Increasing Yield and Profit by Straight-cutting Canola.

Paul R. Watson[1], Stewart A. Brandt[2], George W. Clayton[3], & K. Neil Harker[3]

[1]Alberta Research Council: Bag 4000, Vegreville, AB, T0B 2S0
[2]Agriculture and Agri-Food Canada: Saskatoon Research Centre, P.O. Box 10, Scott, SK, S0K 4A0
[3]Agriculture and Agri-Food Canada: Lacombe Research Centre, 6000 C & E Trail, Lacombe, AB, T4L 1W1

Key Words: canola, straight-cut, straight combining.

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. Overall, factors causing shatter loss and crop yield differed between locations. Not surprisingly, crop density was affected by Target Crop Density and percent green seed was affected by Harvest Timing.

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.

Consequently, this research was undertaken to determine if straight combining shatter losses would be reduced sufficiently with higher yield potential to make straight combining viable in western Canada.

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, Table 2) 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

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.

Table 2. List of treatments used in the CHMS.

1. CDL + FL + WRL + HTE	9. CDL + FL + WRL + HTL
2. CDL + FL + WRE + HTE	10. CDL + FL + WRE + HTL
3. CDL + FH + WRL + HTE	11. CDL + FH + WRL + HTL
4. CDL + FH + WRE + HTE	12. CDL + FH + WRE + HTL
5. CDH + FL + WRL + HTE	13. CDH + FL + WRL + HTL
6. CDH + FL + WRE + HTE	14. CDH + FL + WRE + HTL
7. CDH + FH + WRL + HTE	15. CDH + FH + WRL + HTL
8. CDH + FH + WRE + HTE	16. CDH + FH + WRE + HTL
Checks	
17. CDL + FL + WRL - swath at 50% color change.	19. SRL + FL + WRL - swath ahead of combine.
18. CDH + FH + WRE - swath at 50% color change	20. SRH + FH + WRE - swath ahead of combine.

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

Plant densities, for both canola and tame oat, were determined by two randomly chosen, 0.5 m^2 quadrates per plot. Canopy interlock was evaluated using light attenuation readings, two per plot, were conducted using a LI-COR Photometer with a line quantum sensor.

Canola seed loss, occurring during pre- and post-harvest operations, 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. Trays were replaced into the plots to collect seed loss occurring from swathing or combining operations. The exception to this procedure occurred in plots that were designated for swathing, curing and combining, where the trays were not placed back into the plot prior to picking up the swath with the combine. The seed collected from this operation can only be attributed to loss occurring during swathing, i.e. cutter bar, movement of the plants on the table and laying in a swath prior to being picked up by the combine and not ejection loss.

Seed was hand-collected from the main stem from randomly sampled canola plants, where applicable, in order to determine the targeted swathing stage of 50 – 60% seed colour change.

Pods were partitioned into top, middle and bottom pods, split open, seeds removed and colour categorized as being either turned or unturned. An average of 68% seed colour change was determined for plots that required swathing.

Seed was hand-collected from the main stem of ten randomly sampled canola plants per plot and where applicable, weighed, oven-dried and re-weighed to determine seed moisture immediately prior to combining according to Canadian Grain Commission procedures. The percentage of green seed per plot was determined using the crush roller method. Three sub-samples were taken from each plot and averaged.

Data Analysis

All 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

Crop density differed among treatments ($p < 0.0001$) at both Lacombe and Vegreville. Within locations, crop density did not differ for the low-density treatment, but did for the high-density treatment (Table 3). Contrasts by treatment factors indicated that crop density differed only by the Target Crop Density factor ($p < 0.0001$).

Table 3. Mean crop density for each treatment (Trt) at the Lacombe and Vegreville locations.

Trt	Target Crop Density	Fertility	Weed Removal Timing	Harvest Timing	Lacombe	Vegreville
1	Low	Low	Late	20	44.5	52.0
2	Low	Low	Early	20	43.5	50.0
3	Low	High	Late	20	57.3	54.8
4	Low	High	Early	20	40.8	53.8
9	Low	Low	Late	10	41.8	50.8
10	Low	Low	Early	10	51.5	56.8
11	Low	High	Late	10	49.0	61.0
12	Low	High	Early	10	50.3	54.5
17	Low	Low	Late	S[1]	50.8	50.5
19	Low	Low	Late	Sc[2]	49.5	52.8
5	High	Low	Late	20	112.3	119.0
6	High	Low	Early	20	102.3	118.0
7	High	High	Late	20	95.0	106.5
8	High	High	Early	20	95.3	103.5
13	High	Low	Late	10	96.0	117.8
14	High	Low	Early	10	100.0	113.3
15	High	High	Late	10	93.8	109.5
16	High	High	Early	10	105.5	109.5
18	High	High	Early	S	102.8	94.8
20	High	High	Early	Sc	85.8	98.0
LSD					**20.3**	**14.9**

1 Check: swath at 50-60% colour change
2 Check: swath immediately before combining

Percent light interception differed among treatments (p <0.0001) at both Lacombe and Vegreville (data not shown). Contrasts by treatment factors indicated that percent light interception differed only for the Fertility factor at the Lacombe site.

Shatter loss differed among treatments (p <0.0001) at both Lacombe and Vegreville. Contrasts by treatment factors (Table 4) indicated that shatter loss differed consistently by Harvest Timing, but other factors were location-specific.

Table 4. Contrast means and p-values for treatment factor comparisons of shatter loss (kg/ha).

Treatment Factor	Lacombe			Vegreville		
	Low/Late	High/Early	*p*	Low/Late	High/Early	*p*
Target Crop Density[1]	27	38	ns	59	89	0.0006
Fertility[1]	26	38	ns	76	72	ns
Weed Removal Timing[2]	32	33	ns	65	84	0.0355
Harvest Timing[2]	14	44	<0.0001	39	129	<0.0001

1 Crop Density and Fertility: L=Low, H=High
2 Weed Removal and Harvest: L=Late, E = Early

Ejection loss differed among treatments (p <0.0001) at both Lacombe and Vegreville. Contrasts by treatment factors (Table 5) indicated that ejection loss differed by Target Crop Density and Fertility at the Lacombe site only.

Table 5. Contrast means and p-values for treatment factor comparisons of ejection loss (kg/ha).

Treatment Factor	Lacombe			Vegreville		
	Low/Late	High/Early	*p*	Low/Late	High/Early	*p*
Target Crop Density[1]	223	233	0.0290	799	828	ns
Fertility[1]	198	259	0.0058	825	802	ns
Weed Removal Timing[2]	210	245	ns	789	838	ns
Harvest Timing[2]	177	163.5	ns	974	880	ns

1 Crop Density and Fertility: L=Low, H=High
2 Weed Removal and Harvest: L=Late, E = Early

Crop yield differed among treatments (p <0.0001) at both Lacombe and Vegreville (Table 6). Contrasts by treatment factors (Table 7) indicated that crop yield differed by Target Crop Density, Fertility and Weed Removal timing at Lacombe, and by Harvest Timing at Vegreville. The predominant factor differentiating crop yield was Fertility at Lacombe and Harvest Timing at Vegreville. Treatment factors had less influence on yield at Vegreville than Lacombe (Figure 1) and yield was, therefore, more homogeneous. At Vegreville, all treatments yielded better than the check (Figure 1).

Table 6. Mean crop yield (kg/ha) each treatment (Trt) at the Lacombe and Vegreville locations.

Trt	Target Crop Density	Fertility	Weed Removal Timing	Harvest Timing	Lacombe	Vegreville
1	Low	Low	Late	20	1640	3051
2	Low	Low	Early	20	2809	2785
3	Low	High	Late	20	4155	3169
4	Low	High	Early	20	4378	3415
5	High	Low	Late	20	2946	2584
6	High	Low	Early	20	2698	3052
7	High	High	Late	20	4402	3099
8	High	High	Early	20	4539	3225
9	Low	Low	Late	10	2238	3172
10	Low	Low	Early	10	2338	3590
11	Low	High	Late	10	4040	3136
12	Low	High	Early	10	4123	3240
13	High	Low	Late	10	2494	3431
14	High	Low	Early	10	2413	3454
15	High	High	Late	10	4243	3380
16	High	High	Early	10	4182	3450
17	Low	Low	Late	S[1]	2803	2378
18	High	High	Early	S	4167	2441
19	Low	Low	Late	Sc[2]	2411	1871
20	High	High	Early	Sc	3436	2030
LSD					**345**	**563**

Table 7. Contrast means and p-values for treatment factor comparisons of crop yield (kg/ha).

Treatment Factor	**Lacombe**			**Vegreville**		
	Low/Late	High/Early	*p*	Low/Late	High/Early	*p*
Target Crop Density[1]	3093	3583	<0.0001	2981	3003	ns
Fertility[1]	2478	4185	<0.0001	2937	3048	ns
Weed Removal Timing[2]	3154	3510	0.0019	2927	3058	ns
Harvest Timing[2]	3446	3284	ns	3047	3354	0.0045

1 Crop Density and Fertility: L=Low, H=High
2 Weed Removal and Harvest: L=Late, E = Early

Percent green seed differed among treatments at both Lacombe ($p = 0.0002$) and Vegreville ($p<0.0001$) locations (Table 12). Contrasts by treatment factors (Table 13) indicated that percent green seed differed by Harvest Timing at both locations (Table 13). Other factors varied by location.

Table 13. Contrast means and p-values for treatment factor comparisons of percent green seed (kg/ha).

Treatment Factor	Lacombe			Vegreville		
	Low/Late	High/Early	*p*	Low/Late	High/Early	*P*
Target Crop Density[1]	0.6	0.2	0.0008	3.6	3.6	Ns
Fertility[1]	0.3	0.5	ns	3	4.2	0.0043
Weed Removal Timing[2]	0.4	0.3	ns	3.8	3.4	0.0106
Harvest Timing[2]	0.8	0.1	<0.0001	4.8	2.5	<0.0001

1 Crop Density and Fertility: L=Low, H=High
2 Weed Removal and Harvest: L=Late, E = Early

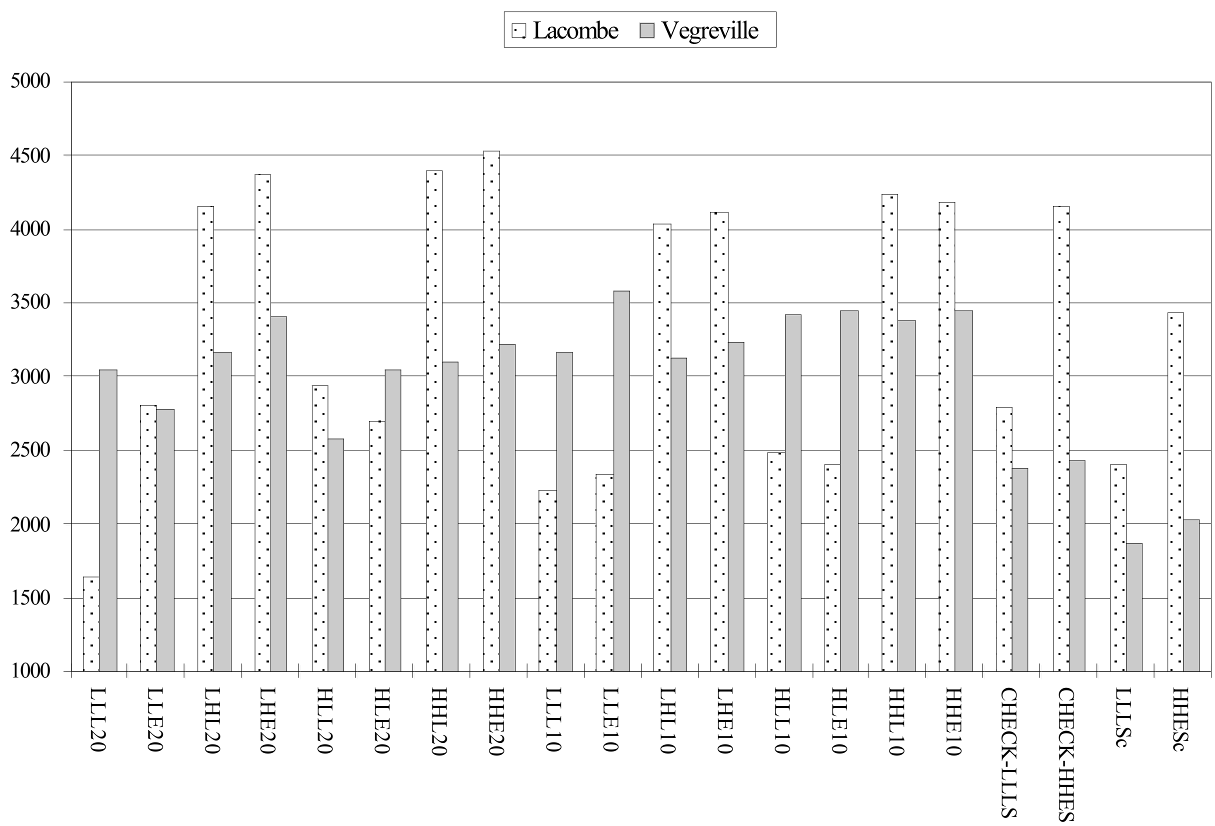

Figure 1. Crop yields at Lacombe and Vegreville. Codes (see also Table 1) are given as Density, Fertility Weed Removal timing and Harvest Timing. Swathed checks for comparison are indicated (LLES and HHES).

Conclusions

Factors causing shatter loss and crop yield differed between locations. In Lacombe, fertility had the largest effect on yield, whereas harvest time had the largest in Vegreville. Notwithstanding, these results suggest straight-combining using standard harvest equipment may be economically feasible.