Increasing Canola and Pea Crop Frequency;

Cultivar, Fungicide, and Crop Rotation Effects on Disease/Weed Pressure and Yield

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Abstract

Field experiments in 1999 at Melfort and Scott in the 2nd year of a 5 year study revealed substantive yield losses associated with canola cultivars having low blackleg resistance, pea and canola in continuous rotations, and the decision not to apply fungicides. These yield reductions could not be attributed to reductions in spring soil water or an increase in weed competition. In a year characterized by above normal precipitation disease was determined to be the main factor contributing to canola and pea yield loss confirming the risks associated with low diversity rotations. At Scott in a canola-canola sequence greater blackleg pressure reduced the yield of a cultivar with little blackleg resistance by an average of 53% compared to the same canola grown on pea or wheat stubble and by 28% when replaced by a cultivar with moderate resistance. Application of Quadris fungicide reduced blackleg severity and incidence and reduced yield loss from 53% to 35% and from 28% to 9%. For pea grown on pea stubble at Scott an increase in mycosphaerella pressure led to a yield reduction of 28% compared to pea on wheat stubble. An application of Quadris reduced that yield loss to only 14%. Despite hail damage at Melfort higher canola yields could also be linked to lower levels of blackleg severity and incidence when a cultivar with greater blackleg resistance was selected and/or Quadris was applied. Although sclerotinia severity was low at both locations the proportion of more damaging stem infections was greater at Melfort than at Scott. Pea disease assessment at Melfort was complicated by severe hail damage and failed to show a reduction in mycosphaerella blight severity with Quadris although straw and seed yield measurements did indicate a yield increase occurred. These results although preliminary reinforce the benefits of following recommended crop rotations and growing canola cultivars with greater blackleg resistance. Results also underline the importance of appling fungicides when the frequency of growing canola or pea in rotation is increased. Site-specific responses such as greater blackleg pressure at Scott and the potential for greater sclerotinia induced yield loss at Melfort were also observed.

Introduction

The once in four year recommendation for production of canola and pea in rotation is based primarily on dealing with diseases and weeds in these crops (Brandt and Zentner 1995, Brandt et al. 1996, Campbell et al. 1990). Research by Christen et al. (1995) attributed canola yield reduction when grown more frequently to an increase in the incidence of fungal diseases. Growers frequently question whether improved disease and weed control can overcome these limitations. Past research has demonstrated potential yield advantages based on the selection of a preceding crop (Bourgeois and Entz 1996, Campbell et al., 1990) and on the benefits of a diversified rotation(Campbell et al. 1997). Research has shown that individual crops in rotation can affect the demographics of both detrimental and beneficial microorganisms in the soil which in turn can affect the growth of a subsequent crop (Clapperton et al. 1997). Currently the impact of crop rotation on plant pathogens in the soil and on the incidence and severity of disease of crops in those rotations is not well understood. Study objectives were established to determine if canola and pea can be grown more frequently in rotation without loss of productivity and to document the technological limitations that may exist. This includes an investigation into the management issues associated with the production of a herbicide tolerant hybrid canola variety with moderate blackleg resistance compared to a conventional cultivar in use when the one in four year rotation recommendation was developed. The study is also designed to investigate the benefit of fungicides in crop production.

Primary Objective- Examine the impact of cultivar improvement and pesticide use on disease and weed management and determine how this impacts on recommendations for frequency of canola in rotation.

Secondary Objective- To evaluate the frequency of canola and/or pea in the rotation on yield, cost of disease and weed control and losses due to weeds in order to develop crop sequence recommendations for canola.

Materials and Methods

To investigate the interaction of climatic conditions and crop management practices, two experimental locations representing climatic extremes for the Parkland region of Saskatchewan were chosen, Scott in the Moist Dark Brown and Melfort in the Moist Black soil zones. Field experiments were designed as 4 replicate split-plots with seven rotations, with all phases of each rotation present each year. Fungicide applications were the sub-plots. Rotations with canola have cultivar as an additional factor.

Rotation #	Rotation Phase Description	Rotation #	Rotation Phase Description
1	continuous Canola	5	Pea-Canola-Wheat
2	continuous Pea	6	Canola-Wheat-Pea-Wheat
3	Canola-Wheat	7	Canola-Wheat-Flax-Wheat
4	Pea-Wheat		

The conventional variety Westar and herbicide resistant hybrid with improved blackleg resistance Invigor 2273 were grown at Scott. The rationale is to update the hybrid canola to the most desirable cultivar available over the course of the study. At Melfort relocation (necessitated by variable nitrogen levels over the 1998 experimental site) to a site previously treated with Pursuit (imazethapyr) required growing two Smart canola varieties, 45A71 with fair blackleg resistance and 46A73 with good blackleg resistance. Varieties of other crops were Highlight field peas, AC Barrie hard red spring wheat, Flanders flax at Scott and Normandy flax at Melfort. The study was managed under conservation tillage and best practices to optimize crop production at each location.

All crops at Melfort were seeded on May 28th using a Conserva Pak drill with a 9 inch row spacing into canola stubble. Canola at Scott was seeded on May 8th, peas on May 18th, wheat on May 20th, and flax on June 3rd using a Versatile hoe drill on a 8 inch row spacing on the previous 1998 test site for a two year rotation affect. Nitrogen as 46-0-0 was side banded while phosphorous as 11-51-0 at Scott and 14-20-10-10 at Melfort was applied at the time of seeding based on soil test recommendations.

Fungicide applications on canola included Quadris (azoxystrobin 125 g ai/ha) at the rosette stage for blackleg, Ronilan (vinclozolin 500 g ai/ha) at early flowering for sclerotinia, and at Scott, Rovral Flo (iprodione 480 g ai/ha) for alternaria at late flowering. Peas received an application of Quadris (175 g ai/ha) at early flowering with an additional two applications at Scott spaced one week apart. Wheat received a single application of Tilt (propiconazole 125 g ai/ha) at the flag leaf stage. Fungicides were applied with 100 L/ha of water using a three point hitch sprayer fitted with cone guards at Scott and a shop built dessication sprayer with wind cones at Melfort.

Soil moisture at Scott was measured from 2 cores/plot at depth intervals of 0-15, 15-30, 30-60 and 60-90 cm in October and in the spring prior to seeding. Six cores/rep were taken at Melfort and bulked to characterize soil moisture conditions for the entire test site. Emergence counts were done on 2- 1 meter rows on each fungicide split at Scott and on the non-fungicide half at Melfort. Petal testing for sclerotinia (Morrall and Thomson, 1991) was done using 4 petals/ branch from 3 branches/plot taken from the non-fungicide half of all Westar plots at Scott and select plots of 45A71 and 46A73 at Melfort. Post spraying weed counts and identification were done on 25-0.25 m^2 random sampling sites in the fungicide treated half of each plot. Weekly apothecia surveys were conducted in continuous pea and canola plots after the canopy closed. Pre harvest weed and crop biomass yields were bulked from 1 meter row samples collected at 2 locations within each fungicide split, dried at 60 Celsius for 24 hours and weighed. Canola was swathed at 30% seed change. Peas, wheat , and flax were straight cut with all grain yields obtained from a 15 meter combine pass.

At Scott all plots except canola received a pre-emergent application of Roundup (glyphosate at 445 g ai/ha). The hybrid canola at Scott received an in crop application of Liberty (glufosinate ammonium at 500 g ai/ha) on June 8th. Edge granular (ethafluralin at 1232 g ai/ha) was surface applied without incorporation to all pea and Westar plots at Scott on October 19th ,1998. At Melfort both canola cultivars received an application of Poast Ultra (sethoxydim at 500 g ai/ha) on June 22nd. At Scott peas received Assure II (quizalofop ethyl at 47 g ai/ha) on June 12th and at Melfort sethoxydim at 500 g ai/ha on June 25th. Peas also received Sencor 500F (metribuzin at 0.13L ai/ha) and MCPA amine 300 (Amine 300 at 141 g ai/ha) on June 13th at Scott and June 21st at Melfort. Wheat was sprayed with Achieve 80 DG (tralkoxydim at 80 g ai/ha) and Buctril M (bromoxynil and MCPA ester each at 276 g ai/ha) on June 10th at Scott and June 23rd at Melfort. Flax was sprayed with sethoxydim at 211 g ai/ha and bromoxynil/MCPA ester at 276 g ai/ha on June 10th at Scott and June 22nd at Melfort.

To evaluate disease severity various published and modified scales were used based on disease and crop type. Higher values in all scales represent increased severity. Canola disease assessment at swathing (30% seed colour change) were conducted on 200 plants/plot using a 0-5 scale for blackleg (Newman 1984) and 0-1 scale for sclerotinia (Kutcher unpublished). The Kutcher scale uses the following severity classifications.

Disease Rating	Location	Symptoms
1.0	Lower	Main stem lesion affecting entire plant
0.75	Upper	Three or more major branches girdled
0.5	Upper	Two major branches girdled
0.25	Upper	One major branch girdled
0.01	Pod	Less than 10 pods showing infection

Pea root disease surveys were conducted at 3-4 weeks post emergence on 20 plants/plot using the Hwang et al. Lentil scale from 0-4 (Hwang et al., 1994). A foliar pea mycosphaerella survey was conducted prior to flowering on 5 sites/plot using the Xue scale from 0-9 (Xue 1997) followed by foliar and stem ratings for mycosphaerella blight every week to two weeks prior to physiological maturity (plant dry down) on 5-10 plants/plot. Stems ratings were based on the Wang scale from 0-9 (Wang 1998). At Melfort powdery mildew was rated using a scale based on work by Allen Xue. The scale uses the following severity classifications.

Disease severity	infected plants	infected area	Disease severity	infected plants	infected area
0	0	0	5	100%	10-24%
1	1-4%	trace	6	100%	25-49%
2	5-9%	1-2%	7	100%	50-74%
3	10-49%	3-4%	8	100%	75-99%
4	50-99%	5-9%	9	100%	100%

Wheat leaf spot and whole plant ratings were conducted on 10-25 plants/plot near heading and anthesis stages of growth at Melfort and at flag leaf and milk-soft dough stages at Scott. Wheat leaf disease ratings were based on Horsfall-Barratt scale from 0-11(Horsfall et al., 1945) and whole plant ratings on McFadden scale from 0-11 (Mcfadden, 1991). Crown root rot ratings were conducted at maturity on 10-25 plants/plot using the Ledingham/Tinline scale from 0-4 (Ledingham et al., 1973). Disease incidence was determined based on the percentage of plants infected.

Analyses of variance and means separation using the LSD test was performed using PROC GLM in SAS (SAS Institute Inc., Cary, NC). Regression analyses and correlation was conducted using JMP software. The transformation sqrt(weed count+0.5) was applied to weed count data prior to statistical analyses.

Results and Discussion

Climatic Conditions

Rainfall at Scott between May 1st and August 31st was 23 mm above the 36 year average of 215 mm (Table 1). Above normal rainfall in April helped to increase stored soil moisture to near normal levels at the time of seeding. Cooler than normal temperatures between May 1st and July 31st helped slow the spread of disease, while moist conditions in July and early August when the crop canopy was closed created conditions conducive to disease development. Low rainfall in the latter half of August and above normal temperatures helped speed the maturity of crops allowing harvest to be completed by early September.

Melfort climatic conditions were similar to Scott. May provided near normal precipitation amounts with below normal in June at only 14 mm and above average in July with 96 mm (Table 1). Moisture in July created very humid conditions within the crop canopy initiating the spread of blackleg and development of sclerotinia. Melfort like Scott experienced below normal temperatures between May 1st and July 31st slowing the spread of disease. Unfortunately the test at Melfort suffered a severe hail storm on August 5th resulting in significant yield loss.

Canola Disease Reaction

At Scott Invigor 2273 had consistently lower blackleg severity and incidence than Westar when grown on wheat, pea, or canola stubble (Figure 1 and Table 4). At Melfort selection of 46A73, a more blackleg resistant canola variety than 45A71 also resulted in a reduction in blackleg severity (Figure 1). Lower levels of blackleg severity and incidence at Melfort can be attributed to both varieties at Melfort possessing some degree of blackleg resistance and being subject to a lower inoculum load. The disease control benefits of the moderately blackleg resistant variety Invigor 2273 at Scott were greatest on canola stubble, reducing blackleg severity by 1.7 and incidence by 37.5% when averaged across fungicide and non fungicide plots compared to an average reduction in severity of only 0.4 and incidence of 10.6% on pea and wheat stubble. A significant fungicide X cultivar interaction for blackleg severity and incidence at Scott indicated Quadris application reduced blackleg for both canola cultivars but that Quadris was more effective on Westar than Invigor 2273. Quadris reduced disease severity in Westar by an average of 0.7 and incidence by 17.3% compared to a reduction in severity of only 0.2 and incidence of 7.1% for Invigor 2273. The fact that fungicides had a greater impact on Westar than Invigor 2273 is not surprising considering the higher levels of disease pressure in Westar. At Melfort however where generally lower levels of blackleg pressure existed only the more disease resistant variety 46A73 showed a reduction in blackleg pressure with Quadris. A closer look at the effects of Quadris on blackleg at Scott showed significant reductions in all crop rotations for both cultivars, but a trend towards declining benefit with lighter disease pressure associated with more diverse rotations. Blackleg incidence in Westar on canola stubble was reduced by 13% compared to a 22% and a 17% reduction for Westar on pea and wheat stubble, respectively. The trend was less pronounced for Invigor 2273. This may be an indication that blackleg was present in the continuous canola rotation prior to Quadris applications at the rosette stage of growth thus reducing ability of the fungicide to halt the spread of blackleg. Blackleg infection of canola on pea or wheat stubble may have occurred later thus increasing Quadris's ability to control this disease. If true, this could help form the basis for recommending earlier and potentially multiple applications of Quadris when crop rotations increase the risk of blackleg infestations.

Petal testing at Scott predicted low levels of sclerotinia. The majority of infections occurred after anthesis with approximately 65-75% of the infections occurring on branches producing low severity levels of 0.09 for Invigor 2273 and 0.02 for Westar. Greater sclerotinia incidence in Invigor 2273 (18.1%) then Westar (9.2%) was attributed to a heavier crop canopy as evidenced by higher biomass yields and that Invigor 2273 matured approximately 15 days later then Westar during a period characterized by warm humid conditions (41mm of rain and mean daily temperatures of 16.6 Celsius) conducive to sclerotinia development (Martens et al. 1988).

Although petal testing at Melfort in late July and early August revealed the potential for significant yield loss due to sclerotinia, severity in 45A71 and 46A73 was similar to Invigor 2273 at Scott while incidence was only 7.3%. Closer investigation revealed 95% of the sclerotinia infections at Melfort occurred on the main stem compared to only 25% and 35% for sprayed and unsprayed Invigor 2273 at Scott. More stem infections result in a higher disease severity rating than branch infections because associated yield losses are greater. This indicates that canola at Melfort was more at risk of damaging sclerotinia infections than at Scott. With the light infestation of sclerotinia associated reductions in sclerotinia severity and incidence at Scott and Melfort with the fungicide Ronilan were small and did not have a significant impact on yield

Pea Disease Reaction

At Scott an initial assessment of mycosphaerella blight on peas on July 6th, prior to the first Quadris application revealed a greater infestation level (2.3 out of 9) on pea stubble then wheat stubble(0.5) (See Figure 3). Stevenson and Van Kessel (1996) also observed reduced leaf disease severity in pea-wheat rotations. Subsequent surveys of stem and leaf infection on July 19th and August 11th after 3 Quadris applications (July 12th, July 21st and August 5th) also revealed greater disease pressure on pea stubble than wheat stubble, but no reductions in mycosphaerella severity as a result of Quadris applications until August 11th. Reduced disease pressure as a result of Quadris application was determined only on the leaves, which is not surprising considering that leaves were the contact location for Quadris. Quadris reduced foliar severity levels by 0.7 for peas on pea stubble and by 1.3 for peas on wheat stubble. Disease incidence was 100% by July 19th. At Melfort no reduction in mycosphaerella blight or powdery mildew infections in pea were observed in disease ratings conducted on August 3rd and August 13th after a single application of Quadris on July 20th. The fact that the final disease rating occurred at an earlier growth stage at Melfort (70% of pods reaching their final length) then at Scott (pod ripening) and that multiple applications of Quadris were applied at Scott and not at Melfort may explain why no reduction in mycosphaerella with Quadris was observed at Melfort. Earlier ratings were conducted in response to significant leaf, branch, and stem damage from the hail storm. A survey of root rot on June 24th at Scott revealed average disease ratings of 0.9 (out of 4) and an incidence of 48%, but no observable impact of previous wheat or pea crops. Plating diseased root tissue samples on potato dextrose media confirmed the presence of the fungal pathogen fusarium. Pea root rot severity surveys at Melfort indicated the presence of disease with an average disease rating of 0.3 on a scale of 0-4.

Weed Control

At Scott the numbers of annual broadleaf, annual grassy and perennial weeds were higher in Westar than Invigor 2273 canola (Table 2). The same relationship held for total weed biomass. These differences reflect the relative effectiveness of the herbicides used with each canola type and were consistent for all rotations, with one exception. Annual grassy weeds, primarily volunteer wheat numbers were higher for Invigor 2273 grown on wheat than on canola or pea stubble, and were reflected as greater weed biomass. Despite these differences, weeds had only a minor impact on yield, because even in Westar, weed biomass accounted for 10 % or less of total crop biomass. Increased weed numbers and biomass typically relate to greater seed production which could lead to increased control costs or yield losses. In addition, the combination of weed species that dominated (wild buckwheat, lamb's quarters and wild mustard could prove costly to control with post emergent treatments in conventional canola. Rotation has had only very minor effects on weeds to date, reflecting the early stage of the study, which has not allowed sufficient time for major shifts to occur. Herbicides applied in pea, wheat and flax were very effective in reducing weed numbers, and rotation effects were not evident with any of these crops(data not shown).

At Melfort only small weed differences between treatments existed. The predominant weed in all crops was stinkweed followed by wild oats. Higher concentrations of stinkweed were observed in canola with an average annual weed density of 20 plants/m^2, which was reduced slightly in wheat and flax to 14.5/m^2 and 13.3/m^2 with an application of bromoxynil/MCPA ester and to 9.7 plants/m in peas with an application of metribuzin and MCPA Amine 300. Grassy weed populations were less than 4 plants/m^2 in all crops. Small differences between treatments should enhance our ability to determine the impact of cultivar selection, and crop rotation on weeds in future years.

Grain Yields

Plant density counts at Scott and Melfort revealed all treatments had plant stands adequate to optimize yield. Soil moisture measurements to 90 cm at Scott prior to seeding revealed no rotation or cultivar differences. The Melfort experimental site was cropped to wheat in 1998 and canola in 1997 ensuring a uniform distribution of soil moisture across treatments. With weeds and soil moisture ruled out as factors affecting yield, yield differences between treatments were attributed to cultivar, rotation and fungicide affects on disease severity and incidence. Unfortunately significant crop damage and grain loss at Melfort as a result of a hail storm made the determination of crop disease impact on grain production difficult and required observations from Melfort to be tempered with some degree of uncertainty.

Canola Yields

Larger canola yield differences between treatments occurred at Scott where levels of blackleg pressure were higher then at Melfort. Smaller canola yield differences between cultivars at Melfort may be a reflection of hail damage but could also be attributed to a smaller blackleg resistance difference between varieties. Better weed control at Melfort may also have been a contributing factor as both cultivars were classed as herbicide resistant varieties with similar post spraying weed populations of stink weed and wild oats. Fungicides applied to the more blackleg resistant variety (46A73) resulted in a grain yield increase of 20% from 620 kg/ha to 745 kg/ha and 17% straw yield increase while 45A71 showed a 41% grain yield increase from 378 kg/ha to 534 kg/ha. Despite the hail damage yield increases with fungicides were linked to lower levels of blackleg and sclerotinia pressure. At Scott rotation, cultivar and fungicides all influenced canola yield, but effect of one factor was influenced by the other two. Yield was lowest for Westar canola on canola stubble, without fungicides applied (1080 kg/ha) and highest for Invigor canola on pea or wheat stubble with or without fungicides (2630-2850 kg/ha) (Table 3). Fungicides applied to Westar canola on canola stubble increased yield by 40 % but yield was still less than 60% of Invigor 2273 on wheat or pea stubble. Yield of Invigor 2273 on canola stubble was reduced, but not nearly as much as for Westar. Application of fungicides to Invigor 2273 on canola stubble increased yield to more than 85 % of its yield on pea or wheat stubble. Fungicides also increased yield of Westar on wheat but not on pea stubble. Westar canola on wheat stubble with fungicides applied yielded surprisingly well at more than 90 % of Invigor 2273 in the same rotation. Fungicides had no significant effect on yield of Invigor 2273 grown on pea or wheat stubble.

Yield responses to fungicides and effects of rotation, cultivar and fungicides on blackleg incidence and severity all suggest that the major factor influencing canola yield differences was blackleg. Blackleg assessment and yield results suggest that a Quadris application provided a consistent reduction in disease severity across a wide range of disease pressures for a given cultivar but only increased yields when disease pressure was above a threshold level. Regression of yield with blackleg severity at Scott indicated that canola experienced a reduction in yield of 531 kg/ha with each unit increase in blackleg severity (Figure 2). The high r^2 value for the relationship between blackleg severity and yield confirms that blackleg was the most significant factor in the reduction of canola yield at Scott (Figure 2).

Despite the presence of sclerotinia and incidence as high as 22.8% for Invigor 2273 at Scott, associated yield losses were small as most infections occurred after anthesis and were found on branches rather than the main stem. At Melfort where the percentage of more damaging main stem infections was higher, yield increases associated with reductions in sclerotina severity and incidence when Ronilan was applied were also small. Estimated yield gains for 45A71 were 4.5% and 3% for 46A73. Grain quality test results were mixed with fungicides increasing 46A73 seed weight from 3.92 to 4.05 gm/1000(P=0.10) and increasing the bushel weights of 45A71 from 65.8 kg/hal to 66.0 kg/hal.

Pea Yields

At Scott continuous pea yielded 24% less than pea grown on wheat stubble. This cannot be associated with differences in soil moisture as pea on pea had 13 mm more soil water than pea on wheat to a 90 cm depth prior to seeding. Annual broadleaf weed density differences between rotations of 1.7 plants/m^2 and weed biomass differences of 28 kg/ha were also small. The most significant factor reducing yields on continuous pea plots at Scott appears to have been greater levels of mycosphaerella on leaves and stems. Reductions in mycosphaerella severity related to Quadris application resulted in a yield increase of 19% for pea on pea and 8% for pea on wheat (Table 3). In 1998 Quadris applications at Scott increased pea on wheat stubble yields by 12% from 2226 kg/ha to 2502 kg/ha. Although Melfort pea yield was increased 32% by application of Quadris, grain loss due to hail damage puts reasonable doubt on the extent of the increase. A pea yield increase with Quadris in 1999 is supported however by the fact that an 8% straw yield increase also occurred. In 1998 a 15% pea yield increase from 2706 kg/ha to 3133 kg/ha was recorded at Melfort when fungicides of Quadris and Kumulus were applied. Grain quality tests of seed weight and bushel weight in 1999 confirmed fungicide application on pea at Melfort increased seed weight by 9 gm/1000 seed from 137 gm/100 to 146gm/1000 and volumetric weight by 0.5 kg/hal from 83.0 kg/hal to 83.5 kg/hal.

Summary

In a year when climatic conditions were conducive to disease development test results at Scott and Melfort revealed substantive pea and canola yield benefits associated with canola cultivar, fungicide, and rotation decisions. With spring soil water measurements and weed surveys revealing only small differences between treatments, yield increases were attributed primarily to reductions of blackleg in canola and mycosphaerella in pea.

At Scott choice of a canola cultivar with little blackleg resistance in the canola-canola sequence reduced yields by 53% from yields of the same canola on wheat or pea stubble compared to only a 27% reduction when replaced by a blackleg resistant cultivar. Quadris fungicide applied to the blackleg susceptible canola variety grown on canola stubble reduced blackleg severity and increased yield by 40%. However the higher yield was still 42% less than its yield achieved on wheat stubble with fungicides (2628 kg/ha). Quadris applied to the hybrid with moderate blackleg resistance reduced blackleg severity to a lesser degree but increased yields by 25% in the canola-canola sequence, bringing the yield to within 13% of its yield on wheat stubble with and without fungicides (2834 kg/ha) and 7% of its yield on pea stubble with or without fungicides (2654 kg/ha). Although hail damage at Melfort prevented an accurate assessment of treatment affects higher canola yields could be linked to lower levels of blackleg severity and incidence at Melfort when a cultivar with greater blackleg resistance was selected and/or Quadris was applied. Together these results indicate a blackleg resistant variety in rotation with other crops reduces yield loss due to blackleg and eliminates the need for fungicide applications to control blackleg. It also underlines the benefits of a fungicide application to control blackleg and prevent yield loss even on a blackleg resistant variety when wet climatic conditions in conjunction with more frequent canola rotations produce very high levels of blackleg pressure. Although sclerotinia severity was low at both locations a higher percentage of stem infections at Melfort relative to Scott indicated that canola grown in the Melfort area (Black soil zone) is likely to be more at risk to sclerotinia yield loss.

When peas were grown on pea stubble yields dropped by 24% compared to peas grown on wheat stubble. An application of Quadris reduced mycosphaerella in turn reducing yield loss from 24% to 14%. Yields however remained 20% less then when Quadris was applied to peas grown on wheat stubble (5790 kg/ha). At Melfort where hail damage made an accurate disease assessment difficult no reduction in mycosphaerella with Quadris was observed however seed and biomass yields indicated Quadris did contribute to a yield increase, as it did in 1998 when yield of pea on wheat stubble increased by 15% . Although these results are preliminary consistent pea yield increases across locations (Melfort & Scott) and across years (1998 & 1999) with Quadris suggests fungicides to control mycosphaerella in peas are warranted if canopy closure is sufficient to create a microclimate of increased humidity and temperature. Control of mycosphaerella becomes even more important when more frequent pea crops result in increased inoculum levels and increased disease pressure.

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Table 1. Monthly Precipitation and Mean Monthly Temperatures at Scott and Melfort in 1999 and long term averages from 1960-1996.

Month	Precipitation (mm)		Temperature (Celsius)	
	1999	Long Term	1999	Long Term
	Scott (long term:1960-1996)			
April	52	23	5.2	3.2
May	66	36	9.4	10.5
June	43	66	13.6	14.6
July	81	67	15.1	17.1
August	48	46	16.8	16.4
	Melfort (long term; 1961-1991)			
May	42	39	10.2	10.6
June	14	62	14.0	15.5
July	96	67	15.9	17.6
August	36	53	17.0	16.3

Table 2. Weed Density, Weed and Total Crop Biomass for Canola at Scott in 1999.

		Weeds/m^2				
	Rot	Annual Broadleaf Weeds	Annual Grassy Weeds	Perennial Weeds	Weed Biomass (kg/ha)	Total Crop Biomass (kg/ha)
Canola Hybrid	CC	0.3	0.8	0	0	**6069 B**
	PC	1.2	0.2	0.1	0	**4964 C**
	WC	1.4	3.3	0.1	62	**7739 A**
	Mean	**1.0 B**	**1.4 B**	**0.1 B**	**21 B**	
Westar	CC	12.7	2.5	1.4	314	**4448 B**
	PC	25.3	3.2	1.4	597	**5730 A**
	WC	11.5	5.5	1.6	335	**5991 A**
	Mean	**16.5 A**	**3.7 A**	**1.5 A**	**415 A**	

Values for a given crop across rotations or cultivar means followed by the same capital letter are not different (P=0.05)

Table 3. Canola, Pea, and Wheat yields (kg/ha) as a function of Crop Rotation, Fungicide application, and Cultivar selection at Scott in 1999.

	Crop Rotation	No Fungicide	Fungicide	P > F	Mean
Invigor 2273	canola on canola	**1980**	**2468**	*	**2224 B**
	canola on pea	2627	2681		**2654 A**
	canola on wheat	2819	2848		**2834 A**
Westar	canola on canola	**1083**	**1513**	**	**1299 B**
	canola on pea	2414	2393		**2404 A**
	canola on wheat	**2238**	**2628**	**	**2433 A**
Pea	pea on pea	**3874**	**4616**	*	**4245 B**
	pea on wheat	**5350**	**5790**	*	**5570 A**
Wheat	wheat on canola	**3989**	**4331**	*	**4160 B**
	wheat on flax	4878	4808		**4843 A**
	wheat on pea	**4217**	**4643**	*	**4430 B**

Mean rotation yields for a given crop followed by the same letter are not different (P=0.05).
Fungicide difference (*: P=0.05, **: P=0.01).

Table 4. Blackleg Incidence (%) as a function of Crop Rotation, Fungicide application, and Cultivar selection at Scott in 1999.

	Crop Rotation	No Fungicide	Fungicide	P > F	Mean
Invigor 2273	canola on canola	**44.8**	**39.4**	*	**42 A**
	canola on pea	18.3	12.6	*	**15.4 B**
	canola on wheat	22.2	11.9	*	**17.1 B**
	Mean	**28.4 B**	**21.3 B**		
Westar	canola on canola	**86.1**	**72.9**	*	**79.5 A**
	canola on pea	40.1	18.5	*	**29.3 B**
	canola on wheat	**32.8**	**15.8**	*	**24.3 B**
	Mean	**53.0 A**	**38.0 A**		

Crop rotation incidence for a cultivar and mean cultivar incidence followed by the same letter are not different (P=0.05). Fungicide difference (*: P=0.05).

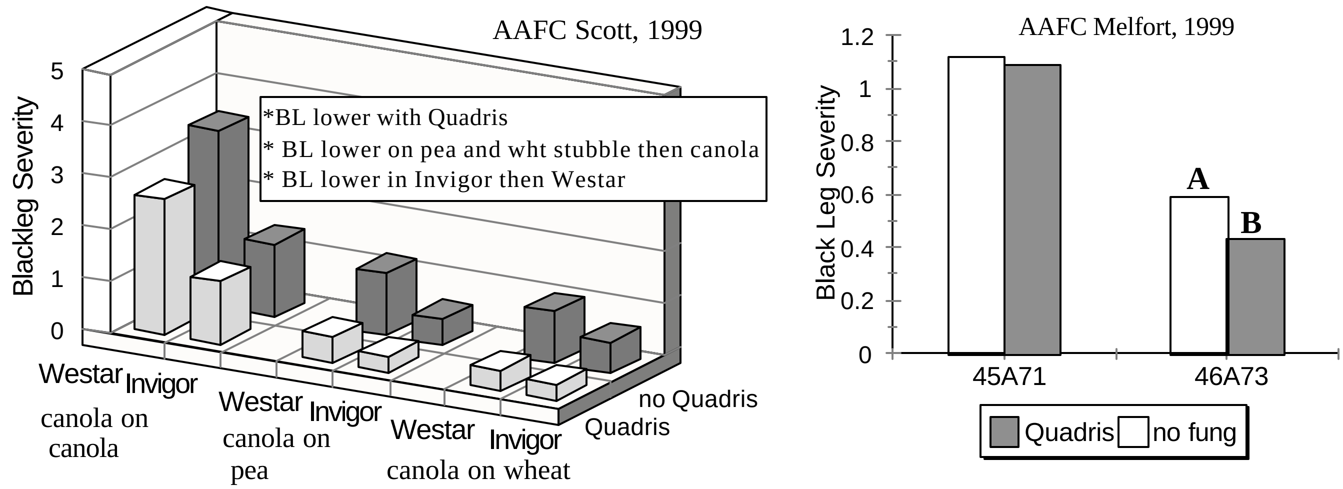

Figure 1. Blackleg severity in canola at Scott and Melfort in 1999.

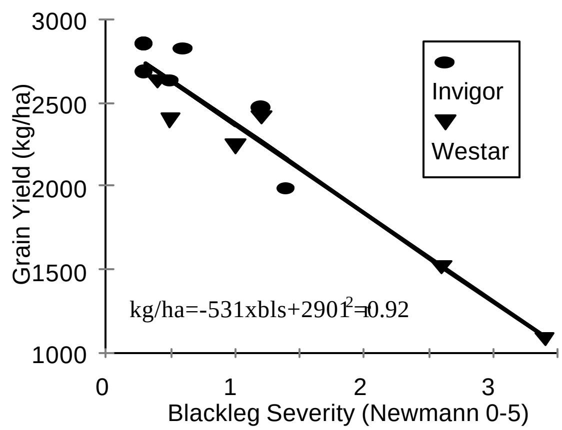

Figure 2. Impact of blackleg severity on canola yields at Scott in 1999.

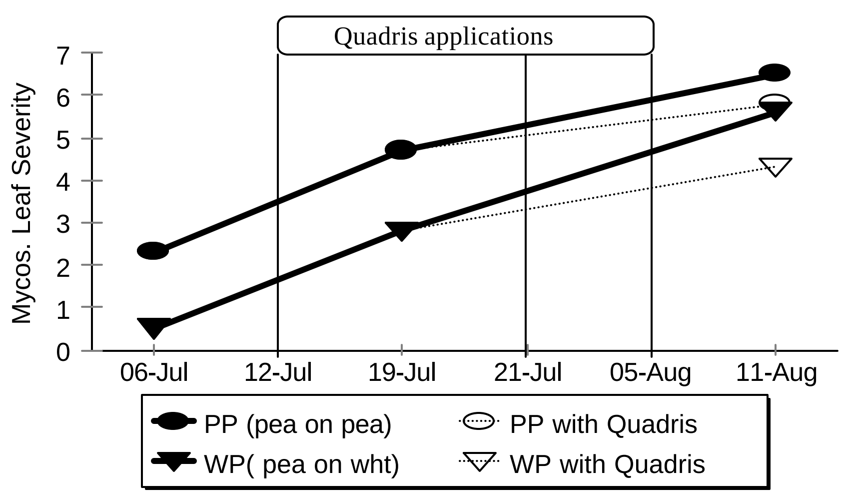

Figure 3.
Mycosphaerella foliar severity for peas grown on pea stubble and wheat stubble at Scott in 1999.