Chapter Six

DISEASES OF OILSEED CROPS

FLAX (*Linum usitatissimum*)

BROWNING AND STEM BREAK

Polyspora lini

Cultural: Practice crop rotation, plant flax in fields distant from those of the previous year and use disease-free seed from dry areas, or from crops not showing browning or stem break. Early seeding may reduce injury since the crop could ripen before the disease becomes severe.

Resistant Cultivars: None (see Notes).

Chemical: None.

Notes:Cvs. differ in resistance but variation for pathogenicity also occurs in the fungus.

References:

1. Henry, A.W. 1934. Observations on the variability of *Polyspora lini* Lafferty. Can. J. Res. 10: 409-413.

2. Henry, A.W. and Ellis, C. 1971. Seed infestation of flax in Alberta with the fungus causing browning or stem-break. Can. Plant Dis. Surv. 51: 76-79.

HEAT CANKER AND FROST INJURY

Nonparasitic

Cultural: Heat canker due to scorching by excessively heated soil, and frost canker due to freezing temperatures at soil level produce similar symptoms of blight and girdling in flax seedlings. Preventive measures are a firm seedbed to promote even and vigorous stands, dense seeding in a north-south direction, and shading provided by crop residue.

Resistant Cultivars: None.

Chemical: None.

References:

1. Vanterpool, T.C. 1961. Effects of high surface-soil temperature on cereals and flax. Can. Plant Dis. Surv. 41: 306-309.

2. Vanterpool, T.C. 1963. Note of a non-parasitic canker of flax seedlings - an interpretation. Can. J. Plant Sci. 43: 408-410.

PASMO

Mycosphaerella linorum (imperfect state *Septoria linicola*)

Cultural: Practise crop rotation with at least three years between flax. Clean seed thoroughly as the fungus can be seed-borne. Sow flax early to avoid disease build-up at maturity in wet autumn weather. Seed the recommended rates and control weeds to prevent high moisture levels in crop canopy.

Resistant Cultivars: None (see Notes).

Chemical: None.

Notes: Cultivars currently grown in Western Canada are moderately susceptible. The disease usually occurs late in the season with increasing moisture in the fall. However, high disease incidence and severity can occur in mid-season after prolonged rainfall and build-up of moisture in crop canopy.

POWDERY MILDEW

Oidium lini

Cultural: Seed flax early to avoid disease build-up at maturity. Seed recommended rates and control weeds to prevent high moisture levels in crop canopy. Crop rotation will help reduce the inoculum pressure.

Resistant Cultivars: AC Carnduff, AC Hanley, AC Lightning, AC Watson, AC Emerson, AC McDuff, CDC Bethune, FP2016, Linola 989, Linola 1084, McGregor.

Intermediate: Flanders, Andro, Linola 947, Taurus, AC Macbeth, 2047

Susceptible: Somme, NorMan, NorLin, Vimy, CDC Arras, CDC Normandy, CDC Valour, Linott, AC Linora.

Chemical: None.

Notes: This disease has been first reported in Canada in 1997, and has increased rapidly since then. Little is known about host range and race specificity. Use of resistant cultivars is the only practical control.

References:

1. Rashid, K. Y. 1998. Powdery mildew on flax; a new disease in western Canada. Can. J. Plant Pathol. 20: 216.

RUST

Melampsora lini

Cultural: Clean seed carefully to eliminate any pieces of plant debris that might be carrying rust. Early planting may help the crop mature before rust becomes serious. Flax should not be planted on flax stubble and preferably, new flax fields should be located as far as possible from previous year's flax crops. Since volunteer flax can carry the disease from year to year, control volunteers in the field, along field edges, and around sloughs or low areas.

Resistant Cultivars: All registered cultivars: Andro, CDC Arras, CDC Bethune, AC Carnduff, Culbert, Dufferin, AC Emerson, AC Hanley, AC Lightning, Flanders, FP2016, Linola 947, Linola 989, Linola 1084, AC Linora, Linott, AC McDuff, McGregor, NorLin, NorMan, Raja, CDC Normandy, Somme, CDC Valour, Vimy, and AC Watson, AC Macbeth, CDC Mons, 2047.

Susceptible: None of the registered cultivars in Canada. Noralta, Redwood 65 (see Note 1).

Chemical: None.

Notes:

1. Noralta and Redwood 65 are susceptible to races 370 and 371 in the seedling stage, but develop some resistance in postseedling stages (2).

2. The rusts found on blue-flowered wild flax (*L. lewisii, L. perenne*) do not infect common flax, nor do those generally found on yellow flowered wild flax (*L. rigidum, L. sulcatum*) (1). However, rust races that infect common flax can infect yellow-flowered flax but not blue-flowered flax.

References:

1. Zimmer, D.E. and Hoes, J.A. 1974. Race 370, a new and dangerous North American race of flax rust. Plant Dis. Rep. 58: 311-313.

2. Hoes, J.A. and Kenaschuk, E.O. 1980. Post seedling resistance to rust in flax. Can. J. Plant Pathol. 2: 125-130.

SEED DECAY, SEEDLING BLIGHT, ROOT ROT

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

Cultural: Practice crop rotation for at least 3 years between flax but avoid legumes and sugar beets because these crops are susceptible to the same strains of *Rhizoctonia solani*. Sowing into a firm seedbed and sowing on cropped land (stubble) rather than summerfallow should reduce losses from *Rhizoctonia solani* since this fungus is more destructive on loose soil.

Resistant Cultivars: None.

Chemical: Because flax is very susceptible to seedling blight, all flax used as seed should be treated with a fungicide to control seed-borne and soil-borne diseases and to promote good seedling growth. Treat seed with carbathiin + thiram (COM) DU, SU; maneb (COM) WP.

Limitations: For carbathiin + thiram, do not store treated seed over 18 months and do not graze fields sown with treated seed for 4 weeks after emergence. For maneb, do not store treated seed more than 1 year before planting.

WILT

Fusarium oxysporum f. sp. *lini*

Cultural: To prevent build-up of the pathogen, practice a 3-year rotation using cereals, corn or grasses.

Resistant Cultivars: AC Hanley, AC Lightning, AC Linora, AC Emerson.

Intermediate: All other currently registered cultivars.

Susceptible: None.

Chemical: None.

Notes:In the absence of flax, the fungus can survive indefinitely in the soil, so the only practical control is the use of resistant cultivars. Avoid the use of trifluralin herbicide in previously infected fields because this will result in a large reduction of flax emergence (2).

References:

1. Kommedahl, T., *et al.* 1970. A half century of research in Minnesota of flax wilt caused by *Fusarium oxysporum*. Minn. Agric. Exp. Sta., Tech. Bull. 273. 35 pp.

2. Rashid, K.Y. and Kenaschuk, E.O. 1993. Effect of trifluralin on fusarium wilt in flax. Can. J. Plant Sci. 73: 893-901.

OTHER DISEASES

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

Anthracnose & Seedling Blight (*Colletotrichum lini*) NC

Aster Yellows (aster yellows phytoplasma) MI

Boll Blight (Nonparasitic) NC

Brown Stem Blight (*Alternaria linicola*) NC

Crinkle (Oat Blue Dwarf) (oat blue dwarf virus) MI

Dieback (Nonparasitic) NC

CANOLA (RAPESEED) AND MUSTARD (*Brassica* spp. and *Sinapis alba*)

ALTERNARIA BLACK SPOT (GRAY LEAF SPOT)

Alternaria brassicae, A. raphani

Cultural: Rotate with non-cruciferous crops. Control volunteers and cruciferous weeds during the rotation. Early swathing of badly infected crops may prevent serious losses from shattering and seed shrinkage. All seeds should be cleaned thoroughly to remove shrunken, severely infected seed. Seed from southern or drier areas of the prairies carries less inoculum and could be used as a seed source (see Note 1). Storage of seed lightly-infected with *Alternaria* may improve germination (see Note 3).

Resistant Cultivars: None (see Note 2).

Chemical: Treat seed destined for planting with thiabendazole + thiram + lindane (COM) SU. Spray with iprodione (COM) SU or azoxystrobin (COM) (see Note 4).

Notes:

1. Seed germination and seedling emergence were not directly related to seed infestation by pathogenic *Alternaria* species (2).

2. *Brassica rapa* (= *B. campestris*) cultivars are much more susceptible than *B. napus* cultivars.

3. Seed-borne *Alternaria* reduces germination, but the viability of the fungi declines during storage with a corresponding increase in germination. This may be important for seed growers, but may not improve grade in commercial production (Robin Morrall, personal communication).

4. Lindane products are no longer registered for use on canola. Refer to provincial guides for details.

References:

1. Petrie, G.A. 1973. Diseases of *Brassica* species in Saskatchewan. 1970-72. II. Stem, pod and leaf spots. Can. Plant Dis. Surv. 53: 83-87.

2. Petrie, G.A. 1974. Fungi associated with seeds of rape, turnip rape, flax and safflower in Western Canada, 1968-1973. Can. Plant Dis. Surv. 54: 155-165.

3. Dorrance, M.J. 1994. Practical Crop Protection: Weeds, insects, diseases. Alberta Agriculture, Food & Rural Development, Edmonton AB.

4. Clear, R.M. and S.K. Patrick. 1995. Frequency and distribution of seedborne fungi infecting canola seed from Ontario and western Canada - 1989 to 1993. Can. Plant Dis. Surv. 75: 9-17.

BLACKLEG

Leptosphaeria maculans (imperfect state *Phoma lingam*)

Cultural: Use a minimum 4 year rotation, especially under dry conditions where infested stubble decomposes slowly. Never seed rapeseed or mustard on stubble of these crops or adjacent to a field which had the disease the previous 2 years. Control wild mustard (*Sinapis arvensis*) and volunteer plants between crops.

For updates on cultivar description and disease reaction see Canola Council web site
Cultivar Resistance:

	Resistant (1)	**Moderately Resistant (2)**	**Moderately Susceptible (3)**	**Susceptible (4)**	**Very (5) Susceptible**
Argentine (*Brassica napus*)	44A04, 44A89, 44A53, 449 (RR), 45A02, 45A03, 45A45, 45A53 (RR), 45A55, 45A57, 45H20, 46A65, 46A76 (CF), 499 (RR), Bianca II, Conquest (RR), Foremost, Hi-Q, Hyolo, IMPULSE, Invigor 2573, Invigor 2663, LG3310, LG3311, LG3366, LG3525 (RR), MillenniUM 01, MillenniUM 02, MillenniUM, 03, Nex715, Nex720, OAC Dynamite, Prominent, Q2, Quantum, Sentry, Skyhawk, SP Armanda, SW 5001,	23-38, 220, 500, 1134 CA, 1812, 46A05, 46A41, 46A52 (RR), 46A73 (CF), 46A74 (CF), 561RR, 799RR, AC-H102, Admire, Agassiz, BATTLEFORD, Beacon, Bianca, BULLET, Castor, Cartier BX, Challenger, CLAVET, CORONET, Cyclone, DEFENDER, EAGLE, Ebony, Garrison, Helsey, Heritage, Hero, Hudson, Hylite 225 (RR), Hyola 428, Hyola 454 (RR), Hylite 201, IMC 207, Invigor 2273, Invigor 2463, Invigor 2473, Jewel, LG3220, LG3235 (RR), LG3333, LG3345 (RR), LG3369, LG3455 (RR), Lolinda, Magnum, Mercury, Neptune, Peace, PR 5338 (RR), Renegade BX, RR Champion, Sprint, SWALLOW (LL), SW Flare (RR), SW Gladiator (RR), SW Legion (LL), SW RazoR, SW WaRRior, Thunder, TRAILBLAZER, Venus, Wildcat, Zodiac BX	1174 CA, 295 BX, 2631 LL, 1492, 2631 (LL), 3360, 3640 (LL), 3850 (LL), 3880 (LL), 45A50 (RR), 45A51 (RR), 45A71 (CF), 46A72 (CF), Alliance, Apollo, Armor BX, Ascent, AC Elect, AC Excel, Battalion, Cantera 1867 (RR), Crusher, DAKINI, Delta, DS-Roughrider (RR), Exceed (LL), Frontier, Goliath, HCN14 (LL), HL99, HY-PER Star 100, IMC 03, IMC 105, IMC205, Impact, Independence (LL), Innovator (LL), Invigor 2153 (LL), Invigor 2163 (LL), Legacy, LG3222, LG3360, LG Dawn (RR), Magellan, Nex 705, PRINCETON, Profit, SW ARROW (RR), SW Badge (RR), SWPeak (RR), SW RideR (RR), Trojan	41P55 ACS-C7 Bounty Hyola 401 LG3260 OAC Springfield SW 1007	Allons Westar

CF - Clear Field (imidazolonone tolerant)

RR - Roundup Ready (glyphosate tolerant)
LL - Liberty Link (glufosinate-ammonium tolerant)
BX - Navigator/Compas variety (bromoxynil tolerant)

Cultivar Resistance (continued):

	Resistant (1)	**Moderately Resistant (2)**	**Moderately Susceptible (3)**	**Susceptible (4)**	**Very (5) Susceptible**
Polish (*B. rapa = B. campestris*)	None.	None.	None.	1000, 1007, 41P55, AC Parkland, AC Boreal, AC Sunbeam, AC Sungold, CASH, CHINOOK, Colt, FAIRVIEW, FOOTHILLS, Goldrush, Horizon, Hysyn 100, Hysyn 110, Hysyn 111, Hysyn 120CS, Klondike, MAVERICK, NORWESTER, Reward, SHAMROCK, SPECTRUM, Valleyview, WESTWIN	None.

CF - Clear Field (imidazolonone tolerant)
RR - Roundup Ready (glyphosate tolerant)
LL - Liberty Link (glufosinate-ammonium tolerant)
BX - Navigator/Compas variety (bromoxynil tolerant)

Chemical:

1. Treat seed destined for planting with benomyl + thiram + lindane (COM) WP; carbathiin + thiram + lindane (COM) SU; iprodione + lindane (COM) SU; thiabendazole + thiram + lindane (COM) SU (see Notes) (see Appendix I).

2. Spray with propiconazole (COM) EC or azoxystrobin (COM).

   Limitations: As per label. Only Vitavax RS and Premiere are registered for mustard (see Appendix I).

Notes:

1. The virulent strain of the blackleg fungus caused significant losses in some parts of the prairies. In specific instances losses in yield of 50% or more were recorded. Losses have been reduced by the development of resistant cultivars.

2. Seed may be a very important means by which the disease spreads to new areas. However, in areas where the disease is established, seed treatment is ineffective because seed infection is insignificant in comparison to ascospore infection from plant residues. Since the fungus infects the seed coat and embryo, a systemic fungicide or hot water treatment (50°C for 20 min.) would be necessary for seed treatment.

3. All currently registered varieties of brown (*Brassica juncea*), oriental (*B. juncea*) and yellow (*Sinapis alba*) mustard are resistant to the strains of *Leptosphaeria maculans* prevalent in western Canada.

4. Lindane products are no longer registered for use on canola. Refer to provincial guides for details.

References:

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

2. Gugel, R.K. and Petrie, G.A. 1992. History, occurrence, impact, and control of blackleg of rapeseed. Can. J. Plant Pathol. 14: 36-45.

3. Hall, R. 1992. Epidemiology of blackleg of oilseed rape. Can. J. Plant Pathol. 14: 46-55.

4. Kharbanda, P.D. 1993. Blackleg of Canola in Alberta: Investigations on biology, epidemiology and management. Alberta Environmental Centre Publication # AECV93-R5. 86 pp.

5. Petrie, G.A. 1995. Long term survival and sporulation of *Leptosphaeria maculans* (blackleg) on naturally infested rapeseed/canola stubble in Saskatchewan. Can. Plant Dis. Surv. 75: 23-34.

6. West, J.S, *et al.* 2001. Epidemiology and management of *Leptosphaeria maculans* (phoma stem canker) on oilseed rape in Australia, Canada, and Europe. Plant Pathol. 50; 10-27.

7. Rimmer, S.R. and Buchwaldt, L. 1995. Diseases. *In* Brassica Oilseeds Production and Utilization. Ed. D.S. Kimber and D.I. McGregor. CAB International, Oxford UK. Pp. 111-140.

FUSARIUM WILT

Fusarium oxysporum and *F. avenaceum*

Cultural: None.

Cultivar Resistance:
The cultivars listed below were classified on the basis of experimental evidence and disease surveys. This list is subject to change because few cultivars have been tested, and because testing protocols have not been standardized.

Resistant	Moderately Susceptible	Susceptible
46A76 Nexera 710 Quantum	LG 3345 Quest	45A55 Nexera 705 LG 3525

Chemical: None.

References:

1. Benard, D. and Lange, R.M. 2002. Identification and quantification of a new canola wilt in western Canada. Final Project Report, Canola agronomic esearch program AG #2000-6 and Farming for the Future matching Grants Research Program Project #2000M633: 30 pp.
2. Benard, D. *et al.* 2002. Survey of Fusarium wilt and other canola diseases in Alberta, 2001. Can. Plant Dis. Surv. 82: 80-82.
3. Benard, D. *et al.* 2001. Survey of Fusarium wilt and other canola diseases in Alberta, 2000. Can. Plant Dis. Surv. 81: 102-104.
4. Harrison, L.M. *et al.* 2002. Fusarium wilt, a new fungal disease of canola (web page). [http://www.agric.gov.ab.ca/diseases/fusarium-wilt_canola.html]

ROOT ROT COMPLEX AND FOOT ROT

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

Cultural: Rotate with cereals, and control cruciferous weeds and volunteer plants. Shallow seeding reduces root rot. Maintaining fertility levels may help to decrease the severity of the root rot complex (brown girdling root rot).

Resistant Cultivars: None.

Chemical: None.

Notes:

1. From survey work, *B. juncea* (Brown and Oriental Mustard) may be more susceptible than other *Brassica* spp.

2. *B. rapa* (= *B. campestris*) generally is more susceptible than *B. napus* to the root rot complex (7).

References:

1. Acharya, S.N. *et al.* 1984. Screening rapeseed/canola for resistance to damping-off and seedling root rot caused by *Rhizoctonia solani*. Can. J. Plant Pathol. 6: 325-328.

2. Berkenkamp, B. and Vaartnou, H. 1972. Fungi associated with rape root rot in Alberta. Can. J. Plant Sci. 52: 973-976.

3. Harrison, L. *et al.* 1997. Blackleg of canola. Agdex 149/632-3. Alberta Agriculture, Food & Rural Development, Edmonton.

4. Harrison, L. 1995. Personal communication, Alberta Agriculture, Food and Rural Development, Fairview.

5. Kaminski, D.A. and Verma, P.R. 1985. Cultural characteristics, virulence, and in vitro temperature effect on mycelial growth of *Rhizoctonia* isolates from rapeseed. Can. J. Plant Pathol. 7: 256-261.

6. Petrie, G.A. 1973. Diseases of *Brassica* Species in Saskatchewan 1970-72. III. Stem and root rots. Can. Plant Dis. Surv. 53:88-92.

7. Sippell, D.W. *et al.* 1985. Rhizoctonia root rot of rapeseed in the Peace River region of Alberta. Can. J. Plant Pathol. 7: 184-186.

8. Turkington, T.K. *et al.* 1995. The influence of tillage and nitrogen fertilizer on brown girdling root rot of canola. Can. J. Plant Pathol. 17: 363 (abstr).

9. Vanterpool, T.C. 1974. *Pythium polymastum* pathogenic on oilseed rape and other crucifers. Can. J. Bot. 52: 1205-1208.

SCLEROTINIA STEM ROT

Sclerotinia sclerotiorum

Cultural: Allow at least 4 years between susceptible crops. However, the effect of crop rotation may be reduced if inoculum is blown from adjacent fields. Cereals and grasses are immune while rapeseed, mustard, field peas, beans, lentils, soybeans, sunflowers, and clovers are susceptible. Control volunteers and susceptible weed species. Use cleaned seed free of sclerotia (see Note 1). In severely infected fields, early swathing may reduce losses due to shattering.

Resistant Cultivars: apetalous cultivars may escape infection to a greater degree than petalled cultivars.

Chemical: Iprodione (COM) WP, SU, or vinclozolin (COM) WP; at 20 to 30% bloom. (See Appendix I) or azoxystrobin (COM) see note 2).

Limitations: As per label. Preharvest interval - 45 days (vinclozolin). The above fungicides are registered for use on canola but not mustard.

Notes:

1. The standard for No. 1 seed (pedigreed and non-pedigreed) is a maximum of 20 sclerotia/kg of seed and for No. 2 seed (pedigreed and non-pedigreed), a maximum of 40 sclerotia/kg of seed. Sclerotia in seed can be removed by using a spiral cleaner.

2. To decide whether the use of a fungicide is economical, estimate disease risk using (1) the sclerotinia stem rot check list; or (2) petal testing as described in the Canola Growers Manual, or visit sclerotinia risk maps updated twice a week on the Internet.

References:

1. Bradnock, W.T. 1979. Standards for sclerotia of *Sclerotinia sclerotiorum* in rapeseed. Trade Memorandum T-2-97. Can. Dep. Agric., Ottawa.

2. Evans, I.R., and P. Thomas. 1995. Disease forecasting for sclerotinia white rot in canola. Agdex 149/632-4. Alberta Agriculture, Food & Rural Development. Edmonton AB.

3. Morrall, R.A.A. and Dueck, J. 1982. Epidemiology of sclerotinia stem rot of rapeseed in Saskatchewan. Can. J. Plant Pathol. 4: 161-168.

4. Thomson, Jill, R. *et al*. 1984. Efficacy of aerial application of benomyl and iprodione for the control of Sclerotinia stem rot of canola (rapeseed) in central Alberta. Can. J. Plant Path. 6: 75-77.

5. Turkington, T.K., and R.A.A. Morrall. 1993. Use of petal infestation to forecast sclerotinia stem rot of canola: The influence of inoculum variation over the flowering period and canopy density. Phytopathology 83: 682-689.

6. Turkington, T.K., R.A.A. Morrall, and R.K. Gugel. 1991. Use of petal infestation to forecast sclerotinia stem rot of canola: evaluation of early bloom sampling, 1985-90. Can. J. Plant Pathol. 13: 50-59.

SEEDLING BLIGHT (DAMPING OFF)

Rhizoctonia solani, *Fusarium* spp., *Pythium* spp. (2) and (3).

Cultural: Sow sound seed into a firm, moist seedbed. Do not seed too deep, 1.25-2.5 cm is optimal, and seed when the soil temperature at seeding depth is at least 10EC (see Notes). Rotate with non-cruciferous crops and control volunteers and cruciferous weeds during the rotation. Fertilizer placed with the seed may delay and reduce emergence (4).

Resistant Cultivars: None.

Chemical: Treat seed with benomyl + thiram (COM) DU; carbathiin + thiram + lindane (COM) SU; iprodione + lindane (COM) SU; thiabendazole + thiram + lindane (COM) SU (see Note 2) (see Appendix I); metalaxyl (COM) LI seed treatment for *Pythium* spp.

Limitations: As per label. Only Vitavax RS and Premiere are registered for mustard.

Notes:

1. Early and deep seeding into cold, dry soil can result in losses of up to 100% of the stand. Severe damage can also result when canola is sown after canola or a canola-summerfallow rotation. Reseeding may be successful if soil temperature and soil moisture levels are adequate after the initial seeding failure (1, 5).

2. As flea beetle control may be required for canola and mustard seedlings, all seed treatments registered are dual purpose.

3. Lindane products are no longer registered for use on canola. Refer to provincial guides for details.

References:

1. Committee. 1980. Soil temperature for germination. Alberta Agric. Agdex 590-1.

2. Gugel, R.K. *et al.* 1987. Etiology of the rhizoctonia root rot complex of canola in the Peace River region of Alberta. Can. J. Plant Pathol. 9: 119-128.

3. Hwang, S.F. *et al.* 1986. Characterization of *Rhizoctonia solani* isolates from canola in west central Alberta. Plant Dis. 70: 681-683.

4. Nyborg, M. 1961. The effect of fertilizers on emergence of cereal grains, flax and rape. Can. J. Soil Sci. 41: 89-98.

5. Teo, B.K. *et al*. 1988. Influence of soil moisture, seeding date, and Rhizoctonia solani isolates (AG2-1 and AG4) on disease incidence and yield in canola. Can. J. Plant Pathol. 10: 151-158.

WHITE LEAF SPOT (GREY STEM)

Pseudocercosporella capsellae (Mycosphaerella capsellae)

Cultural: Rotate with non-cruciferous crops. Control volunteers and cruciferous weeds.

Resistant Cultivars: None.

Chemical: None.

Notes: White leaf spot, which occurs early and could be economically important, has been overlooked because it has been confused with alternaria leaf spot.

References:

1. Petrie, G.A. 1973. Diseases of *Brassica* species in Saskatchewan, 1970-72. II. Stem, pod, and leaf spots. Can. Plant Dis. Surv. 53: 83-87.

2. Petrie, G.A. and Vanterpool, T.C. 1975. *Pseudocercosporella capsellae* the cause of white leaf spot and gray stem of cruciferae in Western Canada. Proc. Can. Phytopath. Soc. 42: 20.

WHITE RUST (STAGHEAD)

Albugo candida

Cultural: Rotate with non-cruciferous crops. Control volunteers and cruciferous weeds (see Note 1).

Cultivar Resistance:

	Resistant	Intermediate	Susceptible
B. rapa (= *B. campestris*)	AC Boreal AC Sunbeam Foothills Reward AC Parkland	1000, 1007, 41P55, ACS-C7, AC Sungold, Cash, Chinook, Fairview, Goldrush, Hysyn 100, Hysyn 110, Hysyn 120 CS, Hysyn 111, Maverick, Norwester, Shamrock, Spectrum, SW 1000, SW1007, Valleyview, Westwin	Colt Horizon Klondike
Sinapis alba (yellow mustard)	All currently registered cultivars.	None	None
B. juncea (oriental mustard)	None	Cutlass, AC Vulcan	Forge, Lethbridge 22A
B. juncea (brown mustard)	None	None	All currently registered cultivars (Note 2).

Chemical: None.

Notes:

1. Stinkweed (*Thlaspi arvense*), marsh yellow cress (*Rorippa islandica* and wild mustard (*Sinapsis arvensis*) carry strains of *A. candida* that can infect Torch (*B. rapa*) while an isolate from shepherd's purse did not infect Torch (2).

2. *B. juncea* is attacked by races 2A and 2V of *A. candida*, whereas *B. rapa* is attacked by races 7A and 7V. The cultivars differ in resistance to races 2A and 7A for *B. juncea* and *B. rapa*, respectively. All cultivars are susceptible to races 2V and 7V for *B. juncea* and *B. rapa*, respectively.

References:

1. Petrie, G.A. 1973. Diseases of Brassica species in Saskatchewan. 1970-72. I. Staghead and aster yellows. Can. Plant Dis. Surv. 53: 19-25.

2. Thomas, P.L. Personal communication. Alberta Agriculture, Food & Rural Development, Lacombe.

3. Verma, P.R. and Petrie, G.A. 1980. Effect of seed infestation and flower bud inoculation on systemic infection of turnip rape by *Albugo candida*. Can. J. Plant Sci. 60: 267-271.

4. Rimmer, S.R. *et al.* 2000. Virulence of isolates of *Albugo candida* from western Canada to *Brassica* species. Can. J. Plant Pathol. 22: 229-235.

SULFUR DEFICIENCY

Nonparasitic

Cultural: Apply fertilizer containing sulfate at 30 kg/ha of sulfur to sulfur-deficient soils.

Resistant Cultivars: None.

Chemical: None.

Notes: Soils on which it is most likely to occur include leached Luvisolic (gray wooded) soils and any well drained, non-calcareous soils.

The typical sulfur deficiency symptom in canola at an early stage of growth is cupped and purplish leaves. In later stages, plants have small, poorly filled pods.

References:

1. Anon. 1977. Principles and practices of commercial farming. Univ. Manit., Winnipeg. 520 pp.

OTHER DISEASES

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

Aster Yellows (aster yellows phytoplasma) NC

Black Rot (*Xanthomanas campestris*) MI

Downy Mildew (*Peronospora parasitica*) NC

SAFFLOWER (*Carthamus tinctorius*)

ALTERNARIA BLIGHT

Alternaria carthami

Cultural: Plant populations that allow good air circulation and fast drying of the leaves should help reduce severity of the disease. In years or areas with frequent rains *Alternaria* may cause severe damage to the leaves, flower bracts, and staining of the seed (1, 2). Use seed produced in areas of low rainfall.

Resistant Cultivars: None (see Note 1).

Chemical: None (see Note 2).

Notes:

1. AC Stirling, AC Sunset and Saffire are moderately susceptible.

2. Contaminated seed appears to be important in the epidemiology of this disease. Seed treatment fungicides are not registered (in Canada) for safflower.

3. Hot water treatment (50ºC for 30 min.) has been shown to be effective in reducing the percentage of safflower seeds with viable *Alternaria* spp. without altering the germination of seeds (3).

References:

1. Cormack, M.W. and Harper, F.R. 1952. Resistance in safflower to root rot and rust in Alberta. Phytopathol. 42(5): 5 (Abstr.)

2. Howard, R.J. 1990. Personal communication. Alberta Special Crops and Hort. Res. Ctr., Brooks, AB.

3. Zazzerini, A. *et al.* 1985. Use of hot-water treatment as a means of controlling *Alternaria* spp. on safflower seed. Plant Dis. 69: 350-351.

SCLEROTINIA HEAD ROT

Sclerotinia sclerotiorum

Cultural: Allow at least 4 years between susceptible crops (see Note). Fababeans, field beans, field peas, mustard, canola (rapeseed), lentils, soybeans and sunflowers are susceptible; cereals and grasses are immune. Sow seed free of sclerotia.

Resistant Cultivars: Saffire, AC Sunset.

Intermediate: AC Sterling.

Susceptible: S-208, S-541, 175, 176.

Chemical: None.

Notes: The effect of crop rotation may be reduced if inoculum is blown in from adjacent fields.

References:

1. Mundel, H.H. *et al.* 1985. Sclerotinia head rot in safflower; assessment of resistance and effects on yield and oil content. Can. J. Plant Sci. 65: 259-265.

SEED DECAY, SEEDLING BLIGHT, ROOT ROT

Alternaria carthami, Pythium spp., Rhizoctonia solani

Cultural: Rotate crops, but avoid legumes and canola because these crops are susceptible to some of the same fungal pathogens. Avoid seeding too deep and into wet, heavy soils. Select and plant seed with low levels of seedborne fungi.

Resistant Cultivars: None. See Notes.

Chemical: Thiram (COM) WP.

Notes:

1. Root rot resistant germplasm has been identified, but these lines are not recommended for planting in Canada.

2. Hot water treatment (50°C for 30 min.) has been shown to be effective in reducing the percentage of safflower seeds with viable *Alternaria* spp. without altering the germination of seeds (3).

References:

1. Cormack, M.W. and Harper, F.R. 1952. Resistance in safflower to root rot and rust in Alberta. Phytopathol. 42(5): 5 (Abstr.).

2. Howard, R.J. 1990. Personal communication. Alberta Special Crops and Hort. Ctr., Brooks, AB.

3. Zazzerini, A. *et al.* 1985. Use of hot-water treatment as a means of controlling *Alternaria* spp. on safflower seed. Plant Dis. 69: 350-351.

OTHER DISEASES

The following diseases, observed on safflower in Western Canada, are of minor importance or are diseases for which no practical control measures are currently recommended.

Gray Mold (*Botrytis cinerea*)

Rust (*Puccinia carthami*)

SUNFLOWER (*Helianthus annuus*)

DOWNY MILDEW

Plasmopara halstedii

Cultural: Control volunteer sunflowers and susceptible weeds, such as ragweed, wild sunflower, and thistle. Use seed from healthy plants, as the fungus is seed-borne. Sunflowers should not be sown in low, wet fields as this favours the development and spread of the fungus.

Resistant Cultivars: 8242NS, AC 60, 3311, 6111, 6322, 63A81, IS 5757, Hysun 311, Hysun 323, Hysun 521, IS 6039, Mustang, MY 8282, PRO09215, Proseed 9310, 8282, (Hysun 311 and Hysun 323 are resistant to races 2 and 3. See notes.)

Intermediate: Capri, Challenger, Cadet, CLOL 803, Comet-C, IS 7111, MRS 40, MY 7240, SF 128, Sunwheat 101, Trisun 846, Yukon, 6230, 6150.

Susceptible: AC Aurora, Bigfoot, IS 7000, Kodiak, MY 9338, PVN 2301, RH 3703, Sunwheat 103, AC Sierra, SF 187, SF 270, ST 439, 828, 6300, 63A21, 6946, IS 8004, IS 8048, IS 6421, 63A70, 63C71.

Chemical: Treat seed with metalaxyl to prevent seedborne infection and to protect seedlings from soilborne infection.

Notes: The resistance of these cultivars refers only to downy mildew race 2. Commercial hybrids and varieties are susceptible to other races that presently occur in Manitoba (Ref. 2). Only Hysun 311 and Hysun 323 are resistant to race 3.

References:

1. Goossen, P.G. and Sackston, W.E. 1968. Transmission and biology of sunflower downy mildew. Can. J. Bot. 46: 5-10.

2. Rashid, K.Y. 1993. Incidence and virulence of *Plasmopora halstedii* on sunflower in western Canada during 1988-1991. Can. J. Plant Pathol. 15 (3): 206-210.

3. Zimmer, D.E. 1975. Some biotic and climatic factors influencing sporadic occurrence of sunflower downy mildew. Phytopathology 65: 751-754.

LEAF MOTTLE AND WILT

Verticillium dahliae

Cultural: When planting susceptible cultivars, practice a crop rotation of at least 5 years, even if the disease is not yet known to occur in the particular field. Control volunteers and broad-leaved weeds. Use disease-free seed when expanding sunflower production into new areas because the fungus can be seed-borne.

Resistant Cultivars: AC 60, Cadet, Capri, Challenger, CLOL 803, Comet-C, Hysun 311, Hysun 323, Hysun 521, IS 5757, IS 6039, IS 6421, IS 7000, IS 7111, Kodiak, Mustang, MRS 40, MY 8282, MY 7240, P63A81, Proseed 9310, PRO 9215, PVN 2301, SF 128, SF 187, ST 439, Sunwheat 101, Yukon, 828, 3311, 6111, 6230, 6322, 6946, 63A70, 63C71, 8242NS.

Intermediate: Bigfoot, IS 8048, MRS 517, MY 9338, RH 3703, SF 270, Sunwheat 103, Trisun 846, 6150, 6300, 63A21.

Susceptible: AC Aurora, IS 8004, AC Sierra.

Chemical: None.

References:

1. Zimmer, D.E. *et al.* 1973. Evaluation of sunflower to rust and Verticillium wilt. Plant Dis. Rep. 57: 524-528.

RUST

Puccinia helianthi

Cultural: Locate new fields as far as possible from fields where sunflowers were grown the preceding year. Control wild sunflowers and volunteers. Turn under rust-carrying debris of the previous crop.

Resistant Cultivars: 6300 (resistant to races 2, 3 and 4), Hysun 323 (resistant to races 2 and 3)

Intermediate: AC 60, Bigfoot, Cadet, Capri, Challenger, CLOL 803, Comet-C, Hysun 311, Hysun 521, IS 8048, IS 7000, IS 7111, 63A70, 6946, Kodiak, MRS 40, PRO 9215, Proseed 9310, PVN 2301, SF 128, SF 187, ST 439, Sunwheat 101, Sunwheat 103, Yukon, 828, 3311, 6111, 6230, 6322, 63C40 (See notes).

Susceptible: AC Aurora, AC Sierra, IS 5757, IS 6039, IS 6421, IS 8004, Mustang, MY 9338, MY 7240, MY 8282, P63A81, RH 3703, SF 270, Trisun 846, 8242NS, 63A21, 63C71, 6150.

Chemical: One and/or two applications of the fungicides mancozeb, propiconazole, fluazinam, chlorothalonil, and myclobutanil reduce rust severity and improve yield (non-registered fungicides, ref 3).

Notes: The reaction of these hybrids refers only to sunflower rust race 2 which was predominant in Manitoba a few years ago. Most Commercial hybrids are susceptible to the new rust races 3 and 4 common in southern Manitoba and eastern Saskatchewan.

References:

1. Rashid, K. 1991. Incidence and virulence of *Puccinia helianthi* on sunflower in western Canada during 1988-1990. Can J. Plant Pathol. 13: 356-360.

2. Zimmer, D.E. *et al.* 1973. Evaluation of sunflower for resistance to rust and verticillium wilt. Plant Dis. Rep. 57: 524-528.

2. Rashid, K. Y. 1997. Effects of fungicides on rust severity and yield in sunflower. HELIA 20: 43-48.

SCLEROTINIA WILT AND HEAD ROT

Sclerotinia sclerotiorum

Cultural: Sow well cleaned seed, free of sclerotia. Use cereals, corn or grasses in a crop rotation, allowing at least 4 years between susceptible crops such as beans, buckwheat, fababeans, lentils, mustard, and rapeseed. Control broadleaved weeds and volunteer susceptible crops. Since dense seeding promotes Sclerotinia wilt, do not exceed the recommended seeding rates, and seed uniformly. Plant spacings of 30 cm and greater reduce root contact and plant-to-plant spread of the disease.

Resistant Cultivars: None.

Intermediate: Capri, Challenger, MRS 40, ST 330 for wilt (see notes).

Susceptible: All other commercial hybrids and cultivars to wilt and head rot.

Chemical: None.

Notes:

1. Reaction to sclerotinia wilt is based on 3-year testing in naturally infested fields.

2. The pathogen may infect sunflower stems and heads and cause mid-stem breakage and head rot.

3. Survival of sclerotia of *Sclerotinia sclerotiorum* is affected by hyperparasites such as *Coniothyrium minitans*. The sclerotia produced on the underground portion of the host tissue are more readily killed by hyperparasites than those produced in above ground tissue (2).

References:

1. Hoes, J.A., and H.C. Huang. 1985. Effect of between-row and within-row spacings on development of sclerotinia wilt and yield of sunflower. Can. J. Plant Pathol. 7: 98-102.

2. Huang, H.C. 1977. Importance of *Coniothyrium minitans* in survival of sclerotia of *Sclerotinia sclerotiorum* in wilted sunflower. Can. J. Bot. 55: 289-295.

3. Rashid, K.Y., and W. Dedio. 1992. Differences in the reaction of sunflower hybrids to sclerotinia wilt. Can. J. Plant Sci. 72: 925-930.

OTHER DISEASES

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

Aster Yellows (aster yellows phytoplasma) MI

Bacterial Leaf Spot (*Pseudomonas syringae*) NC

Botrytis Head Rot (*Botrytis cinerea)* NC

Leaf and Stem Spot (*Alternaria zinnae, Septoria helianthi*) NC

Phialophora Yellows (*Phialophora asteris* f. sp. *helianthi*) NC

Phoma Black Stem (*Phoma oleracea* f. sp. *helianthi-tuberosi*) NC

Phomopsis Stem Canker (*Phomopsis helianthi*) NC

Powdery Mildew (*Erysiphe cichoracearum*) NC

Rhizopus Head Rot (*Rhizopus* sp.) NC

GENERAL REFERENCES

1. Bergland, D.R. 1994. Sunflower production. Extension Bulletin 25. North Dakota State University Extension Service, Fargo, ND

2. Burgess, L. *et al.* 1979. Insect pests and diseases of rape and mustard. Rapeseed Assoc. Can., Publ. 48.

3. Canola council of Canada. 1992. Canola Growers Manual: Grow with Canola. Revised yearly. Winnipeg, Man.

4. Davidson, J.G.N. and Ellis, P.J. 1983. Disease control in canola/rapeseed. *In* Canola/rapeseed production and research review in the Peace River region. Agric. Can. Res. Sta., Beaverlodge, Publ. NRG-83-7.

5. Evans, I. 1987. Diseases of canola. Alberta Agriculture, Agdex 149/632-2.

6. Flax Council of Canada. 1996. Growing flax. Winnipeg, Man.

7. Gill, K.S. 1987. Linseed. Indian Council of Agricultural Research, new Delhi, India.

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9. Hoes, J.A. 1975. Diseases of flax in Western Canada. Pp. 415-423 *in* J.T. Harapiak (ed.). Oilseed and pulse crops in Western Canada. Western Cooperative Fertilizers Ltd., Calgary.

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11. Kharbanda, P.D., and J.P. Tewari. 1996. Integrated management of canola diseases using cultural methods. Can. J. Plant Pathol. 18: 168-175.

12. Martens, J.W. *et al.* 1984. Diseases of field crops in Canada. Pp. 116-121.

13. Millikan, C.R. 1951. Diseases of Flax abd Linseed. Tech. Bull. No. 9, Dept. Of Agric., Victoria Australia.

14. Multiple papers. 1992. Symposium on biology and control of *Leptosphaeria maculans*. Can. J. Plant Pathol. 14: 30-75.

15. Muskett, A.E. and J. Colhoun. 1947. The Diseases of the Flax Plant (*Linum usitatissimum* Linn.). W. & G. Baird Ltd. Belfast, Northern Ireland.

16. Paul, V.H. and Rawlinson, C.J. 1992. Diseases and Pest fo Rape. Verlag Th. Mann, D-4560. Gelsenkirchen-Buer, Germany.

17. Petrie, G.A. 1975. Diseases of rapeseed and mustard. Pp. 399-413 *in* J.T. Harapiak (ed.). Oilseed and pulse crops in Western Canada. Western Cooperative Fertilizers Ltd., Calgary.

18. Tewari, J.P. and Mithen, R.F. 1999. Diseases. *In* Biology of Brassica Coenospecies. Ed. C. Gomez-Campo. Elsevier, New York, NY. Pp. 375-411.

19. Thomas, P.M. 1984. Canola Growers Manual. Canola Council of Canada, Winnipeg, MB. (Http://www.canola-council.org/).

20. Turner, J. 1987. Linseed Law: A Handbook for Growers and Advisors. Alderman Printing & Bookbinding, Ipswich, BASF UK Ltd., Hadleigh, UK.

Appendix I. Fungicides registered for use against diseases of oilseeds in Canada

Crop	Disease	Trade Name	Active Ingredient	Formulation	PCP #
Canola (rapeseed)	alternaria black spot	Rovral Flo	iprodione	FL	18977, 24378
		Quadris	azoxystrobin	FL	26153
	blackleg (seed borne)	Vitavax RS[a] Fungicide	carbathiin + thiram	LI	25862
		Helix Helix Xtra	thiamethoxam + fludioxonil + difenoconazole + mefenoxan	LI	26637 26638
		Foundation Lite	iprodione + thiram	LI	25592
	blackleg (foliar)	Tilt	propiconazole	EC	19346
		Quadris	azoxystrobin	FL	26153
	sclerotinia stem rot[b] (foliar)	Ronilan EG	vinclozolin	EG	24894
		Rovral Flo	iprodione	FL	18977, 24378
		Quadris	azoxystrobin	FL	26153
	seedling blight[c] (damping off)	Vitavax RS Fungicide	carbathiin + thiram	LI	25862
		Helix Helix Xtra	thiamethoxam + fludioxonil + difenoconazole + mefenoxan	LI	26637 26638
		Foundation Lite	iprodione + thiram	LI	25592
		Apron FL	metalaxyl	LI	24262
		Allegiance	metalaxyl	LI	26674
Mustard	seedling blight (damping off)	Vitavax RS Flowable Vitavax RS Dynaseal Cloak	carbathiin + thiram + lindane	SU	16451 24482 22121
		Helix Helix Xtra	thiamethoxam + fludioxonil + difenoconazole + mefenoxan	LI	26637 26638
		Foundation Lite	iprodione + thiram	LI	25592

[a] Vitavax RS Fungicide is a component of the Gaucho seed treatment system.

[b] Products containing benomyl remain registered but little product is believed to exist since DuPont has decided to discontinue products with this active ingredient.

[c] As of June 30, 2001 products containing lindane were no longer to be used on canola although they can still be used on mustard. However due to a large volume of product carry-over no decision has been made as of November, 2001 by PMRA regarding use of products containing lindane on canola for the 2002 crop year.

Appendix I. Fungicides registered for use against diseases of oilseeds in Canada (continued)

Crop	Disease	Trade Name	Active Ingredient	Formulation	PCP #
Flax	seed decay, seedling blight, root rot	IPCO N-M Drill Box	maneb	DU	10660
		Vitavax Powder	carbathiin + thiram	DU	15538
		Vitaflo 280	carbathiin + thiram	SU	11423
		Vitavax Single Solution	carbathiin	SN	14069
Sunflower	downy mildew	Apron FL	metalaxyl	LI	24262
		Allegiance	metalaxyl	LI	26674