

# Flax on the Farm

## Disease and Environmental Disorder Monitoring and Control

Flax is susceptible to a number of diseases, however economic losses tend to be minimal in most years. This, combined with the fact that many diseases are unique to flax, makes it a great choice for incorporation into rotations.

### Methods of Disease Control

- Chemical
  - Scouting for diseases and the accurate identification of them is critical before making chemical application decisions.
  - Follow best practices for chemical control of diseases. Using the right product at the proper stage during optimal conditions and at the recommended rate will maximize the efficiency of control and prevent the development of resistance.
  - Only four groups of foliar fungicides are registered for use on flax, so chemical rotation is important to reduce the risk of developing resistance.
  - Consult product labels and provincial crop protection guides for application rates and restrictions related to environmental conditions, personal protective equipment (PPE), water volume, number of applications, application intervals, sequential applications, tank mixes, crop staging, re-entry periods, buffer zones, re-cropping and pre-harvest intervals.
  - Using pest control products that are not registered on flax or that are applied outside of the recommended pre-harvest interval (PHI) can result in marketing and trade issues related to maximum residue limits (MRLs).
- Host Tolerance/Resistance
  - Refers to the ability of a plant to suppress, prevent or tolerate the growth of a pathogen.
  - Genetic resistance to plant disease is a good way to reduce the crop's susceptibility to the disease.
  - Host resistance in flax is available for: rust, Fusarium wilt and powdery mildew.
    - All commercially available flax varieties are immune to rust. The majority of flax varieties are rated as moderately resistant to powdery mildew
    - Fusarium wilt resistance of currently available flax varieties ranges from moderately resistant to resistant.
  - No commercially available varieties of flax are genetically resistant to pasmo.
  - Disease resistance ratings of flax varieties can be found in the provincial seed guides:
    - [Alberta](#)      [Saskatchewan](#)      [Manitoba](#)
  - Host resistance can be overcome through mutation of the pathogen. Adherence to recommended pesticide rates and product rotation is important to reduce the chances of the pathogen reproducing and mutating.
- Cultural
  - Includes mechanical, environmental or other non-chemical or non-biological methods of controlling a disease (e.g. crop rotation)
- Biological
  - Refers to natural enemies of the pest.
  - Can include parasitoids, predators and diseases.
  - These organisms play a largely behind the scenes role in controlling the populations of many pest species on the Prairies.

## Integrated Disease Management (IDM)

- Integrated Disease Management is the practice of evaluating all available methods of pest control (chemical, cultural and biological) and making decisions on which single or combination of methods to use based on economics, environmental safety, and efficacy. Most diseases are best managed through an integrated approach which includes multiple management strategies. This will improve the effectiveness of disease control and will reduce selection pressure on the pathogen which can lead to the development of fungicide insensitivity.
- With general public concern over the safety of pesticides and their effect on beneficial organisms, this crop management practice has gained prominence in recent years.
- 6 elements of IDM:
  - Prevention of disease problems
  - Accurate identification and knowledge of diseases, their damage and natural enemies
  - Surveillance of diseases, crop damage, natural enemies and weather conditions
  - Application of economic thresholds
  - Suppression of disease populations
  - Evaluation of results

## Scouting

- Continuous monitoring of diseases and environmental disorders throughout the growing season is important for the effective implementation of control measures.
- Scouting should be done on a weekly basis and more frequently when conditions are favourable for an outbreak (e.g. humid conditions, crop lodging, heavy weed pressure, etc.).

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## Flax Diseases: Then and Now

### By: Barb Ziesman PhD, Provincial Plant Disease Specialist

Due to dry conditions across a large portion of the province, disease levels were generally low in most crops in 2018 including flax. PasmO was reported in 54% of the 85 Saskatchewan flax fields surveyed last year. Both the severity and prevalence of the disease were lower than reported in the previous three years (2015, 2016 and 2017). Powdery mildew (6% of crops), aster yellows (6 % of crops), Fusarium wilt and root diseases were reported in 2018, but at low levels.

It is common to see variation in disease levels from year-to-year, due to differences in environmental conditions. When the pathogen is present, the environmental conditions during the growing season will influence whether or not infection will occur and the severity of the infection. Disease levels will be highest when pathogen levels are high and when the environmental conditions are favourable for disease development. This means that fungicide application decisions need to be made during the growing season and need to be based on what is happening that year, especially for foliar diseases. PasmO is often the most prevalent disease of flax. Understanding the environmental conditions that favour disease development will be helpful to estimate the risk of disease development, which can be used to guide disease management decisions throughout the growing season.

**PasmO** is a polycyclic disease caused by the fungus *Septoria linicola*. Polycyclic diseases have more than one disease cycle or infection cycle per season which means that the disease can spread and severity can increase quickly when environmental conditions favour disease development. With most polycyclic diseases, new spores are produced within each disease lesion, and these spores can then be spread to healthy plant tissues to cause new lesions and increase disease severity. PasmO disease development is favoured by warm, wet conditions. Rain events promote the spread of the disease as rain splashing is the primary way that spores move from a disease lesion to healthy plant tissue.

*As with most diseases, pasmo will be best managed through an integrated approach to disease management. Some strategies for managing pasmo are as follows:*

- *Follow a minimum of a three-year rotation to allow time for infected residue to break down between flax crops.*
- *Avoid seeding flax adjacent to fields where flax was seeded in the previous year.*

- *Plant flax varieties with lodging resistance. Lodging within the crop will keep the canopy moist and favour disease development.*
- *Use the recommended seeding rates. Higher than recommended seeding rates may result in increased crop lodging.*
- *Control weeds. When the canopy is dense with both weeds and flax plants, the microclimate within the canopy will become more favourable for disease development as a denser canopy holds more moisture.*
- *Apply foliar fungicides at early flowering when disease pressure warrants a fungicide application.*

When deciding whether or not to apply a fungicide, it is important that you scout the field to look for disease symptoms. Since pasmo is a polycyclic disease we can use initial symptoms of the disease to assess risk and apply foliar fungicides to prevent further disease spread. The goal is to minimize stem infection which can result in weakened stems and yield losses. Prior to and near flowering, scout crops and look for the presence of brown to black lesions on the lower leaves. If lesions are present and environmental conditions are suitable for disease development, consider applying a registered fungicide. In wet years or when frequent showers occur during flowering, visit your fields 1 to 2 weeks after the first foliar fungicide. If pasmo lesions are present on new growth and conditions are still favourable for disease development, a second fungicide application may be warranted. Refer to the product label and follow all application rates, timing restrictions and pre-harvest intervals.

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The accurate identification of diseases and environmental disorders, knowledge about their lifecycles and methods of prevention and control are key to making good crop management decisions. Below are descriptions of the various diseases and environmental disorders that you may come across in your flax crop and the methods that can be used to prevent or control them.

**Table 1. Diseases of flax**

Disease	Causal organism(s)	Characteristics	Symptoms	Cultural control	Chemical control	Economic concern?	Comments	Unique to flax?
Alternaria blight	<i>Alternaria</i> spp.	seed and residue-borne fungus	seedling stage: dark red lesions on seedling leaves and stems, roots with water-soaked brown appearance, older plants: dark red to brown spots on older leaves and flower parts, leaf death, bud death, seed abortion	follow standard flax rotation, control flax volunteers	none	very rarely	seed that is black in colour may be infected with <i>Alternaria</i>	no
Aster yellows	Phytoplasma	bacterial parasite transmitted by aster/six-spotted leaf hoppers blown in from the US via southerly winds, moves through the plant via the sugar-conducting tissues (phloem), overwinters in the roots of alfalfa and perennial weed species	deformed flower parts that look like leaves and set no seed, uppermost sections of stems turn pale green to yellow, may affect single branches or entire plants, infected plants often stunted	seed early, good control of perennial weeds, seed far from alfalfa	none	very rarely	infection occurs early in the season but symptoms do not appear until flowering, symptoms tend to be worse in wet soils, epidemics in 1957 and 2012 due to unusually early leafhopper migrations during abnormally warm springs	no
Crinkle	Oat blue dwarf virus (OBDV)	virus transmitted by aster/six-spotted leaf hoppers blown in from the US via southerly winds, moves through the plant via the sugar-conducting tissues (phloem)	leaf puckering/wrinkling, stunted growth, reduced branching	seed early	none	very rarely	virus also infects barley, oats and wheat	no
Fusarium wilt	<i>Fusarium oxysporum</i> f. sp. <i>lini</i>	soil, residue and seed-borne fungus, enters roots and moves through plant via water-conducting tissues (xylem), infection can occur at any growth stage, spores spread by wind and rain	early season infection results in seedling death before or shortly after emergence, later season infection causes yellowing of leaves, wilting (typically only on one side of the plant), stem bent like a shepherd's crook	plant a resistant variety, plant clean seed (i.e. with very little chaff), seed early, seed at the higher end of the recommended rate, practice a 1 in 4 year rotation, never seed flax after flax, avoid using trifluralin on previously infected fields due to significant negative impact on the emergence of the subsequent flax crop, good control of flax volunteers	seed treatments- Insure Pulse, Vitaflo	occasionally	currently registered varieties are moderately resistant (MR) or resistant (R), fungus grows best in warm soil, spores can survive in soil up to 10 years, inoculum very rapidly builds up in soils	yes
Grey mould	<i>Botrytis cinerea</i>	seed-borne fungus, attacks plants at all growth stages	seedling stage: brownish spots on the seedling stem close to the soil surface, wilted plants that fall over and die, older plants: stems turn light brown and become soft, plants parts above infected stem die followed by the death of the whole plant, under humid conditions a fuzzy grey coloured mould will appear on plant tissues	plant a lodging resistant variety, follow recommended fertilizer rates (i.e. avoid over-fertilizing), seed at the low end of the recommended rate, maintain good weed control	none	very rarely	fungus grows best in warm moist conditions	no
Pasmo	<i>Septoria linicola</i>	residue and seed-borne fungus, infects all above-ground plant parts at any growth stage, spores dispersed by wind and rain	circular brown spots on leaves early in the season, defoliation, alternating green and brown/black bands on stems (candy cane-like) late in the season, premature ripening, boll drop if plants left to stand for a long time before harvest, during ripening appears as reddish brown patches of lodging plants in the field from a distance	plant a lodging resistant variety, plant clean seed (i.e. with very little chaff), seed at the lower end of the recommended rate, seed early, follow recommended fertilizer rates, practice a 1 in 5 year rotation, plant flax crop as far away from previous year's crop as possible, maintain good weed and volunteer flax control	foliar fungicides- Acapela, Headline EC, Priaxor	yes	currently registered varieties are susceptible (S) or moderately susceptible (MS), stem lesions can weaken stems causing lodging, grows best in humid conditions (warm and moist), can cause yield losses up to 60% if a foliar fungicide is not applied, infection after seed fill causes no economic losses, seed that is grey in colour may be infected with pasmo	yes
Powdery mildew	<i>Oidium lini</i>	crop residue-borne fungus, tends to infect plants at later growth stages	begins as powdery white spots on leaves which can spread to cover entire leaves causing leaf death, can also infect stems and pedicels (individual flower stems) which in severe cases will cause stem breakage and boll drop	grow a moderately resistant (MR) variety, plant clean seed (i.e. with very little chaff), seed early, practice a 1 in 4 year rotation, bury infested residue, good control of flax volunteers	none	rarely	relatively new disease for flax (first observed in 1997), currently registered varieties are moderately susceptible (MS) or moderately resistant (MR), pathogen thrives under warm (20-25°C) humid conditions but does not do well under rainy conditions, has caused yield losses of 20-30% in research plots	yes

**Table 1. Continued**

Disease	Causal organism(s)	Characteristics	Symptoms	Cultural control	Chemical control	Economic concern?	Comments	Unique to flax?
Root rot	<i>Rhizoctonia solani</i> , <i>Pythium</i> spp., <i>Fusarium</i> spp.	soil-borne fungi, infect plants at later stages of development so symptoms often don't appear until after flowering	wilted plants, premature ripening, stunted roots, discoloured roots	do not seed deeper than necessary, plant high quality (i.e. not damaged) seed, seed at the high end of the recommended rate, practice a 1 in 4 year rotation, specifically for <i>Rhizoctonia solani</i> : seed early, do not seed after legumes or sugar beet, do not sow on summerfallow, pack after seeding, practice conservation tillage	seed treatments- Insure Pulse, INTEGO Solo, Vitaflo	rarely	same fungi that cause seed rot and seedling blight	no
Rust	<i>Melampsora lini</i>	crop residue-borne fungus, infects all above ground plant parts, spores spread by wind	inconspicuous yellow pustules on the cotyledons and lower leaves of seedlings, large orange powdery pustules on the leaves, stems and bolls of older plants that eventually turn black, can lead to defoliation and stem girdling	plant a resistant variety, plant clean seed (i.e. with very little chaff), seed early, practice a 1 in 4 rotation, bury infested residue, good control of weeds and flax volunteers, plant flax crop as far away from previous year's crop as possible	none	no	was the most economically important disease of flax until the introduction of resistant varieties in the 1970s, caused yield losses from 25 to 50%, all currently registered varieties are resistant, growing a non-resistant variety may lead to the erosion of the current level of varietal resistance due to the development of new races, pathogen prefers high humidity, warm days and cool nights and higher soil temperatures,	yes
Sclerotinia	<i>Sclerotinia sclerotiorum</i>	soil-borne fungus	water-soaked elongated lesions on stems, stem girdling, premature ripening leading to bleached/grey stems, dark brown/black sclerotia (fruiting bodies) develop inside stems, sclerotia look like mouse droppings	plant a lodging resistant variety, follow recommended seeding and fertilizer rates, avoid water-logged soils	foliar fungicides- Priaxor, Proline 480 SC, Serenade Max	very rarely	tends to only occur in significantly lodged flax under high moisture conditions, flax crop is not a significant source of the disease the following year because the survival rate of the sclerotia is low compared to those produced on other crops	no
Stem break and browning	<i>Aureobasidium pullulan</i> var. <i>lini</i> ( <i>Polyspora lini</i> )	crop residue and seed-borne fungus	water-soaked spots on early leaves which later develop purple margins, leaf lesions spread to the first node of the stem and may eventually cover a large portion of the stem, plants often fall over when in bud or early flower stage due to a canker at the first node	seed early, do not plant seed harvested from an infected field, practice a 1 in 4 year rotation, plant flax crop as far away from previous year's crop as possible, good control of flax volunteers	none	rarely	harvest losses occur due to plants laying on the ground that can't be picked up by the combine, disease most common in the Parkland regions of AB and SK	yes

Compiled from the Diseases of Field Crops in Canada, Field Crop Disease Handbook, Flax, The Genus Linum, Guidelines for the Control of Plant Diseases in Western Canada and Growing Flax publications, as well as from personal communications with Dr. Khalid Rashid.

**Table 2. Foliar fungicide options for flax**

Active(s)	Product(s)	Crop stage	No. applications allowed <sup>σ</sup>	Tank mix partners	Group(s)	pasmo	Sclerotinia
fluxapyroxad, pyraclostrobin	Priaxor	20-50% flowering	2		7, 11	√	√**
picoxystrobin	Acapela	prior to disease development or at 20% flowering*	2	Coragen, Assure II	11	√	
prothioconazole	Proline 480 SC	20-50% flowering <sup>§</sup>	1	Decis 5 EC, Lorsban 4E, Matador 120EC	3		√
pyraclostrobin	Headline EC	20% flowering	2	Decis 5 EC	11	√	

Compiled from the 2019 AB, SK and MB crop protection guides. Check product labels for application rates and restrictions (environmental conditions, PPE, water volume, number of applications, application intervals, sequential applications, tank mixes, crop staging, re-entry periods, buffer zones, re-cropping and pre-harvest intervals).

\*approximately 7 to 10 days after the initiation of flowering

\*\*suppression only of Sclerotinia

<sup>σ</sup>off-label tank mixes supported by the manufacturer

<sup>§</sup>most effective when applied early in the morning before petals fall off

**Table 3. Environmental disorders of flax**

Disorder	Cause	Symptoms	Cultural control	Chemical control	Economic concern?	Comments	Unique to flax?
Boll blight	combination of several different diseases and environmental stresses	bud, flower and/or young boll death	none	none	very rarely	incidence often a result of warm, dry conditions following cold, wet weather	yes
Chlorosis	iron, manganese or zinc deficiency or waterlogged soils	otherwise healthy plants have pale green to yellow leaves with distinct green veins towards the top of the plant, slowed growth, prolonged conditions may cause dieback of the main stem and tillering, delays maturity	plant a resistant variety, seed later, apply deficient micronutrient in a test strip and if crop responds, apply to entire field	none	occasionally	seedlings on cool wet calcareous soils most susceptible, plants typically grow out of the condition once the soil dries out, AC Emerson is the most tolerant variety, soil and plant tissue samples can be sent to an accredited lab for determination of which micronutrient is lacking, research has shown that addition of the deficient micronutrient is rarely profitable	no
Heat canker	damage to seedling stem due to extreme soil heating	excessive heating of soil when seedlings are young damages the stem, may lead to seedling death or development of scar tissue (swollen, rough and cracked) near the soil surface which later causes plants to fall over and to tiller, plants often topple over after a high wind, plants will die if growing point damaged by the canker	seed at the higher end of the recommended rate, follow recommended agronomic practices to produce an even vigorous stand, seed in a north-south direction, seed early, practice conservation tillage	none	occasionally	increased incidence when the soil crusts, plant stands are poor and soils are light in texture and dark in colour	no
Frost canker	damage to seedling stem from frost	frost damage to seedlings at the soil surface may kill young seedlings or lead to the development of scar tissue (swollen, rough and cracked) near the soil surface which later causes plants to fall over and to tiller, plants will die if growing point damaged by the canker	seed later, seed at the higher end of the recommended rate, follow recommended agronomic practices to produce an even vigorous stand	none	occasionally	severity tends to be worse in low-lying areas, on light soils and when plant stands are thin	no

Compiled from the Diseases of Field Crops in Canada, Field Crop Disease Handbook, Flax, The Genus Linum, Guidelines for the Control of Plant Diseases in Western Canada and Growing Flax publications.

- If you need help identifying an insect, weed, disease or environmental disorder in your flax crop you can:
  - Speak to a Crop or Pest Specialist at your regional Provincial Ministry of Agriculture Office
  - Consult your Agronomist
  - Submit a plant or insect sample to a Provincial Laboratory
    - [Saskatchewan](#)
    - [Manitoba](#)

**For more information contact the following:**

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**Useful links:**

1. Provincial Crop Protection Guides:

- [Alberta](#)
- [Saskatchewan](#)
- [Manitoba](#)

2. PMRA Pesticide Product Label Search:

- [Online](#)
- [App](#)

3. Provincial government disease management websites:

- [Alberta](#)
- [Saskatchewan](#)
- [Manitoba](#)

4. Disease identification and management information:

- [Diseases of Field Crops in Canada](#)