11.0 Determining agronomic suitability of European flax (linseed) cultivars in Manitoba

Project Duration: 2018-2019
Collaborators: MFGA, PCDF, PESAI, WADO, BASF, Limagrain NL, van de Bilt zaden en vlas

Objectives

- The current study was developed to examine agronomic attributes (yield, height and maturity) of European-origin flaxseed cultivars and to see if they have a competitive advantage and agro-climatic fit within Manitoba flax production areas.

Background

Flax is a temperate industrial oilseed crop grown mainly in Canada, China and Russia. Currently available genetic resources may accelerate the accomplishment of breeding objectives such as yield, early maturity, disease resistance and seed oil content (Hall et al., 2016). Canadian Prairies produce more than 40% of the world's flax for oil and are the largest exporters of linseed in the world (Irvine et al., 2010; Booker and Lamb, 2012). With the declining popularity of flax as a rotational crop choice in Manitoba, farmers need incentive to grow and increase production area under flax. A longstanding concern is that current flax cultivars are not keeping up with yield advances, similar to gains made in canola, soybeans and to a lesser extent, cereals. This disparity is what encourages a switch away from flax and into higher-yielding, more profitable crops. Flax does have an important role to fill in Manitoba. As a non-host crop for many of the major diseases in western Canada, flax is well suited to break disease cycles and provide a stable, steady return as part of a balanced rotation. With the closure of private breeding programs at Nutrien Ag Solutions, and the public breeding programs at Agriculture and Agri-Food Canada, only a single breeder of flax remains in Canada at the Crop Development Centre. With the introduction and evaluation of European lines, there may be the possibility of a higher yielding cultivar, or a cultivar with more desirable quality characteristics may be found to be well suited to Manitoba's agro-climate.

Materials & Methods

Sites-Melita (WADO), Arborg (PESAI) and Roblin (PCDF)
Experimental Design – Randomized Complete Block Design with three replicates
Treatments – 7 Flax varieties (CDC Bethune, OVB 1001-01, LG Lion, Batsman, LG Aquarius, OVB 0815-02 and Biltstar), all treated identically at each site for fertility and weed control as per PRCO standards for Linseed Co-op testing.

Seeding rate treatment - 40lbs/acre at 5/8" depth, adjusted for individual variety germination %

Stubble Melita-oat/wheat/sunflower, Roblin- oat/barley silage, Arborg-fallow

Soil type Melita (Waskada loam), Roblin (Erickson clay loam), Arborg (heavy clay)

Data collected – yield, plant height at maturity, days to maturity, flowering period

Table 11.0a: Applied Agronomy by site

			Fertility (lb/acre)					
Location	**Plot Size**	**Seeding Date**	**Available**	**Applied**	**Herbicides**	**Spray Date**	**Desiccation Date**	**Harvest Date**
Arborg	9.12m²	15-May	104 N 30 P 680 K	50 N 20 P	Curtail M @ 0.8L/acre Centurion @ 0.075L/acre Reglone @ 0.7L/acre	10-Jun	06-Sep	16-Sep
Melita	12.96m²	06-May	81 N 10 P 192 K	108 N 35 P 20 K	Select @ 0.120L/acre Basagran Forté @ 0.91L/acre	10-Jun 18-Jun	--	29-Aug
Roblin	5.98m²	21-May	57 N 26 P 450 K	63 N 12 P	(PRE) Glyphosate @ 0.64L/acre + Authority @ 0.18L/acre Assure II @ 0.3L/acre + Basagran Forté @ 0.9L/acre Reglone @ 1L/acre	24-May 10-Jun	17-Sep	24-Sep

European Flax at Flowering phase, July 3rd, 2019 at Melita

Results and Discussion

Yield:

Yield differences were significant between European-origin lines and the Canadian-origin check, CDC Bethune, at only Melita (2018) and Roblin (2019) sites. At Melita in 2018, two European lines produced less yield than CDC Bethune while at Roblin in 2019, CDC Bethune also yielded significantly more than four of the six European lines (Tables 11.0b & c). LG Lion and LG Aquarius were the only European lines to show significant yields similar to CDC Bethune at Melita in 2018 and Roblin in 2019.

Plant height:

All three sites reported significant differences in plant height in 2018, with most lines being significantly shorter than CDC Bethune. However, the number of cultivars statistically differing from the check varied from site to site and year to year (Table 11.0d). Roblin reported significant height differences in 2019, where CDC Bethune was statistically taller that all European-origin cultivars.

Days to Maturity & flowering:

The number of days for flax to reach physiological maturity (75% bolls brown and rattling) at Arborg was similar in both 2018 and 2019. Melita and Roblin experienced a greater number of days required to reach the same flax maturity levels in 2019 than 2018, which may have been a factor of rainfall and environmental differences (Table 11.0e). On average, length of flowering period was longer in 2019 compared to 2018 (Table 11.0f).

Quality:

Shannon Froese at the CDC, Saskatoon, conducted flaxseed quality analysis for the 2018 crop. Results are shown in Table 11g. Higher iodine values are preferred by the industrial use buyers of flaxseed.

Project findings:

Dry and drought-like conditions at the test sites contributed to overall lower yields particularly at Arborg site, as evidenced by low commercial yield across the province according to Manitoba Agricultural Insurance Corporation. Provincial average yields were 26 and 20 bu ac^{-1} in 2018 and 2019, respectively, compared to the 10-year average of 22 bu ac^{-1}. Rainfall distribution and time of arrival played an important role in crop development, affecting plant height and yield across the three test locations (Tables 11b & c).

Short-stature flax was a result of continued moisture stress, along with overall thinner than ideal stands and the opportunity for weed competition. European flax lines were consistently shorter when compared to CDC Bethune, ranging from 4 to 10 centimeters shorter than check in both years.

Overall days to maturity (DTM) were +1 to -5 days from the 87 DTM CDC Bethune rating in 2018 (Table 11.0e), while in 2019 all European lines took 6 to 9 days longer than the check. Correspondingly, flowering period in European flax cultivars was +1 to -7 days in variance from the average 21 days of CDC Bethune in 2018 (Table 11.0f). In 2019, flowering period lengthened overall and European cultivars ranged from +4 to -1 days against a check variety flowering length of 34 days.

Table 11.0b. Performance of different flax lines in European flaxseed test in 2018

			2018 Yield			
	Arborg		**Melita**		**Roblin**	
VARIETY	kg ha^{-1}	bu ac^{-1}	kg ha^{-1}	bu ac^{-1}	kg ha^{-1}	bu ac^{-1}
CDC Bethune (Check)	1675	26.6	2227	35.4**ab**	2057	32.7
OVB 1001-01	1674	26.6	2169	34.5**ab**	1959	31.1
LG Lion	1717	27.3	2314	36.8**a**	1598	25.4
Batsman	1560	24.8	1973	31.4**cd**	1670	26.5
LG Aquarius	1358	21.6	2156	34.3**b**	1518	24.1
OVB 0815-02	1362	21.7	2116	33.6**bc**	1565	24.9
Biltstar	1447	23.0	1840	29.3**d**	1608	25.6
GRAND MEAN	**1542**	**24.5**	**2114**	**33.6**	**1710.71**	**27.2**
CV %	**9.1**		**3.7**		**14.8**	
LSD	**-**	**-**	**141**	**2.2**	**-**	**-**
Sign Diff	**No**		**Yes**		**No**	

Table 11.0c. Performance of different flax lines in European flaxseed test in 2019

	2019 Yield					
	Arborg		Melita		Roblin	
VARIETY	kg ha^{-1}	bu ac^{-1}	kg ha^{-1}	bu ac^{-1}	kg ha^{-1}	bu ac^{-1}
CDC Bethune	2119	33.7	2719	43.2	3616	57.5a
OVB 1001-01	1885	30.0	2798	44.5	3166	50.3bcd
LG Lion	1960	31.2	2704	43.0	3464	55.1ab
Batsman	1933	30.7	2848	45.3	3071	48.8cde
LG Aquarius	1833	29.1	2849	45.3	3302	52.5abc
OVB 0815-02	1913	30.4	2738	43.5	2689	42.8ef
Biltstar	1844	29.3	2758	43.9	2792	44.4def
GRAND MEAN	**1927**	**30.6**	**2773**	**44.1**	**3157**	**50.2**
CV%	**7.3**		**6.0**		**7.0**	
LSD	**-**	**-**	**-**	**-**	**395**	**6.3**
Sign Diff	**No**		**No**		**Yes**	

Table 11.0d. Analysis of variance and mean comparison for flax plant height (cm) in 2018 & 2019

VARIETY	**Arborg18**	**Arborg19**	**Melita18**	**Melita19**	**Roblin18**	**Roblin19**
CDC Bethune	44.0a	44.0	62.0a	57.0	55.3a	64.0a
OVB 1001-01	36.0cd	37.0	51.7b	59.0	55.7a	56.0b
LG Lion	38.0bcd	40.0	51.7b	53.0	46.0b	44.0c
Batsman	40.0abc	37.0	53.3b	58.0	48.0b	50.0bc
LG Aquarius	37.0bcd	38.0	49.3bc	57.0	45.7b	48.0c
OVB 0815-02	36.3cd	35.0	50.0bc	54.0	46.3b	48.0c
Biltstar	41.7ab	39.0	46.0c	49.0	45.3b	49.0c
GRAND MEAN	**39.0**	**38.5**	**52.0**	**55.3**	**48.9**	**51.1**
CV %	**6.8**		**5.9**		**7.4**	**7.3**
LSD	**4.7**		**5.5**		**6.4**	**6.7**
Sign Diff	**Yes**	**No**	**Yes**	**No**	**Yes**	**Yes**

Table 11.0e. Mean days to physiological maturity of flax recorded at three sites in 2018 & 2019

Variety	Arborg18	Arborg19	Melita18	Melita19	Roblin18	Roblin19	Average18	Average19
CDC Bethune	95	92	84	92	82	84	87	89
OVB 1001-01	98	91	86	96	81	105	88	98
LG Lion	94	92	85	93	79	106	86	97
Batsman	91	90	84	95	77	101	84	95
LG Aquarius	90	91	83	98	74	102	82	97
OVB 0815-02	91	90	84	99	79	104	85	98
Biltstar	91	92	84	100	76	119	84	104

Table 11.0f. Mean duration of flowering period (days) recorded at three sites in 2018 & 2019

Variety	Arborg18	Arborg19	Melita18	Roblin18	Roblin19	Average18	Average19
CDC Bethune	29	37	22	11	32	21	34
OVB 1001-01	31	39	25	11	34	22	37
LG Lion	20	37	15	10	29	15	33
Batsman	13	39	22	11	33	15	36
LG Aquarius	16	39	17	11	39	15	39
OVB 0815-02	16	39	22	12	34	17	36
Biltstar	16	39	12	13	33	14	36

2019 data not available for Melita

Table 11.0g. Fatty acid and iodine content of 7 flax varieties in 2018

	2018 Quality Results							
	OMEGA LEVEL			**Ω-9**	**Ω-6**	**Ω-3**	**Ω-9**	
VARIETY	**FATTY ACID (%)**	**Palmitic C16:0**	**Stearic C18:0**	**Oleic C18:1**	**Linoleic C18:2**	**α-Linolenic C18:3**	**Eicosenoic C20:1**	**Iodine Value**
CDC Bethune		6.00	3.8	18.75	17.5	53.94	0.0	187.57
OVB 1001-01		5.55	5.0	21.17	23.3	44.94	0.1	176.09
LG Lion		6.08	4.1	18.65	14.0	57.15	0.0	189.73
Batsman		6.39	4.2	18.50	14.4	56.39	0.1	188.35
LG Aquarius		5.82	3.8	18.21	15.6	56.53	0.0	190.53
OVB 0815-02		6.59	5.0	18.19	13.9	56.22	0.1	186.71
Biltstar		5.50	5.1	17.52	15.3	56.52	0.1	189.31
	GRAND MEAN	**5.99**	**4.4**	**18.71**	**16.3**	**54.53**	**0.0**	**186.90**

References

Booker, H. M. and Lamb, E. G. 2012. Quantification of Low-level GM Seed Presence in Canadian Commercial Flax Stocks. *AgBioForum* **15 (1): 31-35.**

Hall, L. M., Booker, H., Siloto, R. M. P., Jhala, J. M., and Weselake, R. J. 2016. Flax (*Linum usitatissimum*): In: *Industrial Crops* **157-194**.

Irvine, R. B., McConnell, J., Lafond, G. P., May, W. E., Hultgreen, G., Ulrich, A., Stonehouse, K., Chalmers, S. and Stevenson, F. C. 2010. Impact of production practices on fibre yield of oil seed flax under Canadian prairie conditions. *Canadian Journal of Plant Science* **90: 61-70.**