Proposal # 7
Impact of Preceding Crops on Incidence and Severity of Disease in Canola

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See the following link for a Progress Report summarizing this study from 2000-2009.
http://www.ag.ndsu.edu/nc-canola/2009progress/jenks-2009-progress.pdf

Introduction

Current agronomic recommendations are to plant a broadleaf crop like canola or sunflower no more than once every four years to avoid buildup of disease pathogens. However, some producers have planted canola for two consecutive years on the same field in an attempt to increase overall profit potential.

I. Description of Proposed Project

Six crop rotations were initiated in spring 2000 to evaluate the influence of previous crops and cropping sequences on disease levels in canola, flax, wheat, and barley. This study will continue the same crop sequences so a true rotation may be observed. The study will consist of three 4-year rotations, one 3-year rotation, one 2-year rotation, and one 1-year rotation with different sequences of canola, flax, wheat, and barley. The study is being conducted at the North Central Research Extension Center, Minot, ND.

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.

II. Materials and Methods

Crop Rotations

Six crop rotations were established at Minot, ND in 2000. This study will continue the same crop sequences so a true rotation may be observed (Table 1). Each crop will be planted into a 30 foot by 180 foot plot, with a 30-foot border around all sides of each plot. In each year there will be 7 canola plots, 2 flax plots, 5 wheat plots, and 4 barley plots. Each treatment will be replicated four times. Every crop of the rotation must be grown in every year to help

explain the effect of individual years. Therefore, we will need to establish and maintain 72 plots per year (Table 2).

Table 1. Proposed crop rotations by year and sequence.

Rotation	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
1	C	C	B	W	C	C	B	W	C	C	B	W
2	C	W	C	W	C	W	C	W	C	W	C	W
3	F	C	B	W	F	C	B	W	F	C	B	W
4	F	W	C	W	F	W	C	W	F	W	C	W
5	C	B	W	C	B	W	C	B	W	C	B	W
6	C	C	C	C	C	C	C	C	C	C	C	C

B = barley C=canola F=flax W=wheat

Table 2. Proposed number of treatments and plots.

Rotation 1	4 treatments x 4 replications	= 16 plots
Rotation 2:	2 treatments x 4 replications	= 8 plots
Rotation 3:	4 treatments x 4 replications	= 16 plots
Rotation 4:	4 treatments x 4 replications	= 16 plots
Rotation 5:	3 treatments x 4 replications	= 12 plots
Rotation 6:	1 treatment x 4 replications	= 4 plots
Total:	18 treatments x 4 replications	= 72 plots

Rotations shown with every crop present in every year

1	C	C	B	W	1
	C	B	W	C	2
	B	W	C	C	3
	W	C	C	B	4
2	C	W	C	W	5
	W	C	W	C	6
3	F	C	B	W	7
	C	B	W	F	8
	B	W	F	C	9
	W	F	C	B	10
4	F	W	C	W	11
	W	C	W	F	12
	C	W	F	W	13
	W	F	W	C	14
5	C	B	W	C	15
	B	W	C	B	16
	W	C	B	W	17
6	C	C	C	C	18

We will compare disease levels in canola where the preceding crop was either wheat (BWC), canola (WCC), or flax (WFC). We can also compare disease levels in canola where the crop two years previous was a small grain (BWC), canola (CWC), or flax (FWC). Another way to look at it is that we are monitoring disease levels in:

1) canola on canola
2) canola every other year
3) canola following flax, another SSR susceptible broadleaf crop
4) canola on wheat
5) canola every three years
6) canola every year

One-half of each canola plot will be sprayed with a fungicide to help determine the full impact of disease pathogens. In other words, one-half of each plot will receive a fungicide application while the other half will receive no fungicide application. Therefore, for canola, data must be collected on 56 experimental units.

Disease Sampling

Each half (fungicide treated, and untreated) of every canola plot will be sampled for Sclerotinia spores and disease, and for blackleg and alternaria black spot incidence and severity.

Sclerotinia

Sclerotinia ascospore counts. Ascospore sampling will be done within the canopy of each canola plot. Sampling for spores will be done at 20% bloom and again 1 week later. Petri plates with Steadman's (Steadman *et al*) semi-selective medium will be placed on the soil surface at four locations in the center of canola subplots to sample spores in the plot. The plates will be exposed with the covers removed for 2 ½ hours. After exposure, the plates will be covered and incubated for 3 days at 70-75º F in the dark.

Colonies of Sclerotinia will be identified 3 days after exposure by a color change in the blue medium surrounding the colonies, resulting in a yellow halo. Presence of a thin, prostrate shiny growth will also be used to confirm that the colonies in the halos are Sclerotinia. The number of Sclerotinia colonies will be counted on each plate and the total number of colonies per plot and sampling date will be calculated.

Canola petals will also be tested for the presence of ascospores. Petals will be collected from four areas within each canola subplot on the same ascospore sampling dates previously mentioned. Four petals from each sampling area will be placed on a petri dish with the same semi-selective media previously mentioned. The petri plates will be incubated, and the presence or absence of sclerotinia ascospores will be observed the same way. Sclerotinia

disease risk will be reported on the scale of 0 to 45% incidence being low risk, 45-90% incidence being high risk, and 90 to 100% incidence being high risk (Morrall and Thomson 1991).

Sclerotinia Incidence and Severity. Sampling will be done at 10 locations per subplot for a total of 100 plants sampled per subplot, as for blackleg. The same stems analyzed for blackleg will also be analyzed for Sclerotinia. Sclerotinia will be identified by stems that are bleached white. Diseased stems may also be spongy or shredded and have sclerotia (hard black bodies) inside the stems. In order to assure accurate assessment of bleached stems, the sampling should be done within one week of swathing before the healthy stems lose their green color and become straw colored. Sclerotinia incidence (percent of infected plants), and severity on a scale of 0 to 5 (0 being healthy, 5 being dead) will be calculated for each plot.

Flax will also be evaluated for sclerotinia incidence and severity. A total of 100 plants per plot will be evaluated in a similar fashion as canola.

Blackleg

The sampling will be done two times during the growing season. The first evaluation will be conducted prior to bolting. Canola leaves on 10 plants at 10 random locations per subplot will be evaluated for blackleg lesions. Incidence of the lesions will be recorded, not severity.

The second evaluation will be conducted when the crop is in the swath. The sampling locations will be paced off, and 10 consecutive stems at each location, beginning where the pace ends, will be removed and inspected for blackleg. This will assure a sample size of 100 plants per subplot. Blackleg will be identified by blackened lower stems, or lesions on the lower stem that are dark gray with a black border and with black fruiting bodies (pycnidia), or by plant crowns that are black, or gray or streaked with gray (determined by cutting the stem off at the crown). Blackleg incidence (percent infected plants), and severity on a scale of 0 to 5 (0 being healthy, 5 being dead) will be calculated for each plot will be calculated for each plot.

Alternaria Black Spot

Sampling will be done at 10 locations in each canola plot. The locations and timing of sampling will correspond to those for blackleg and Sclerotinia. A sample of 5 pods will be collected at random from several different stems at each of 10 locations. The percent of pod area infected (severity) will be estimated using the severity scale of Conn *et al*. Average severity and incidence for each plot will be calculated.

I. Economic Benefit

We typically see higher grain yields when we include another crop in the rotation compared to growing continuous wheat (Peel 1998). The following table shows the effect of previous crops on wheat yields:

The table below (Table 3) shows that incorporating flax into the rotation with wheat generally improved wheat yields the following year compared to wheat on wheat. This study was conducted before canola became an important crop in the region. However, we expect that incorporating canola into the rotation will supply similar benefits to the wheat crop.

We believe other economic benefits will be demonstrated from the proposed study. The cost of fungicide applications in canola is extremely high. Any practice that will reduce disease pressure will reduce the cost of controlling the disease or could render the fungicide application unnecessary. Quadris and Ronilan are both labeled for SSR control in canola. A low rate of Quadris for light disease pressure is approximately $12 per acre compared to $30 per acre for the recommended rate for high disease pressure. Ronilan would cost approximately $13 to $20 per acre depending on disease pressure.

Table 3. Effect of previous crop on wheat yields, Fargo, ND (Miller 1984)

	Wheat yield, bu/A - Conventional tillage								
Previous crop	1977	1978	1979	1980	1981	1982	1983	1984	8 yr avg.
Wheat	22	26	35	37	34	39	43	16	31
Barley	27	25	35	37	42	46	48	18	35
Flax	31	37	36	35	37	47	43	37	38
Corn	31	32	43	37	45	53	39	38	38
Soybean	42	43	42	42	46	49	54	45	45
Sunflower	29	33	44	41	45	39	43	44	40
Sugarbeet	34	34	41	38	44	43	52	47	42
Average	31	33	39	38	42	44	46	35	

One of the goals of this study is to design a crop rotation that allows a producer to grow potentially profitable crops in a sequence that minimizes disease pressure. If we can reduce disease pressure from heavy to light through a slight change in crop sequence, then the producer would essentially reduce his fungicide cost $7 to $18 per acre by lowering the rate of fungicide needed to control diseases.

I. **Environmental Benefit**

Benefits typically seen from proper crop rotations include reduced insect and disease problems, improved soil fertility, improvements in soil tilth and aggregate stability, better soil water management, and reduction in soil erosion (Peel 1998).

In the proposed study, we may see that reducing disease pressure through crop rotations will not only reduce the cost to the producer, but will also reduce the amount of fungicide applied to the crop and into the environment. For example, the Quadris application rate for high disease pressure is 15.4 oz per acre compared to 6.2 oz per acre for light disease pressure. Therefore, a proper crop rotation may not only reduce the costs associated with a fungicide application, but could reduce the fungicide load to the crop and environment by as much as 60%.

II. Segments Benefitting

The information collected from this study should be beneficial to canola, flax, wheat, and barley producers in North Dakota. We will gain a better understanding of the impact that these specific crop sequences have on pest pressure, crop yield, and crop quality. The data should help producers plan their crop rotations by having a greater understanding of the risks and benefits of rotations involving canola, flax, wheat, and barley. Most producers are on an extremely tight budget and need to be able to plan ahead for possible expenses. An even greater benefit would be to have the ability to plan the rotation to avoid certain expenses, such as high fungicide rates needed for high disease pressure, while raising crops that may be profitable.

III. Technology Transfer

The results of this study will be published in a refereed journal such as Agronomy Journal. The major findings, practical applications, and recommendations will be distributed to producers and crop consultants through the Northern Canola Growers Association, North Dakota Oilseed Council, the North Dakota Extension Service, and other commodity organizations. The data will also be presented at scientific meetings such as the American Society of Agronomy or the American Phytopathological Society annual meeting.

Literature Review

Crop rotation with pathogen non-hosts is considered to be a very important cultural factor for reducing disease in crops. This practice is primarily directed toward the reduction of pathogen inoculum by eliminating susceptible hosts. The success of crop rotation as a cultural control measure is related to the longevity of pathogen inoculum, the wide host range of certain pathogens and the proximity of fields of susceptible host crops grown next to rotated fields. Rotations alone will not always reduce disease as spore inoculum can also come from neighboring fields (Williams 1981).

Three to four-year rotations between susceptible crops have been suggested to reduce Sclerotinia stem rot caused by *Sclerotinia sclerotiorum*. This may not be sufficient and Williams and Stelfox (1980) found that the number of viable sclerotia of this organism in soil was unchanged after 3 consecutive years of barley following canola. This study also revealed

that 2 consecutive years of canola led to higher numbers of viable sclerotia than one year of canola.

Three-year rotations usually reduce the severity of blackleg caused by *Leptosphaeria maculans* (Petrie 1986). The fungus has been found to survive in stubble for more years with the most damaging infections arising from inoculation produced by 2-3 year old stubble. Over 90% of the canola stubble harboring black leg disappears in 2 years; however, the more decay-resistant crowns and taproots released ascospores of *Leptosphaeria maculans* for an additional 3-5 years following an infected crop of canola (Petrie 1995).

McLaren et al. evaluated the prevalence and incidences of blackleg and sclerotinia stem rot in 1997 and 1998 in 173 and 278 fields, respectively. Fields were categorized into 2(one year out of canola)-5 year rotations. As the canola rotations increased from 2 to 5 years the incidence of blackleg decreased during both field seasons. The effectiveness of canola rotations in reducing this disease depends on the presence of inoculant in adjacent fields. In Canada, ascospores of *Leptosphaeria maculans* can be dispersed for up to 2 km (Petrie 1978). Crop rotation and field placement needs to be considered for disease avoidance.

Tillage may also reduce blackleg incidence and severity compared with a no-till system. Blackleg stem severity in canola preceded by 3-years of canola in a no-till system was 3, compared to only 1.5 in canola in the same rotation but with conventional tillage (Fernando 2004, Guo et al. 2005). This is likely due to decomposition and microbial degradation of the blackleg fungus on the canola residue as it is incorporated into the soil profile. A four year study (1999 – 2002) in Manitoba, Canada showed both rotation and tillage to significantly reduce the number of infected plants, the number of blackleg lesions per leaf, and the number of infected leaves per plant (Guo et al. 2006).

Rotation effect on the prevalence and incidence of Sclerotinia stem rot was less consistent (McLaren et al). In one region surveyed, disease incidence was reduced from 42 to 7 % when rotation was increased from 2-3 years. However disease incidence in the 4-5 year rotations was 14 and 37 % respectively. The disease incidence was less in the 5-year rotation than in the 2-year rotations in 1998, but disease levels varied considerably in the 3 and 4 year rotations.

Seedling blight and root rot of canola can be reduced with the use of rotation. In Alberta, a higher incidence of root rot caused by *Rhizoctonia solani* was reported when canola was preceded by fescue (Evans 1994). Growing barley for 2-3 years after canola significantly reduced the population of *R. solani* under zero-tillage (Yang et al. 1995). Alternaria blight of canola, caused by *Alternaria brassicae*, can be minimized by having 3 non-host crops between canola crops (Thomas 1985).

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Budget

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