1. PROJECT TITLE:

Seeding Rate and Seeding Date Effects on Flax Establishment and Yield

2. PROJECT NUMBER: #20120372

3. PRODUCER GROUP SPONSORING THE PROJECT

Saskatchewan Flax Development Commission
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4. PROJECT LOCATION

This project was conducted on rented land near Agriculture and Agri-Food Canada's Indian Head Research Farm. The legal land description: NE 31 18 12 W2 (RM #156).

5. PROJECT START AND END DATES

Start date: April 1, 2013
End date: February 10, 2014

6. PROJECT CONTACT PERSONS

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7. PROJECT OBJECTIVE

- To demonstrate the effects of low, medium and high seeding rates at early and late seeding dates on flax establishment and seed yield.

8. RATIONALE

For optimal flax yields, the typical recommended minimum plant population is 300 plants/m2. 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 and that future flax agronomic research needs to focus on how management effects flax emergence. Flax is a poor competitor with weeds early on in the season and experience has shown that this crop has difficulty recovering from a poor start. Thus, 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, there yields can be compromised if seeding is delayed too long and it is typically recommended that flax be seeded by mid-May.

This project was intended to help producers see the potential benefits of using higher seeding rates, particularly when seeding early into cool soils. The results will be combined with the Northern Adapted Flax Variety Development research project to help the industry redefine best management practices for flax production.

9. METHODOLOGY

A field trial was completed in 2013 by the Indian Head Agricultural Research Foundation (IHARF) on behalf of the Saskatchewan Flax Development Commission. The trials were located near Indian Head, Saskatchewan (R.M. #156) on an Indian Head Heavy Clay (Rego thin Black Chernozem) soil. The focus of the trial was to demonstrate the effects of seeding date and seeding rate on flax establishment and seed yield. A factorial combination of two seeding dates (early May and late May) and three seeding rates (40, 55 and 70 kg ha-1) were arranged in a split plot design with seeding date as the main plot, seeding rate as the sub-plot and four replicates.

The flax variety CDC Bethune was seeded directly into spring wheat stubble on either May 11 (early) or May 29 (late) using a SeedMaster plot drill equipped with 8 openers spaced 30 cm apart and a trimmed plot length of 10.5 m. The seeding rate used was varied according to the protocol with the chosen rates being 40 kg ha-1 (low), 55 kg ha-1 (medium) and 70 kg ha-1 (high) 50 kg ha-1. Urea, monoammonium phosphate, potassium chloride and ammonium sulphate were side-banded at seeding to provide 90, 30, 15 and 15 kg ha-1 of N, P2O5, K2O and S. All plots received a pre-emergent burnoff of 590 g glyphosate ha-1 on May 17 along with two separate applications of 40 g tepraloxydim ha-1 (June 12 and June 28) to control multiple flushes of wild oats.

Additionally, in-crop applications of 280 g bromoxynil ha-1 plus 280 g MCPA ester ha-1 were applied on either June 24 (early seeding) or July2 (late seeding). A single application of 99 g pyraclostrobin ha-1 was applied on either July 10 (early seeding) or July 19 (late seeding) to minimize the potential effects of pasmo. Plant densities were estimated by counting the number of seedlings in 2 m of crop row per plot on either May 30 (early seeding) or June 27 (late seeding). Heights were estimated by recording the height of four plants per plot on August 2. Days to maturity were estimated for each plot by recording the Julian date when approximately 75% of the bolls had turned brown and are expressed as days from planting. The centre five rows of each plot were straight-combined on either September 22 (early seeding) or September 24 (late seeding) using a Wintersteiger plot combine.

All harvest samples were cleaned, weighed and yields were converted to kg ha-1 and corrected to 10% seed moisture content. All response data were analysed using the Mixed procedure of SAS 9.3 and Fisher's least significant difference test to detect individual treatment differences with results declared significant at P ≤ 0.05. Orthogonal contrasts were used to describe the response to seeding rate with early seeding, late seeding and averaged across seeding dates. Growing season weather data were monitored and recorded using the an Environment Canada weather station located approximately 1.75 km southwest of the site.

10. RESULTS

10-A. PROJECT RESULTS

Weather

Table 1. *Mean monthly temperatures and precipitation amounts along with long-term (1981-2010) normals for the 2013 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
Long-term	10.8	15.8	18.2	17.4	15.6
	Precipitation (mm)				
2013	17.1	103.8	50.4	6.1	177
Long-term	51.8	77.4	63.8	51.2	244

There were above-average temperatures in May and cooler than normal temperatures in July; otherwise close to normal temperatures. It was drier than normal overall, but well above normal precipitation in June. It was very dry late in summer.

Effects on Plant Density

- Plant densities affected by both seeding date (P = 0.031) and rate (P < 0.001) with no interaction between date and rate (P = 0.256)
- Overall higher plant populations were achieved with delayed seeding, presumably due to warmer soils and timely rainfall events after seeding; however, it is also possible that some further emerge occurred after the measurements were completed in the early seed plots
- Plant populations increased linearly with seeding rate but not quadratically for both seeding dates and when averaged across seeding rates
- With early seeding, 40 kg ha^{-1} seeding rates were not sufficiently high to achieve the desired minimum density of 300 plants $^{-2}$; however with delayed seeding even the lowest seeding rate resulted in more than 400 plants m^{-2}

Effects on Maturity

- Days to maturity for flax was affected by both seeding date ($P < 0.001$) and rate ($P < 0.001$) with a significant interaction between date and rate ($P < 0.001$)

- Due to cooler conditions during emergence and lower plant populations, early seeded flax took significantly longer to mature than late seeded flax (108 versus 100 days); however the early seeded flax was still ready to harvest ahead of the late seeded plots.
- The number of days to maturity was unaffected by seeding date in the early seeded flax but decreased linearly with increasing seeding rate with delayed planting. It should be noted that, where applicable, the observed effects of seeding rate on maturity small enough to be agronomically insignificant and these measurements were also somewhat subjective.

Effects on Seed Yield

- Seed yield for flax was not significantly affected by seeding date (P = 0.150) but did respond to seeding rate (P = 0.002); the interaction between seeding date and rate was not significant for seed yield (P = 0.609).
- Averaged across rates, there was no significant difference in yield between seeding dates; however early seeding was favoured numerically with a mean yield that was 6% greater than with delayed seeding
- Averaged across dates, yields at the highest seeding rate were significantly higher than those achieved with 40-55 kg ha^{-1} seeding rates; however, the observed yield increase with seeding rate was less than 5% and would not necessarily result in proportionate increases in profits when the cost of seed is taken into consideration.
- Yield response to seeding rate was linear in all cases and never quadratic indicating that plant populations continued to increase with increasing seeding rate for full range of rates evaluated. A quadratic response would indicate that plant populations start to level off at the higher rates.

Table 2. *Seeding date and rate effects on flax establishment, maturity and seed yield.*

Effect / Contrast	Plant Density	Days to Maturity	Seed Yield
	Type III Tests of Fixed Effects*		
	---------- p-values ----------		
Seeding Date	0.031	<0.001	0.150
Seeding Rate	<0.001	<0.001	0.002
Date X Rate	0.256	0.012	0.609
	Orthogonal Contrasts for Seeding Rate*		
	---------- p-value ----------		
Early – linear	<0.001	0.121	0.019
Early – quadratic	0.854	0.753	0.667
Late – linear	0.007	<0.001	0.001
Late – quadratic	0.794	0.223	0.908
Overall – linear	<0.001	<0.001	<0.001
Overall – quadratic	0.753	0.278	0.699

*Data were analysed using the mixed procedure of SAS 9.3

***Table 3**. Least squares means for seeding date, seeding rate and date X rate for the dependent variables plant density, days to maturity and seed yield.*			
Main Effect / Treatment	Plant Density (plants m^{-2})	Maturity (days from planting)	Seed Yield (kg ha^{-1})
	Least Squares Means		
Seeding Date			
Early (May 11)	342 b	107.9 a	3012 a
Late (May 29)	490 a	100.4 b	2846 a
SE	29.8	0.27	176.6
Seeding Rate			
Low (40 kg ha^{-1})	336 c	104.7 a	2867 b
Medium (55 kg ha)	411 b	104.1 b	2923 b
High (70 kg ha^{-1})	501 a	103.8 b	2998 a
SE	27.1	0.24	172.0
Date X Rate			
Early – Low	239	108.1 a	2965
Early – Medium	338	107.9 a	3002
Early – High	449	107.8 a	3069
Late – Low	431	101.3 b	2769
Late – Medium	485	100.3 c	2844
Late – High	553	99.8 d	2927
SE	36.5	0.30	178
*Data were analysed using the mixed procedure of SAS 9.3			

10-B. PROJECT EXTENSION ACTIVITIES

This project was presented at a field day at the AAFC Research Station in Indian Head on July 25, 2013. There were 68 people in attendance, including producers, researchers, industry and staff.

The day began with registration and coffee in the morning, followed by introductions and an explanation of the ADOPT program. The group travelled to the field plots and toured each of the four demonstration sites featuring flax varieties, fertilizers, herbicides, fungicides and seeding date and seeding rates. The group returned to the Research Station for lunch and a question-and-answer session on the national re-constituted flaxseed program. The day closed with a special presentation from the SaskFlax Board to IHARF in memory of Dr. Guy Lafond.

Promotional activities for the event included:

Item	*Where displayed*	*Estimated audience*
Event posting	Events calendar of SaskFlax, IHARF and Ministry of Agriculture websites	2,500
Web page/registration page	IHARF website	500
News release	SaskFlax website	500
Notice	Summer issue *Canadian Flax Industry Update* print newsletter	6,500
News release	Agriculture media and Saskatchewan Weekly Newspaper members	+100
Advertisement	*The Western Producer*	22,000
Pamphlet	Mailed to IHARF contact list	300
Announcement	Annual Indian Head Crop Management Field Day	200
Field signs	At the demonstration plots	265
Post-event news release	SaskFlax website	500
Report on the field day	Fall issue *Canadian Flax Industry Update* print newsletter	6,500

11. CONCLUSIONS AND RECOMMENDATIONS

- Flax performed well at both seeding dates. While better emergence was achieved with later seeding, the early seeded flax was ready to harvest at an earlier date and tended to yield a bit higher (not statistically significant).
- Days to maturity was substantially reduced with delayed seeding and was also reduced significantly (albeit slightly) with increasing seeding rate.
- All treatments achieved the minimum recommended plant density of 300 plants m^{-2} except for the combination of a low seeding rate with early seeding. Despite the higher populations achieved with delayed seeding, the yield response to increasing seeding rate was similar to that observed with early seeding.
- Yields increased significantly and linearly with increasing seeding rate at both seeding dates; however, the magnitude of the increase was small (less than 5%) when averaged across seeding dates.
- Excessive plant populations could have undesirable effects such as increase disease and/or lodging; however neither of these was problematic at Indian Head in 2013.

12. ACKNOWLEDGEMENTS

This demonstration was funded by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward bi-lateral agreement. This support was acknowledged as follows:

- Signs acknowledging ADOPT and FMC were in place for both the IHARF Crop Management Field Day (194 attendees) on July 23, 2013 and the Flax Crop Walk on July 25, 2013 (68 attendees)
- advertisement in *The Western Producer* on July 11, 2013
- insert mailed to IHARF's contact list of 7,000
- articles in both the summer and fall issues of the 2013 *Canadian Flax Industry Update*, a newsletter mailed to registered flax producers in Saskatchewan and Manitoba
- news releases both prior to and following the field day on July 25, 2013

13. APPENDICES

No additional appendices are included with this report.

14. ABSTRACT/SUMMARY

Indian Head Agricultural Research Foundation conducted a field demonstration on behalf of SaskFlax to demonstrate the effects of seeding date and seeding rate on flax establishment and seed yield. A factorial combination of two seeding dates (early May and late May) and three seeding rates (40, 55 and 70 kg ha-1) were arranged in a split plot design with seeding date as the main plot, seeding rate as the sub-plot and four replicates.

Flax performed well at both seeding dates. Days to maturity was substantially reduced with delayed seeding and was also reduced significantly with increasing seeding rate. Despite the higher populations

achieved with delayed seeding, the yield response to increasing seeding rate was similar to that observed with early seeding.

The project was demonstrated at a flax field day on July 25, 2013 with 68 participants.

15. EXPENDITURE STATEMENT

ADOPT Expenditure Statement * Only report the use of ADOPT funds. Do not report expenses covered by other sources of funding.

Project Number:	20120372
Project Title:	Seeding Rate & Seeding Date Effects on Flax Establishment and Yield
Total approved ADOPT funding for this project:	$4,500
Date this form was completed:	December 16, 2013

Table 1

Description of Expenses									
	Salaries & Benefits	Consultant Fees & Contractual Services	Rental Services	Materials & Supplies	Travel – Field Work	Travel – Collaboration/ Consultation	Field Day	Admin	Misc
Student	$1,000.00								
Technical/Professional Assistants	$2,000.00								
Materials & Supplies – crop supplies, transport, food, etc.				$700.00					
Advertising, refreshments, meals, etc.							$350.00		
Report/collaboration								$200.00	
Miscellaneous – communications/ collaboration									$250.00
Category Totals	$3,000.00			$700.00			$350.00	$200.00	$250.00
PROJECT TOTAL EXPENSES	$3,000.00			$700.00			$350.00	$200.00	$250.00

Table 2

Categories	Total approved Budget, Appendix "B" of Contract	Actual Spent on Project
Salaries & Benefits		
Students	$1,000.00	$1,000.00
Postdoctoral/Research		
Technical/Professional Assistants	$2,000.00	$2,000.00
Consultant Fees & Contractual Services		
Rental Costs		
Materials & Supplies	$700.00	$700.00
Project Travel		
Field Work		
Collaborations/Consultations		
Other		
Field Day	$350.00	$350.00
Administration	$200.00	$200.00
Miscellaneous	$250.00	$250.00
TOTAL	$4,500.00	$4,500.00