Impact of Preceding Crops on Incidence and Severity of Disease in Canola

Progress Report

March 16, 2009

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Research Objectives

1. Document the influence of crop rotation on the incidence and severity of sclerotinia, blackleg, and alternaria black spot in canola.
2. Determine the impact of the previous crop on disease levels in canola.
3. Determine if fungicide applications can be eliminated or rates reduced by altering the sequence of crops in the rotation.

Research Procedures

Crop Rotation

Table 1. Crop rotations and treatments.

Rotation	Trt	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	1	Canola	Canola	Barley	Wheat	Canola	Canola	Barley	Wheat	Wheat
	2	Canola	Barley	Wheat	Canola	Canola	Barley	Wheat	Canola	Barley
	3	Barley	Wheat	Canola	Canola	Barley	Wheat	Canola	Canola	Canola
	4	Wheat	Canola	Canola	Barley	Wheat	Canola	Canola	Barley	Canola
2	5	Canola	Wheat	Canola	Wheat	Canola	Wheat	Canola	Wheat	Canola
	6	Wheat	Canola	Wheat	Canola	Wheat	Canola	Wheat	Canola	Wheat
3	7	Flax	Canola	Barley	Wheat	Flax	Canola	Barley	Wheat	Flax
	8	Canola	Barley	Wheat	Flax	Canola	Barley	Wheat	Flax	Canola
	9	Barley	Wheat	Flax	Canola	Barley	Wheat	Flax	Canola	Barley
	10	Wheat	Flax	Canola	Barley	Wheat	Flax	Canola	Barley	Wheat
4	11	Flax	Wheat	Canola	Wheat	Flax	Wheat	Canola	Wheat	Flax
	12	Wheat	Canola	Wheat	Flax	Wheat	Canola	Wheat	Flax	Wheat
	13	Canola	Wheat	Flax	Wheat	Canola	Wheat	Flax	Wheat	Canola
	14	Wheat	Flax	Wheat	Canola	Wheat	Flax	Wheat	Canola	Wheat
5	15	Canola	Barley	Wheat	Canola	Barley	Wheat	Canola	Barley	Wheat
	16	Barley	Wheat	Canola	Barley	Wheat	Canola	Barley	Wheat	Canola
	17	Wheat	Canola	Barley	Wheat	Canola	Barley	Wheat	Canola	Barley
6	18	Canola	Canola	Canola	Canola	Canola	Canola	Canola	Canola	Canola

Eighteen treatments consisting of six crop rotations involving canola, spring wheat, barley and flax were established at Minot, ND in 2000 (Table 1). This (2008) was year nine of the rotation sequence. Every crop included in the rotation must be grown each year in order to explain the effect of individual years. Each year there are four replications of each treatment; 7 canola, 5 wheat, 4 barley, and 2 flax.

Table 2. Canola variety and critical dates for 2000 to 2008.

Year	Variety	BL Rating	Seed	Swath	Harvest	SSR Risk Test	BL/SSR Evaluation
2000	2573	R	29-Apr	8-Aug	17-Aug	29-Jun / 2-Jul	9-Aug
2001	3455	R	30-Apr	3-Aug	7-Aug	27-Jun / 3-Jul	6-Aug
2002	2663	R	2-May	29-Jul	5-Aug	27-Jun / 2-Jul	8-Aug
2003	2061	MR	19-May	6-Aug	15-Aug	3-Jul / 10-Jul	18-Aug
2004	4870	R	23-April	3-Aug	16-Aug	2-Jul / 9-Jul	16-Aug
2005	910	R	5-May	26-July	1-Aug	24-June / 1-Jul	8-Aug
2006	5550	R	6-May	3-Aug	8-Aug	29-June / 7-Jul	26-July
2007	7145	R	10-May	31-July	8-Aug	29-June / 6-Jul	2-Aug
2008	8440	R	9-May	NA	21-Aug	?	?

The plots were 30 by 180 feet with a 30-foot border surrounding each plot. One-half of the plot is untreated while the other half is treated with a fungicide to help protect canola from sclerotinia stem rot (SSR). Canola varieties selected were rated "MR" or "R" for blackleg resistance (Table 2). Varieties alternated between Liberty Link and Roundup Ready.

Disease Sampling

All canola plots (both the untreated and fungicide-treated halves) were sampled for the presence of sclerotinia spores and disease, and for blackleg incidence and severity.

Sclerotinia

Sclerotina ascospore counts: Sampling for ascospores was done within the canopy of each canola subplot using two different methods, 1) lower canopy testing, and 2) petal testing.

Lower canopy testing: The first test was conducted at 20% bloom and the second was conducted one week later. Petri plates with Steadman's semi-selective media (Steadman *et al.* 1994) were placed on the soil surface at four different locations in each canola subplot. The lids were removed and the plates were left exposed underneath the canopy for 2.5 hours. After exposure, the plates were covered and placed in the dark at room temperature (70-75ºF) for 3 days.

Petal testing: Canola petals were also tested for the presence of ascospores. This test was also done at 20% bloom and then again one week later. Petals were collected from four different locations within each subplot. At each location, four main racemes were clipped and placed into a ziplock baggy. From these four flowering stems, four petals were randomly chosen and placed on a Petri plate with Steadman's semi-selective media. The plates were then placed in the dark at room temperature for 3 days.

After the three day incubation period all plates were assessed to determine Sclerotinia disease risk. The scale used was 0 to 45% incidence being low risk, 45 to 90% incidence considered moderate risk, and 90 to 100% considered high risk for SSR (Morrall and Thomson, 1991).

Sclerotinia Incidence and Severity: Ten standing canola stems were evaluated for SSR incidence and severity at ten random locations for a sample size of 100 plants per subplot. Sclerotinia was identified by bleached white stems that were spongy or shredded. Sclerotinia incidence (percent of infected plants) and severity on a scale of 0 to 5 (0 being healthy, 5 being dead) was recorded.

Blackleg

Canola was evaluated for blackleg incidence and severity two times during the growing season. The first was a leaf evaluation for blackleg incidence and the second was a stem evaluation to determine incidence and severity.

Starting in 2005, ten plants were evaluated in ten random locations in each canola subplot for the presence or absence of blackleg lesions. This evaluation was done early in the growing season when plants were still in the vegetative stage (4-leaf to bolting).

The second evaluation was conducted when canola was in the swath (2000 – 2008). Standing canola adjacent to the swath was clipped off at soil level so the crown of the plant could be assessed for blackleg presence and severity. Blackleg severity was expressed on a 0 to 5 scale, 0 being no disease and 5 being completely girdled and dead. Incidence, the number of infected plants out of 100, was also determined for each subplot.

Results and Discussion

Sclerotinia

Sclerotinia ascospore levels in 2008 indicated low to moderate risk, based on results from petal and lower canopy testing (Fig 1). Early and late lower canopy tests also showed low to moderate risk with 25 and 31% incidence, respectively. Early and late petal tests showed sclerotinia risk to be low with 25 and 13%, respectively. Even though the risk was significantly different at each evaluation date, there was no significant difference between any of the rotations on either date.

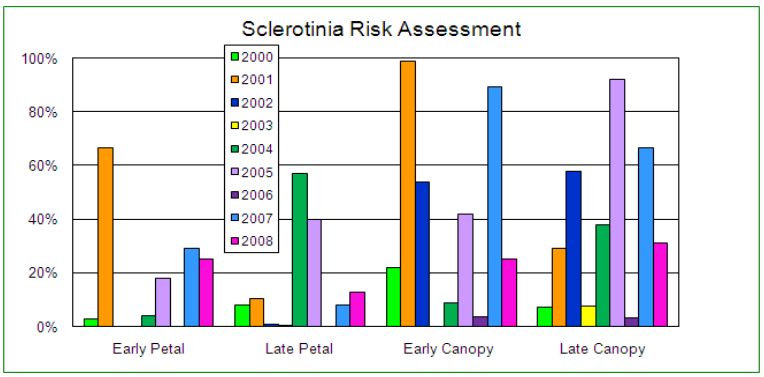

Fig 1. Sclerotinia risk assessment

In general, petal testing from 2000 to 2008 indicated low to moderate disease risk. In 2001, early petal and lower canopy testing showed the highest incidence over the course of the study. In June 2001, there was almost three inches of rain before the first risk tests were conducted. However, very little rainfall occurred between or after the two testing dates, which helps explain why the early tests were higher than the later tests. In 2005, conditions seemed ideal for disease proliferation. We received over 10 inches of rainfall in the month of June, which helped create an environment conducive to ascospore production. Most of the rain fell in early or late June. Nearly five inches of rain fell between the early and late tests, which resulted in higher ascospore levels detected in the late test compared to the early test. However, even with these wet conditions, SSR was very low in late-season evaluations. Conditions last season (2007) seemed to be ideal for disease production and proliferation. Between the end of May and the beginning of July we received over 12 inches of rain and had above normal temperatures. Midway through the month of July rainfall ceased and temperatures jumped even higher. This contributed to the significant drop in incidence between the two tests for ascospores. Conditions this season (2008) seemed to be less than ideal for disease production and proliferation. Between the end of May and the beginning of July we received less than 5.5 inches of rain and had normal to below normal temperatures. July and August brought 7 inches of rain and temperatures remained within the normal range.

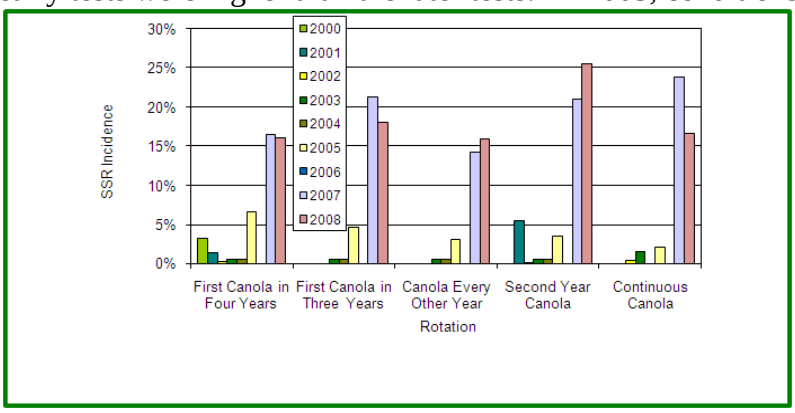

Fig 2. Sclerotinia ascospore incidence

In most years of the study, dry conditions have prevailed before and during flowering inhibiting ascospore production and disease proliferation. In all years, SSR disease incidence has been less

than 25% with no significant correlation to rotation or fungicide treatment (Fig 2). Our observations indicate that SSR disease risk is more likely dependent on environmental conditions than on rotation.

Blackleg

Vegetative evaluation: Blackleg lesions were visible in the vegetative stage in 2005, but not 2006. Early-season rainfall was plentiful in 2005, while 2006 was very dry. As mentioned earlier, conditions in 2007 looked very promising for blackleg disease pressure. Early-season conditions were very conducive to blackleg spore production and proliferation with above-normal precipitation and temperatures. Foliar lesions were very visible in 2007. Incidence was highest in continuous canola at 50 percent (data not shown). Rotations with canola more frequently had higher incidence. Second-year canola and canola every other year had 30 and 28 percent incidence respectively, whereas incidence in all other rotations was between 16 and 20 percent. We observed a significant drop in incidence in 2008 compared to 2007. Conditions were very cool and dry in April-May 2008. Vegetative blackleg in 2008 ranged from only 6-16% in all rotations. There was a trend for lower incidence where canola was grown once every four years.

Late-season evaluation: In 2001 to 2003, blackleg incidence was higher in rotations that included canola most frequently (every-other-year, second-year canola, and continuous canola). In 2004 and 2005, blackleg incidence was generally similar across rotations. In 2006, blackleg incidence was higher in second-year canola and continuous canola compared to rotations where a crop other than canola was grown for at least one year (Fig 3).

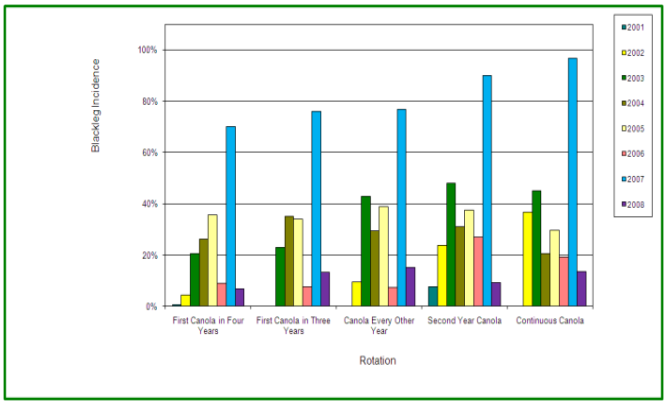

Fig 3. Late-season blackleg disease incidence.

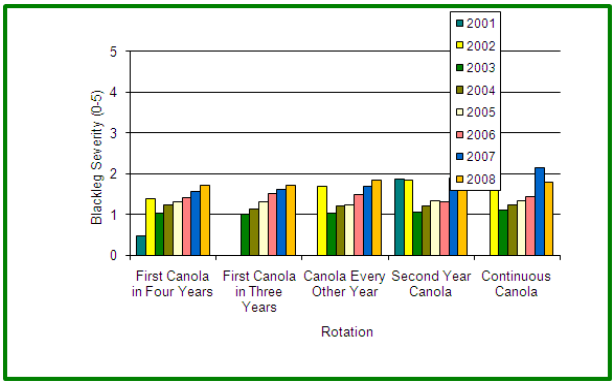

Fig 4. Blackleg plant severity

Blackleg incidence in 2007 was higher than previous years by a large margin (Fig 3). Similar to the early-season vegetative evaluation, canola incidence increased as canola frequency in the rotation increased. Even in the "ideal" rotation, canola once-every-four-years, blackleg incidence was 70 percent.

Although blackleg incidence was higher in some rotations in certain years, blackleg severity was generally low and similar across rotations. Since 2002, blackleg severity has been steadily increasing in all rotations, but still has remained relatively low (Fig 4). In 2007, the numbers continued to increase and for the first time severity in the continuous canola rotation

was above two (on the severity rating scale of 0-5). A "two" on the rating scale is where we would start to see yield loss with about 20-25% of the stem infected with blackleg. In general, severity continued to increase in 2008 in all rotations, but still remained below a two on the rating scale. To date, there has been no obvious correlation between blackleg severity and crop rotation. We believe blackleg severity may not have increased very much over individual growing seasons for two reasons: (1) we plant a variety that is moderately-resistant or resistant to blackleg, and (2) because the study is being conducted under a conventional tillage system, which inhibits disease survival.

Over all years of the study, there have been no canola yield differences between fungicide-treated and untreated plots, nor have there been yield differences between rotations (data not shown).

Future Research

This study will be continued for three more years when each rotation will have completed at least three cycles. To date, there have been no patents or publications from this study; however, we are preparing one publication and one M.S. thesis based on the first eight years of the study.

Outreach Opportunities

Markle, D. M. and B. M. Jenks. 2004. Impact of Preceding Crops on Incidence and Severity of Disease in Canola. North Dakota Oilseed Council Meeting. February. Minot, North Dakota.

Mazurek, S.A. and B. M. Jenks. 2006. Impact of Preceding Crops on Incidence and Severity of Disease in Canola. NCGA Canola Forum. January. Minot, North Dakota.

Mazurek, S.A. and B. M. Jenks. 2006. Impact of Preceding Crops on Incidence and Severity of Disease in Canola. Board of Visitors Annual Meeting. January. Minot, North Dakota.

Mazurek, S.A. and B. M. Jenks. 2006. Impact of Preceding Crops on Incidence and Severity of Disease in Canola. NCREC Canola Field Day. June. Minot, North Dakota.

Markle, D. M. and B. M. Jenks. 2006. Impact of Preceding Crops on Incidence and Severity of Disease in Canola. American Society of Agronomy Annual Meeting. November. Indianapolis, Indiana.

Mazurek, S.A. and B. M. Jenks. 2007. Impact of Preceding Crops on Incidence and Severity of Disease in Canola. Board of Visitors Annual Meeting. January. Minot, North Dakota.

Mazurek, S.A. and B. M. Jenks. 2007. Impact of Preceding Crops on Incidence and Severity of Disease in Canola. NCREC Canola Field Day. June. Minot, North Dakota.

Mazurek, S.A. and B. M. Jenks. 2007. Impact of Preceding Crops on Incidence and Severity of Disease in Canola. NCGA North Dakota-Minnesota Canola Researchers Meeting. October. Fargo, North Dakota.

Mazurek, S.A. and B. M. Jenks. 2008. Impact of Preceding Crops on Incidence and Severity of Disease in Canola. Board of Visitors Annual Meeting. January. Minot, North Dakota.

Mazurek, S.A. and B. M. Jenks. 2008. Impact of Preceding Crops on Incidence and Severity of Disease in Canola. NCGA Meeting. April 17. Rugby, North Dakota.

Mazurek, S.A. and B. M. Jenks. 2008. Impact of Preceding Crops on Incidence and Severity of Disease in Canola. NCREC Canola Field Day. June 30. Minot, North Dakota.

Mazurek, S.A. and B. M. Jenks. 2008. Impact of Preceding Crops on Incidence and Severity of Disease in Canola. American Phytopathological Society Annual Meeting. July. Minneapolis, Minnesota.

Mazurek, S.A. and B. M. Jenks. 2008. Impact of Preceding Crops on Incidence and Severity of Disease in Canola. NCGA North Dakota-Minnesota Canola Researchers Meeting. October. Fargo, North Dakota.

Mazurek, S.A. and B. M. Jenks. 2008. Impact of Preceding Crops on Incidence and Severity of Disease in Canola. MN Canola Council Annual Meeting. December. Roseau, Minnesota.

Literature Cited

Morrall, R. A. and J.R. Thompson. 1991. Petal test manual for Sclerotinia in canola. University of Saskatchewan, Saskatoon, SK 25pp.

Steadman, J.R., J. Marcinkowska and S. Rutledge. 1994. A semi-selective medium for isolation of *Sclerotinia sclerotiorum.* Can. J. Plant Pathology 16: 68-70.