

## Mitigating the risk of blackleg disease of canola using fungicide strategies.

G. Peng<sup>1</sup>, W.G.D. Fernando<sup>2</sup>, C.L. Kirkham<sup>1</sup>, R. Lange<sup>3</sup>, R.H. Kutcher<sup>4</sup>, D. McLaren<sup>1</sup>, E. Johnson<sup>1</sup>, K. Turkington<sup>1</sup>. <sup>1</sup>AAFC, Saskatoon/Melfort/Scott, SK; Brandon, MB; Lacombe, AB, respectively; <sup>2</sup>Dept. Plant Sciences, University of Manitoba, MB; <sup>3</sup>Alberta Innovates, Vegreville, AB; <sup>4</sup>Dept. Plant Sciences, University of Saskatchewan.

Correspondence: [gary.peng@agr.gc.ca](mailto:gary.peng@agr.gc.ca)

### Abstract

Blackleg, the most widespread disease on canola on the prairies, has been managed mainly through use of resistant cultivars in combination with crop rotation. Over the past few years, crop rotation has been tightened in favor of canola production due largely to profitability considerations but this practice can speed up changes in pathogen race structure that may lead to losses of resistance for some of the current canola cultivars. In this study, fungicides strategies were assessed as a second line of defense for control of blackleg and canola yield benefit in case when the variety resistance is overcome by the pathogen. In 2011, the fungicide Headline, Quadris, and Quilt were applied at 2-4 leaf stage and/or bolting to target varying periods of infection at three locations on the prairies. On the susceptible cultivar Westar, an early application (2-4 leaf) of Headline or Quadris reduced the disease at Carman, MB, but not at Melfort or Vegreville relative to non-treated controls. None of the fungicide treatments increased canola yield substantially either. The study will be continued for two more years at multiple locations across the prairies.

### Introduction

Blackleg, caused by *Leptosphaeria maculans*, is the most widespread disease of canola in western Canada, with the potential to greatly reduce canola yields and decrease economic returns of growers if canola cultivars lose resistance to the disease. In the last two decades, blackleg has been managed primarily with the use of resistant cultivars and 4-year crop rotations. In recent years, however, many growers are producing canola in shortened rotations across the Prairies in response to market signals. Additionally, research has shown that there is great variability of virulence in the pathogen population (Chen and Fernando 2006; Kutcher et al., 2007; Kutcher et al., 2010), which suggests that the pathogen may, or from anecdotal reports from growers, have already overcome the resistance present in some of the current canola cultivars.

Reports from industry and enquires from several areas, particularly southern Manitoba, indicate that growers are again feeling blackleg is such a threat that they may consider to add fungicides as an additional disease management tool. Growers are asking for information on products available and their benefits for blackleg control. A new product, the well-known fungicide pyraclostrobin (Headline<sup>®</sup>), has recently received registration for use on blackleg of canola in western Canada. Previously registered products include propiconazole (Tilt<sup>®</sup>) and azoxystrobin (Quadris<sup>®</sup>). A combination of the latter two active ingredients is being sought for registration in Canada under the product name Quilt Xcel<sup>®</sup>. Research has shown that single fungicide applications may be effective on canola varieties susceptible to blackleg (Kutcher et al. 2003), although the economic benefit was not as great as using a resistant cultivar and under some conditions no economic benefit was observed. Improvements in fungicide efficacy may be possible using newer products, better application timing, or even multiple applications of different fungicides.

The objectives of this study were to examine the efficacy of a new fungicide or combination of fungicides, application timing, and multiple application strategies during the critical period of infectivity to mitigate blackleg impact on canola. The study was attempted to help assess the value of registered fungicides in best management practices for blackleg control in case, or when genetic resistance fails.

### **Materials and Methods**

The study consisted of three field trials located in Carman, MB, Melfort, SK, and Vegreville, AB. Prior studies indicated little or no benefit of fungicides on resistant canola cultivars (Kutcher et al. 2003). Therefore the susceptible (S) cultivar Westar was used for most part of this study. The resistant (R) cultivar 45H29 and moderately resistant (MR) cultivar 43E01 were used but treated only with pyraclostrobin at 2-4 leaf stage for comparisons.

The plot size was 2×8m, 4×8m, and 1.6×6m at Carman, Melfort, and Vegreville sites, respectively. The seeding rate was 150 seed /m for R and MR cultivars, and 175 seed/m for the S cultivar Westar, with row spacing at about 20 cm. Cultivars used for these trials were a mixture of Roundup ready and conventional (Westar) canola, but for the weed management, they were all treated like conventional. Edge was broadcast in Melfort prior to seeding due to high weed pressure. At all sites, a tank mixture of Poast, Muster and Lontrel was used in crop for post-emergent weed control.

Plant infection relied primarily on natural pathogen inoculum from stubbles in adjacent areas where a S canola cultivar was planted in the previous year. At the Carman site, a conidial suspension of *L. maculans* (PG2) was sprayed throughout the plot area on June 23, 2011, five days prior to the first fungicide application (2-4 leaf stage) to enhance the infection. The fungicide rate and carrier volume followed label recommendations. The experiment used a randomized block design with 4 replicates.

#### **Treatments:**

On the S cultivar Westar:

non-sprayed (control)

Headline<sup>®</sup> @ 2-4 leaf stage

Quadris<sup>®</sup> @ 2-4 leaf stage

Tilt<sup>®</sup> @ 2-4 leaf stage

Quilt Xcel<sup>®</sup> @ 2-4 leaf stage

Headline<sup>®</sup> @ just prior to bolting

Tilt<sup>®</sup> @ 2-4 leaf stage, Headline<sup>®</sup> @ just prior to bolting

Headline<sup>®</sup> @ 2-4 leaf stage, Tilt<sup>®</sup> @ just prior to bolting

MR cultivar, non-sprayed (check 1)

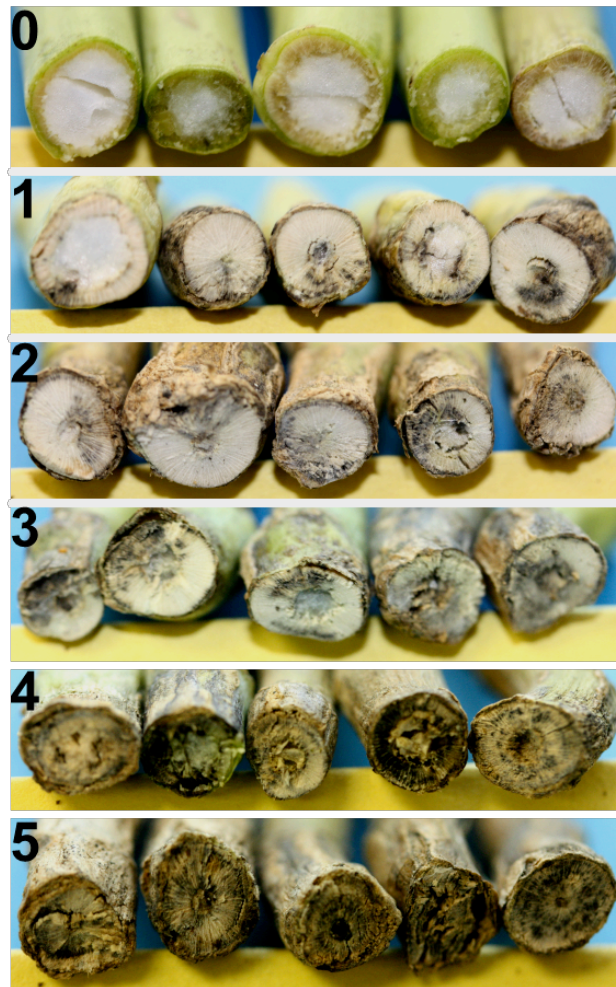
MR cultivar, Headline<sup>®</sup> @ 2-4 leaf stage

R cultivar, non-sprayed (check 2)

R cultivar, Headline<sup>®</sup> @ 2-4 leaf stage

At the growth stage of 5.1 to 5.3 (Harper and Berkenkamp 1975), fifty plants were uprooted from each replicate and a 0-5 scale (Fig 1, Table 1) was used to determine disease severity by cutting through hypocotyls and/or tap roots and estimating the % area of diseased tissue in the cross-section. The disease incident was also recorded, and canola yield taken from each plot after harvest.

Data from different locations could not be pooled due to non-homogeneity of variance, and were therefore analyzed separately. Logarithm transformation was used to improve the normality of disease incidence data prior to the analysis of variance (ANOVA). The treatment effect on yield was analyzed separately for different cultivar due to their inherently varying potential of yield. Treatment means were separated using Dunnett's test which allowed comparisons of different treatments against non-treated controls.



**Fig 1.** A pictorial range of blackleg disease severity (0-5)

**Table 1.** Description of blackleg rating scale <sup>a</sup>

Rating	Description
0	No disease visible in the cross section
1	Diseased tissue occupies up to 25% of cross-section
2	Diseased tissue occupies 26 to 50% of cross-section
3	Diseased tissue occupies 51 to 75% of cross-section
4	Diseased tissue occupies more than 75% of cross-section with little or no constriction of affected tissues
5	Diseased tissue occupies 100% of cross-section with significant constriction of affected tissues; tissue dry and brittle; plant dead

<sup>a</sup> Based on the recommendation by the Western Canada Canola/Rapeseed Recommending Committee (WCC/RRC), 2009.

## Results

On the susceptible cultivar Westar, blackleg incidence was moderate to high (49-83%) at different locations (**Table 2**) while the disease severity was low to medium (**Table 3**). The disease was noticeably more prevalent and severe at the Carman and Vegreville sites than at Melfort. An early application (2-4 leaf stage) of Headline or Quadris reduced the disease incidence and severity at Carman, MB, whereas the same treatment with Quilt only reduced the disease incidence slightly at this location. None of the fungicides reduced blackleg at Melfort or Vegreville relative to non-treated controls (**Table 2, 3**).

The S cultivar Westar showed an average yield of 23-40 bushes/acre depending on the location, and MR and R cultivars generally had about 15-20 bushes/acre yield advantage over the S cultivar at the same location (**Fig 2, 3**). However, none of the fungicide treatments increased canola yield substantially relative to non-treated controls, regardless of the cultivar resistance.

**Table 2.** Effect of fungicides on blackleg incidence (%)

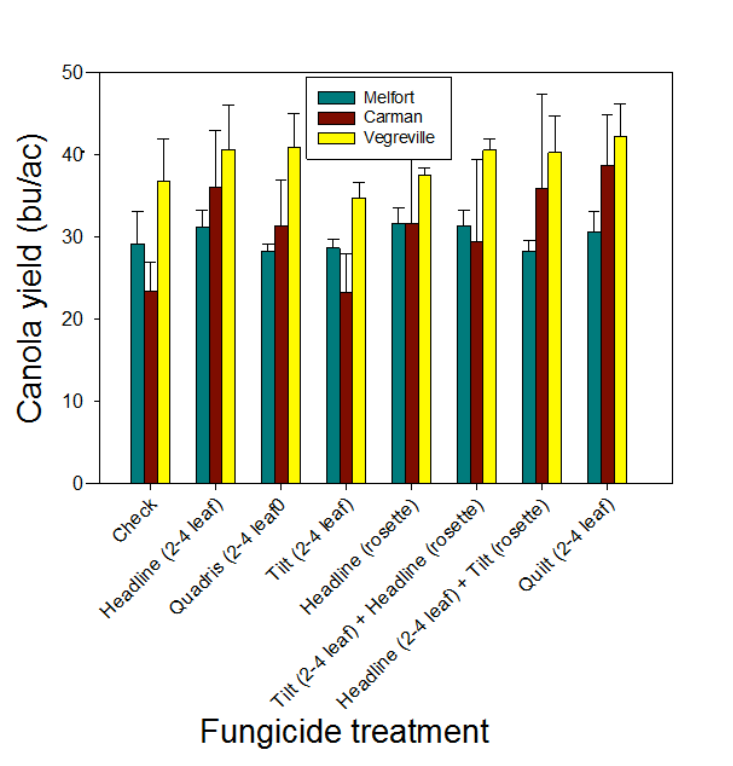
Cultivar	Treatment	Melfort	Carman	Vegreville
S - Westar	Non-treated control	49	70	83
	Headline (2-4 leaf)	46	18 *	75
	Quadris (2-4 leaf)	50	28 *	67
	Tilt (2-4 leaf)	63	77	79
	Quilt (2-4 leaf)	37	41 *	75
	Headline (rosette)	51	62	70
	Tilt (2-4 L) + Headline (bolting)	39	44	69
	Headline (2-4 L) + Tilt (bolting)	33	25 *	70
MR- 43E01	Check	42	75	75
	Headline (2-4 leaf)	21 *	22 *	61
R- 45H29	Check	9	63	53
	Headline (2-4 leaf)	8	17 *	51

\* Significant at  $P=0.05$  (Dunnetts' test).

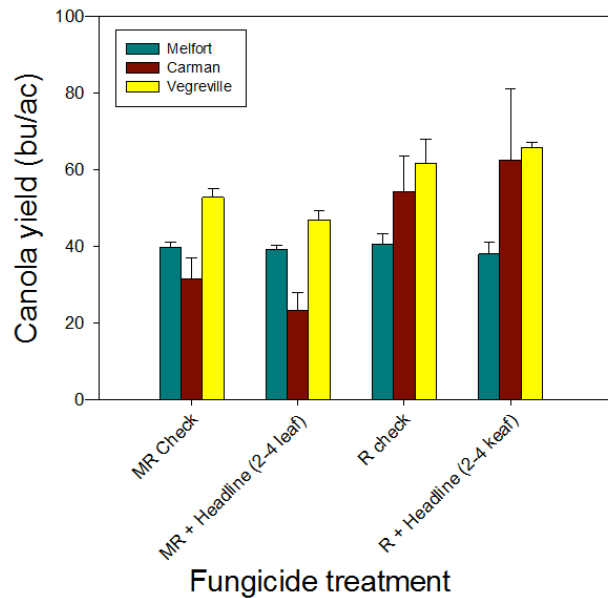
**Table 3.** Effect of fungicide treatments on blackleg severity

Cultivar	Treatment	Melfort	Carman	Vegreville
S - Westar	Nontreated check	0.9	1.8	1.5
	Headline (2-4 leaf)	0.9	0.4 *	1.2
	Quadris (2-4 leaf)	0.9	0.6 *	1.1
	Tilt (2-4 leaf)	1.1	2.7	1.4
	Quilt (2-4 leaf)	0.5	1.0	1.4
	Headline (rosette)	0.9	1.5	1.2
	Tilt (2-4 L) + Headline bolting)	0.6	1.2	1.1
	Headline (2-4 L) + Tilt (bolting)	0.6	0.7 *	1.2
	MR- 43E01	Check	0.3	1.8
R- 45H29	Headline (2-4 leaf)	0.6	0.4 *	0.7
	Check	0.1	1.7	0.6
	Headline (2-4 leaf)	0.1	0.3 *	0.6

\* Significant at  $P=0.05$  (Dunnetts' test).



**Fig 2.** Effect of fungicide treatments on yield of the susceptible cultivar Westar



**Fig 3.** Effect of fungicide treatments on yield of R and MR canola cultivars.

## Discussion

Canola production in Canada is a multi-billion dollar industry, with a production target of 15 M metric tonnes by 2015. An annual reduction in production of even a small percentage translates into a large amount of lost income for canola growers, which can be further multiplied throughout the Canadian economy due to the losses in value-added industries (crushers and retailers).

This project takes a proactive approach to blackleg management by examining the efficacy and yield benefit of fungicide strategies for disease control should varietal resistance fail. At present, genetic resistance to the disease is largely holding up in most part of western Canada. The move to tighter crop rotations can result in the build-up of pathogen inoculum and therefore exacerbate the selection pressure on the pathogen to overcome the current sources of genetic resistance. A second line of defense may be required since growers in some parts of western Canada have reported increasingly severe blackleg symptoms in their canola crops and are asking if fungicides would be of benefit. Currently there is little information to suggest that fungicides are economically beneficial, especially on resistant cultivars. If resistance fails, however, this may be the next best strategy to alleviate losses. Increased efficacy from fungicides may be possible with newer products or formulations, better application timing, or multiple application strategies. The knowledge gained by this research will be useful to canola growers directly.

The timing of fungicide at 2-4 leaf stage was intended to protect the seedlings against early infection, which tends to be most detrimental to canola plants. For the same purpose, fungicide seed dressing may also be considered (Marcroft and Potter 2008). The second treatment at the bolting stage should reinforce the effect by protecting leaves from later-released ascospores or even by pycnidial spores (Ghanbarnia et al. 2009, 2011). However, these fungicide products and strategies did not show significant reduction of blackleg disease at the Melfort and Vegreville sites, and the reason for this is not

clear. At Carman where *L. maculans* inoculum (PG2) was applied 5 days prior to the early fungicide treatment, Headline and Quadris showed substantial effect in disease reduction. The artificial plant inoculation might have provided an opportunity for more refined timing of fungicide application, but the relatively greater efficacy of the fungicides Headline and Quadris was noticeable at this site. However, this efficacy did not translate into significant yield benefit due to the variability of data.

At Carman and Vegreville sites where blackleg was observed at moderate levels, the R and MR cultivars did not look so resistant showing similar disease incidence and severity as on the S cultivar Westar. Although the pathogen race structure was not checked at these sites, one would expect the R or MR cultivar to be resistant against the PG2 type used at Carman site for plot inoculation. Despite the level of disease observed, the yield of R and MR cultivars did not seem to be affected as much and were substantially higher than that of the S cultivar. These newer cultivars might have inherently higher yielding potential due to years of improvements, but it is also possible that they possess a high level of tolerance to blackleg, which helped alleviate disease impact on plant development and the yield.

Although the information presented in this paper was based on multiple-site trials in 2011, it is still preliminary and more year/site data are required to gather a trend and draw a conclusion. The trials will be continued for another two years at more locations across the prairies.

### References cited

- Chen, Y. and Fernando, W.G.D. 2006. Prevalence of pathogenicity groups of *Leptosphaeria maculans* in western Canada and North Dakota, USA. *Can. J. Plant Pathol.* 28: 533-539.
- Ghanbarnia, K., D. W. G. Fernando, and G. Crow. 2009. Developing rainfall- and temperature-based models to describe infection of canola under field conditions caused by pycnidiospores of *Leptosphaeria maculans*. *Phytopathology* 99: 879-886.
- Ghanbarnia, K., D. W. G. Fernando, and G. Crow. 2011. Comparison of disease severity and incidence at different growth stages of naturally infected canola plants under field conditions by pycnidiospores of *Phoma lingam* as a main source of inoculum. *Can J Plant Pathol.* 33: 355-363.
- Gossen, B. D., and Anderson, K. L. 2004. First report of resistance to strobilurin fungicides in *Didymella rabiei*. (Abstr.) *Can. J. Plant Pathol.* 26:411.
- Harper, F.R., and Berkenkamp, B. 1975. Revised growth-stage key for *Brassica campestris* and *B. napus*. *Can. J. Plant Sci.* 55:657-658.
- Kutcher, H.R., Ulrich, D., and Brandt, S. 2003. Plant disease implications of intensive crop rotations of canola and field pea in western Canada. In "Proceedings of the symposium, Dynamic Cropping Systems: Principles, Processes and Challenges" pages 273-276, August 4-7, 2003 Radisson Inn, Bismarck, ND.
- Kutcher, H.R., Keri, M., McLaren, D.L., and Rimmer, S.R. 2007. Pathogenicity of *Leptosphaeria maculans* in western Canada. *Can. J. Plant Pathol.* 29: 388-393.
- Kutcher, H.R., Balesdent, M.H., Rimmer, S.R., Rouxel, T., Chevre, A.M., Delourme, R., and Brun, H. 2010b. Frequency of avirulence genes among isolates of *Leptosphaeria maculans* in western Canada. *Can. J. Plant Pathol.* 31: 77-85.
- Marcroft, S. J. and T. D. Potter. 2008. The fungicide fluquinconazole applied as a seed dressing to canola reduces *Leptosphaeria maculans* (blackleg) severity in south-eastern Australia. *Aus. Pl. Pathol.* 37(4): 396-401.
- Western Canada Canola/Rapeseed Recommending Committee (WCC/RRC) Incorporated. 2009. Procedures of the Western Canada Canola/Rapeseed Recommending Committee for the evaluation and recommendation for registration of canola/rapeseed candidate cultivars in western Canada.