson, M., Bowness, R., Hwang, S.F., Turnbull, G.D., Strydhorst, S., Clayton, G., Harker, N., Bing, D.J., Lupwayi, N., Cole, D., and Byer, J. 2005. Diseases of lupines in central and northern Alberta in 2003 and 2004. Can. Plant Dis. Surv. 85: 87-88.

7. Holtz, M.D., Chang, K.F., Hwang, S.F., Gossen, B.D., and Strelkov, S.E. 2011. Characterization of *Fusarium avenaceum* from lupin in central Alberta: genetic diversity, mating type and aggressiveness. Can. J. Plant Pathol. 33: 61-76.

8. Holtz, M.D., Chang, K.F., Hwang, S.F., Gossen, B.D., and Strelkov, S.E. 2013. Characterization of *Fusarium* spp. associated with lupin in central Alberta, Canada. Can. J. Plant Pathol. 35: 56-67.

9. Hwang, S.F., Chang, K.F., Strelkov, S.E., Gossen, B.D., and Howard, R.J. 2014. The impact of *Fusarium avenaceum* on lupin production on the Canadian prairies. Can. J. Plant Pathol. 36: 291-299.

10. Zhou, Q.-X., Chang, K.-F., Hwang, S.-F., Strelkov, S.E., Gossen, B.D., and Chen, Y.,-Y 2009. Pathogenicity and genetic diversity of *Rhizoctonia solani* isolates from lupin and other crops in Alberta, Canada. Can. J. Plant Pathol. 31: 340-347.

PEPPERMINT (*Mentha piperita, M. aquatica × 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*)

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.

Stolon Rot (*Fusarium* spp., *R. solani*)

References:

1. Chang, K.F., Burke, D.A., Howard, R.J., and Hwang, S.F. 2002. Occurrence of stolon rot in *Mentha* spp. in southern Alberta in 2001. Can. Plant Dis. Surv. 82: 83-84.

Powdery Mildew (*Erysiphe cichoracearum*)

Rust (*Puccinia menthae*)

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., *Pythium* spp., *Penicillium* spp.

Cultural: Sow seed in warm moist soil.

Resistant Cultivars: None.

Chemical: Use seed treatment metalaxyl (COM) SU; fludioxonil (COM) SN; difenoconazole + metalaxy (COM) SU.

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: Kanrich (*Rpm1*), PI 88788, (*Rpm2*), Burlison, Columbia, Harosoy, PI 86150, PI 90138.

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: Apply fluazinam (COM) L, Follow label directions.
Spray picoxystrobin (COM) SU, at the 1st flower blooming and follow with 2nd spray 7 -10 days later at full bloom.

Biological: Apply *Bacillus subtilis* (COM) SU when conditions become conducive to disease development. Repeat on 7 – 10 days intervals.

SEED ROT, ROOT ROTS and SEEDLING BLIGHT

Pythium spp., *Rhizoctonia solani, Fusarium* spp., *Phytophthora sojae, Phomopsis longicolla*

Cultural: None.

Resistant Cultivars: None.

Chemical: Seed treatment with - captan (COM) SU; captan + diazinon (COM) SU; carbathiin + thiram (COM) SU; fludioxonil (COM) SN; metalaxyl (COM) SU; metalaxyl-M + fludioxonil (COM) SU;

fludioxonil + metalaxyl-M + thiamethoxam (COM) SU; thiabendazole + metalaxyl + fludioxonil (COM) SU; penflufen+ prothioconazole + metalaxyl (COM) SU; trifloxystrobin + metalaxyl (COM) SU; 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. Chang, K.F., Nyandoro, R., Howard, R.J., Hwang, S.F., Turnbull, G.D., Laflamme, P., Strelkov, S.E., and McLaren, D.L. 2013. Occurrence of soybean root rot in southern Alberta, Canada in 2011 and 2012. Can. Plant Dis. Surv. 93: 170-173.

2. Curley, R.L. and Burton, J.C. 1975. Compatibility of *Rhizobium japonicum* with chemical seed protectants. Agron. J. 67: 807-808.

3. McLaren, D.L., Henriquez, M.A., Conner, R.L., Chang, K.F., Henderson, T.L., and Kerley, T.J. 2014. Soybean root rot in Manitoba in 2012 and 2013. Can. Plant Dis. Surv. 94: 201-202.

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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:

Frog Eye Leaf Spot (*Cercospora sojina*) MI.

Chemical: Apply flutriafol (COM) SU, penthiopyrad (COM) EC, prothioconazole (COM) SU, propiconazole + trifloxystrobin (COM) EC, pyraclostrobin (COM) EC, tebuconazole(COM) EC or azoxystrobin + propiconazole (COM) SU. Follow label directions.

Biological: Apply *Bacillus subtilits* (COM) SU when conditions become conducive to disease development. Repeat on 7 – 10 days intervals.

Asian Soybean Rust (*Phakopsora pachyrhizi*) MI. Currently not found in western Canada but recent outbreaks in the southern United States have caused concern.

Chemical: Apply azoxystrobin (COM) EC, azoxystrobin + propiconazole (COM) SU, flutriafol (COM) SU, metconazole (COM) EC, penthiopyrad (COM) EC, propiconazole + trifloxystrobin (COM) EC, picoxystrobin (COM) SU, prothioconazole (COM) SU, pyraclostrobin (COM) EC, propiconazole (COM) EC, or tebuconazole(COM) EC. Follow label directions.

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; metalaxyl (COM) SU; thiram (COM) WP. Control of *R. solani* with foliar fungicide azoxystrobin (COM) SU or prothioconazole (COM) SU – apply once in furrow at seeding or a banded application over the row soon after emergence but before the 6th leaf stage. Limitations: As per label.

Notes: *Phoma betae* may also cause 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: azoxystrobin + difenoconazole (COM) SU – Apply prior to disease appearing and do not exceed 3 applications per year.
copper hydroxide (COM) WP – spray when disease threatens and continue every 10-14 days;
mancozeb (COM) WG, WP – spray when disease threatens and repeat at 7-10 day intervals;
metiram (COM) WG – spray when disease noticed and repeat 7-10 days;
prothioconazole (COM) SU and/or pyraclostrobin (COM) EC – spray at the onset of disease.
metconazole (COM) EC – Apply prior to rust development or at onset of the disease.
thiophanate-methyl WP – Apply when disease first appears. Repeat 14-21 days later if required.

Limitations: Preharvest intervals: 1 day (copper hydroxide); 21 days (mancozeb, metiram); 7 days (pyraclostrobin); three applications (prothioconazole) per crop year.

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

References:

1. Clark, M.M. and Cheverie, R.M. 2008. Diseases diagnosed on commercial crops in Prince Edward Island, 2007. Can. Plant. Dis. Surv. 88: 38-42.

2. Khan, J. *et al*. 2008. Survival, Dispersal and Primary Infection site for Cercospora beticola in Sugar Beet. Plant Dis. 92: 741-745.

3. Secor, G.A. *et al*. 2010. Monitoring fungicide sensitivity of Cercospora beticola of sugar beet for disease management decisions. Plant Dis. 94:1272-1282.

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.* l964. 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*)

Chemical: Apply foliar spray of or pyraclostrobin (COM) EC at the first sign of disease. azoxystrobin + difenoconazole (COM) SU – Apply prior to disease appearing and do not exceed 3 applications per year.

Storage Rot (*Penicillium* spp., *Phoma betae*, *Rhizopus* spp., *Erwinia* spp., *Botrytis* spp., and *Fusarium* spp.)

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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. 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)

4. Chen, W., Sharma, H.C., and Muehlbauer, F.J. 2011. Compendium of Chickpea and Lentil Diseases and Pests. Am. Phytopathol. Soc., St. Paul, Minn. 165 pp.

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8. Hall, R. 1991. Compendium of Bean Diseases. Am. Phytopathol. Soc., St. Paul, Minn. 73 pp.

9. 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.

10. Huang, H.C., Muendel, H.H., Erickson, R.S., Chelle, C.D., Balasubramanian, P.M., Kiehn, F. and Conner, R.L. 2007. Resistance of common bean (*Phaseolus vulgaris* L.) cultivars and germplasm lines to the purple variant of bacterial wilt (*Curtobacterium flaccumfaciens* pv. *flaccumfaciens*). Plant Pathol. Bull. 16: 91-95.

11. Kraft, J.M., and Pfleger, F.L. 2001. Compendium of Pea Diseases and Pests (2nd ed.). Am. Phytopathol. Soc., St. Paul, Minn. 67 pp.

12. Krupinsky, J.M., Bailey, K.L., McMullen, M.P., Gossen, B.D. and Turkington, T.K. 2002. Managing plant disease risk with diversified cropping systems. Agron. J. 94: 198-209.

13. Schwartz, H.F., Steadman, J.R., Hall, R. and Forster, R.L. (Eds). 2005. Compendium of Bean Diseases, Second Edition. Am. Phytopathol. Soc., St. Paul, MN. 120 pp.

14. Watanebe, T. 2010. Pictorial Atlas of Soil and Seed Fungi: Morphologies of cultured fungi and key to species. (3rd Ed). CRC Press, Boca Raton, 404 pp.

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APPENDIX I. Foliar fungicides registered for use on special crops.

This publication is not updated annually. Refer to provincial crop protection guides and product labels for registrations, application details and precautions.

Crop	Disease	Active Ingredient	Trade Name	Formulation	PCP#
canaryseed	leaf mottle	propiconazole	Tilt 250 EC Pivot 418 EC Bumper 418 EC	250 g/L EC 418 g/L EC 418 g/L EC	19346 28219 28017
chickpea	ascochyta blight	fluopyram + prothioconazole	Propulse SU	200 g/L + 200 g/L	30511
		fluxapyroxad + pyraclostrobin	Priaxor DS	250 g/L + 250 g/L	30646
		penthiopyrad	Vertisan EC	200 g/L	30332
		azoxystrobin	Quadris	250 g/L EC	26153
		azoxystrobin + chlorothalonil	Quadris + Bravo 500	tank mix	26153 + 15723
		boscalid	Lance WDG	70% WG	27495
		boscalid + pyraclostrobin	Headline Duo		28862 + 28863
		chlorothalonil	Bravo 500	500 g/L SU	15723
		prothioconazole	Proline 480 SC	480 g/L SC	28359
		pyraclostrobin	Headline EC	250 g/L EC	27322
	gray mould	boscalid	Lance WDG	70% WG	27495
		Bacillus subtilis	Serenade Max Serenade ASO	14.6% WP 1.34% AS	28549 28626
	powdery mildew	propiconazole	Tilt 250 EC Bumper 418 EC Pivot 418 EC Propel	250 g.L EC 418 g/L EC 418 g/L EC 250 g/L EC	19346 28017 28219 29548
		azoxystrobin + propiconazole	Quilt	75 g/L + 125 g/L mixture	28328
	white mould	boscalid	Lance WDG	70% WG	27495
		Coniothyrium minitans	Contans	1 x 10^9 cfu/g	29066
		Bacillus subtilis	Serenade Max Serenade ASO	14.6% WP 1.34% AS	28549 28626
coriander	blossom blight	azoxystrobin	Quadris	250 g/L EC	26153
corn	rust, leaf blight	propiconazole	Tilt 250 EC Pivot 418 EC Bumper 418 EC	250 g/L EC 418 g/L EC 418 g/L EC	19346 28219 28017
		pyraclostrobin	Headline EC	250 g/L EC	27322
		azoxystrobin	Quadris	250 g/L EC	26153
faba bean	ascochyta leaf and pod spot	pyraclostrobin	Headline EC	250 g/L EC	27322
	powdery mildew	pyraclostrobin	Headline EC	250 g/L EC	27322
	white mould	boscalid	Lance WDG	70% WG	27495
field bean	anthracnose	azoxystrobin	Quadris SU	250 g/L EC	26153
		pyraclostrobin	Headline EC	250 g/L EC	27322
		tribasic copper sulphate	Copper 53W	53% WP	9934

Crop	Disease	Active Ingredient	Trade Name	Formulation	PCP#
	common blight/ halo blight and bacterial brown spot	tribasic copper sulphate	Copper 53W	53% WP	9934
		copper hydroxide	Kocide 101 Kocide 2000* Parasol WP Parasol Flowable	50% WP 35% SG 50% WP 24.4% SU	14417 27348 24671 25910
	powdery mildew	pyraclostrobin	Headline EC	250 g/L EC	27322
		azoxystrobin	Quadris SU	250 g/L EC	26153
		azoxystrobin + propiconazole	Quilt SU	75 g/L + 125 g/L mixture	28328
	rust	propiconazole	Tilt 250 EC Bumper 418 EC Pivot 418 EC Propel	250 g.L EC 418 g/L EC 418 g/L EC 250 g/L EC	19346 28017 28219 29548
		pyraclostrobin	Headline EC	250 g/L EC	27322
		azoxystrobin + propiconazole	Quilt SU	75 g/L + 125 g/L mixture	28328
	stem rot/white mould	picoxystrobin	Acapela SU	250 g/L SU	30470
		fluopyram + prothioconazole	Propulse SU	200 g/L + 200 g/L	30511
		boscalid	Lance WDG	70% WG	27495
		thiophanate methyl	Senator 70 WP	70% WP	25343
		vinclozolin	Ronilan EG	50% WG	24894
		Bacillus subtilis	Serenade Max Serenade ASO	14.6% WP 1.34% AS	28549 28626
		fluazinam	Allegro 500 F	40%	27517
		Coniothyrium minitans	Contans	1 x 10^9 cfu/g	29066
field pea	mycosphaerella blight	azoxystrobin	Quadris SU	250 g/L EC	26153
		chlorothalonil	Bravo 500	500 g/L SU	15723
		boscalid	Lance WDG	70% WG	27495
		picoxystrobin	Acapela SU	250 g/L SU	30470
		fluxapyroxad + pyraclostrobin	Priaxor DS	250 g/L + 250 g/L	30646
		penthiopyrad	Vertisan EC	200 g/L	30332
		pyraclostrobin	Headline EC	250 g/L EC	27322
	powdery mildew	fluxapyroxad + pyraclostrobin	Priaxor DS	250 g/L + 250 g/L	30646
		pyraclostrobin	Headline EC	250 g/L EC	27322
		sulphur	Kumulus DF	80% WG	18836
		azoxystrobin	Quadris	250 g/L EC	26153
		propiconazole	Tilt 250 EC Bumper 418 EC Pivot 418 EC Propel	250 g.L EC 418 g/L EC 418 g/L EC 250 g/L EC	19346 28017 28219 29548
		azoxystrobin + propiconazole	Quilt SU	75 g/L + 125 g/L mixture	28328

Crop	Disease	Active Ingredient	Trade Name	Formulation	PCP#
	gray mould	boscalid	Lance WDG	70% WG	27495
	white mould or gray mould	*Bacillus subtilis*	Serenade Max Serenade ASO	14.6% WP 1.34% AS	28549 28626
	white mould	picoxystrobin	Acapela SU	250 g/L SU	30470
		fluxapyroxad + pyraclostrobin	Priaxor DS	250 g/L + 250 g/L	30646
		Coniothyrium minitans	Contans	1 x 10^9 cfu/g	29066
ginseng	alternaria leaf spot	iprodione	Rovral WP Rovral WDG	500 g/kg WP 500 g/kg WG	15213 24709
		chlorothalonil	Bravo 500	500 g/L SU	15723
		mancozeb	Dithane F-45 Dithane DG Dithane M-45 Dithane WSP Manzate DF Manzate Pro-stick Penncozeb 75 DF Penncozeb 80 WP	37% WG 75% WG 80% WP 80% WP 75% WG 75% WP 80% WP 75% WG	20552 20553 8556 23655 21057 28217 25396 25397
	botrytis grey mould	chlorothalonil	Bravo 500	500 g/L SU	15723
		fenhexamid	Elevate 50 WDG	50% WG	25900
	phytophthora root rot and foliar blight	fosetyl-AL	Aliette WDG Aliette WP Aliette Systemic	80% WG 80% WP 80% WG	24458 24564 27688
		metalaxyl-M	Ridomil Gold 480 Ridomil Gold 1G	480 g/L EC 1% GR	25384 26612
	pythium damping off	metalaxyl-M	Ridomil Gold 480	480 g/L EC	25384
	pythium damping off (seed treatment)	metalaxyl - M & S	Apron XL LS	33.3% SU	25585
	rhizoctonia damping off and crown rot	azoxystrobin	Quadris	250 g/L SU	26153
lentil	anthracnose, ascochyta blight	fluxapyroxad + pyraclostrobin	Priaxor DS	250 g/L + 250 g/L	30646
		azoxystrobin	Quadris	250 g/L EC	26153
		boscalid (not for anthracnose)	Lance WDG	70% WG	27495
		chlorothalonil	Bravo 500	500 g/L SU	15723
		mancozeb	Dithane Rainshield Manzate DF Manzate Pro-Stick Penncozeb 75DF	75% DF 75% DF 75% DF 75% DF	29221 21057 28217 25397
		pyraclostrobin	Headline EC	250 g/L EC	27322
		prothioconazole (not anthracnose)	Proline 480 SC	480 g/L SC	28359
		azoxystrobin + propiconazole	Quilt SU (anthracnose only)	75 g/L + 125 g/L mixture	28328

Crop	Disease	Active Ingredient	Trade Name	Formulation	PCP#
lentil	powdery mildew	propiconazole	Tilt 250 EC Bumper 418 EC Pivot 418 EC Propel	250 g.L EC 418 g/L EC 418 g/L EC 250 g/L EC	19346 28017 28219 29548
		azoxystrobin + propiconazole	Quilt SU	10.125 L + 101.25 L	28328
	white mould, gray mould	boscalid	Lance WDG	70% WG	27495
		Bacillus subtilis	Serenade CPB	1 x 10^9 CFU/g	30143
		fluxapyroxad + pyraclostrobin	Priaxor DS	250 g/L + 250 g/L	30646
soybean	frogeye / cercospora leaf spot	propiconazole	Tilt 250 EC Bumper 418 EC Pivot 418 EC Propel	250 g.L EC 418 g/L EC 418 g/L EC 250 g/L EC	19346 28017 28219 29548
		azoxystrobin	Quadris	250 g/L EC	26153
		flutriafol	Fullback 125 SC	125g/L SU	31679
		pyraclostrobin	Headline EC	250 g/L EC	27332
		azoxystrobin + propiconazole	Quilt	75 g/L + 125 g/L mixture	28328
	brown spot	flutriafol	Fullback 125 SC	125g/L SU	31679
	powdery mildew	azoxystrobin	Quadris	250 g/L EC	26153
		propiconazole	Tilt 250 EC Bumper 418 EC Pivot 418 EC Propel	250 g.L EC 418 g/L EC 418 g/L EC 250 g/L EC	19346 28017 28219 29548
		azoxystrobin + propiconazole	Quilt	75 g/L + 125 g/L mixture	28328
	Asian soybean rust	azoxystrobin	Quadris	250 g/L EC	26153
		flutriafol	Fullback 125 SC	125g/L SU	31679
		propiconazole	Tilt 250 EC Bumper 418 EC Pivot 418 EC Propel	250 g.L EC 418 g/L EC 418 g/L EC 250 g/L EC	19346 28017 28219 29548
		pyraclostrobin	Headline EC	250 g/L EC	27332
		azoxystrobin + propiconazole	Quilt	75 g/L + 125 g/L mixture	28328
sugar beet	cerospora leaf spot	copper hydroxide	Kocide 101 Parasol WP Parasol DP	50% WP 50% WP 37.5% WG	14417 24671 28406
		mancozeb	Dithane M-45 Dithane WSP Manzate DF Manzate Pro-Stick Penncozeb 80 WP	80% WP 80% WP 75% WG 675% WG 80% WP	8556 23655 21057 28217 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. Seed treatments registered for use on special crops.

This publication is not updated annually. Refer to provincial crop protection guides and product labels for registrations, application details and precautions.

Seed Treatment	PCP#	Seed Rot & Seedling Blight								Seed-borne diseases		
		Corn	Chick-pea	Field Bean	Field Pea	Lentil	Soy-bean	Sugar Beets	Sor-ghum	Bean Anthra-cnose	Corn Head Smut	Lentil/Pea/ Chickpea Ascochyta
azoxystrobin												
Dynasty 100FS	28394	X		X						X		
captan												
Agrox FL	24684	X	X	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)												
DCT Dual Purpose	14986			X						X		
carbathiin + thiram												
Anchor	18788				X	X	X					
Vitaflo 280	11423	X		X	X	X	X				X	X (pea only)
Vitaflo 220	21174	X		X			X				X	
Vitaflo SP	303081	X		X	X	X	X					
Loveland Vitaflo	30380	X		X	X	X	X					
carbathiin + thiabendazole												
Crown	23430		X			X						X (except pea)
difenoconazole + metalaxyl												
Dividend XL RTA	25777	X							X			
fluazinam												
Allegro 500F	27517			X			X					
fludioxonil												
Maxim 480 FS	27001	X	X	X	X	X	X	X	X			
fludioxonil + metalaxyl-M												
Maxim XL	27071	X										
Apron Maxx RTA	27577		X	X	X	X	X			X		X
Apron Maxx RFC	28817		X		X	X						

Seed Treatment	PCP#	Seed Rot & Seedling Blight								Seed-borne diseases		
		Corn	Chick-pea	Field Bean	Field Pea	Lentil	Soy-bean	Sugar Beets	Sor-ghum	Bean Anthra-cnose	Corn Head Smut	Lentil/Pea/ Chickpea Ascochyta
fludioxonil + metalaxyl-M + thiamethoxam												
Cruiser Maxx Beans	28821			X			X					
mancozeb												
Dithane M-45	27616	X										
Manzate 200	10526	X										
metalaxyl												
Allegiance FL	26674	X	X	X	X	X	X	X	X			
Belmont 2.7 FS	30246	X	X		X	X	X					
Apron FL	24262	X	X	X	X	X	X	X	X			
Apron XL LS	25585	X	X	X	X	X	X	X	X			
Apron Advance	30627		X			X						
Apron Maxx RTA	27577		X	X	X	X	X					
thiram												
Thiram 75WP	27556	X		X	X		X	X				
sedaxane												
Vibrance 500FS	30438			X			X					
sedaxane + fludioxonil + metalaxyl												
Vibrance Maxx			X	X	X	X	X					
trifloxystrobin + metalaxyl												
Trilex AL	29160		X	X	X	X	X					
trifloxystrobin + metalaxyl + penflufen												
Trilex EverGol	30645		X	X	X	X						