

Management of Oilseed Diseases

Randy Kutcher¹, Kelly Turkington², K. Rashid³, Stephen Strelkov⁴, Ralph Lange⁵, and Stewart Brandt⁶

¹ Agriculture & Agri-Food Canada, Melfort, SK, ² Agriculture & Agri-Food Canada, Lacombe, AB,

³ Agriculture & Agri-Food Canada, Morden, MB, ⁴ University of Alberta, Edmonton, AB,

⁵ Alberta Research Council, Vegreville, AB, ⁶ Agriculture & Agri-Food Canada, Scott, SK

Introduction

The management of oilseed diseases, which refers to diseases of canola and flax in this presentation, should employ any and all strategies that have been shown to reduce the impact of the various diseases. This is referred to as integrated pest management (IPM). The practices will vary among the diseases and crops, since not all strategies will be equally effective against all diseases of both crops. Well known methods of dealing with diseases of canola and flax include genetic resistance of the host crop, agronomic practices such as crop rotation, use of pesticides, disease avoidance by use of clean seed and seed treatments, and exclusion of the pathogen from production areas by quarantine.

Canola Diseases

Blackleg. Blackleg is the most widespread disease of canola in western Canada. It comes in two forms referred to as avirulent and virulent. The avirulent form of the disease was reported in western Canada in the 1960s and is of little economic consequence to canola. The virulent form of the disease was observed in the 1970s in Saskatchewan and has spread across the prairies, although the incidence of the disease is still reported to be less in AB than in MB or SK. The use of resistant varieties has been the first line of defence for the control of virulent blackleg in western Canada in the past 15 years. The majority of varieties now fall into the moderately resistant or resistance categories, although there are still a few that are moderately susceptible.

The organism that causes blackleg (*Leptosphaeria maculans*) has the ability to change or adapt to cultivars with genetic resistance. Collections of samples of the blackleg pathogen (isolates) from across the prairies in recent years have indicated that the pathogen does vary in ability to cause disease on different varieties of canola. Recognition of the variability of the pathogen allows plant pathologists and breeders to search out new sources of resistance to introduce into canola in order to maintain a high level of genetic resistance.

Rotation of canola with other crops is just as important as genetic resistance for the control of blackleg. Although a 4-year rotation with cereals and pulses is recommended and has been shown to be an effective blackleg control strategy, economic realities, coupled with good genetic resistance in new varieties have induced producers to intensify rotations to less than one canola crop every 4 years on a particular field. Moreover in some areas of western Canada some producers will grow canola on canola residue for several years in a row. Results from studies at Melfort and Scott indicate that the severity of the disease increases with the intensity of the rotation, while yield of canola decreases. Use of blackleg resistant varieties significantly reduces

disease severity and yield loss, particularly under rotations of 2- and 3-years. However, the presence of disease symptoms on the resistant variety will result in infected residue, which will provide inoculum to initiate the disease in future canola crops. The shorter the rotation, the greater the build-up of infected residue, and therefore the greater the risk of blackleg. Also, since the blackleg pathogen has the ability to adapt to resistant varieties the greater the amount of infected canola residue, the greater the risk of selecting for strains of the pathogen that may overcome the resistance of the host variety.

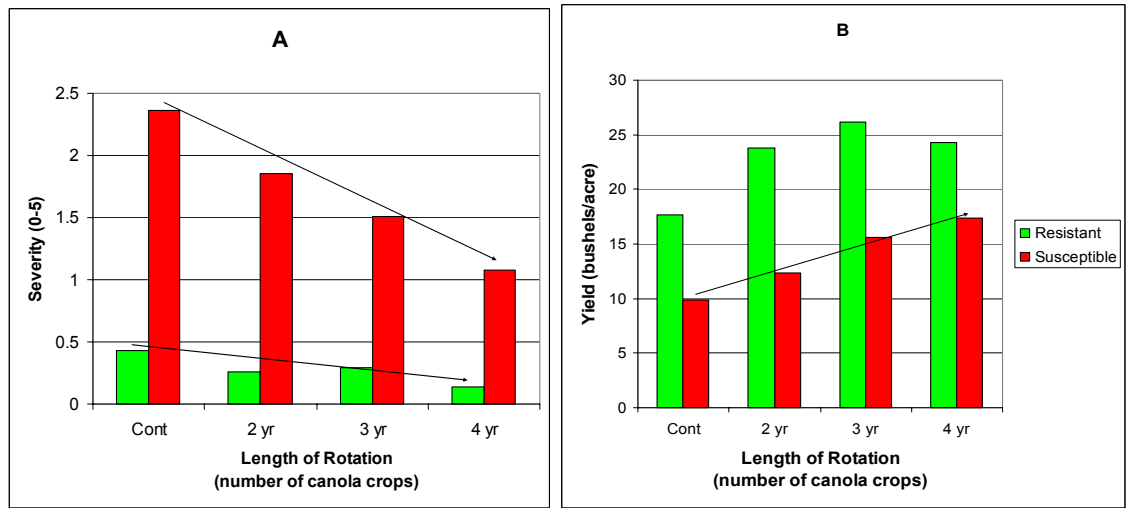


Figure 1. Severity of blackleg (A) and yield of canola (B) in rotations of blackleg susceptible and blackleg resistant varieties of canola over 10 site-years at Scott and Melfort, SK (2000-2004). Cont: continuous canola; 2 yr: canola – wheat; 3 yr: canola – wheat - field pea; 4 yr: canola – wheat - field pea or flax - wheat.

Despite the widespread presence of blackleg in western Canada disease avoidance strategies should continue to be used. For example seed treatment use is recommended to help prevent the spread of new strains of the disease, while seed testing for the blackleg pathogen is still done in Alberta. Blackleg may also be avoided by the control of volunteer canola that may be present in subsequent cereal or pulse crop years of the rotation. In Australia, there is a recommendation to avoid planting canola within 1 kilometre of a previous canola crop to reduce infection from airborne spores of the pathogen. While it would be difficult to envision widespread adoption of this strategy in Canada, it is worth considering if the previous canola crop was heavily infected by blackleg. In the past, tillage has been recommended to bury infected residue and thereby reduce the amount of inoculum of the pathogen on the soil surface. However, under the environmental and cropping system conditions in western Canada most studies involving tillage systems have not shown tillage to be a highly effective blackleg control strategy. Moreover, during the mid 1970's to late 1980's when blackleg prevalence and severity increased in Saskatchewan, Manitoba, and east central Alberta, typical practices for seedbed preparation would have been characterized as aggressive conventional tillage, while summer fallowing was still a commonly used practice. Although fungicides are registered for blackleg control they do not usually appear to be economical when resistant varieties are grown under a 4-year crop rotation.

Sclerotinia stem rot. Strategies to manage sclerotinia stem rot in canola in western Canada are very different from those used for blackleg. For example, while there may be subtle differences among varieties for incidence of sclerotinia stem rot there are no varieties that are considered resistant. A 4-year or longer crop rotation may help to reduce sclerotinia infection but has not been shown to be as effective as rotation is for blackleg control. There are a number of reasons for this. One reason is because the resting bodies produced by the pathogen (*Sclerotinia sclerotiorum*), which are referred to as sclerotia are very long-lived in the soil. Another reason these strategies are not highly effective is because the pathogen has a wide host range that includes most of the common broadleaf weeds and crops found in western Canada. This contributes to survival of the pathogen in many fields even in the absence of canola. And a third reason is that the disease has the potential to be dispersed relatively long distances between fields by wind, since the spores produced by this fungus are air-borne.

The strategy most often employed to control sclerotinia stem rot is the application of foliar fungicide during flowering of the crop. There are four products currently registered: Ronilan DF[®] (vinclozolin), Rovral Flo[®] (iprodione), Lance[®] (boscalid), and Quadris[®] (azoxystrobin). Fungicide application is a significant investment for canola producers, and because of the variability of stem rot from year-to-year, region-to-region and field-to-field, routine application of fungicide may not be economical. As an example of the variability, results from an experimental field at Melfort are presented in Figure 2. In 1998 and 2000, sclerotinia stem rot incidence was reduced significantly from the control and yield increased. However, in 1999 there was little reduction in symptoms or increase in yield using the same treatments: this, despite the fact that the experiments were all located on the same field and managed with the same protocol each year. The main difference among the years was that 1999 was cooler than 1998 or 2000. This delayed flowering in 1999, but also resulted in a longer period of flowering than in 1998 or 2000.

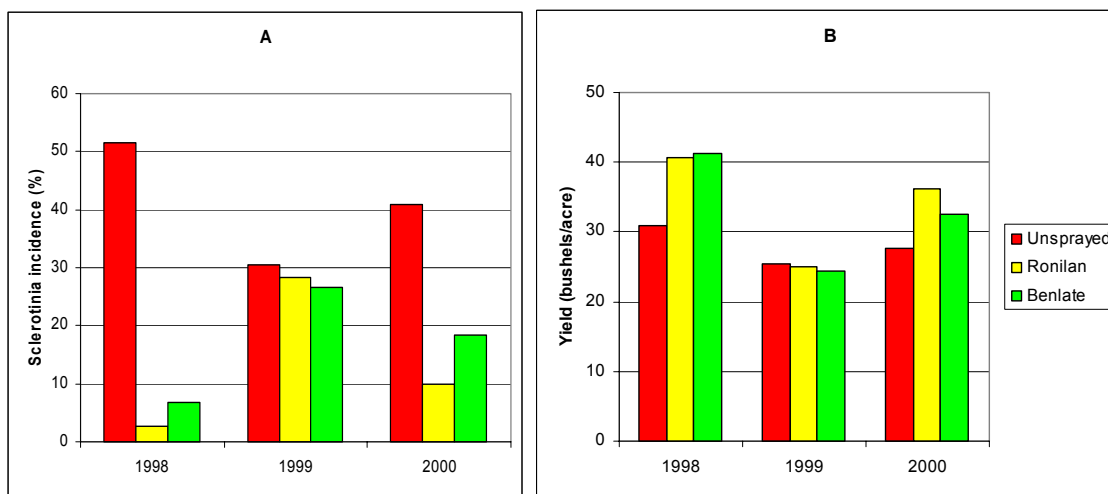


Figure 2. Sclerotinia incidence (A) and canola yield (B) for fungicide treatments at Melfort, SK

In order to increase the probability of an economic benefit from fungicide application for control of sclerotinia stem rot in canola, growers must be able to predict with reasonable certainty, the conditions under which spraying is warranted. Several attempts have been made to provide canola producers with decision support systems to help with in-crop fungicide decisions. Currently, there are two tools to help growers better understand the disease and to guide fungicide application decisions: the petal test kit and the sclerotinia checklist. The petal test was developed at the University of Saskatchewan and is available from Discovery Seeds in Saskatoon. The sclerotinia stem rot checklist can be found in the Canola Growers Manual, at the Canola Council website, or on the hard copy or CD version of the manual.

The petal test represents a pathogen-based type of forecasting system that relies on assessment of the level of flower petals infested with *S. sclerotiorum*. It is a system that relies on the importance of petals in the stem rot disease cycle. The fungus produces wind-borne spores dispersed from the apothecia (mushrooms produced by the sclerotia in soil), which infest the canola flower petals. Infested petals eventually drop from the flowers and lodge in the crop canopy. Spores of *S. sclerotiorum* require these petals as an energy source during initiation of infection into the plant. Determination of the number of petals infested by the pathogen from a particular field has been correlated with risk of development of stem rot and subsequent yield loss. However, the test is a snap shot of the particular moment when the petals are collected and subsequent infection and disease development in the crop is strongly influenced by weather conditions, particularly precipitation and relative humidity. Nevertheless petal testing throughout the flowering period can indicate fields where the risk of sclerotinia is low and spraying is not warranted even if yield potentials are high and weather conditions are favourable.

The other tool that can be used to help predict the severity of sclerotinia stem rot in canola is the sclerotinia checklist. The original checklist was developed over 20 years ago by Thomas and Evans at Alberta Agriculture. The current checklist is based on research data that quantifies the risk of sclerotinia infection based on the length of rotation, previous sclerotinia infection, density of the crop, weather conditions in the past 14 days, the weather forecast, and the numbers of apothecia observed. Points are assigned based on the assessment of these factors for a particular field. If the total score is above a threshold value when assessed at first flower there is a high probability that the field will benefit from fungicide application.

There are numerous factors that can influence the risk of sclerotinia stem rot infection of a canola crop, some of which relate to crop canopy density. The canopy can be modified by seeding rate, row spacing and fertility. While difficult to determine, these factors can have an effect of the severity of sclerotinia infection given favourable environmental conditions. Generally thick, dense canopies lead to faster canopy closure faster than thin canopies. This affects soil moisture levels beneath the canopy, which affects the germination of the resting bodies (sclerotia) of the stem rot fungus. Moist soil conditions for approximately 10 days or more induces sclerotia to form apothecia and subsequent spore release. Sclerotinia has been observed to be severe in heavily lodged fields or areas within a field. Therefore choosing cultivars that resist lodging should be beneficial to reduce sclerotinia severity. Recent work at Melfort, SK and Lacombe, AB has shown that lodging was influenced by row spacing and fertility. Greater lodging was observed at wider row spacings (> 12 inches). Fertility, particularly N fertility also leads to thick

canopies and increased risk of lodging and therefore heavily fertilized fields may be more at risk of the disease. This was observed in a study at Lacombe, AB in 1998 (Figure 3).

Recognition by growers, of management practices and environmental conditions that increase the risk of sclerotinia stem rot should help in the control of the disease.

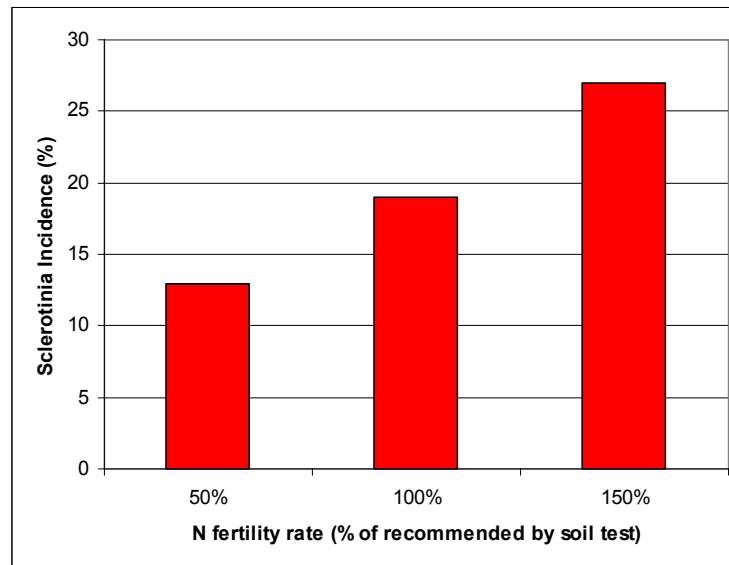


Figure 3. Incidence of sclerotinia stem rot as nitrogen (N) rate increased at Lacombe, AB in 1998.

Fusarium Wilt. Fusarium wilt of canola is caused by the fungus *Fusarium oxysporum* f. sp. *conglutinans* (FOC), a species that causes wilt diseases of many crop species. The variant of the fungus that causes wilt of canola is specialized to Brassica crops such as canola, cabbage and mustards. Different strains that cause diseases of other crops such as flax or peas will not infect canola, and canola strains will not infect other crops. Fusarium head blight or scab of cereals is an entirely different disease.

Symptoms of fusarium wilt are typically first observed after flowering or in the early pod filling stage. Leaves will become bright yellow, beginning with the veins. Soon after, stems will turn yellow, then all yellowed tissues will turn brown or reddish brown as the water conducting tissues of the plant become blocked. Occasionally, plants with symptoms on only one side of the main stem, or leaves with yellowing on only a single side will be seen. After the water-conducting tissues have been blocked, pods will cease filling, shrivel, and become twisted.

FOC is a soilborne fungus that can persist in field for very long periods, and should be considered to be permanent in affected fields. The fungus is not carried on canola seeds, but is probably distributed by wind or surface water flows. Because the organism is so long-lived, crop rotation is ineffective. Effective control by seed treatments of foliar fungicides has not been demonstrated. Despite this, canola producers are unlikely to encounter any problems with fusarium wilt because rapid action by plant pathologists and plant breeders soon after the disease

was discovered in 1999 meant that susceptible varieties and breeding lines were rapidly withdrawn from sale.

Yield losses due to fusarium wilt, which can exceed 30%, can be completely eliminated by using resistant varieties, as shown in Table 1. Table 1 also shows that the disease is not present in all fields, but there is no easy way to measure the amount of FOC present in a soil. For this reason, canola growers should only plant resistant varieties. However, the resistance ratings of most canola varieties currently available on the market are not published, so growers would be well advised to ask if a variety they are considering is resistant. As of 2006, seed companies are required to provide resistance test data before any new variety can be registered. This means that variety-specific information will be available for all cultivars registered after 2006 from seed companies or seed retailers.

Almost all varieties tested to date have been resistant to fusarium wilt. Known susceptible varieties such as 45A55, DS Roughrider or Canterra 1604 have been withdrawn from the market. In 2005, only a single instance of fusarium wilt was noted in production fields in Alberta and Saskatchewan, although the disease was observed in a number of fields in Manitoba.

It is doubtful that susceptible varieties will be introduced to the market in future, since inheritance of resistance is probably controlled by a single gene. This means that it is a simple task for plant breeders to incorporate FOC resistance into argentine canola; a task that will be made simpler by molecular genetic markers that will soon be available to breeders. Unlike blackleg, resistance to fusarium wilt is unlikely to break down. In cabbage, which is also resistant to FOC, resistance has remained effective for nearly 70 years. FOC is very uniform at the genetic level; this means that varieties bred to be resistant to one strain of FOC should be resistant to all strains.

Table 1. Fusarium wilt disease severity and yield in large-plot¹ field trials at Killam and Lavoy, AB in 2005.

Site	Variety	Severity (1-9) ²	Yield (bu/ac at 7% moisture)
Killam (No disease)	Canterra 1604 (Susceptible)	1.1	43.7
	Cougar CL (Resistant)	1.1	39.7
Lavoy (Severe disease)	Canterra 1604 (Susceptible)	4.4	14.8
	Cougar CL (Resistant)	1.1	33.7

¹ Harvested area of each plot at Killam was 576 m² at Lavoy, and 2800 m² at Killam.

² 1=no disease, 9=dead plant.

Clubroot. Clubroot of crucifers, caused by the obligate parasite *Plasmodiophora brassicae*, is a new disease of canola on the prairies, although it has been a major problem on cole crops in British Columbia and eastern Canada for many decades. A soilborne disease, clubroot derives its name from the formation of conspicuous galls or “clubs” on the roots of affected plants. The formation of these galls impedes water and nutrient uptake by the plant, leading to wilting, stunting, and premature ripening, which in turn reduce yield and seed quality. A survey in 2005 revealed the presence of more than 40 clubroot-infested canola fields in central Alberta.

Management of clubroot is complicated by the fact that the pathogen produces long-lived resting spores, which can remain viable in the soil for up to 15 years. There are currently no fungicides

registered for control of the disease on canola, and no genetically resistant cultivars are available. A number of strategies have traditionally been used to manage the disease on cole crops, including liming of the soil and application of calcium cyanamide, a nitrogen fertilizer with fungicidal properties. However, none of these strategies have been evaluated for their effectiveness in controlling clubroot on canola under prairie conditions. The rationale behind liming the soil is that clubroot development is favoured in acidic soils, and therefore an increase in the pH of the soil should reduce disease severity. However, while this strategy has had some success in cole crops, it may not be a feasible option for management of clubroot on canola, considering the large quantities of lime that would be required to elevate the soil pH sufficiently over an entire field. Similarly, the effectiveness and economic feasibility of the use of calcium cyanamide for control of clubroot have not been assessed on the canola crop. Given the lack of management options and the longevity of the pathogen resting spores, exclusion of the disease from “clean” fields, along with long crop rotations in infested fields, remain the only strategies available for management of clubroot on canola.

As clubroot is a soilborne disease, the most effective method of preventing its spread is to remove soil and crop debris from farm equipment before leaving infested fields, thereby preventing its transport into new fields. Soil conservation practices, such as minimum or zero tillage, may also help prevent the spread of the disease by minimizing soil movement by erosion. However, once a field is infested, long rotation out of canola (and other crucifers) becomes the only viable option for managing clubroot. Rotations should be at least five to seven years in length, and care should be taken to control volunteer canola and susceptible weeds in the rotation crops, as these may serve as hosts for the pathogen. While this length of rotation may be insufficient to completely rid a field of clubroot, the disease severity should be significantly reduced when canola is planted again.

Flax Diseases

Flax growers should be aware of a number of diseases that may affect their production.

Seedling Blight. This is a common disease of flax caused by a complex of *Rhizoctonia solani* and or *Fusarium* and *Pythium* spp. Seedling blight usually has a relatively low impact (<1% of plants affected) on the crop, but under stressful environmental conditions it can cause a serious problem. *Rhizoctonia* is particularly damaging under warm soil conditions. The flax seed coat is delicate, especially in the yellow-seed coat cultivars, and can be subject to damage at harvest, allowing easy pathogen entry after seeding. Affected seedlings turn yellow, wilt and die and may occur singly or in patches in a field. There is no single method of control. Ensuring the harvested seed is not damaged due to improper combine settings will result in healthy seed, while fungicide seed treatment will control most seed-borne pathogens and shallow seeding (just deep enough to reach moisture) will help to ensure good emergence. A firm seedbed reduces infection by *Rhizoctonia*. Follow a good rotation, which not only means a number of years between flax crops, but also avoiding flax on summer fallow and legumes since legumes are also susceptible to *Rhizoctonia*.

Rust. Caused by *Melampsora lini*. This is not an issue for current flax growers, but needs to be mentioned since it is a great success story. Prior to the mid-1970s, yield losses were as much as

25% to this disease. However, due to a very successful breeding program and constant monitoring of the situation, all registered Canadian flax cultivars are immune to local rust races. There are no yield reductions from this disease at the present time in western Canada.

Pasmo. Caused by *Septoria linicola*. This is the most common foliar disease of flax that most growers will observe since it occurs throughout the prairies and is visible on all above-ground parts of the plant. Yield losses occur due to premature ripening, which reduces seed filling. If infected flax is left standing for straight combining the diseased bolls can also be broken off by wind and rain. The symptoms are brown spots on the leaves, which may senesce early, and brown to dark bands on the stems, which are especially noticeable in mid-late August. The pathogen is stubble-borne so removing the stubble, following a 3-4 year crop rotation, and avoiding flax in fields adjacent to the previous year's flax fields will reduce infection. Early seeding may, in some years, help the crop to escape infection or severe epidemics.

Fusarium Wilt. Caused by *Fusarium oxysporum* f.sp. *lini*. This soil-borne pathogen invades through the roots of the flax plant and is usually most damaging under warm conditions. The pathogen may kill the plant shortly before or after emergence. Delayed infection results in yellowing and wilting of leaves followed by browning and death of the plant. The tops of wilted plants often curve downward in the shape of a shepherd's crook. Plants may occur in patches or appear singly throughout the field. The pathogen survives in soil and in previous flax residue and may spread by wind, water run-off or on seed. It is long-lived in soil. There are a number of strains of this pathogen, but the development of wilt resistant cultivars (a few Canadian cultivars are resistant, but the majority are moderately resistant) have reduced the yield losses caused by this disease. A 4-year crop rotation will help to reduce inoculum in a field, and seed treatment will help to restrict entry of the pathogen into new areas.

Powdery Mildew. Caused by the fungus *Oidium lini*. This is the most recent disease discovered affecting flax on the Prairies and has been observed since 1997 (no information is available on how, when and from where this pathogen came to become established on flax in western Canada). It has been observed in all flax growing areas in Manitoba and Saskatchewan with variable incidence and severity from year to year. Usually the early signs of this disease are observed towards the end of July as grey to white mycelia covering leaves and stems. Severely infected leaves dry up and senesce resulting in crop defoliation and stems become weak and break under rainy and windy conditions. Up to a 20% seed yield reduction has been reported from infected flax plots. Stem infections will reduce the fibre yield and quality. Some Canadian cultivars are moderately resistant to this disease while others are susceptible. Control can be achieved by using resistant cultivars. Early seeding will help crops escape severe epidemics that occur at the end of the season.

Alternaria blight. Caused by *Alternaria linicola*. This is a common stubble-, and seed-borne pathogen observed in most growing areas of the Prairies. Symptoms are black lesions on leaves and stems that coalesce to form large lesions, resulting in crop defoliation and weak stems. It can penetrate the bolls to reach the seed, which reduces seed quality and viability. No resistant cultivars are available in Canada. Removal of crop residue, following a 3-year crop rotation, avoiding last years adjacent flax fields, use disease-free seed and seed treatments will help reduce the impact of this disease on yield and seed quality.