Improving profitability of flax production in high moisture environments

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The advent of canlin cultivars of flax appears to offer the potential for greatly expanded flax acreage providing yields are high enough. Over the period of time 1988-93 average yields of McGregor flax were similar to those of Global canola under irrigated conditions at Outlook Saskatchewan. Scelerotinia and blackleg do not affect flax and both species appear to have similar effects of subsequent cereal grain crops. Delaying planting has reduced yields by 20 % in years where early frosts did not affect yields. Early planting would generally preclude the use of trifluralin since planting into cold soils is not recommended. Flax planted at the end of May can be up to 10 cm taller than crops planted in early May. High seeding rates reduced yields in all 3 years. High seeding rates sometimes induced more lodging but this affect was not consistent. Narrow row spacings did not increase seed yields. High yields can be obtained over a wide range of seeding rates and row spacings providing weed control is excellent and seeding is done during the first half of May.

Introduction

The effect of seeding rate and row spacing on the seed yields of flax has not been determined under irrigated conditions in the temperate zone of the world. In India varying row spacings between 10 and 35 cm did not affect yields under irrigated conditions (Elsahookie 1978). Likewise under zero tillage seeding flax yields were the same at 10, 20 or 30 cm spacings when moisture conditions were good (Lafonde 1993). Under dryland conditions and conventional tillage (Stevenson et al 1992) found that 9 cm spacings outyielded 18 cm spacings which in turn outyielded 27 cm.

Lafonde (1993) found that yields increased in a linear manner with seeding rate but this increase was small. Gubbels and Kenaschuk (1989) found very little effect of seeding rates between 400 and 800 seeds/m^2. Seeding rates of 200 seeds/m^2 had lower yields for most cultivars and 800 seeds/m^2 increased lodging particularly with lodging prone cultivars. In South Dakota seeding rates between 260 and 1280 seeds/m^2 did not affect the yields of 10 flax cultivars with varying seed sizes (Albrechtsen and Dybing 1973). Hanson and Lukah (1990) found that 500 plants/m^2 was the optimum seeding rate in North Dakota under conditions where lodging was not a problem. These plant populations were obtained with seeding rates of 55-66 kg/ha 75 and 90% of the time while a 33 kg/ha seeding rate reached these populations only 12 percent of the time.

A nine year study at Minot North Dakota found that early maturing cultivars such as Norlin preformed better at late seeding dates (Thompson et al 1988). Crops planted in the first week of June yielded 21% less than crops planted in the first week of May. The shortest crops were obtained from early planting.

Materials and Methods

Cultivar response to seeding date

The design was a 5 replicate split plot with main plots being seeding dates (Early, Mid and Late May) and subplots being the cultivars and 6.1 m long. McGregor, Norlin, Flanders and AC Linora flax were planted at 400 seeds/m^2 in plots 2.2 m wide. The test was established on a Bradwell silt loam soil.

Actual seeding dates

year	Early (07)	Mid (17)	Late (27)
1991	May 07	May 17	May 27
1992	May 05	May 18	May 26
1993	May 11	May 21	May 28

Effect of seeding method and rate

McGregor flax was planted at 30, 50 and 70 kg/ha (400, 700 and 1000 seeds/m^2) in plots 2.2 m wide and 15 m long in rows 20 cm apart or broadcast and incorporated using sweeps operated about 4 cm deep. In addition a 3 m wide Amazone drill was used to plant McGregor at 50 kg/ha (700 seeds/m^2) at 8 cm and 16 cm. Plant counts, heights, lodging and yields were measured on all 6 replicates.

Results and Discussion

Response of cultivars to seeding date

Flax was frozen in 1992 greatly decreasing the yields of flax planted near the end of May (Table 2). However, even in 1991 and 1993 when frost was not a factor yields were reduced by 20% relative to seeding in early May. There was a significant interaction between year, seeding date and cultivar but no cultivar was consistently superior at late seeding dates (Table 1). Norlin yields were negatively impacted to a similar extent as other cultivars in contrast to the report of Thompson et al (1988). While frost can destroy early seeded flax the relatively low cost of seeding relative to the potential losses would favour early planting.

Delaying seeding increased plant height every season for all cultivars tested although the response to seeding date varied somewhat due to cultivar and year (Table 1 and 2). Taller plants will result in longer straw which is more difficult to direct seed into or more material to bunch and burn.

Seed size was not reduced by delayed planting and oil content was similar (data not shown). There were significant cultivar effects for both of these traits with Flanders having the highest oil content.

There were significant differences in lodging due to cultivar and the interaction between cultivar and year(Table 1). However, delayed seeding did not have a consistent effect on lodging and genetic resistance is the best method of controlling this problem.

Table 1. ANOVA of the response of cultivars to seeding date

Source	DF	Yield (kg/ha) MS	Pr>F	Lodging MS	Pr>F	Height cm MS	Pr>F
Year (Y)	2	5010422	.001	29.6	.07	317	.006
Year(Rep)	12	384181		8.5		40	
Seeddate (SD)	2	6193998	.0001	20.1	.02	853	.0001
Y*SD	4	831909	.0003	15.3	.02	19	.44
Y*SD*R	24	102937		4.4		20	
Cultivar (C)	3	101447	.141	12.6	.04	99	.0001
C*SD	6	36737	.672	3.7	.54	25	.05
Y*C	6	136237	.027	7.1	.15	146	.0001
Y*C*SD	12	121525	.015	4.1	.52	7	.81
Error C	105	54630		4.4		12	

Table 2. Effect of seeding date on flax yields

Cultivar	Seeding date	yield kg/ha 1991	1992	1993	Lodging 1-9 1991	1992	1993	Height cm 1991	1992	1993
Flanders	May 7	1535	2576	2273	4.0	2.6	4.4	74	76	70
Flanders	May 17	1418	1973	1980	6.5	3.8	5.4	79	79	72
Flanders	May 27	1338	1373	1803	5.2	6.0	5.4	83	83	81
	mean	1489	1974	2018	5.2	4.1	5.1	79	74	75
Linora	May 7	1650	2593	2060	3.8	2.6	7.4	76	76	69
Linora	May 17	1618	1821	1987	5.6	3.0	6.4	78	79	74
Linora	May 27	1444	1352	1651	4.4	4.2	5.2	80	83	74
	mean	1571	1922	1899	4.6	3.3	6.3	78	80	73
McGregor	May 7	1635	2431	2376	2.6	3.2	4.6	80	73	77
McGregor	May 17	1418	2552	2060	5.4	2.8	4.6	81	73	79
McGregor	May 27	1228	1489	1757	2.2	4.8	3.6	84	82	84
	mean	1443	2158	2064	3.4	3.6	4.3	82	76	80
Norlin	May 7	1649	2566	2206	3.5	2.8	5.2	73	76	68
Norlin	May 17	1593	2146	1826	6.2	5.6	4.6	80	80	71
Norlin	May 27	1204	1650	1549	6.8	4.0	5.2	80	85	75
	mean	1482	2120	1860	5.5	4.1	5.0	78	80	71
	May 7	1569	2668	2206	3.5	2.8	5.4	76	73	71
	May 17	1503	2173	2011	5.9	3.8	5.3	80	76	74
	May 27	1265	1435	1747	4.6	4.75	4.9	82	82	[illegible]

Effect of seeding method and seeding rate

Over the 3 years yields declined at every seeding rate above the lowest rate (Table 3 and 4). Under irrigated conditions it appears that plant populations as low as 300 seeds/m^2 or lower may are sufficient and seeding rates of 30 kg/ha are adequate for McGregor flax. This is slightly lower than other reports (Gubbels and Kenaschuk 1989, Hanson and Luhak 1990, Lafond 1993). Lodging differences are difficult to rate in flax; thus lodging may be part of the reason for lower yields at higher seeding rates but at we were unable to make this determination based on our estimates of lodging. Higher plant populations restrict branching and establish full cover sooner in the season.

Yields were not affected by row seeding or broadcasting (Table 3). Plots established by broadcasting seed and covering by cultivating to a depth of 5 cm resulted in significantly lower plant populations than row seeded plots in each season. Lodging differences due to seeding rate were of little biological significance. Over the three years yield of 8 cm spaced rows was 2037 kg/ha vs 2027 kg/ha for the 16 cm spaced rows. This was not significant in any year.

Table 3. ANOVA of seeding method and seeding rate of McGregor flax on yield and other agronomic traits

		Yield (kg/ha)		Plants/m^2		Height cm	
	DF	MS	Pr>F	MS	Pr>F	MS	Pr>F
Year	2	9010290	.0001	1897	.0001	378022	.0001
Rep(year) Error a	15	465442		14		8602	
Rate	2	1112123	.0001	2	.69	491009	.0001
Method	1	9843	.657	138	.0001	888533	.0001
M*R	2	37429	.473	7	.31	7373	.25
Y*M	2	194792	.024	254	.0001	41649	.0001
Y*R	4	151665	.022	3	.79	8737	.004
Y*M*R	4	77995	.190	11	.12	22147	.161
Error b	75	49504		6		5164	

The number of plants established was greater with row planting than broadcasting and incorporating the seed by cultivation (Table 4). Plant counts varied between years and while plant counts were always lower for broadcast treatments percentage decrease varied between seasons. Despite large differences in plant numbers yields were not reduced indicating that under centre pivot irrigation in Saskatchewan seeding rates even lower than 30 kg/ha should be tested.

Oil content and seed size were not affected by seeding method or seeding rate.

Maturity differences were not noted. Maturity differences may have been hiden by the fact that adequate water is always available and the plants remain green often past physiological maturity.

Table 4. Effect of seeding rate and seeding method on yields, height and plant plants of McGregor flax

year	SEED METHOD	SEED RATE KG/HA	YIELD KG/HA	HEIGHT CM	PLANTS /m2
90	BROADCAST	30	2664	71	302
91	BROADCAST	30	1605	78	228
93	BROADCAST	30	2168	75	133
	mean		2146	75	221
90	BROADCAST	50	2340	69	457
91	BROADCAST	50	1506	78	380
93	BROADCAST	50	2220	77	171
	mean		2022	75	336
90	BROADCAST	70	2194	69	554
91	BROADCAST	70	1408	80	509
93	BROADCAST	70	1953	78	227
	mean		1852	76	430
90	ROW	30	2889	61	467
91	ROW	30	1584	80	377
93	ROW	30	2131	79	316
	mean		2201	73	387
90	ROW	50	2606	62	525
91	ROW	50	1427	79	524
93	ROW	50	1873	77	452
	mean		1969	72	500
90	ROW	70	2138	61	675
91	ROW	70	1319	78	736
93	ROW	70	1920	78	523
	mean		1792	73	645

Summary

Rules for obtaining optimum yields of flax under irrigated conditions
1. Lodging resistant cultivar
2. Seed as early as possible
3. Row spacing is not critical but information on very wide spacings is not available
4. High plant populations decrease yields under weed free conditions but the reasons for this are not clear.
5. Ensure good water and nutrient levels.

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