Increasing yield and profit by straight-cutting canola

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Abstract
Straight combining canola (*Brassica napus*) can save producers time, fuel costs, and equipment wear. Research was undertaken at three locations to determine if straight combining shatter losses would be reduced sufficiently with higher yield potential to make straight combining viable in western Canada. This research employed a randomized complete block design. Treatments included crop density (low and high), fertility (low and high), time of weed removal (early and late), and harvest time (early and late). Factors were selected to offer a range of yields to evaluate the relationship between potential yield and shatter loss. Different components of potential yield were important in determining yield and seed losses before and during harvest operations. In Lacombe, fertility has been the most important factor. In Vegreville, timing of weed removal was paramount in 2006. At Scott in 2006, it appears that all operations must be conducted under best management practices or there is a substantially increased probability of reduced yield when straight-cutting. These results generally fit the hypothesis that ability to straight-cut is dependant upon maximizing potential yield. Under higher-yielding conditions, a key factor has led to success at straight-cutting. Under low-yielding conditions, all factors contributing to increased potential yield must be used to ensure feasibility of straight-cutting.

Introduction
Straight combining canola (*Brassica napus*) can save producers time, fuel costs, and equipment wear. Straight combining canola is uncommon on the Canadian prairies since producers believe the risk of yield losses due to shattering are substantial. Shattering can occur because hail or high wind smashes the pods, or when harvesting equipment moves through the crop. Shatter loss due to hail is not avoidable, but growers can visually gauge when canola stands are suitable for straight combining then set and operate the combine to minimize shattering further. Producer concerns of shatter risk have been borne out by research undertaken at the Canola Production Centers (CPC). In general, shattering losses from straight combining canola outweighed yield benefits compared to swathing. Trials were conducted at 8 locations over three years and showed that straight combined canola yielded 11% less than swathed canola. Results varied from 50% yield loss to small increases depending on the variety used and environmental conditions. However, very low yields at two locations account for that difference. At the remaining locations, straight combined plots showed 3% better yields than swathed plots. Trials where straight combining have been most successful have experienced crop lodging. These results were obtained when the recommended time to swathing was 30-40% seed colour change

and have not been re-examined since the recommendation for swathing was changed to 50-60% seed colour change.

Wilson Lovell and a few neighbours in the Lacombe area have been straight-cutting canola for about 5 years with straight-cut headers. They do not select shatter-resistant varieties, but generally select the latest releases in high-yield hybrids, although they have been successful with non-hybrid varieties as well. Their approach has been to seed canola early, fertilize for high yield, and straight combine after the first heavy frost. The frost takes out stragglers in low spots, and grade is unaffected by the few remaining green seeds. As with the CPC trials where lodging occurs, they have a heavy crop and, "the thicker the mat is, the safer they feel". He attributes 10% yield increase to straight combining and does not believe he has incurred more shatter losses than neighbours who swath. These producer results, together with the increased yield potential of varieties in the last few years suggest a new examination of straight combining canola should prove profitable.

This research was undertaken to determine if straight combining was viable as a result of equal or superior yield to straight-cutting.

Materials and Methods

Research Locations

Research was undertaken at three locations representing a gradient of moisture and fertility considered likely to be successful for straight-combining. 1) The Alberta Research Council (ARC) - Vegreville, AB, 2) Agriculture and Agri-Food Canada (AAFC) Lacombe, AB, and 3) AAFC Scott, SK.

Experimental Design

This research employed a randomized complete block design. Treatments (Table 1) included crop density (low and high), fertility (low and high), time of weed removal (early and late), and harvest time (early and late). Factors were selected to offer a range of yields to evaluate the relationship between potential yield and shatter loss. Crop density assumed 50% emergence. Weed removal timing was based on crop leaf stage. Fertility was based on addition of nitrogen (N). Harvest timing was based on moisture content for straight-cut.

Table 1. Factor names, levels codes and rates used in the CHMS.

Factor Name (Code)	Factor Level	Level Code	Rate
Crop density (CD)	Low	L	40 plant m^{-2}
	High	H	160 plant m^{-2}
Fertility (F)	Low	L	0 kg N ha^{-1}
	High	H	140 kg N ha^{-1}
Weed removal timing (WR)	Early	E	3-leaf stage
	Late	L	6-leaf stage
Harvest time (HT)	Early	E	Straight-cut at 20% moisture
	Late	L	Straight-cut at 10% moisture
		Sw50	Swath @ 50% seed colour change
		SwC	Swath @ prior to combining

Tame oat, used to simulate the competitiveness of a grassy weed. It was cross-seeded to the entire experimental area, at a 2.5 cm depth, to a target density of 100 plants m^{-2}. Liberty Link canola, c.v. Invigor 5020, was seeded to a 4 m width to the length of each plot, at a 1.25 cm depth. Seeding was performed with a double-disc, low disturbance, press drill on a 20 cm row spacing. The seeder was calibrated to deliver 75 and 150 canola seeds m^{-2}. Plots were fertilized according to soil test recommendations for canola. A blend of nitrogen and sulphur fertilizer was applied between paired crop rows, whereas, phosphorous was seed-placed for each row.

Herbicide treatments were applied using a Spra-Coupe calibrated to deliver 113 l/ha of spray solution using TurboTee Jet 110 01 tips, 100 mesh screens and an operating pressure of 275 kpa. Glufosinate ammonium (Liberty®) at 3.375 l/ha and clethodim (Centurion®) at 0.065 l/ha were tank mixed with Amigo® at 0.5% v/v. Early weed removal herbicide treatments were applied at the 3 leaf stage of canola. Late removal herbicide treatments were applied at the 6 leaf stage.

Data Collection

Data collected in this study included: plant densities for both canola and tame oat, canopy interlock, green seed percentage, canola seed loss that occurred during pre- and post-harvest operations, and yield. Canola seed loss was determined by placing two seed shatter trays diagonally within each plot. Prior to swathing, curing and combining or straight-cut combining operations, the contents of each tray were collected and this seed was attributed to be shatter loss. Yield was evaluated by collecting, cleaning and weighing seed on a per plot basis.

Data Analysis

Data were log-transformed to improve normality and reduce correlation of means with standard errors. Data were analyzed with SAS™. Differences between treatments were determined using PROC GLM. Means separations were performed using contrasts, but are delineated using Duncan's protected LSD. Non-transformed data are presented.

Results and Discussion

At Lacombe, in both 2005 (Table 2) and 2006 (Table 3), Fertility had the greatest effect on yield. Of the treatments that did not differ from the highest-yield treatment, all had 100% fertility in common. Furthermore, the top 10 treatments in 2005, and 9 of 10 in 2006 had high fertility. This demonstrates that fertility supercedes the timing and nature of harvest at Lacombe.

At Vegreville in 2005, the situation was less clear. Fertility and Seeding Rate seemed to matter little, whereas early weed removal and early harvest tended to be important. The implication here is that producers may need only reduce weed pressure early to be able to straight-cut canola.

At Scott in 2006, Weed Removal Timing, followed be Seeding Rate and Fertility appeared most important. The implication from this result is that canola growers may need to do all things right in order to straight-cut canola.

Mean percent shatter loss ranged from approximately 1% of total yield up to approximately 4% (Table 6). In general, shatter loss was a minor component f total yield loss. Mean losses during combining ranged from approximately 5% to 20%. At Lacombe in 2005, combine losses were generally highest when fertility was low (Table 6). In 2006, combine losses did not vary substantially, but were greatest at the late harvest time. In Vegreville in 2005, Combine losses were greater overall, but were highest for the late weed removal treatment. At Scott in 2006, the highest percent shatter losses were observed. Other than swath treatments, combine losses were greatest when straight-cut occurred at 10% moisture.

These results suggest that different components of potential yield influence both yield and seed loss at different locations.

Table 2. Mean yield for each treatment at Lacombe in 2005. Data are ordered by yield.

Treatment	Seed Rate	Fertility	Weed Removal	Harvest	Yield	Group
8	150	100	Early	St20	4539	A
7	150	100	Late	St20	4402	A
4	50	100	Early	St20	4378	A
15	150	100	Late	St10	4243	A
16	150	100	Early	St10	4182	A
18	150	100	Early	Sw50	4167	A
3	50	100	Late	St20	4155	A
12	50	100	Early	St10	4123	A
11	50	100	Late	St10	4040	A
20	150	100	Early	SwC	3436	B
5	150	20	Late	St20	2946	C
2	50	20	Early	St20	2809	DC
17	50	20	Late	Sw50	2803	DC
6	150	20	Early	St20	2698	DCE
13	150	20	Late	St10	2494	DFE
14	150	20	Early	St10	2413	FE
19	50	20	Late	SwC	2411	FE
10	50	20	Early	St10	2338	F
9	50	20	Late	St10	2238	F
1	50	20	Late	St20	1640	G

Table 3. Mean yield for each treatment at Lacombe in 2006. Data are ordered by yield.

Treatment	Seed Rate	Fertility	Weed Removal	Harvest	Yield	Group
16	150	100	Early	St10	3682	A
12	50	100	Early	St10	3560	A
15	150	100	Late	St10	3471	AB
11	50	100	Late	St10	3458	ACB
18	150	100	Early	Sw50	3417	ACDB
8	150	100	Early	St20	3225	ECDB
20	150	100	Early	SwC	3174	ECDBF
14	150	20	Early	St10	3163	ECDF
7	150	100	Late	St20	3138	EDGF
10	50	20	Early	St10	3122	EDGF
3	50	100	Late	St20	2970	EHGF
9	50	20	Late	St10	2962	EHGF
4	50	100	Early	St20	2953	EHGF
13	150	20	Late	St10	2947	IHGF
17	50	20	Late	Sw50	2884	IHJG
6	150	20	Early	St20	2738	IHJK
5	150	20	Late	St20	2683	IJK
19	50	20	Late	SwC	2665	JK
1	50	20	Late	St20	2540	K
2	50	20	Early	St20	2522	K

Table 4. Mean yield for each treatment at Vegreville in 2005. Data are ordered by yield.

Treatment	Seed Rate	Fertility	Weed Removal	Harvest	Yield	Group
10	50	20	Early	St10	3590	A
14	150	20	Early	St10	3454	A
16	150	100	Early	St10	3450	A
13	150	20	Late	St10	3431	A
4	50	100	Early	St20	3415	A
15	150	100	Late	St10	3380	BA
18	150	100	Early	Sw50	3247[1]	
12	50	100	Early	St10	3240	BA
8	150	100	Early	St20	3225	BA
9	50	20	Late	St10	3172	BA
3	50	100	Late	St20	3169	BA
17	50	20	Late	Sw50	3163[1]	
11	50	100	Late	St10	3136	BAC
7	150	100	Late	St20	3099	BAC
6	150	20	Early	St20	3052	BAC
1	50	20	Late	St20	3051	BAC
2	50	20	Early	St20	2785	BDC
20	150	100	Early	SwC	2700[1]	
5	150	20	Late	St20	2584	DC
19	50	20	Late	SwC	2488[1]	

1. Estimated swath losses of 33% due to equipment failure

Table 5. Mean yield for each treatment at Scott in 2006. Data are ordered by yield, descending.

Treatment	Seed Rate	Fertility	Weed Removal	Harvest	Yield	Group
16	150	100	Early	St10	1676	A
20	150	100	Early	SwC	1648	A
8	150	100	Early	St20	1620	A
14	150	20	Early	St10	1582	A
18	150	100	Early	Sw50	1560	A
4	50	100	Early	St20	1553	A
12	50	100	Early	St10	1517	A
7	150	100	Late	St20	1509	BA
6	150	20	Early	St20	1484	BAC
15	150	100	Late	St10	1395	BAC
10	50	20	Early	St10	1152	BDC
11	50	100	Late	St10	1112	DC
13	150	20	Late	St10	1098	DC
2	50	20	Early	St20	1094	DC
5	150	20	Late	St20	1084	DC
3	50	100	Late	St20	1033	D
17	50	20	Late	Sw50	694	E
19	50	20	Late	SwC	653	E
1	50	20	Late	St20	640	E
9	50	20	Late	St10	623	E

Table 6. Percent Shatter and Combine losses at each location. See Table 5 for treatment information.

Treatment	Lacombe 05		Lacombe 06		Vegreville 05		Scott 06	
	Shatter	Combine	Shatter	Combine	Shatter	Combine	Shatter	Combine
1	0.3	16.0	2.0	7.4	1.0	29.6	1.0	1.5
2	0.6	6.5	4.0	5.8	0.3	23.4	1.6	2.8
3	0.3	4.5	1.8	6.3	0.5	26.0	1.6	1.3
4	0.3	3.2	1.9	5.0	0.4	19.3	2.8	3.1
5	0.9	3.5	4.2	4.6	1.4	26.4	1.8	2.0
6	0.7	5.4	4.9	5.5	2.3	20.9	2.4	4.1
7	0.2	2.9	3.6	5.8	0.3	24.5	2.0	2.9
8	0.2	3.9	4.2	6.7	1.6	19.0	3.6	4.4
9	1.2	4.8	3.4	8.1	1.4	14.7	1.7	3.4
10	1.1	4.7	3.6	6.9	2.3	18.5	2.6	5.9
11	1.1	4.6	4.6	7.3	3.8	17.9	2.3	4.3
12	1.0	5.0	2.9	7.1	2.4	17.8	3.5	6.9
13	1.0	4.3	4.7	6.2	2.7	16.6	2.9	6.4
14	1.6	6.0	6.3	6.3	4.7	23.5	3.5	8.5
15	1.8	4.3	6.2	6.9	3.0	13.4	3.5	8.5
16	1.2	4.3	4.1	7.3	3.7	40.8	4.5	8.4
17	-	-	-	2.6	0.1	3.0	4.1	0.2
18	-	-	-	3.1	0.0	3.5	-	11.1
19	1.5	19.3	1.6	2.8	2.9	27.5	2.2	5.3
20	2.0	29.3	2.7	3.1	2.8	20.2	5.8	12.0
Mean	0.9	7.3	3.7	5.7	1.9	20.3	2.8	5.2

Conclusions

Different components of potential yield were important in determining yield and seed losses before and during harvest operations. In Lacombe, fertility has been the most important factor. In Vegreville, timing of weed removal was paramount in 2006. At Scott in 2006, it appears that all operations must be conducted under best management practices or there is a substantially increased probability of reduced yield when straight-cutting. These results generally fit the hypothesis that ability to straight-cut is dependant upon maximizing potential yield. Under higher-yielding conditions (i.e. Lacombe and Vegreville), a key factor has led to success at straight-cutting. Under low-yielding conditions (i.e. Scott), all factors contributing to increased potential yield must be used to ensure feasibility of straight-cutting.