2014 Annual Report
for the

Agricultural Demonstration of Practices and Technologies (ADOPT) Program

Project Title: Seeding Rate and Seeding Date Effects on Flax Establishment and Yield

(Project #20130353)

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Project Identification

1. **Project Title:** Seeding Date and Seeding Rate Effects on Flax Establishment and Yield
2. **Project Number:** 20130353
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 objective of this project was to demonstrate the effects of low, medium and high seeding rates at early and late seeding dates on flax establishment and seed yield for traditional and northern adapted varieties.

8. **Project Rationale:**

For optimal flax yields, minimum plant populations of 300 plants m^{-2} are typically recommended in Saskatchewan. Past research has shown that this minimum threshold was only achieved 60% and 73% of the time with early and late plantings, respectively. This provides evidence that flax producers need to pay close attention to emergence with their seeding practices, adjusting their rates if necessary, and that future flax agronomic research needs to focus on management effects on flax establishment. Flax is a poor competitor with weeds early in the season and experience has shown that this crop has difficulty recovering from a poor start; therefore, problems with plant establishment often result in sub-optimal yields. Postponing seeding until soils have warmed up can result in more rapid and complete emergence; however, flax requires a relatively long growing season and yields can be compromised if seeding is delayed too long. It is typically recommended that flax be seeded by mid-May. The proposed project will help producers see the potential benefits of using early maturing varieties and/or higher seeding rates, particularly when seeding early into cool soils.

Methodology and Results

9. Methodology:

Field trials were completed in 2013 and 2014 by the Indian Head Agricultural Research Foundation (IHARF) and in 2014 by 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 a tilled field at Melfort, Saskatchewan (R.M. #428). The treatments were a factorial combination of two seeding dates (early May and late May), three seeding rates (low, normal and high) and, in 2014, two varieties (traditional and northern adapted) for a total of 12 treatments. The treatments were arranged in split-plot design with seeding dates as the main plots and seeding rates and varieties as the sub-plots. The targeted seeding dates (SD) were early (as early as possible) and late (late-May). The actual seeding rates (SR) for three SR treatments were 35-39 kg ha^{-1} (low), 50 kg ha^{-1} (normal) and 69-75 kg ha^{-1} (high). The two variety (VAR) treatments were CDC Bethune (traditional) and FP2454 (northern).

Selected agronomic information and dates of field operations for both sites are provided in Table 1. At Indian Head, flax was direct-seeded using a SeedMaster plot drill equipped with 8 openers spaced 30 cm apart and a trimmed plot length of 10.5 m. Urea, monoammonium phosphate, potassium chloride and ammonium sulphate were side-banded at rates considered sufficient to ensure that nutrient availability was not limiting. Weeds were controlled using registered pre-emergent and in-crop herbicide applications which were selected to control the specific species encountered on the site. To help ensure that pasmo infection was not a limiting factor, foliar fungicide was applied in both years with separate applications for each seeding date. 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 either growing season at Indian Head, therefore detailed notes were not taken and lodging data are not presented. Days from planting to maturity were recorded for all plots in both years and were defined as the date when approximately 75% of the bolls had turned colour. Pre-harvest glyphosate was applied in 2014 to terminate weeds and assist with crop dry down with a separate application for each date. Each plot was straight-combined using a Wintersteiger plot when it was fit to so. The harvest samples were cleaned and weighed with yields expressed in kg ha^{-1} and corrected to 10% seed moisture content.

Table 1. Selected agronomic information for flax seeding date by rate demonstrations at Indian Head (IH; 2013-14) and Melfort (ME; 2014).

Description	IH-2013	IH-2014	ME-2014
Previous Crop	Spring Wheat	Spring Wheat	Canola
Pre-Emergent Herbicide	May-17 (all) 590 g glyphosate ha^{-1}	May-18 (all) 890 g glyphosate ha^{-1} + 140 g sulfentrazone ha^{-1}	None. Plots tilled with a rototiller.
Seeding Date	May-11 (early) May-29 (late)	May-11 (early) May-27 (late)	May- 16 (early) June- 2 (late)
Fertility (kg N-P_2O_5-K_2O-S ha^{-1})	90-30-15-15	90-22-11-11	36-15-0-0
In-Crop Herbicide 1	Jun-12 (all) 40 g tepraloxydim ha^{-1}	Jul-7 (all) 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}
In-Crop Herbicide 2	Jun-24 (early) Jul-2 (late) 280 g bromoxynil ha^{-1} + 280 g MCPA ester ha^{-1}	n/a	July 24 (all) 500 g sethoxydim ha^{-1}
In-Crop Herbicide 3	Jun-28 (all) 40 g tepraloxydim ha^{-1}	n/a	n/a
Emergence Counts	May-30 (early) Jun-27 (late)	Jun-9 (early) Jun-25 (late)	June 5 (early)
Foliar Fungicide	Jul-10 (early) Jul-19 (late) 99 g pyraclostrobin ha^{-1}	Jul-12 (early) Jul-27 (early) 99 g pyraclostrobin ha^{-1}	n/a
Pre-Harvest Application	n/a	Sep-5 (early) Sep-17 (late)	Sept 15 (all)
Harvest Date	Sep-22 (early) Sep-24 (late)	Sep-17 (early) Oct-9 (late)	Sept 29 (all)

In preparation for seeding at Melfort, on May 15th 2014, 100 kg N/ha as 34-0-0 was broadcast over the entire plot area. For each seeding date, the soil was tilled and packed 1 to 3 days before seeding. Flax was seeded using a Fabro seeder (7 in row spacing) and 15 kg of P_2O_5/ha of 11-52-0 was added to the seed row. CDC Bethune and FP2454 were used for both dates with the early date treatment seeded May 16th and the late June 2nd. For post-emergent weed control, registered 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 in each plot.

Lodging at Melfort was estimated using the Belgian lodging scale but treatment related differences were very small and not significant and lodging data are not presented. Days from planting to maturity were recorded for all plots in both years and were defined as the date when approximately 75% of the bolls had turned colour. Pre-harvest glyphosate was applied in 2014 to terminate weeds and assist with crop dry down with a separate application for each date. Each plot was straight-combined using a Wintersteiger plot when it was fit to so. The harvest samples were cleaned and weighed with yields expressed in kg ha^{-1} and corrected to 10% seed moisture content.

All available response data were analysed using the Mixed procedure of SAS 9.3 with the effects of SD, SR, VAR and all possible two and three-way interactions considered fixed and the effects of replicate considered random. Fisher's protected LSD was test to separate treatment means. 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 stations.

10. Results:

Mean monthly temperatures and precipitation amounts for the 2013-14 growing seasons at Indian Head are presented relative to the long-term averages in Table 2. While both springs were late in terms snow melt and accessing fields, May was drier than normal in 2013 and 2014. Temperatures in May were above average in 2013 but cooler in 2014. In contrast, June was wetter and cooler than average in both years, especially 2014 when more than 2.5 times the long-term normal precipitation was received. The extremely wet weather in 2014 resulted in prolonged wet conditions and substantial crop injury while delaying in-crop herbicide applications. July was cooler than normal in both years with very little precipitation in 2014; however, with all of the precipitation in June, soil moisture was abundant until the latter half of the month. August was extremely dry in 2013 but extremely wet in 2014. Overall growing conditions were generally more favourable in 2013 than they were in 2014 at Indian Head and this was reflected in the yields of most crops in the region.

Table 2. Mean monthly temperatures and precipitation amounts along with long-term (1981-2010) normals for the 2013 and 2014 growing season at Indian Head, Saskatchewan.

Year	May	June	July	August	Avg. / Total
	------------------------------*Mean Temperature (°C)* ------------------------------				
2013	11.9	15.3	16.3	17.1	15.2
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)* ------------------------------				
2013	17.1	103.8	50.4	6.1	177
2014	36	199.2	7.8	142.2	385
Long-term	51.8	77.4	63.8	51.2	244

Monthly weather data and long-term averages for the 2014 growing season at Melfort are provided in Table 3. 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 3. 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 overall tests of all fixed effects and their interactions are presented for plant density, days to maturity and seed yield in Tables 7-9 of the Appendices along with least squares means for all of the two- and three-way interactions (Tables 10-13). While these tables may be referred to where appropriate, the discussion will primarily focus on the main effects for which treatment means are presented in Tables 4, 5 and 6 for plant density, days to maturity and seed yield, respectively.

Least squares means for the main effects of SD, VAR and SR on plant densities of flax are provided in Table 4. Seeding date had a significant impact on plant density at Indian Head in 2013 ($P = 0.031$) but not 2014 ($P = 0.230$) (Table 7). In 2013, plant populations were 148 plants m^{-2} lower with early seeding than they were when seeding was completed late in May (342 vs 490 plants m^{-2}) but, on average, populations at both dates were above the recommended minimum of 300 seeds m^{-2}. This was not necessarily unexpected since, with early seeding, soils are often cool and emergence can either be lower or spread out over a longer period when compared to later seeding into warmer soils. In contrast, however, while certainly not the case during either the 2013 or 2014 growing seasons, later seeding can also sometimes result in poorer emergence, particular when conditions are dry. In 2014 at Indian Head, plant populations were similar for both seeding dates at 458-484 plants m^{-2} when averaged across SR treatments. At Melfort in 2014, seeding date also affected plant density (P=>.001), but in contrast to Indian Head, late seeding resulted in 49% fewer plants than early seeding. This was most probably due to excess rain and cool temperatures experienced at this site in 2014. With late seeding and at the lowest seed rates, plant densities were below the desired 300 plants m^{-2} (data not shown).

As expected, the effect of SR on plant densities was highly significant at all location years ($P < 0.001$) with each incremental increase in seeding rate resulting in a significant increase in the number of established plants. Averaged across seeding dates (and varieties in 2014), plant populations at the low to high seeding rates ranged from 336-501 plants m^{-2} in at Indian head in 2013 and 364-567 plants m^{-2} in 2014 while at Melfort in 2014, densities ranged from 348 to 614 plants m^{-2} (Table 4). While the SD × SR interaction was not significant for plant density at Indian Head in 2013 (Table 7; $P = 0.256$), it is worth noting that the combination of a low seeding rate and early seeding resulted in densities of 239 plants m^{-2}, slightly below the recommended minimum of 300 plants m^{-2}. At Melfort in 2014, densities for the lowest seed rate with late seeding were also below this threshold at 260 plants m^{-2}.

In 2014 at Indian Head, the effect of VAR was also significant ($P = 0.007$) with slightly lower populations established with the northern adapted variety (FP2454) compared to the traditional variety (CDC Bethune). Similarly at Melfort, plant density was significantly (P= 0.01) lower with the northern adapted variety than the traditional variety. Despite the difference between varieties, the observed densities at any given seeding rate and date were similar enough that the differences between varieties were unlikely to have much impact on maturity or yield.

Table 4. Least squares means for main effects on flax plant density at Indian Head (IH; 2013-14) and Melfort (ME; 2014).

Main effect	Plant Density		
	IH-2013	**IH-2014**	**ME-2014**
Seeding date (SD)	----------	plants m^{-2}	----------
Early	342 b	484 a	627[a]
Late	490 a	458 a	325[b]
S.E.M.	29.8	13.5	—
Variety (VAR)			—
Traditional	—	497 a	513[a]
Northern	—	446 b	440[b]
S.E.M.	—	12.9	—
Seeding rate (SR)			—
Low	336 c	364 c	348[c]
Medium	411 b	482 b	466[b]
High	501 a	567 a	614[a]
S.E.M.	27.1	15.6	—

Least squares means for the main effects of SD, SR and VAR on days to flax maturity at all location years are provided in Table 5 with the overall tests of fixed effects and interactions reserved for the appendices (Table 8).At Indian Head, maturity was significantly affected by all main effects ($P <$ 0.001-0.040) and by the SR × SR interaction in 2013 and the SD × VAR interaction in 2014. Seeding date had the biggest impact on maturity whereby flax seeded in early May took 5-7 days longer to reach maturity than when seeded at the end of May. Crops seeded into cool soils take longer to germinate and emerge than when seeded into warmer soils, especially when moisture is not limiting at either date. Therefore, later seeded crops do typically mature in a shorter period of time. However, flax is a relatively long-season crop and seeding early always resulted in an earlier harvest and lower risk of yield loss due to early frost, which can be important when growing this crop in cooler, more northern environments. Seeding at heavier rates also accelerated maturity by 0.9-1.3 days; however, emergence was excellent both years and reasonably dense, uniform stands were achieved even at the lowest seeding rates and there were no major issues with maturity. In 2014 at Indian Head, while the northern variety matured slightly earlier than the traditional variety on average, it was actually slightly later when seeded early but more than a day earlier with late seeding. At Melfort, maturity was only affected by seeding date, with the late seeded treatments maturing in three fewer days than the early seeded ones. At Melfort in 2014, flax matured in fewaer days than at Indian Head, but this likely reflects the later seeding dates used at Melfort. With later seeding, heat units generally accumulate more rapidly, partially offsetting the effects of delayed seeding.

Table 5. Least squares means for main effects on flax maturity at Indian Head (IH; 2013-14) and Melfort (ME; 2014).

Main effect	Maturity		
	IH-2013	**IH-2014**	**ME-2014**
Seeding date	--- days from planting ---		
Early	107.9 a	109.4 a	98a
Late	100.4 b	104.7 b	95b
S.E.M.	0.27	0.37	—
Variety			—
Traditional	—	107.2 a	97
Northern	—	106.9 b	97
S.E.M.	—	0.27	—
Seeding rate			—
Low	104.7 a	107.7 a	97
Medium	104.1 b	107.1 b	97
High	103.8 b	106.4 c	97
S.E.M.	0.24	0.27	—

Flax yield was affected only by seeding rate as a main effect at Indian Head in 2013 ($P = 0.002$) and there was no interaction between SD and SR ($P = 0.609$). A small but significant yield increase with increasing seeding rates was detected; however, the increase was quite small at less than 4 kg ha^{-1} yield gain for each additional kg of seed from the lowest to the highest rate. In 2014 at Indian Head, SR was again the only main effect that affect flax yield ($P = 0.018$) but the SD × VAR interaction was also significant ($P = 0.033$). Similar to the previous season, while there was a linear increase in seed yield with seeding rate at Indian Head, the magnitude was small with only a 2.3 kg ha^{-1} yield increase for each additional kg of seed. While none of the differences between SD × VAR treatments were significant according to the multiple comparisons test, the interaction appeared to be due to a tendency for the Bethune (traditional) to yield slightly higher than the northern variety when seeded in late May but not when seeded early (Table 12). At Melfort, flax yields were not affected by SD ($P = 0.465$) or SR ($P = 0.301$) on average but the northern adapted variety (FP2454) yielded significantly (132 kg ha^{-1} or 6%) higher than the traditional variety when averaged across seeding dates and rates. However, there was a SR × VAR interaction ($P = 0.032$) whereby the Bethune yields were slightly lower at the highest seeding rate compared to the low and medium SR treatments while FP2454 yields were constant across seeding rates. At Melfort, plant densities for Bethune exceeded 900 plants m^{-2} with early seeding, so excessively high plant density may have played a role in this interaction.

Table 6. Least squares means for main effects on flax yield at Indian Head (IH; 2013-14) and Melfort (ME; 2014).

Main effect		**Seed Yield**	
	IH-2013	**IH-2014**	**ME-2014**
Seeding date		kg ha^{-1}	
Early	3012 a	1262 a	2310 a
Late	2846 a	1309 a	2282 a
S.E.M.	176.6	167.5	101.7
Variety			
Traditional	—	1287 a	2230 b
Northern	—	1284 a	2362 a
S.E.M.	—	119.3	101.7
Seeding rate			
Low	2867 b	1226 b	2333
Medium	2923 b	1325 a	2296
High	2998 a	1305 ab	2258
S.E.M.	172.0	120.1	103.6

Project Extension Activities

This demonstration was shown at the Indian Head Crop Management Field Days on July 23, 2013 and on July 22, 2014 which were attended by approximately 200 producers and industry representatives each year. A dedicated Flax Field Day was co-hosted by IHARF and SaskFlax on July 23, 2013 which was attended by 68 participants and featured speakers from the Saskatchewan Ministry of Agriculture, University of Saskatchewan, FMC Corporation and IHARF. At the 2014 IHARF field day, 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. 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) at both the Agronomy Research Update at the University of Saskatchewan in December 2013 and at the Agri-ARM Research Update on January 15, 2015 at Prairieland Park during the Crop Production Show. Finally, results from this project will be made available in the 2014 IHARF and NARF Annual Reports (available online) and also through 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 varying seeding rates, seeding dates and, in 2014, varieties, with locations at Indian Head and Melfort, Saskatchewan. The overall agronomic performance of flax was relatively insensitive to the seeding dates and rates that were evaluated in this demonstration. While early seeding did result in significantly lower plant populations in one of three cases, it also resulted in lower plant densities in one case. Overall yields were similar regardless of whether flax was seeded as early as possible in May or at the end of the month. That said, flax requires approximately 110 days to mature and early seeded flax was always ready to harvest earlier in the fall and, as such, will be at a lower risk of yield or quality loss due to fall frost. While seeding early is recommended, preferably not later than the 15th of May, this demonstration showed that postponing seeding by 2-3 weeks will not necessarily result in lower yields or maturity issues. However, caution is advised since the further seeding is delayed (i.e. into the month of June) the greater the risk of fall frost and yield / quality reduction will be, particular in regions with shorter growing seasons.

While significant at two of three sites, the effect of seeding rate was relatively small at the rates used and environmental conditions encountered with this demonstration. At Indian Head, increasing seeding rates from under 40 kg ha^{-1} to over 70 kg ha^{-1} only resulted in an addition 2-4 kg for each additional kg of seed used. At Melfort, there was no observed benefit to higher seeding rates. However, excellent emergence was achieved at all three sites and higher seeding rates are likely to be more beneficial under less favourable conditions at and immediately following planting. Higher seeding rates also tended to accelerate maturity which can be advantageous with delayed seeding or in more northern environments.

At Indian Head the traditional and northern adapted varieties performed similarly when averaged across dates and seeded early; however, with delayed seeding the traditional variety tended to yield slightly higher. At Melfort, the northern adapted variety yielded consistently higher than the traditional variety, with a mean yield advantage of 6%. While the new northern adapted flax varieties such as FP2454 were not necessarily bred for more southern regions such as Indian Head, this variety was competitive with the traditional variety CDC Bethune at this location. At Melfort, planting a northern adapted variety appeared to be somewhat advantageous. These varieties were bred for early season vigor, indeterminate flower habits, accelerated stem dry-down and earlier maturity, and therefore may be good fits for cooler, more northern locations where flax acres have been traditionally small and the length of the growing season can potentially be limiting.

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 northern adapted flax variety used in the project was provided in-kind by Crop Protection Services.

13. Appendices

Table 7. Effects of seeding date, seeding rate and variety (2014 only) on flax establishment at Indian Head (IH; 2013-14) and Melfort (ME; 2014).

	Plant density		
	IH-2013	IH-2014	ME-14
Effect		p-values	
Seeding Date (SD)	0.031	0.230	—
Variety (VAR)	—	0.007	—
Seeding rate (SR)	<0.001	<0.001	—
SD × VAR	—	0.695	—
SD × SR	0.256	0.064	—
VAR × SR	—	0.587	—
SD × VAR × SR	—	0.962	—

Table 8. Effects of seeding date, seeding rate and variety (2014 only) on flax maturity at Indian Head (IH; 2013-14) and Melfort (ME; 2014).

	Maturity		
	IH-2013	IH-2014	ME-14
Effect		p-values	
Seeding Date (SD)	<0.001	<0.001	—
Variety (VAR)	—	0.004	—
Seeding rate (SR)	<0.001	<0.001	—
SD × VAR	—	<0.001	—
SD × SR	0.012	0.355	—
VAR × SR	—	0.355	—
SD × VAR × SR	—	0.636	—

Table 9. Effects of seeding date, seeding rate and variety (2014 only) on flax seed yield at Indian (IH; 2013-14) and Melfort (ME; 2014).

	Seed Yield		
	IH-2013	IH-2014	ME-14
Effect		p-values	
Seeding Date (SD)	0.150	0.849	0.465
Variety (VAR)	—	0.901	0.002
Seeding rate (SR)	0.002	0.018	0.301
SD × VAR	—	0.033	0.366
SD × SR	0.609	0.419	0.842
VAR × SR	—	0.982	0.032
SD × VAR × SR	—	0.352	0.064

Table 10. Least squares means for 2-way interaction effects on flax plant density at Indian Head (IH; 2013-14) and Melfort (ME; 2014).

Main effect	Plant Density		
	IH-2013	**IH-2014**	**ME-2014**
SD × VAR	plants m^{-2}		
Early – Trad	—	506	—
Early – North	—	462	—
Late – Trad	—	487	—
Late – North	—	429	—
S.E.M.	—	18.3	—
SD × SR			
Early – Low	239	365	—
Early – Med	338	525	—
Early – High	449	561	—
Late – Low	431	363	—
Late – Med	485	440	—
Late – High	553	573	—
S.E.M.	36.5	22.1	—
SR × VAR			
Low – Trad	—	377	—
Low – North	—	351	—
Med – Trad	—	516	—
Med – North	—	449	—
High – Trad	—	597	—
High – North	—	537	—
S.E.M.	—	21.7	—

Table 11. Least squares means for 2-way interaction effects on flax maturity at Indian Head (IH; 2013-14) and Melfort (ME; 2014).

Main effect	Maturity		
	IH-2013	**IH-2014**	**ME-2014**
SD × VAR	--------------------------- days from planting ---------------------------		
Early – Trad	—	109.2 b	—
Early – North	—	109.6 a	—
Late – Trad	—	105.3 c	—
Late – North	—	104.2 d	—
S.E.M.	—	0.38	—
SD × SR			
Early – Low	108.1 a	110.1	—
Early – Med	107.9 a	109.4	—
Early – High	107.8 a	108.6	—
Late – Low	101.3 b	105.3	—
Late – Med	100.3 c	104.8	—
Late – High	99.8 d	104.1	—
S.E.M.	0.30	0.39	—
SR × VAR			
Low – Trad	—	107.9	—
Low – North	—	107.5	—
Med – Trad	—	107.1	—
Med – North	—	107.0	—
High – Trad	—	106.6	—
High – North	—	106.1	—
S.E.M.	—	0.29	—

Table 12. Least squares means for 2-way interaction effects on flax yield at Indian Head (IH; 2013-14) and Melfort (ME; 2014).

Main effect	Seed Yield		
	IH-2013	**IH-2014**	**ME-2014**
SD × VAR		kg ha^{-1}	
Early – Trad	—	1232 a	2261
Early – North	—	1292 a	2359
Late – Trad	—	1342 a	2198
Late – North	—	1276 a	2366
S.E.M.	—	168.6	105.3
SD × SR			
Early – Low	2965	1186	2339
Early – Med	3002	1328	2303
Early – High	3069	1271	2288
Late – Low	2769	1266	2328
Late – Med	2844	1322	2289
Late – High	2927	1338	2228
S.E.M.	178	169.8	108.9
SR × VAR			
Low – Trad	—	1224	2291 a
Low – North	—	1228	2376 a
Med – Trad	—	1328	2279 a
Med – North	—	1322	2313 a
High – Trad	—	1309	2118 b
High – North	—	1301	2398 a
S.E.M.	—	122.5	108.9

Table 13. Least squares means for 3-way interaction effects on plant density, maturity and seed yield of flax at Indian Head (IH) and Melfort (ME) in 2014.

Main effect	Plant Density		Maturity		Seed Yield	
	IH-14	ME-14	IH-14	ME-14	IH-14	ME-14
VAR × SD × SR	------- plants m^{-2} -------		- days from planting -		--------- kg ha^{-1} ---------	
Trad – Early - Low	376	—	110.0	—	1152	2261
Trad – Early – Med	557	—	109.0	—	1274	2366
Trad – Early – High	585	—	108.5	—	1270	2157
Trad – Late - Low	378	—	105.8	—	1296	2321
Trad – Late – Med	474	—	105.3	—	1382	2192
Trad – Late – High	610	—	104.8	—	1348	2080
North – Early - Low	355	—	110.3	—	1220	2417
North – Early – Med	493	—	109.8	—	1382	2240
North – Early – High	538	—	108.8	—	1273	2420
North – Late - Low	348	—	104.8	—	1236	2335
North – Late – Med	405	—	104.3	—	1263	2386
North – Late – High	535	—	103.5	—	1328	2376
S.E.M.	30.7	—	0.41	—	173.3	118.7

Abstract

14. Abstract/Summary:

The Indian Head Agricultural Research Foundation (IHARF) and Northeast Agriculture Research Foundation (NARF) conducted field demonstrations in 2013 and 2014 on behalf of the Saskatchewan Flax Development Commission (SaskFlax). The project objective was to demonstrate the effects of low, medium and high seeding rates at early and late seeding dates on flax establishment and seed yield for traditional and northern adapted varieties. Overall, neither seeding date nor seeding rate had a substantial impact on flax productivity or yield in any cases. The effect of seeding date on its own was not significant in any of the three cases; however, early seeding did result in earlier harvest and less risk of fall frost. Increasing seeding rates did result in slightly earlier maturity and higher yields at Indian Head; however, the magnitude of the increases were small and the potential benefits to rates beyond the typical 45-55 kg ha^{-1} were unlikely to justify the added seed cost. Yields of the traditional and northern adapted varieties were generally similar at Indian Head but the northern adapted variety yielded significantly higher at Melfort. While interactions between factors were occasionally detected for individual variables and sites, none were particularly consistent across sites. At Indian Head, the project was shown to more than 200 producers and industry representatives each year at the IHARF

Crop Management Field Day in July. In addition, results were presented at the Agronomy Research Update at the University of Saskatchewan in December 2013, the Agri-ARM Research Update (Crop Production Show, Saskatoon, SK) in January 2015 and the IHARF Soil and Crop Management Seminar (White City, SK) in February 2015. Project highlights and results will also be available in the 2014 IHARF Annual Report.