Fall Seeded Canola – Agronomic Studies and Growth Analysis

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Introduction

Fall seeded canola has yielded about 25% higher than traditional mid-May seeded canola studies conducted in the Moist Dark Brown Soil Climactic Zone of Saskatchewan from 1994-98. (Kirkland and Johnson, 1999). The major advantage with fall seeding has been the avoidance of environmental stress, in particular high air temperatures during the sensitive flowering and early seed development stage. In addition to increased yields, fall seeded canola has matured up to 21 days earlier than the mid-May seeded canola. Fall seeded canola produces larger seed and a higher seed oil content. Fall seeded crops are generally shorter than spring seeded crops which may reduce lodging problems.

The objective of this paper is two-fold:

1) to provide a brief update of some results of agronomic studies conducted at Scott;
2) to provide preliminary results of a growth analysis study conducted at Scott and Melfort in 1998 and 1999.

Agronomic Studies

Effect of Seeding Method and Seed Depth

Many growers want to broadcast seed their fall-seeded canola on the soil surface based on the relative success of volunteer canola establishment in some years. Studies conducted on fallow and stubble at Swift Current have found broadcast seeding (followed by harrowing for incorporation) to be ineffective (Table 1). Plant emergence is very uneven with broadcast seeding. Broadcast seeding delayed flowering and crop maturity by 11 days and 8 days, respectively. Similar results have been obtained at Scott. There is some speculation that over-winter survivability of seed on the soil surface may be much lower than seed that is planted at an optimum depth (Gusta, personal communication).

Table 1: Effect of broadcast seeding and seed depth on plant establishment (plants/m^2) and yield (kg/ha) of fall seeded canola (McDonald, unpublished data, Swift Current, 1998-99)

	1998				1999			
	Fallow		Stubble		Fallow		Stubble	
Seed Depth	Plants/m2	Yield (kg/ha)	Plants/m2	Yield (kg/ha)	Plants/m2	Yield (kg/ha)	Plants/m2	Yield (kg/ha)
Broadcast	17	1448	18	652 b	4 b	577 b	7 c	734 b
1.25 cm	28	1521	25	928 a	13 ab	1326 a	23 b	1240 a
2.50 cm	34	1447	25	809 ab	20 a	1458 a	31 a	1382 a
Pr>F	0.967	0.123	.288	0.058	0.029	0.012	0.000	0.009

Two studies conducted at Scott in 1997 showed that plant establishment and yield of fall seeded canola declined dramatically when seeded deeper than 2.5 cm (Figure 1).

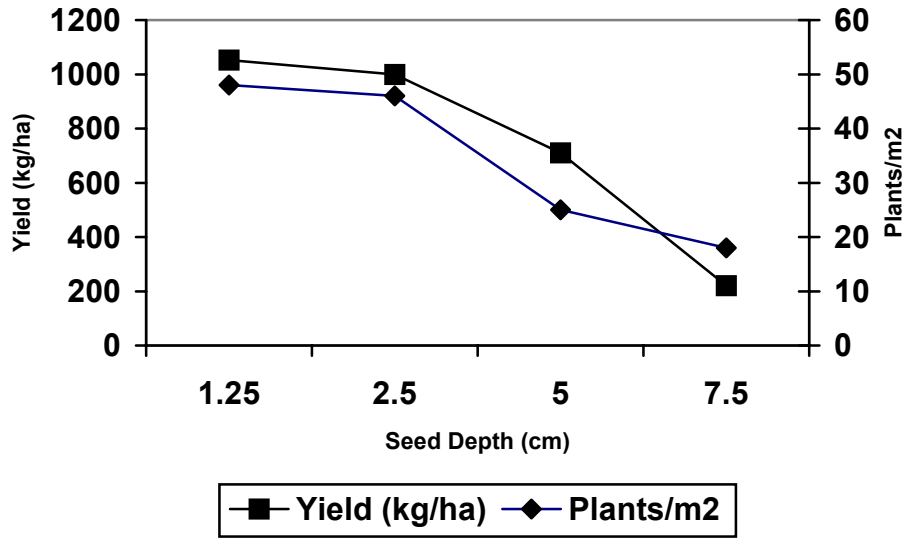
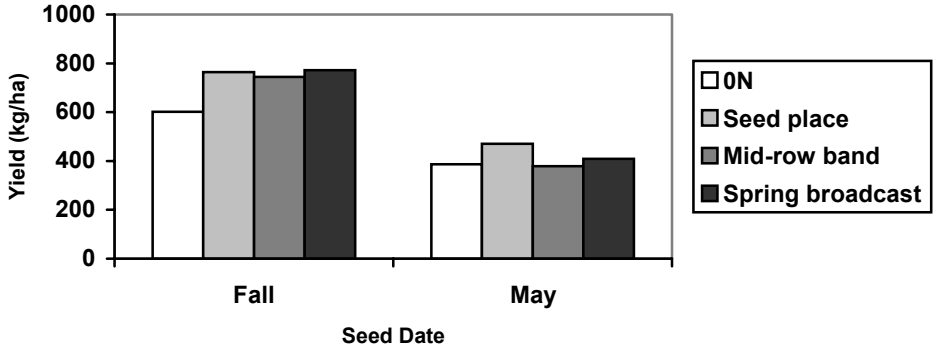


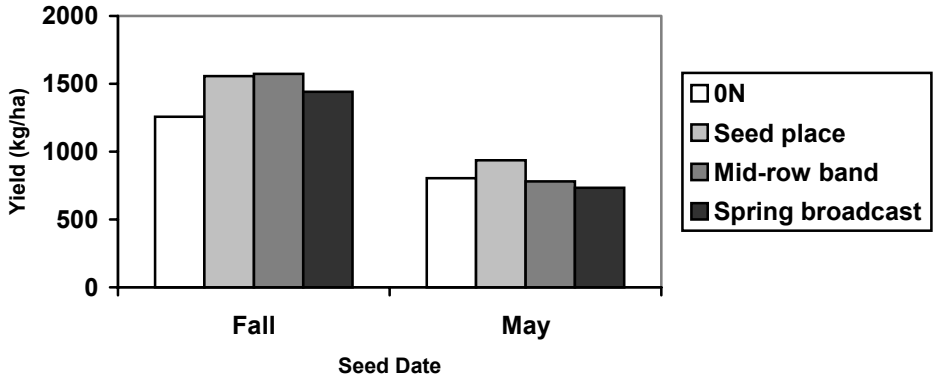
Figure 1: Effect of Seed Depth on Plant Establishment and Yield of Fall Seeded Quest Canola - Mean of Two Experiments, Scott 1997

Effect of Canola Seed Date on Nitrogen Fertilizer Response

The early growth of fall seeded canola allows the crop to make optimum use of early spring moisture and to avoid mid-summer temperature and moisture stress. Studies conducted at Scott in below years of precipitation (1997, 1998) showed that fall seeded canola was able to show a positive crop response to a 51 kg-N/ha application, while mid-May seeded canola showed no response (Figure 2). Environmental conditions were the yield-limiting factor for mid-May seeded canola in 1997 and 1998.



1997



1998

Figure 2: Effect of fertilizer application and placement on yield of canola seeded at 2 seed dates, Scott, 1997-98

Similar yield responses for seed placed and mid-row banded urea fertilizer were observed in fall seeded canola (Figures 1 & 2). Seed-placed N-fertilizer generally had lower plant populations, but yield was unaffected due to the plasticity of the canola crop. In 1999, yields of spring broadcast urea fertilizer were somewhat lower, likely due to volatilization losses. Spring broadcast of urea fertilizer is not recommended for winter

cereal production in the Prairies (Fowler, 1992) due to potential volatilization losses, therefore growers should avoid this application method for fall seeded canola.

A more intensive study on seed placed fertilizer was conducted in 1997 to investigate if fall seeded canola could tolerate higher rates of seed-placed nitrogen. Rates of 0, 45, 90 and 135 kg-N/ha were seed-placed with canola seeded at three seed dates (fall dormant, April 16, May 6). Plant emergence counts revealed similar trends for seed-placed fertilizer for the three seed dates, as there was no seed date X fertilizer rate interaction (Figure 3). The lower densities from the higher fertilizer rates did not result in lower yields (data not shown) due to the plant's ability to adjust to low plant densities. However, fall seeded canola generally has lower plant densities than spring-seeded canola (Kirkland and Johnson, 1999), therefore it is recommended that seed-placed nitrogen guidelines established for spring-seeded canola should be applied to fall-seed canola.

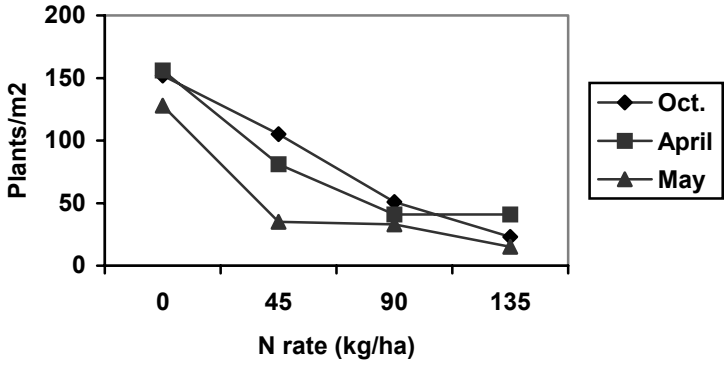


Figure 3: Effect of seed placed fertilizer rate on plant establishment of canola seeded at three seed dates, Scott, 1997.

Effect of Fungicide Seed Treatment

A number of different fungicide seed treatment studies were conducted at Scott in 1997 and 1998. The treatments in the studies varied, therefore it is difficult to present the data in a summarized form. However, significant improvements in crop establishment and crop yield were obtained from fungicide seed treatment in 4 of 5 studies conducted.

Growth Analysis

Introduction

Fall and early-spring seeded canola crops tend to be shorter than mid-May seeded canola (Kirkland and Johnson, 1999). In addition, yield increases due to fall seeding were correlated to thousand-kernel weight ($r=0.593$, $P = 0.005$). Does the shorter crop mean less biomass production and higher harvest index? What yield components contribute to the higher yield? Are the responses similar in a semi-arid and sub-humid environment?

To address this question, studies investigating biomass accumulation, crop development, yield components and harvest date were conducted at Scott and Melfort in 1998 and 1999.

Methods and Materials

Canola (*cv.* Quest in 1998, LG3295 in 1999) was seeded in late fall and spring at both Scott and Melfort. Canola was seeded at a rate of 6.7 kg/ha on cereal stubble with the exception of Scott in 1999 where it was seeded on chemical fallow. Dates of seeding, swathing and harvesting are included in Table 2. Glyphosate was applied at a rate of 450 gai/ha at the 3 to 4 leaf stage of canola for weed control. Biomass was taken at regular intervals by cutting, removing, and drying two rows of plants one meter in length. Growth rates were calculated (kg/ha/day) for two stages: emergence to 50% flowering and 50% flowering to maturity. Plant emergence counts were taken three to four weeks after emergence. Pods per plant were counted on 20 plants selected per plot. Ten pods per plant were removed and the seed was counted. Pod and seed counts were done at the watery dough stage to avoid seed loss from pod shattering. Plots were swathed at maturity and harvested with a plot combine. Seed weight was determined by counting and weighing 500 seeds per plot.

Results

Scott

Fall-seeded canola was significantly shorter in height in 1998 and showed a similar trend in 1999 (Table 3). Fall seeded canola produced higher total harvest biomass in 1999 with a similar trend shown in 1998. However, the harvest index of fall seeded canola was significantly higher than spring seeded canola in 1998, while the fall seeded canola had a lower harvest index in 1999 (*P=0.10*). Yields of fall seeded canola were twice as high as mid-May seeded canola in 1998 but yields were similar in 1999. This is likely due to the cooler, wetter conditions experienced in July and August at Scott in 1999, relative to the harsh, dry conditions that prevailed in the same months in 1998. Straw yields were similar in 1998 but the fall-seeded canola produced more straw in 1999.

The rate of biomass development for fall seeded canola was less prior to the 50% flower stage than spring seeded canola in 1998 (Table 4). There was no difference in 1999. The slow rate of biomass accumulation in 1998 may be related to the cool temperatures that fall- seeded canola experiences at early growth stages. In addition, conditions were dry in the spring of 1998 with no appreciable precipitation until mid-June. In 1999, conditions were much more favorable in the spring, and later emergence of the fall-seeded canola resulted in similar biomass accumulation between the seed dates.

In both years, biomass accumulation from flowering to maturity for fall seeded canola was greater than spring seeded canola. In 1998, the low rate of biomass accumulation from spring seeded canola was likely due to severe environmental stress experienced during this time period.

Plant establishment was similar for fall and spring seeded canola in 1998 (Table 5). Fall seeded canola did not establish as well in 1999 due to an extremely dry April. The lower plant population did not result in lower crop yields due to the elastic nature of the crop. Fall seeded canola produced a similar number of pods per plant and seeds per pod in 1998. There was a 2-fold increase in seed weight, similar to the increase in crop yield. In 1999, fall seeded canola produced more pods per plant likely in response to the lower plant population. Clarke and Simpson (1978b) reported higher pod counts in canola seeded at low seed rates. Seeds per pod were also slightly higher in 1999 but there was no difference in seed weight.

Fall seeded canola flowered for 8 and 9 days longer than spring seeded canola in 1998 and 1999, respectively (Table 6). The longer flowering period in 1999 may also be due to the low plant density, as flowering and maturity tended to be much less uniform for fall seeded canola in 1999. Fall seeding advanced maturity (swath date) by 19 to 20 days. Harvest date was advanced by 10 to 14 days (Table 2).

Melfort

Fall-seeded canola was shorter in both years and the height to the first branch was significantly lower than May seeded canola. The low branch formation with pods closer to the soil surface also occurred at Scott but not to the same degree. Harvest biomass and straw yield were significantly lower for fall-seeded canola in 1998 (Table 7). Similar trends for harvest biomass was obtained in 1999, however the straw yield differences were not significant. In both years, grain yields were not significantly different for the two seed dates. Lack of yield response to fall seeded canola at Melfort has been observed in previous studies (Johnston, unpublished data). This may be due to more favorable environmental conditions during the flowering and early seed formation period. In spite of the lack of yield differences, harvest index for fall-seeded canola was significantly higher in 1998 due to less straw production. There was no difference in harvest index in 1999.

The rate of biomass accumulation was lower for the fall-seeded canola prior to the 50% flowering stage (Table 8). Growth rates from 50% flowering to maturity were similar. This slower growth rate in the early stages accounts for the lower total biomass production. This slower growth rate at early stages is likely due to environmental conditions, however Clarke and Simpson (1978a) reported lower dry matter accumulation prior to flowering with low seed rates.

In both years, crop establishment of fall seeded canola was significantly lower than spring seeded canola (Table 9). Fall-seeded canola responded to the lower plant density by producing more pods per plant. Seeds per pod were similar in both years and seed weight was similar in 1999. Seed weights were not measured in 1998 but seed weight would be appear to be higher for fall seeded canola based on calculation.

Fall seeded canola flowered for 9 and 7 days longer than the mid-May seeded canola in 1998 and 1999, respectively (Table 10). Fall seeding advanced crop maturity (swath date) by 7 to 18 days. Harvest date was advanced by 7 days in 1999 (Table 2).

References:

Clarke, J.M. and G.M. Simpson. 1978a. Growth analysis of *Brassica napus cv.* Tower. Can. J. Plant Sci. 58: 587-595.

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Fowler, B. 1992. Nitrogen Fertilization, Winter Wheat Production Manual, Ducks Unlimited Canada. 2530 pp.

Kirkland, K.J. and E.N. Johnson. 1999. Seeding Canola in the Fall, 1993-1999 Results. In Proceedings of the 1999Western Canada Agronomy Workshop pp. 40- 44, Canadian Fertilizer Institute, Brandon, Manitoba.

TABLES:

Table 2: Seed dates, swath and harvest dates for canola growth analysis experiments, Melfort and Scott, 1998-99.

Location	Treatment	Seeding Date	Swathing Date	Harvest Date
1998				
MELFORT	Fall Seed	Oct 29, 1997	Aug 4, 1998	Aug 27, 1998
	Spring Seed	May 14, 1998	Aug 11, 1998	Aug 27, 1998
SCOTT	Fall Seed	Oct 31, 1997	July 24, 1998	Aug 4, 1998
	Spring Seed	May 20, 1998	Aug 12, 1998	Aug 20, 1998
1999				
MELFORT	Fall Seed	Nov 4, 1998	Aug 12, 1999	Sep 9, 1999
	Spring Seed	May 24, 1999	Aug 30, 1999	Sep 16, 1999
SCOTT	Fall Seed	Oct. 28, 1998	Aug 6, 1999	Aug 24, 1999
	Spring Seed	May 18, 1999	Aug 26, 1999	Sep 3, 1999

Table 3: Effect of canola seed date on crop height, harvest biomass, straw yield, grain yield, and harvest index, Scott, 1998

	Harvest Height (cm)	Height to 1st Branch (cm)	Harvest Biomass (kg/ha)	Straw Yield (kg/ha)	Grain Yield (kg/ha)	Harvest Index
Seeding Date						
1998						
Fall	64 b	22	5196	3313	1404 a	0.313 a
Spring	99 a	19	3769	3103	667 b	0.179 b
Pr > F	0.0036	0.6092	0.2192	0.7671	0.0003	0.0251
C.V.	14	28	28	36	14	30
1999						
Fall	89	53 b	8560 a	6059 a	2778	0.30
Spring	101	71 a	5615 b	3401 b	2460	0.43
Pr > F	0.0815	0.00130	0.0228	0.0335	0.1517	0.0976
C.V.	13	13	22	35	12	29

Table 4: Effect of seed date on growth rate of canola (kg/ha/day) from emergence to 50% flower stage and from 50% flower stage to maturity, Scott, 1998-99.

	1998		1999	
	Emergence – 6.5 (kg/ha/day)	6.5 – Maturity (kg/ha/day)	Emergence - 6.5 (kg/ha/day)	6.5 – Maturity (kg/ha/day)
Seed Date				
Fall	31 b	78	62	112 a
Spring	59 a	31	59	61 b
Pr > F	0.004	0.122	0.778	0.017
C.V.	22	80	21	29

Table 5: Effect of seed date on canola yield components, Scott, 1998-99.

	1998				1999			
Seeding Date	Crop Stand (plant/m^2)	Pods per Plant	Seeds per Pod	TKWT (g)	Crop Stand (plant/m^2)	Pods per Plant	Seeds per Pod	TKWT (g)
Fall	137	38 a	24 b	4.3 a	59 b	74 a	24 a	3.4
Spring	126	48 a	28 a	2.2 b	201 a	37 b	18 b	3.3
Pr > F	0.1673	0.0640	0.0021	0.0001	0.0016	0.0284	0.0013	0.1977
C.V.	9	16	5	10	30	38	7	3

Table 6: Effect of seed date on canola flowering period, Scott 1998-99.

Seeding Date	1998			1999		
	Start of Flowering (Jday)	End of Flowering (Jday)	Days of Flowering	Start of Flowering (Jday)	End of Flowering (Jday)	Days of Flowering
Fall	146b	173 b	27 a	163 b	190 b	27 a
Spring	189 a	208 a	19 b	186 a	204 a	18 c
Pr > F	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
C.V.	0	0	0	0	0	0

Table 7: Effect of canola seed date on crop height, harvest biomass, straw yield, grain yield, and harvest index, Melfort, 1998-99.

	Harvest Height (cm)	Height to 1st Branch (cm)	Harvest Biomass (kg/ha)	Straw Yield (kg/ha)	Grain Yield (kg/ha)	Harvest Index
Seeding Date						
1998						
Fall	96 b	6 b	5725 b	3702 b	2023	0.370
Spring	113 a	38 a	7469 a	5476 a	1993	0.270
Pr > F	0.0001	0.0032	0.0258	0.0365	0.7711	0.0843
C.V.	2	47	15	24	8	26
1999						
Fall	84 b	10.5 b	5946	3664	2535	0.393
Spring	118 a	46.1 a	7057	4269	3097	0.404
Pr > F	0.0001	0.0002	0.0590	0.1188	0.0594	0.6183
C.V.	2	14	12	14	14	9

Table 8: Effect of seed date on growth rate of canola (kg/ha/day) from emergence to 50% flower and from 50% flower stage to maturity, Melfort, 1998-99.

	1998		1999	
	Emergence – 50% Flower (kg/ha/day)	50% Flower – Maturity (kg/ha/day)	Emergence – 50% Flower (kg/ha/day)	50% Flower – Maturity (kg/ha/day)
Seed Date				
Fall	30	113	37	85
Spring	60	128	81	91
Pr > F	0.058	0.63	N/A	N/A
C.V.	46	45	N/A	N/A

Table 9: Effect of seed date on canola yield components, Melfort, 1998-99.

	1998				1999			
	Crop Stand (plant/m^2)	Pods per Plant	Seeds per Pod	TKWT (g)	Crop Stand (plant/m^2)	Pods per Plant	Seeds per Pod	TKWT (g)
Seeding Date								
Fall	48 b	120 a	30	.	72 b	105 a	28	3.1
Spring	129 a	82 b	30	.	141 a	80 b	29	3.3
Pr > F	0.0005	0.0024	1.0000	.	0.0107	0.0187	0.7393	0.0798
C.V.	20	11	6	.	28	14	7	4

Table 10: Effect of canola seed date on flowering period, Melfort, 1998-99.

	1998			1999		
Seeding Date	Start of Flowering (Jday)	End of Flowering (Jday)	Days of Flowering	Start of Flowering (Jday)	End of Flowering (Jday)	Days of Flowering
Fall	163 b	191 b	28 a	169 b	202 b	33 a
Spring	183 a	202 a	19 b	193 a	219 a	26 b
Pr > F	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
C.V.	0	0	0	<1	<1	2