Seeding speed and seeding depth effects on canola emergence and yield

K. Neil Harker[1], John O'Donovan[1], Robert Blackshaw[2], Eric Johnson[3], Bill May[4], Guy Lafond[4].
[1]Agriculture & Agri-Food Canada (AAFC), Lacombe Res. Centre, Lacombe, AB Canada.
[2]AAFC, Lethbridge Res. Centre, Lethbridge, AB Canada.
[3]AAFC, Scott Experimental Farm, Scott, SK Canada.
[4]AAFC, Indian Head Experimental Farm, Indian Head, SK Canada.

Abstract. Direct-seeded (no-till) experiments were conducted at four western Canada locations (Lacombe AB, Lethbridge AB, Indian Head SK, and Scott SK) from 2008 to 2010 to determine the influence of cultivar (hybrid vs. open-pollinated), seeding speed (4 vs. 7 mph), and seeding depth (1 vs. 4 cm) on the emergence, maturity, yield, and seed quality of glyphosate-resistant canola. Soil moisture at and following the time of seeding was a major determinant of overall canola emergence. When soil moisture conditions were very poor at seeding, average canola emergence was well below 50%. However, seeding speed, and especially seeding depth, at each location often had a major impact on canola emergence. When seeding was slow (4 mph) and shallow (1 cm) canola emergence was often higher than 50%. Even though slow and shallow seeding usually led to higher levels of canola emergence, the “recipe” approach to optimal canola emergence was not always useful. Under very dry surface moisture conditions, seeding shallow (1 cm) at Scott, SK in 2008 led to much lower emergence than seeding deep (4 cm). Given the high compensatory ability or “plasticity” of canola plants in response to low crop density, crop yields were not always reduced when canola emergence was low. However, low or non-uniform canola emergence sometimes delayed crop maturity and reduced seed quality. Low canola emergence may also necessitate additional herbicide applications and, in addition to greater input costs, lead to higher selection pressure for herbicide resistance.

Introduction

Canola seed is a substantial input cost and canola growers are both astonished and disconcerted by the fact that only 50% of planted seeds emerge (Harker et al. 2003). Canola growers want to know why emergence is low and how to mitigate the risks of low canola emergence and the problems that result from it (poor weed competition, additional herbicide applications, late maturity, low yields, green seed, less profit). Improving canola emergence has the potential to significantly improve net returns. Our objective was to determine if seed type (hybrid vs. open-pollinated), seeding speed (4 vs. 7 mph), and seeding depth (1 vs. 4 cm) would significantly influence canola emergence, maturity, yield and seed quality.

Materials and Methods

Direct-seeded (no-till) experiments were conducted at four western Canada locations (Lacombe AB, Lethbridge AB, Indian Head SK, and Scott SK) from 2008 to 2010 to determine the influence of cultivar (hybrid vs. open-pollinated), seeding speed (4 vs. 7 mph), and seeding depth (1 vs. 4 cm) on the emergence, maturity, yield and seed quality of canola. Glyphosate-resistant hybrid (’71-45RR’) or open-pollinated (’34-65RR’) canola was seeded at 150 seeds m^{-2} in May each year. Glyphosate was applied once in-crop (450 g ae/ha) at the 3-4 leaf stage (canola) to reduce weed competition effects. Individual plot size was 3 by 15 m. Data collection included canola emergence density, flowering dates and durations, crop maturity, canola yield, oil and protein content, and % green seed. Data were analyzed using standard ANOVA and mean separation techniques (PROC MIXED SAS).

Results and Discussion

Data was collected for 10 of 12 possible site years (Tables 1-5). Cultivar effects (hybrid vs. open-pollinated) were relatively minor when compared to seeding speed and seeding depth treatments. Therefore, given the fact that hybrids are much more common than open-pollinated cultivars on the Canadian Prairies, only hybrid canola data will be presented and discussed here. Canola oil and protein content were not consistently influenced by seeding depth and speed, and are not presented here.

Table 1. Hybrid canola emergence (plants m^{-2}) as influenced by seeding depth and speed.

	Lacombe			Lethbridge		ndian Head		Scott		
Treatment	2008	2009	2010	2008	2009	2009	2010	2008	2009	2010
4 mph, 1 cm	101	52	59	45	52	112	129	37	52	89
4 mph, 4 cm	80	**30**	**30**	49	**76**	111	134	**64**	57	**57**
7 mph, 1 cm	79	43	63	**60**	46	98	125	**20**	70	96
7 mph, 4 cm	**61**	**24**	52	35	63	**80**	112	**63**	40	**49**
LSD	24	20	27	12	24	26	49	12	28	18

***Bolded values** were significantly different (P < 0.05) from the expected "optimum" treatment (4 mph, 1 cm).

Seeding deep (4 cm) had the largest negative impact on canola emergence (Table 1). With one exception (Scott 2008), in cases were canola emergence was significantly lower than the expected "optimum" treatment (4 mph, 1 cm), seeding at a depth 4 cm was the problem. In the case of Scott 2008, precipitation during the 3 weeks surrounding seeding was only 10.4 mm (Table 2). Therefore, given very dry conditions, it is not always best to seed shallow (1 cm). However, it is notable that at the location with the lowest precipitation of all site-years (Lacombe in 2009), canola emergence was optimal at a seeding depth of 1 versus 4 cm.

Table 2. Precipitation (mm) 1 wk before seeding (WBS) and 1 & 2 wk after seeding (WAS).

	Lacombe			Lethbridge		Indian Head		Scott		
Time	2008	2009	2010	2008	2009	2009	2010	2008	2009	2010
Date*	5	1	11	18	26	15	20	16	15	14
1 WBS	6.3	2.2	5.7	1.6	2.9	1.4	0	8.2	0.2	2.2
1 WAS	19.6	2.4	0	71.3	0	0.6	24.2	1.8	14.2	0
2 WAS	0	4.4	32.2	10.8	22.9	10.4	23.4	0.4	1.6	89.0
Total	25.7	9.0	37.9	83.7	23.8	12.4	47.6	10.4	16.0	91.2

*May dates of seeding

High seeding speed (7 mph) per se negatively influenced canola emergence only at Indian Head in 2009 and Scott in 2008 (Table 1). Therefore, seeding "deep" (4 cm) appeared to have a stronger negative influence on canola emergence than seeding "fast" (7 mph).

Canola yield was not usually reduced by suboptimal seeding depth and speed treatments (Table 3). The exception was at Lacombe in 2009 where all treatments other than 4 mph at 1 cm led to significantly lower yields. The high compensatory ability or "plasticity" of canola usually preserves yield, but yield is not the whole story. Sparse stands of canola often require greater herbicide inputs to preserve yield with the attendant increases in input costs, additional selection pressure for weed resistance to herbicides, and lower profit margins.

Table 3. Hybrid canola yield (t ha^{-1}) as influenced by seeding depth and speed*.

	Lacombe			Lethbridge		ndian Head		Scott		
Treatment	2008	2009	2010	2008	2009	2009	2010	2008	2009	2010
4 mph, 1 cm	4.8	5.2	3.5	3.1	3.7	2.7	2.4	3.6	3.1	2.1
4 mph, 4 cm	4.4	**4.2**	3.5	2.9	3.9	2.9	2.1	**4.3**	3.2	2.0
7 mph, 1 cm	4.8	**4.7**	3.3	2.8	3.7	2.8	2.1	3.4	3.0	2.2
7 mph, 4 cm	4.7	**4.8**	3.5	2.9	4.0	2.8	2.1	3.8	3.0	2.1
LSD	0.5	0.4	0.5	0.4	0.5	0.4	0.9	0.5	0.4	0.2

***Bolded values** were significantly different (P < 0.05) from the expected "optimum" treatment (4 mph, 1 cm).

Canola maturity can be delayed as canola "branches out" to compensate for poor emergence. There were significant delays in canola maturity at 4 of 10 site-years for sub-optional seeding depth and seeding speed treatments (Table 4). Maturity delays lead to delayed harvests and, depending on fall-harvest weather conditions, can reduce canola seed quality.

Table 4. Days to hybrid canola maturity as influenced by seeding depth and speed*.

	Lacombe			Lethbridge		ndian Head		Scott		
Treatment	2008	2009	2010	2008	2009	2009	2010	2008	2009	2010
4 mph, 1 cm	112	127	125	96	105	109	102	100	118	103
4 mph, 4 cm	**116**	**128**	**127**	97	102	110	104	99	118	**106**
7 mph, 1 cm	**113**	**128**	**126**	95	102	108	103	101	118	103
7 mph, 4 cm	**116**	127	**126**	96	103	109	103	100	118	**107**
LSD	1	1	1	2	1	2	3	4	0	2

***Bolded values** were significantly greater (P < 0.05) than the expected "optimum" treatment (4 mph, 1 cm). Days to maturity were determined from the date of seeding to swathing (wind-rowing).

Green seed levels (Table 5) did not appear to be positively associated with delayed maturity (Table 4). Sub-optimal seeding treatments increased green seed levels at Indian Head in 2009 and 2010 and at Scott in 2009. We were not able to detect significant maturity delays from similar treatments at any of these sites. Therefore, green seed treatments were not necessarily caused by delayed maturity.

Table 5. Hybrid canola % green seed as influenced by seeding depth and speed*.

	Lacombe			Lethbridge		ndian Head		Scott		
Treatment	2008	2009	2010	2008	2009	2009	2010	2008	2009	2010
4 mph, 1 cm	1	1	14	4	1	1	6	1	2	1
4 mph, 4 cm	1	2	20	3	1	2	**7**	0	**3**	1
7 mph, 1 cm	0	1	14	3	1	**3**	**11**	1	**3**	0
7 mph, 4 cm	1	1	14	5	1	2	**14**	0	**3**	1

***Bolded values** would be marketed as a lower grade than the expected "optimum" treatment (4 mph, 1 cm). "Distinctly green" seed levels ≤ 2, > 2 & ≤ 6, and > 6 & ≤ 20% result in canola grades of #1, #2, #3, respectively. Distinctly green" seed levels above 20% are graded as "sample".

Conclusions

Seeding canola too deep (4 cm) sometimes substantially reduced canola emergence. In some cases, poor emergence delayed canola harvest and reduced seed quality. Seeding speed and cultivar (hybrid or open-pollinated) had less impact on canola emergence than seeding depth. Given canola's compensatory ability, low emergence did not always reduce yield. However, to protect yield from weed competition in poor canola stands, additional herbicide inputs may be required.

Although canola growth (Qaderi et al. 2006) and yield (Nuttall et al. 1992; Polowick and Sawhney 1988; Young et al. 2004) are generally favoured by cool conditions, initial canola emergence is favoured by relatively warm temperatures near the soil surface. In this study, canola emergence was also influenced greatly by soil moisture conditions. On the Canadian Prairies and across the Great Plains, the soil moisture conditions necessary for optimal crop emergence are most likely to be found in direct-seeding (no-till) systems (Blevins et al. 1971; Jones et al. 1968; Malhi and O'Sullivan 1990). Precipitation levels cannot be managed, but soil water availability and precipitation retention is greater in direct-seeding (no-till) systems.

Literature Cited

Blevins, R. L., D. Cook, S. H. Phillips, and R. E. Phillips. 1971. Influence of no-tillage on soil moisture. Agron. J. 63:593-596.

Harker, K. N., G. W. Clayton, R. E. Blackshaw, J. T. O'Donovan and F. C. Stevenson. 2003. Seeding rate, herbicide timing and competitive hybrids contribute to integrated weed management in canola (Brassica napus). Can. J. Plant Sci. 83:433-440.

Jones, J. N., J. E. Moody, G. M. Shear, W. W. Moschler, J. H. Lillard. 1968. The no-tillage system for corn (Zea mays L.). Agron. J. 60:17-20.

Malhi, S. S., and P. A. O'Sullivan. 1990. Soil temperature, moisture and penetrometer resistance under zero and conventional tillage in central Alberta. Soil Till. Res. 17:167-172.

Nuttall, W. F., A. P. Moulin, and L. J. Townley-Smith. 1992. Yield response of canola to nitrogen, phosphorus, precipitation, and temperature. Agron. J. 84:765-768.

Polowick, P. L. and V. K. Sawhney. 1988. High temperature induced male and female sterility in canola (Brassica napus L.). Ann. Bot. 62:83-86.

Qaderi, M. M., L. V. Kurepin, and D. M. Reid. 2006. Growth and physiological responses of canola (Brassica napus) to three components of global climate change: temperature, carbon dioxide and drought. Physiol. Plant. 128:710-721.

Young, L. W., R. W. Wilen, and P. C. Bonham-Smith. 2004. High temperature stress of Brassica napus during flowering reduces micro- and megagametophyte fertility, induces fruit abortion, and disrupts seed production. J. Exp. Bot. 55:485-495.