2014 Annual Report

for the

Agricultural Demonstration of Practices and Technologies (ADOPT) Program

Project Title: Flax Response to Fungicide at Varying Row Spacing and Nitrogen Levels

(Project #20130354)

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Project Identification

1. **Project Title:** Flax response to fungicide at varying row spacing and nitrogen levels
2. **Project Number:** 20130354
3. **Producer Group Sponsoring the Project:** Saskatchewan Flax Development Commission (SaskFlax)
4. **Project Location(s):** Indian Head, Saskatchewan, R.M. #156
   Melfort, Saskatchewan, R.M. #428
5. **Project start and end dates (month & year):** April 2014 to February 2015
6. **Project contact person & contact details:**

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Objectives and Rationale

7. **Project objectives:**

The principal objective of this project was to demonstrate the response of flax to fungicide at two separate locations in Saskatchewan where pasmo is frequently encountered. Additional objectives were to evaluate the effects of row spacing (Indian Head, Saskatchewan) and N fertility levels (Melfort, Saskatchewan) along with interactions between these factors and crop response to fungicide.

8. **Project Rationale:**

Pasmo (*Septoria linicola*) is the most common disease that affects flax yields in Saskatchewan and, like many disease, is typically most severe in wet environments and with heavy crop canopies. Headline EC (250 g pyraclostrobin l^{-1}) is currently the only registered foliar fungicide for control of pasmo and has been shown to improve yields when the disease is present; however producers frequently question the potential return on investment for fungicide application on flax. Field trials and demonstrations at Indian Head over the past four years have shown reasonably consistent response to fungicide applications with increases of nearly 30% when disease pressure is high. As expected, the response was smaller or not significant in years or at locations where disease pressure was low.

Since disease pressure is often higher with dense crop canopies, certain management factors such as seeding rates, row spacing and fertility may indirectly affect flax response to fungicide. With respect to fungicide interactions with row spacing, it is conceivable that disease pressure will be lower at wider row spacing due to increase air flow through the crop, particularly earlier in the season before canopy closure is complete. That said, flax is a poor competitor with weeds and there are questions regarding whether seed yields will be reduced at row spacing of 12" and wider. Focussing on nitrogen fertilizer use, past research and producer testimonials suggest that with fungicide application, higher levels of fertility are possible without lodging. Most producers apply 45-90 kg N ha^{-1}; however it is possible that flax will respond to even higher rates under high yielding conditions and with fungicide application. The proposed demonstration will provide a forum for discussing the potential merits of fungicide applications on flax while simultaneously addressing questions regarding optimal row spacing and N fertilizer rates for flax.

Methodology and Results

9. Methodology:

Field trials were completed in 2014 by the Indian Head Agricultural Research Foundation (IHARF) and the Northeast Agriculture Research Foundation (NARF) on behalf of the Saskatchewan Flax Development Commission. The trials were located on no-till fields near Indian Head, (R.M. #156) and Melfort, Saskatchewan (R.M. #428). At each site, ten treatments were arranged in a split-plot design where two foliar fungicide treatments (check, treated) comprised the main plots and the sub-plots were either five row spacing levels at Indian Head (25, 31, 36, 41 and 61 cm) or five N fertilizer rates at Melfort (34, 67, 101, 134 or 168 kg N ha^{-1}). Each treatment was replicated four times at both sites.

At Indian Head, flax was direct-seeded using a SeedMaster plot drill equipped with 8 openers and a trimmed plot length of 10.5 m. Plot widths depended on row spacing, which was varied by repositioning all 8 openers along the frame of the drill as required. For the 61 cm row spacing, the drill was configured for 31 cm spacing but product was diverted to every second opener which was raised to avoid disturbing the soil surface. Consequently, all treatments consisted of eight full rows except for the 61 cm treatments which were only four rows. The seeding rate used was 50 kg ha^{-1} and urea, monoammonium phosphate, potassium chloride and ammonium sulphate were side-banded at rates considered high enough to ensure that nutrient availability was not limiting. All seed and fertilizer rates were held constant on a per area basis. Weeds were controlled using registered pre-emergent and in-crop herbicide applications which were selected to control the specific species encountered on the site. Plant densities were estimated by counting the number plants in 4 x 1 m sections of crop row. No lodging was observed at any point during the growing season at Indian Head, therefore detailed notes were not taken and lodging data are not presented. Prior to maturity, all plots were rated for pasmo on by assessing the percent of stem area affected for 10 plants per plot on a scale of 0-10 where 0 is no disease and 10 is 100 percent of stem area affected by disease. Preharvest glyphosate was applied to terminate weeds and assist with crop dry down. All but the outside flax rows (6 rows on 25-46 cm row spacing and 2 rows on 61 cm spacing) were straight-combined using a Wintersteiger plot combine in late September. The harvest samples were cleaned and weighed with yields expressed in kg ha^{-1} and corrected to 10% seed moisture content.

At Melfort, the soil was tilled and packed 4 days prior to seeding. Flax was seeded with a Fabro disc drill with 7 inch row spacing. At seeding, 15 kg ha^{-1} of P_2O_5 as 11-52-0 fertilizer was placed in the seed row. Nitrogen varied as per the protocol at 30, 60, 90, 120 and 150 kg ha^{-1}. Weeds were controlled using registered pre-emergent and in-crop herbicide applications which were selected to control the specific species encountered on the site. Plant densities were estimated by counting the number plants in 2 x 1 m sections of crop row. Fungicides were applied according to the trial protocol, with 160 ml/ac of Headline applied July 21st. Disease levels were determined by percentage ratings for Pasmo on September 26th as described for Indian Head above. Because pasmo incidence and severity was very low, and because of time constraints, only one replicate was completed. Near the end of the growing season, maturity for each individual plot was recorded to determine treatments effects. In addition, at maturity, the incidence and severity of lodging was determined using the Belgian scale. Preharvest glyphosate was applied to terminate weeds and assist with crop drying. Yield was determined by harvesting the whole plots with a Wintersteiger combine and weighing the total cleaned seed sample taken from the entire plot (8.7122 m^2).

Selected agronomic information and dates of field operations for both sites are provided in Table 1. All available response data were analysed using the Mixed procedure of SAS 9.3 and Fisher's protected LSD test to separate treatment means. Orthogonal contrasts were used to better describe the observed responses to row spacing and N rate. All treatment effects and differences between means were considered significant at $P \leq 0.05$. Growing season weather data were monitored and recorded using online data from the nearest Environment Canada weather station to each site.

Table 1. Selected agronomic information and field operations / data collection activities for flax fungicide demonstrations at Indian Head and Melfort in 2014.

Description	Indian Head	Melfort
Previous Crop	Spring Wheat	Canola
Variety	CDC Bethune	CDC Bethune
Seeding Rate	50 kg ha^{-1}	55 kg ha^{-1}
Pre-Emergent Herbicide	May 18 890 g glyphosate ha^{-1} + 140 g sulfentrazone ha^{-1}	n/a
Seeding Date	May 12	May 21
Fertility (kg N-P_2O_5-K_2O-S ha^{-1})	100-20-10-10	n/a
Plant Density	June 11	June 6
In-Crop Herbicide 1	July 7 99 g clopyralid ha^{-1} + 553 g MCPA ester ha^{-1} + 211 g sethoxydim ha^{-1}	June 24 (all) 280 g bromoxynil ha^{-1}+ 280 g MCPA ester ha^{-1}+ 211 g sethoxydim ha^{-1}
Foliar Fungicide	July 12 99 g pyraclostrobin ha^{-1}	n/a
Pasmo Ratings	August 19	September 26
Pre-Harvest Application	September 5	September 15
Harvest Date	September 25	September 29

10. Results:

Indian Head: Flax Response to Row Spacing and Fungicide Application

Mean monthly temperatures and precipitation amounts for the 2014 growing seasons at Indian Head are presented relative to the long-term (1981-2010) averages in Table 2. Spring arrived late with respect to snow melt, temperatures and field accessibility; however this month was drier than normal and seeding was completed relatively early. June, on the other hand, was extremely wet (258% of average precipitation levels) and somewhat cooler than normal. Prolonged wet conditions throughout the month of June resulted in substantial crop injury and delayed in-crop herbicide applications; however, the flax recovered reasonably well overall. However, with herbicides delayed and suspected Group 1 resistance, wild oat pressure was quite high at this site and was considered a significant yield limiting factor. July was also cooler than average but, with very little precipitation the site was able to dry out for the latter half of the month. The wet weather returned in August with 278% of normal precipitation; however the crop reaching physiological maturity at this time and harvest was completed in late September.

Table 2. Mean monthly temperatures and precipitation amounts along with long-term (1981-2010) normals for the 2014 growing season at Indian Head, Saskatchewan.

Year	May	June	July	August	Avg. / Total
	---------------------------*Mean Temperature (°C)* ---------------------------				
2014	10.2	14.4	17.3	17.4	14.8
Long-term	10.8	15.8	18.2	17.4	15.6
	------------------------------- *Precipitation (mm)* -------------------------------				
2014	36	199.2	7.8	142.2	385
Long-term	51.8	77.4	63.8	51.2	244

The overall tests of fixed effects for the field trial at Indian Head are presented in Table 3. Plant densities were affect by row spacing ($P = 0.034$) but not fungicide ($P = 0.933$) and there was no interaction between the two factors. While overall disease levels were relatively low at Indian Head in 2014 and the disease that was observed set in relatively late in the season, the pasmo rates were affected by all variables with a significant interaction detected ($P = 0.002$-0.037). For seed yield, the effect of row spacing was significant overall ($P < 0.001$) but the fungicide effect was not ($P = 0.374$) and there was no interaction between fungicide treatment and row spacing ($P = 0.765$).

Table 3. Foliar fungicide and row spacing effects on flax establishment, disease, and seed yield at Indian Head in 2014.

	Plant density	Disease	Yield
Effect	-------------------------	p-values	-------------------------
Fungicide (F)	0.933	0.002	0.374
Row spacing (RS)	0.034	0.037	< 0.001
F × RS	0.663	0.005	0.765

Least squares means for the main effects (fungicide treatment and row spacing) on all three variables at Indian Head are presented in Table 4. Emergence at this site was excellent overall with more than the recommended 300 plants m^{-2} achieved on average. Fungicide treatment was not expected to affect plant populations since pasmo affects flax relatively late in the season and the emergence measurements were completed prior to the treatment applications. Row spacing did not have an entirely consistent effect on plant densities but the highest populations (382 plants m^{-2}) were recorded at 31 cm spacing and the lowest, as expected, were observed at 61 cm row spacing (299 b). While there was an overall linear decline in plant population with increasing row spacing ($P = 0.030$), plant populations at 25 cm spacing did not significant differ from those at the 61 cm spacing (Fisher's protected LSD test, $P \leq 0.05$). The relatively low populations at 25 cm row spacing (338 plants m^{-2}) can be largely explained by issues with straw / residue clearance that were encountered on the site at the narrowest row spacing whereby the rear openers occasionally buried sections of the crop rows seeded by the front tier of openers. Interactions between fungicide treatment and row spacing were not significant and are not discussed; however, individual treatment means are presented in the Appendices (Table 9).

Table 4. Least squares means for main effects of foliar fungicide and row spacing on plant density, disease and seed yield of flax at Indian Head in 2014.

Main effect	Plant Density	Pasmo Ratings	Seed Yield
Fungicide treatment	------- plants m^{-2} -------	---------- 0-10 ----------	--------- kg ha^{-1} ---------
Fungicide [Z]	346 a	0.61 b	1412 a
No fungicide	344 a	2.02 a	1218 a
S.E.M.	11.5	0.19	143
Row spacing			
25 cm (10")	338 ab	1.21 ab	1454 a
31 cm (12")	382 a	1.24 ab	1421 a
36 cm (14")	337 ab	1.59 a	1297 ab
41 cm (16")	369 ab	1.44 ab	1335 a
61 cm (24")	299 b	1.08 b	1067 b
S.E.M.	18.2	0.17	114
Orthogonal Contrasts	----------------	Pr. > F	----------------
RS – linear	0.030	0.238	<0.001
RS – quadratic	0.095	0.009	0.876
RS – cubic	0.790	0.926	0.607

[Z] 0.4 l Headline EC ha^{-1} applied at full bloom (approximately 7 days after 1st flowers noted)

Severity of pasmo was rated at Indian Head on August 19, relatively late in the season but prior to physiological maturity. Overall, disease pressure appeared to be relatively low as there were no obvious differences between the treated and untreated plots as there have been in years where disease was a major limiting factor in flax (i.e. Indian Head 2012, Fig. 1). Upon close inspection, however, pasma was present at significant levels but appeared to have infected the flax relatively late in the season and therefore was not expected to have a major impact on seed yield. Fungicide application resulted in a significant reduction in pasmo incidence ($P < 0.001$) and, although the effect of row spacing was significant ($P = 0.037$) there was no specific trend for declining pasmo levels with increasing row spacing, at least for row spacing levels between 25-41 cm.

Despite the reduction in disease incidence, fungicides did not have a statistically significant effect on flax yield at Indian Head in 2014 ($P = 0.374$); however, there was a slight tendency for higher yields (16% on average) when fungicides were applied. An overall linear decline in seed yields with increasing row spacing was detected ($P < 0.001$); however, it is important to note that yields did not significantly differ (Fisher's protected LSD test, $P \leq 0.05$) for row spacing levels ranging from 25-41 cm (10-16"). Furthermore, with relatively low overall yields and heavy weed pressure, this was a good opportunity to test for potential drawbacks to wider row spacing in a non-competitive crop.

While further testing is required to provide conclusive recommendations, it is conceivable that the effects of row spacing would be less prominent under more optimal growing conditions and with better weed control. At 61 cm, yields were significantly lower than the majority of other row spacing levels and planting flax at wider than 41 cm row spacing is not recommended under any circumstances. It is unlikely that growers currently using drills with row spacing of 31-41 cm would experience a significant reduction in yields relative to those using drills with 25 cm or narrower row spacing provided that fertility, weed competition and disease are adequately managed. With no significant interactions between row spacing and fungicide treatment in this particular case (P = 0.607), the effect of row spacing was consistent across fungicide treatments and vise versa.

Melfort: Flax Response to Nitrogen Rate and Fungicide Application

Mean monthly temperatures and precipitation amounts for the 2014 growing season at Melfort is presented in Table 5. Overall, the weather patterns at Melfort in May and June of 2014 were similar to those at Indian Head with cooler and drier than normal conditions in May followed by cool and extremely wet (308% of the long-term average precipitation) weather in June. Precipitation was somewhat above normal in July with normal temperatures. August at Melfort had near normal precipitation and above normal temperatures. Overall the growing season was wetter than normal with near normal temperatures.

Table 5. Mean monthly temperatures and precipitation amounts along with long-term (1981-2010) normals for the 2014 growing season at Melfort, Saskatchewan.

Year	May	June	July	August	Avg. / Total
	----------------------------	*Mean Temperature (°C)*	----------------------------		
2014	10.0	14.0	17.5	17.6	14.8
Long-term	10.7	15.9	17.5	16.8	15.2
	----------------------------	*Precipitation (mm)*	----------------------------		
2014	24.4	169.8	94.6	60.4	349.2
Long-term	42.9	54.3	76.7	52.4	226.3

The effects of fungicide treatment, N fertilizer rate and their interactions on flax yield in Melfort in 2014 are presented in Table 6. At this location, flax yield was affected by N fertilizer rate ($P < 0.001$) but not fungicide application ($P = 0.211$) and there were no significant interactions between the two factors ($P = 0.789$).

Least squares means for the main effects of fungicide application and N fertilizer rate on flax yield at Melfort are presented in Table 7. Average flax yields were somewhat higher at Melfort than at Indian Head (1863 kg ha^{-1} vs 1315 kg ha^{-1}), but again, there was no impact of fungicide and the mean yields between the sprayed and unsprayed plots were similar. There was a stronger than expected overall response to N fertilizer rate with yield s at the 168 kg N ha^{-1} (150 lb N ac^{-1}) rate, which is considerably higher than the typical rates currently used by flax growers, significantly exceeding those achieved at any of the lower rates. Averaged across fungicide treatments, flax yields at the top N fertilizer rate were 60% higher than those at the lowest N rate. The quadratic nature of the N response ($P = 0.017$) was a result of diminishing yield increases with increasing N rates at the higher levels and therefore, the optimal economic N was likely below the maximum levels evaluated in this demonstration but higher than the more typical rates of 50-90 kg N ha^{-1}.

Table 6. Foliar fungicide and nitrogen fertilizer effects on flax seed yield at Melfort in 2014.

	Plant Density	Maturity	Pasmo Rating	Yield
Effect	------	p-values	------	
Fungicide (F)	0.270	0.469	n/a	0.211
Nitrogen Rate (NR)	0.280	0.702	n/a	< 0.001
F × NR	0.060	0.687	n/a	0.789

Table 7. Least squares means for main effects of foliar fungicide and nitrogen rate on seed yield of flax at Melfort in 2014.

Main effect	Plant Density	Pasmo Rating	Seed Yield
Fungicide treatment			kg ha^{-1}
Fungicide [Z]	424	—	1832 a
No fungicide	440	—	1894 a
S.E.M.	—	—	30.9
Nitrogen Rate			
34 kg N ha^{-1}	437	—	1380 d
67 kg N ha^{-1}	443	—	1740 c
101 kg N ha^{-1}	444	—	1923 b
134 kg N ha^{-1}	400	—	2061 b
168 kg N ha^{-1}	436	—	2211 a
S.E.M	—	—	48.6
Orthogonal Contrasts	------	Pr. > F	------
N Rate – linear	—	—	< 0.001
N Rate – quadratic	—	—	0.017
N Rate – cubic	—	—	0.237

[Z] 0.4 l Headline EC ha^{-1} applied at full bloom (approximately 7 days after 1st flowers noted)

Project Extension Activities

This demonstration was shown at the Indian Head Crop Management Field Days on July 22, 2014 which were attended by approximately 200 producers and industry representatives each year. The discussion at the site was led by Zafer Bashi (Saskatchewan Ministry of Agriculture) and Christiane Catellier (IHARF) and revolved around some the current opportunities and challenges of flax production in Saskatchewan. This demonstration was also shown at the Melfort annual Field Day on July 23, 2014 with approximately 160 in attendance. The demonstration was also used at the Crop

Diagnostics School July 29 and 30 at Melkfort, to demonstrate crop response to fertilizer N. Signs were in place to identify treatments and acknowledge the support of the Agricultural Demonstrations of Technologies and Practices (ADOPT) program. The results were also presented by Chris Holzapfel (IHARF) to approximately 65 producers and industry representatives at the Agri-ARM Research Update on January 15, 2015 at Prairieland Park during the Crop Production Show and the IHARF Soil and Crop Management Seminar held on February 4 at White City. Results from this project will also be made available in the 2014 IHARF Annual Report (available online) and a variety of other media (i.e. oral presentations, popular agriculture press, fact sheets, etc.) where there is opportunity to do so.

11. Conclusions and Recommendations

This project demonstrated the response of flax to foliar fungicide applications combined with varying row spacing and N fertilizer levels at two locations in Saskatchewan, Indian Head and Melfort. While a significant yield increase with foliar fungicide application was not detected in either of these individual demonstrations, when results from previous sites are considered the potential for a positive response under heavier disease pressure becomes clearer. Table 8 summarizes the results of a separate analysis where fungicide response data from 8 separate sites were combined and analysed with the effects of site, fungicide and site-by-fungicide were considered fixed. The sites were located at Swift Current (2), Indian Head (5) and Melfort (1). At Swift Current, where conditions tend to be drier and disease tends to be less of an issue, there was no benefit to fungicide in either of the two years for which data is available. In contrast, at Indian Head where yield potential and disease incidence are generally higher, the observed yield increases were significant at $P \leq 0.05$ in 60% of the evaluations and at $P \leq 0.10$ in 83% of the evaluations with an overall mean yield increase of 13% or 262 kg ha^{-1} (4.2 bu ac^{-1}). Interestingly, the response at Indian Head in 2014 was also declared significant when combined with data from multiple locations despite the fact that this increase was not significant when analysed for the single year and combined with the effects of row spacing. More data from Melfort would be required to draw general conclusions for this site regarding flax response to fungicide applications; however, the long-term probability of response to fungicide application at Melfort would likely be similar to that observed at Indian Head. When all data from all locations were combined, the mean yield increase with fungicide was still highly significant ($P < 0.001$) and averaged 10% or 181 kg ha^{-1} (2.9 bu ac^{-1}). However, with a highly significant site-by-fungicide interaction ($P < 0.001$), it is clear that environment plays a critical role and crop scouting and test strips should be utilized to better inform spraying decisions and evaluate the actual benefits (or lack thereof) of foliar fungicide applications on flax.

Table 8. Contrasts evaluating foliar fungicide effects at eight individual sites and averaged across sites. Data were analyzed using the Mixed procedure of SAS 9.3 and the effects of site, fungicide and the site-by-fungicide interaction were all significant at $P < 0.001$.

Location – Year	Check	Fungicide Applied [Z]	Pr. > F
	---------------------- kg ha^{-1} ----------------------		-------- p-value --------
Swift Current – 2010	631	648	0.792
Swift Current – 2011	1603	1667	0.402
Indian Head – 2010	1563	1991	< 0.001
Indian Head – 2011	2044	2152	0.163
Indian Head – 2012	2209	2710	< 0.001
Indian Head – 2013	3092	3198	0.056
Indian Head – 2014	1278	1442	0.037
Melfort – 2014	1832	1894	0.423
Overall Average	1781	1963	< 0.001

[Z] 0.4 l Headline E.C. ha^{-1} applied at full bloom

Focussing on the current demonstrations, there were no interactions between fungicide application and row spacing or N fertilizer rate, despite the impacts of these latter factors being highly significant on their own. It is possible that interactions may have been detected if disease pressure had been a dominant yield limiting factor at either of these locations; however, this was not the case in 2014.

While there was a linear decline in seed yields with increasing row spacing detected at Indian Head, this was considered a 'worst-case' scenario with both excess moisture and heavy weed pressure being major limiting factors at the site. Even under these conditions, the absolute yields achieved at individual row spacing levels ranging from 25-41 cm did not significantly differ from one another; however, yields at 61 cm row spacing were significantly lower than most of the other treatments suggesting that this is simply too wide for this crop. It is possible that under more optimal conditions and when other factors such as overall plant density, fertility, weed pressure and disease are managed appropriately the impact of row spacing levels ranging from 25-41 cm would be negligible. Considering the wide-spread use of drills configured on 31 cm row spacing and the fact that commercial drills are available with row spacing as wide as 38 cm, further evaluation of the effects of row spacing on flax yield over the long-term is well justified.

The observed flax yield response to N fertilizer at Melfort was somewhat unexpected in that yields continued to climb right up the highest rate (168 kg N ha^{-1}) despite the fact that yields were not particularly high and such rates greatly exceed those typically used by experienced flax growers. There was evidence of diminishing yield benefits with increasing N rate at the higher levels and the optimal economic N would likely below the maximum levels evaluated in this demonstration but higher than the more typical rates of 50-90 kg N ha^{-1}, depending on fertilizer and flax prices. Nonetheless, the response to N was stronger than expected and, as we seek improvements to agronomic recommendations for increasing flax yields, the potential for response to N fertilizer rates exceeding those currently used by most producers and tools for improving our ability to predict such responses should not be overlooked.

Supporting Information

12. Acknowledgements:

The project was supported by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward 2 bi-lateral agreement. Acknowledgement of the Saskatchewan Ministry of Agriculture's support for this demonstration will be included as part of all written reports and oral presentations that arise from this work. Seed for the project was provided in-kind by the Agriculture and Agri-Food Canada, the Crop Development Centre and Crop Protection Services.

13. Appendices

Table 9. Least squares means for effects of interactions between foliar fungicide and row spacing on plant density, disease and seed yield of flax at Indian Head in 2014.

Interaction	Plant Density	Pasmo Ratings	Seed Yield
Fungicide × N Rate	------ plants m^{-2} ------	--------- 0-10 ---------	-------- kg ha^{-1} --------
Check – 25 cm	111	1.88 bc	1358
Check – 31 cm	357	1.70 bcd	1291
Check - 36 cm	349	2.73 a	1246
Check – 42 cm	370	2.04 ab	1191
Check – 61 cm	300	1.75 bc	1002
Fung – 25 cm	330	0.55 de	1550
Fung – 31 cm	406	0.79 cde	1550
Fung – 36 cm	325	0.46 e	1347
Fung – 42 cm	368	0.84 cde	1478
Fung – 61 cm	299	0.42 e	1132
S.E.M.	25.7	0.24	160.9
Orthogonal Contrasts		------------ Pr. > *F* ------------	
RS (check) – linear	0.145	0.426	0.004
RS (check) – quadratic	0.217	0.008	0.880
RS (check) – cubic	0.719	0.591	0.951
RS (fung) – linear	0.094	0.377	<0.001
RS (fung) – quadratic	0.246	0.274	0.710
RS (fung) – cubic	0.463	0.684	0.506

Figure 1. Visually obvious response to foliar fungicide application on flax under heavy disease pressure (Indian Head 2010).


25 cm (10")


31 cm (12")


36 cm (14")


41 cm (16")

Figure 2. Flax growing at varying row spacing levels at Indian Head in 2014.

Table 10. Least squares means for effects of interactions between foliar fungicide and nitrogen rate on seed yield of flax at Melfort in 2014.

Interaction	Seed Yield
Fungicide × N Rate	------------------- kg ha^{-1} -------------------
Check – 34 kg N ha^{-1}	1328 f
Check – 67 kg N ha^{-1}	1756 de
Check - 101 kg N ha^{-1}	1891 cde
Check – 134 kg N ha^{-1}	2044 bc
Check – 168 kg N ha^{-1}	2143 ab
Fung – 34 kg N ha^{-1}	1433 f
Fung – 67 kg N ha^{-1}	1724 e
Fung – 101 kg N ha^{-1}	1955 bcd
Fung – 134 kg N ha^{-1}	2079 abc
Fung – 168 kg N ha^{-1}	2278 a
S.E.M.	68.7
Orthogonal Contrasts	------------------- Pr. > F -------------------
N Rate (check) – linear	< 0.001
N Rate (check) – quadratic	0.020
N Rate (check) – cubic	0.283
N Rate (fung) – linear	< 0.001
N Rate (fung) – quadratic	0.267
N Rate (fung) – cubic	0.542

Abstract

14. Abstract/Summary:

The Indian Head Agricultural Research Foundation (IHARF) and Northeast Agriculture Research Foundation (NARF) conducted field demonstrations in 2014 on behalf of the Saskatchewan Flax Development Commission (SaskFlax). The overall project objective was to demonstrate the response of flax to foliar fungicide application with secondary objectives of investigating potential interactions with row spacing (Indian Head) and N fertility (Melfort) along with the general crop response to these secondary factors. Both locations were negatively impacted by excess precipitation in the late spring and heavy wild oat pressure was also a limiting factor at Indian Head; thus, flax yields were considered somewhat below average at both locations. For the individual demonstrations, the effect of fungicide on flax yield was not significant at either location in 2014; however, previous field trials have clearly shown that yield benefits to foliar fungicide application are substantial in years where pasmo is more sever and infects the crop earlier in the season. There were no significant interactions detected between fungicide and row spacing or N fertilizer but this may not necessarily have been the case if disease pressure and yield potential had been higher. At Indian Head, flax yields did decline

linearly with increasing row spacing but yields for individual levels ranging from 25-41 cm did not significantly differ. Furthermore, with relatively low yields due to crop injury early in the season and heavy wild oat pressure, the potential for yield reduction at wide row spacing may have been higher than normal. At Melfort, flax responded well to rates of N fertilizer that were substantially higher than the rates currently used and recommended in Saskatchewan. Further testing is required for more confident recommendations; however, this suggests that flax may benefit from higher N fertilizer rates than are typically being applied. At Indian Head, the project was shown to more than 200 producers and industry representatives at the IHARF Crop Management Field Day in July 2014. In addition, results were presented at the Agri-ARM Research Update (Crop Production Show, Saskatoon, SK) in January 2015 and the IHARF Soil and Crop Management Seminar (White City, SK). Project highlights and results will also be available in the 2014 IHARF Annual Report.