Integrating drift reduction technologies with agronomic practices
CARP SCDC Project 11/05-03
Final Report

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Executive Summary

The project had two main objectives:

1) to determine if good crop management could overcome any reductions in weed control from using coarse spray quality;
2) to determine if twin nozzle configuration improve the efficacy of contact herbicides, compared to a single nozzle configuration.

A two-year study addressed the first objective. The study investigated the interaction of crop inputs (one that targeted high yields vs one that targeted low yields) with carrier volume, spray quality, and herbicide rate. The herbicide under investigation was Liberty, a contact herbicide sensitive to application parameters. The study showed that targeting high yields with inputs such as superior genetics, fertilizer, and optimum plant density had more of an effect on weed biomass and crop yield then herbicide application parameters. Applying Liberty at 0.5 rate in a full input system (one that targeted high yields) resulted in similar wild oat biomass as applying Liberty at 1.0 X in an empty input system (one that targeted low yields). There appeared to be some benefit to using a lower carrier volume when herbicide rate was reduced; however, this did not result in similar levels of weed contol or canola yield as applying herbicide at full rate with higher carrier volumes (recommended practice). In order to optimize canola yield, growers should manage their crop with a combination of good genetics, proper soil fertility, and optimum plant densities. Applying Liberty at recommended rates in fine to coarse spray qualities at carrier volumes of 85 l/ha or higher will protect canola yield and reduce weed interference. A very coarse spray quality should not be used with Liberty.

Five different field studies were conducted to determine if twin nozzle configuration improved the weed control efficacy of contact herbicides. There were no conclusive benefits to using a twin nozzle configuration over a single nozzle configuration in terms of improving the efficacy of contact herbicides such as Liberty.

STUDY 1

Effect of input level, herbicide rate, carrier volume and spray quality on wild oat interference and yield of Liberty Link canola.

Background

As farm size increases, there is more and more pressure to get spraying done quickly and efficiently. The prairie climate is not conducive to spraying with many days being too windy to apply herbicides without drift concerns. Low-drift nozzles that produce a coarser spray quality have become very popular; however, efficacy of some herbicides can be reduced with very coarse spray qualities. Contact herbicides, in particular, appear to be more sensitive to very coarse droplets than systemic herbicides or herbicides that have soil activity.

Integrated weed management studies have demonstrated the importance of crop health in competing with weeds. It is hypothesized that good crop management could overcome any deficiencies from using coarser sprays.

This study investigates the impact of herbicide rate, water volume, and spray quality on the control of wild oats in canola in both a full input and an empty input management system.

Materials and Methods

The study is a complex 4-factor study that was conducted at Scott in 2007 and 2008. Two input levels, a full input and empty input system are seeded in a split-block design. The full input environment is defined as a competitive hybrid variety (9590LL) of canola seeded at the recommended seeding rate (150 seeds m^{-2}) with fertility applied according to a 35 bushel $acre^{-1}$ target yield. The empty input environment is defined as an open pollinated variety (74P00LL), seeded at half the recommended rate (75 seeds m^{-2}) and half the fertilizer recommended for the target yield. Within the main plots, Liberty herbicide was applied at 1.0X and 0.5X rate in 3 different carrier volumes (125, 85 and 45 l/ha) and 3 different spray qualities (medium, coarse, very coarse) using a Randomized Complete Block Design. An untreated check was also included. Wild oat was seeded into the plots at a density of 100 seeds m^{-2} prior to crop seeding. The 1.0 X rate of Liberty herbicide used in this experiment was 1.1 liter $acre^{-1}$ (400 g ai ha^{-1}).

Wild oat biomass data, canola yield, and dockage data is presented in this report. Data was combined over the two years (2007-08).

Results and Discussions

The complexity of this experiment makes it challenging to analyze. There are eleven possible interactions. Fortunately, there are only a few interactions that are significant and consistent over all the variables measured. The main effects of input level, herbicide rate, spray quality and carrier volume had an effect on wild oat biomass (Table 1). Input level, herbicide rate, and spray quality had an effect on canola yield and percent dockage (Table 1). There was a significant input X rate X carrier volume effect for both wild oat biomass and percent dockage. The rate X carrier volume interaction was significant for both crop yield and dockage. The discussion will focus on these interactions since they were significant for more than one of the variables measured.

Table 1: Analysis of variance table.

	Wild oat biomass g m^{-2}	Canola Yield	Percent dockage
Input Level (I)	**<.0001**	**<.0001**	**<.0001**
Rate (R)	**<.0001**	**0.00**	**<.0001**
Spray Quality (S)	**0.01**	**0.07**	**0.00**
Carrier Volume (C)	**0.08**	0.40	0.58
I X R	0.71	0.81	0.16
I X S	0.34	0.87	0.86
I X C	0.37	0.86	0.89
R X S	0.36	0.39	0.17
R X C	0.49	**0.00**	**0.02**
S X C	0.18	0.44	**0.07**
I X R X S	0.70	0.91	0.95
I X R X C	**0.07**	0.63	**0.03**

I X S X C	0.82	0.92	0.34
R X S X C	**0.01**	0.37	0.19
I X R X S X C	0.32	0.96	0.82

Wild oat biomass

Overall, there was 48% less wild oat biomass in the full input system (511 g m^{-2}) compared to the empty input system (978 g m^{-2}). Cutting the Liberty rate in half resulted in a 32% increase in wild oat biomass, which was relatively consistent between the two input levels (Figure 1); however, the 0.5 X rate of the full input system had similar wild oat biomass to the 1.0X rate of the empty input system. Highest wild oat biomass was recorded with the very coarse spray quality (803 g m^{-2}) compared to the coarse (731 g m^{-2}) and medium (672 g m^{-2}) spray qualities, which were statistically similar. The input by rate by carrier volume interaction indicates that carrier volume had limited or no effect at both rates of the full input system and the 1.0 X rate of the empty input system. At the 0.5 X rate of the empty input, wild oat biomass increased as carrier volume increased. This was not expected, since generally a contact herbicide generally responds negatively to higher carrier volumes. This interaction will be discussed further later.

Canola Yield

The full input system resulted in 48% higher canola yields than the empty input system (mean yields of 1442 and 975 kg ha^{-1}), respectively. Cutting the rate by 0.5X resulted in an overall 10% decrease in canola yield. A very coarse spray quality resulted in 6% lower canola yield than the medium or coarse spray qualities (data not shown). The rate by carrier volume interaction indicates that at the 1.0X rate, yields declined as carrier volume decreased; however, the opposite occurred at the 0.5X rate (Figure 2). Although this was not expected, this type of interaction has been seen in a different unpublished study involving a Group 1 graminicide (Wolf and Johnson). Even though lower carrier volumes increased yields at the 0.5X rate, the yields were still lower than the 1.0X rate at the high carrier volumes.

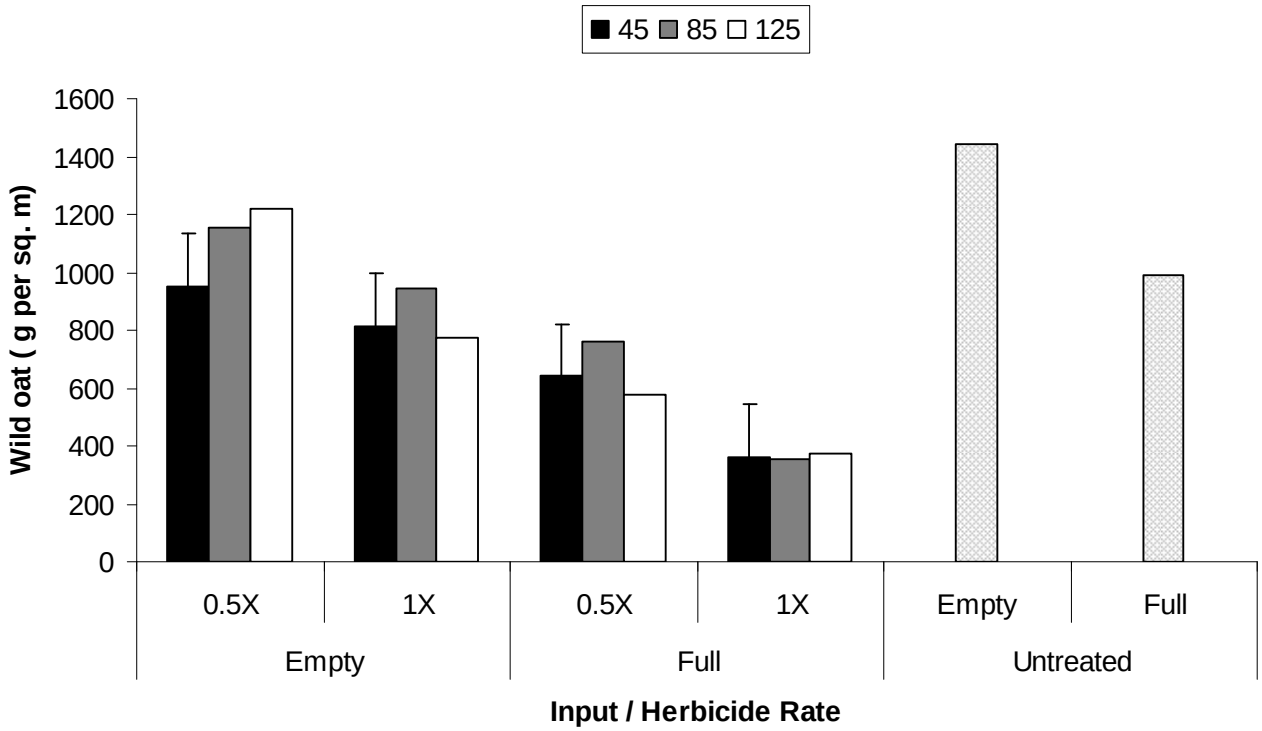

Figure 1: The interaction effects of input level, herbicide rate and carrier volume on wild oat biomass in canola. The error bars represent the $LSD_{0.10}$ for the interaction. Scott 2007-08.

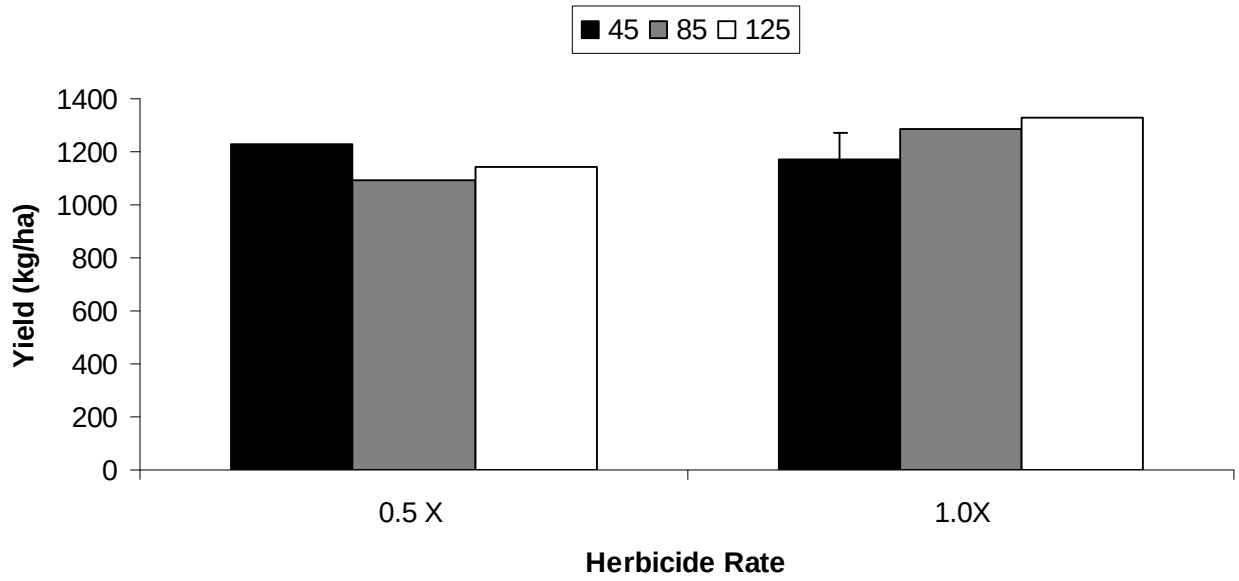

Figure 2: The interaction effects of herbicide rate and carrier volume on canola yield. The error bars represent the $LSD_{0.05}$ for the interaction. Scott 2007-08

Dockage

The results for dockage were very similar to the wild oat biomass data. There was 48% less dockage in the full input system compared to the empty input system (data not shown). Cutting the herbicide rate in half resulted in a 33% increase in dockage. The dockage in the very coarse spray quality treatments was 10 to 14% higher than the coarse and medium spray quality treatments. As was the case with wild oat biomass, the input level by rate by carrier volume interaction was significant (Figure 3). In the full input system, carrier volume had no effect on the percent dockage at both the 0.5 and 1.0 X rates. At the 1.0X rate in the empty input system, there was a reduction in dockage as carrier volume increased but the opposite occurred at the 0.5X rate.

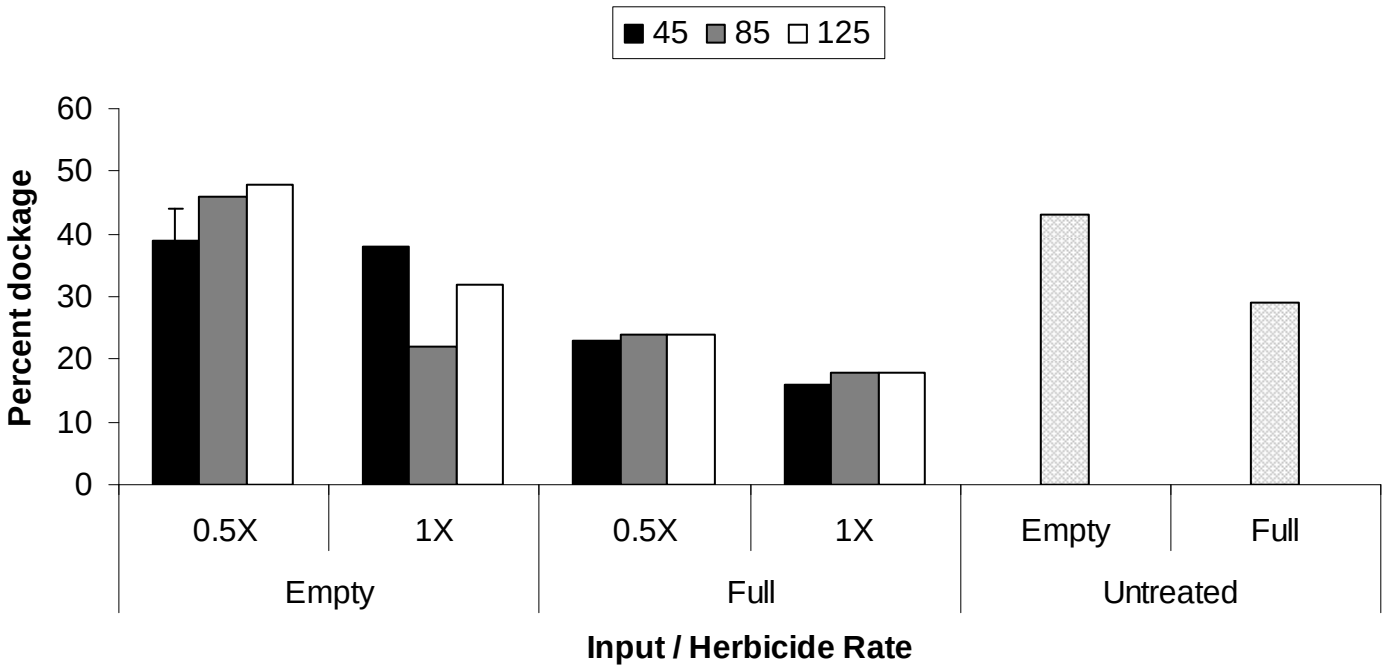

Figure3: The interaction effects of input level, herbicide rate and carrier volume on percent dockage in canola. The error bars represent the $LSD_{0.05}$ for the interaction. Scott 2007-08.

The input level had more effect on wild oat biomass, canola yield or dockage than did herbicide rates, spray qualities, or carrier volumes (Table 2). The effect of carrier volume on wild oat biomass and dockage varied with input system and herbicide rate; however, the magnitude of the differences was in the range of 20 to 30% and the effect was only evident in the empty input systems. Carrier volume effect on canola yield varied with rate with about a 12% magnitude in yield improvement for the optimum treatments.

Table 2: Relative effect of input level, herbicide rate, spray quality, and carrier volume on wild oat biomass, canola yield and percent dockage. Scott 2007-08.

	Wild oat biomass	Canola Yield	Percent dockage
Input level (full vs empty)	48%↓	48%↑	48%↓
Rate (1.0X vs 0.5X)	33%↓	10%↑	33%↓
Spray Quality (Medium or Coarse vs Very Coarse)	20%↓	6%↑	10–14%↓
Carrier Volume	20%↓*	12%↑**	20–30%↓*

* Impact of carrier volume varied with input level and rate

** Impact of carrier volume varied with rate

Conclusions

Producers should concentrate on using superior genetics, obtaining an adequate plant density, and applying proper nutrition when it comes to canola production. In all variables measured, a coarse spray quality was similar to the medium spray quality with performance declining with a very coarse spray quality. Therefore, growers can confidently use of a coarse spray quality without sacrificing efficacy or yield. The results from the limited site-years of this study indicate that using high carrier volumes at lower rates and reduced inputs may result in higher wild oat biomass and percent dockage. From a yield standpoint, there was a slight benefit to using lower water volumes when the rate was reduced across both input levels. Producers should not take this as a recommendation. The take-home message is that growers can not compensate for lower rates by increasing the amount of coverage (using higher carrier volumes).

STUDIES INVESTIGATING THE IMPACT OF TWIN NOZZLE CONFIGURATION ON EFFICACY OF CONTACT HERBICIDES

Hypothesis: Contact herbicide efficacy will be improved by superior coverage of a twin nozzle. A coarse spray applied in a twin configuration will provide similar weed control results as a single nozzle with fine spray quality.

Effect of boom height and nozzle configuration on control of hard-to-wet weeds with Liberty herbicide

Background

It is well known that a contact herbicide such as Liberty is less effective on hard-to-wet weeds such as wild oat or cleavers. Wild oat control can be improved by tank-mixing with a Group 1 graminicide; however, there are no tank-mixes that will improve control of cleavers. At the 2006 ACPC meeting, producers identified the need to improve cleavers control in Liberty Link canola.

Objective

The objective of this probe experiment was to determine if nozzle configuration and boom height have an effect on wild oat and cleavers control in Liberty Link canola.

Materials and Methods

The experiment was conducted at the Scott Research Farm in 2008. Liberty Link canola (*cv* 9590LL) was seeded in an area with inherent populations of wild oat and cleavers at a rate of 6 kg ha^{-1}. Liberty herbicide was applied in a factorial combination of 2 rates (1.3 and 0.65 liters $acre^{-1}$), 4 nozzle configurations (single fine, twin fine, single coarse, and twin coarse), and 2 boom heights (75 and 38 cm). The boom heights were set relative to the top of the target weeds. Liberty was applied slightly late (4-5 leaf stage of canola) to ensure that some treatments would fail. An untreated check was also included. The treatments are listed in Table 3.

Table 3: Treatments in boom height by nozzle configuration study

Treatment	Description	Nozzle	Height	Rate	Volume
1	Single fine	XR11002	76	1 x	100
2	Single coarse	AM11002	76	1 x	100
3	Twin fine	XR11001	76	1 x	100
4	Twin coarse	AM11001	76	1 x	100
5	Single fine	XR11002	38	1 x	100
6	Single coarse	AM11002	38	1 x	100
7	Twin fine	XR11001	38	1 x	100
8	Twin coarse	AM11001	38	1 x	100
9	Single fine	XR11002	76	0.5 x	100
10	Single coarse	AM11002	76	0.5 x	100
11	Twin fine	XR11001	76	0.5 x	100
12	Twin coarse	AM11001	76	0.5 x	100
13	Single fine	XR11002	38	0.5 x	100
14	Single coarse	AM11002	38	0.5 x	100
15	Twin fine	XR11001	38	0.5 x	100
16	Twin coarse	AM11001	38	0.5 x	100
17	Control				

Data collection included visual control ratings and crop yield.

Results

The herbicide failed at the 0.5X rate (0.66 liter acre^{-1}) so only 1.0X rate data is presented. Ratings for cleavers control at both rating dates indicate an improvement in control with both the twin fine and twin coarse nozzles when set at a boom height of 38 cm (Table 4). Control was generally not improved with a single nozzle if boom height was reduced from 75 to 38 cm. The twin nozzles at 38 cm were similar in control to the single fine nozzle at 75cm at the Aug. 11 rating date; however, the use of a lower boom height and/or coarser spray qualities reduces the potential for spray drift.

At the first rating date, highest wild oat control was achieved with the single fine nozzle at 75 cm (Table 5). At the second rating date the twin fine nozzle at the 38 cm height resulted in similar control levels as the single fine nozzle at 75 cm. Wild oat control improved with the twin coarse nozzle when boom height was dropped from 75 cm to 38 cm.

The trends in crop yield tend to validate the control ratings (Figure 4). Yields dropped slightly with the single nozzle configuration when boom height was reduced from 75 to 38 cm. The opposite occurred with the twin nozzles although the effect was not as pronounced with the twin coarse nozzle.

Table 4: Effect of nozzle configuration and boom height on visual control of cleavers with Liberty herbicide. Scott 2008.

	July 3 Rating		August 11 Rating	
	---------- Boom Height----------			
	75 cm	38 cm	75 cm	38 cm
Nozzle Configuration	---------- % Control----------			
Single Fine	58	65	76	48
Single Coarse	58	40	54	50
Twin Fine	48	68	48	74
Twin Coarse	48	65	21	73

Table 5: Effect of nozzle configuration and boom height on visual control of wild oat with Liberty herbicide. Scott 2008.

	July 3 Rating		August 11 Rating	
	---------- Boom Height----------			
	75 cm	38 cm	75 cm	38 cm
Nozzle Configuration	---------- % Control----------			
Single Fine	80	71	73	43
Single Coarse	69	55	54	75
Twin Fine	63	69	60	75
Twin Coarse	63	63	43	64

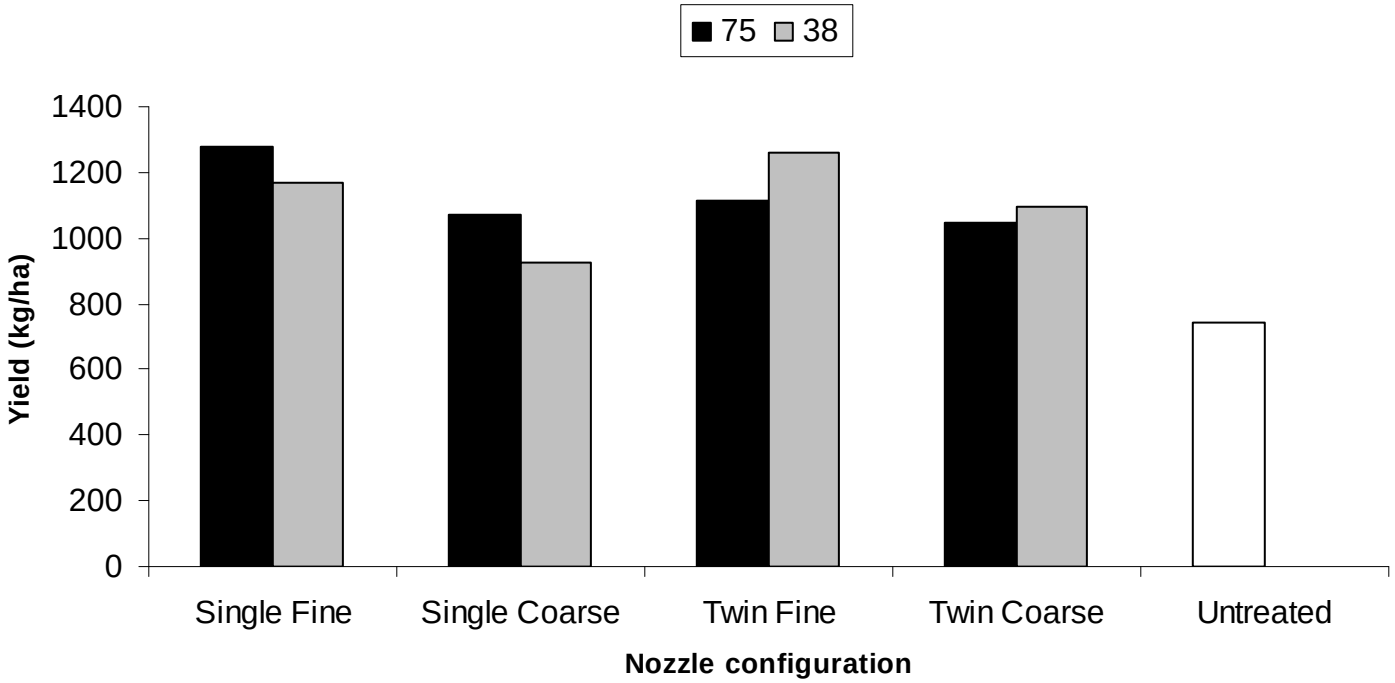

Figure 4: Effect of nozzle configuration and boom height on yield of Liberty Link canola. Liberty applied at 1.3 l acre^{-1}. Scott 2008.

Conclusions

The 2008 study provided some indication that cleavers control may be improved (or at least equal to a standard fine spray quality) with a twin nozzle configuration set at a lower boom height; however, the test was repeated in 2009 and there was no improvement in cleavers control with twin nozzles or lowering boom height. Therefore, it appears that there are limited opportunities to improve cleavers control with Liberty by manipulating application parameters.

Efficacy of Glufosinate (Liberty) in LL canola with Double Nozzles 2006
Locations: Scott

Objective: To determine if double nozzles improve glufosinate activity on hard to kill weeds

Methods and Materials:

The following nozzles were evaluated for control of wild oat, wild mustard, cleavers and kochia in Liberty Link 5020 hybrid canola:

Treatment	Description	Nozzle
1	Untreated	Untreated
2	Single conventional nozzle, vertical	Albux AXI 11003
3	Single pre-orifice nozzle, vertical	Albuz ADI 11003
4	Single air-induced nozzle, vertical	Albuz AVI 11003
5	Double conventional nozzle	TwinJet 8003
6	Double pre-orifice nozzle 1, 60º	DG TwinJet 11003
7	Double pre-orifice nozzle 2, 120º	Turbo TeeJet Duo, 2 x 110015
8	Double air-induced nozzle 1	Albuz AVI Twin 11003
9	Double air-induced nozzle 2	TwinCap with Hypro ULD, 2 x 110015

Liberty was applied at 1.1 L/acre when the canola was in the 2 to 3 leaf stage.

Conclusions:
Results are tabulated in Table 1. All nozzles resulted in greater than 90% control of the weeds present. There was no clear advantage to the double nozzle in this study. Yields of canola were not affected by the nozzle type.

Table 1: Effect of single and double nozzles on control of weeds in Liberty Link canola. Scott. 2006.

Pest Code			Wild Oat		Wild Mustard		Cleavers		Kochia		Wild Oat		Wild Mustard		Cleavers		Kochia		Wild Buckwheat		Canola	
Crop Code																						
Rating Date			2006-06-29		2006-06-29		2006-06-29		2006-06-29		2006-07-21		2006-07-21		2006-07-21		2006-07-21		2006-07-21			
Rating Data Type			CONTROL		CONTROL		CONTROL		CONTROL		CONTROL		CONTROL		CONTROL		CONTROL		CONTROL		YIELD	
Rating Unit			%		%		%		%		%		%		%		%		%		kg/ha	
Trt No.	Treatment Name	Growth Stage	1		2		3		4		5		6		7		8		9		10	
1	UNTREATED		0	b	0	b	0	c	0	c	0	c	0	b	0	b	0	b	0	c	810	a
2	Albux AXI 11003	2-3 LEAF	98	a	98.5	a	98.5	a	98.5	a	99	a	99	a	100	a	100	a	98	ab	880	a
3	Albuz ADI 11003	2-3 LEAF	96	a	97.5	a	97.5	ab	97.5	ab	98	ab	99	a	99.5	a	99	a	100	a	1040	a
4	Albuz AVI 11003	2-3 LEAF	96.5	a	98	a	97	ab	98	ab	97.5	ab	99.5	a	99	a	99.5	a	99	ab	920	a
5	TwinJet 8003	2-3 LEAF	97.5	a	98	a	98	a	98	ab	99.5	a	100	a	99	a	99.5	a	99	ab	960	a
6	DG TwinJet 11003	2-3 LEAF	98	a	98	a	97.5	ab	98	ab	98.5	ab	99.5	a	99	a	99	a	99.5	ab	990	a
7	Turbo TeeJet Duo, 2 x 110	2-3 LEAF	97.5	a	98	a	95.5	ab	96.5	ab	98	ab	99.5	a	99	a	97.5	a	98	ab	910	a
8	Albuz AVI Twin 11003	2-3 LEAF	98	a	98.5	a	98	a	98.5	a	98.5	ab	100	a	99.5	a	99	a	97.5	b	980	a
9	TwinCap with Hypro ULD, 2	2-3 LEAF	93.5	a	96.5	a	94.25	b	94.75	b	94.75	b	100	a	100	a	97.5	a	98.5	ab	1000	a
		LSD (P=.05)	4.641		2.247		3.403		3.335		3.922		1.183		1.782		2.536		2.189		265	
		CV	3.69		1.77		2.7		2.64		3.09		0.92		1.38		1.98		1.71		19.27	
		Grand Mean	86.11		87		86.25		86.64		87.08		88.5		88.33		87.89		87.72		94.28	
		Treatment Prob(F)	0.0001		0.0001		0.0001		0.0001		0.0001		0.0001		0.0001		0.0001		0.0001		0.7413	

Efficacy of Double Nozzles on Grassy Weed Control with Horizon
Locations: Scott

Objective: To determine whether double nozzles improve grassy weed control. Although Horizon is not a canola herbicide, it is a Group 1 herbicide with the same mode of action as canola herbicides such as Assure or Select.

Methods and Materials:
Horizon was applied to a stand of wild oat at both 1X and 0.5X rates with single and double nozzles of different spray quality.

Conclusions:
NDVI is a measurement of the Normalized Deviation Vegetation Index, which is related to plant biomass. It is measured with a Greenseeker. Generally, the higher the NDVI, the higher the plant biomass. In weed control trials like this, the lower the NDVI, the better the control. At 1X rates, all nozzles performed similar. However, at half rates there was little difference between fine single and fine twin nozzles, but there was a benefit from the twin coarse nozzle compared to the single coarse nozzle. At the 3rd rating date, the coarse single nozzle and the coarse twin nozzle resulted in 60% and 88% visual control, respectively at the half-rate. Similar trends were noted with NDVI readings and fresh weight measurements. This is one of the few studies conducted at either Scott or Saskatoon where the twin nozzle resulted in better efficacy than a single nozzle.

Table 1: Effect of single and double nozzles with different spray qualities on wild oat control with Horizon. Scott. 2006.

Pest Code	Wild Oat	Wild Oat	Wild Oat	Wild Oat	Wild Oat	Wild Oat	Wild Oat
Rating Date	2006-06-28	2006-07-07	2006-07-17	2006-06-27	2006-07-03	2006-07-17	2006-07-18
Rating Data Type	NDVI	NDVI	NDVI	CONTROL	CONTROL	CONTROL	Fresh Weight
Rating Unit				%	%	%	G/M2
Trt No. Treatment Name	1	2	3	4	5	6	7
1 FINE SINGLE XR8002 1 x RATE	0.187 b	0.213 cd	0.415 de	94.5 ab	93.25 a	90.5 a	1163 b
2 FINE SINGLE XR8002 0.5 x RATE	0.191 b	0.221 cd	0.482 b-e	88.75 bc	92 ab	89 ab	877 b
3 MEDIUM SINGLE LD11002 1 x RATE	0.203 b	0.248 bcd	0.513 b-e	93 ab	88.5 ab	77 ab	1339 b
4 MEDIUM SINGLE LD11002 0.5 x RATE	0.214 b	0.271 bc	0.544 bcd	85 cd	83.75 bc	77.5 ab	2476 ab
5 COARSE SINGLE ABJ02 1 x RATE	0.182 b	0.189 d	0.385 e	94 ab	95 a	91.5 a	794 b
6 COARSE SINGLE ABJ02 0.5 x RATE	0.211 b	0.312 b	0.609 b	81.75 d	79.25 c	60 c	4249 a
7 COARSE TWIN ABJ01 1 x RATE	0.19 b	0.21 cd	0.426 cde	96.5 a	92.25 a	85 ab	671 b
8 COARSE TWIN ABJ01 0.5 x RATE	0.216 b	0.263 bcd	0.56 bc	90.25 bc	88.25 ab	75.25 b	1669 b
9 FINE TWIN XR8001 1 x RATE	0.184 b	0.213 cd	0.422 cde	97.5 a	94.5 a	88 ab	990 b
10 FINE TWIN XR8001 0.5 x RATE	0.191 b	0.203 cd	0.416 de	96.5 a	93.5 a	90.5 a	630 b
11 UNTREATED	0.523 a	0.738 a	0.818 a	0 e	0 d	0 d	1900 b
LSD (P=.05)	0.0549	0.0798	0.1434	6.081	8.472	14.773	1931.6
CV	16.79	19.73	19.55	5.05	7.17	13.65	87.82
Grand Mean	0.23	0.28	0.51	83.43	81.84	74.93	1523.3
Treatment Prob(F)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.023

Means followed by same letter do not significantly differ (P=.05, LSD)

Eficacy of Glufosinate in LL canola with Double Nozzles 2007
Location: Scott

Objective: To determine if double nozzles improve glufosinate activity on hard to kill weeds

Methods and Materials:

The following nozzles were evaluated for control of broadleaf weeds in Liberty Link open pollinated canola:

Treatment	Description	Nozzle
1	Untreated	Untreated
2	Single conventional nozzle, vertical	Albux AXI 11003
3	Single pre-orifice nozzle, vertical	Albuz ADI 11003
4	Single air-induced nozzle, vertical	Albuz AVI 11003
5	Double conventional nozzle	TwinJet 8003
6	Double pre-orifice nozzle 1, 60º	DG TwinJet 11003
7	Double pre-orifice nozzle 2, 120º	Turbo TeeJet Duo, 2 x 110015
8	Double air-induced nozzle 1	Albuz AVI Twin 11003
9	Double air-induced nozzle 2	TwinCap with Hypro ULD, 2 x 110015

Liberty was applied at 1.1 L/acre when the canola was in the 2 to 3 leaf stage.

Conclusions: All nozzles resulted in excellent control of shepherd's purse, redroot pigweed, lambs quarters and wild buckwheat (Table 1). Weed densities were low to moderate and emerged after canola emergence. Therefore, there was no yield response from herbicide application. The yield of canola from the single air-induced nozzle was statistically lower than the double air induced nozzle, but it is felt that this may be an anomaly since weed control was similar with the single air-induced nozzle and the double air-induced nozzle.

Table 1: Effect of single and double nozzles on weed control in LL canola. Scott. 2007.

Pest Code		Shepherd's Purse	Redroot Pigweed	Lambs Quarters	Redroot Pigweed	Lambs Quarters	Wild Buckwheat	Canola
Crop Code								
Rating Date		2007-07-08	2007-07-08	2007-07-08	2007-07-31	2007-07-31	2007-07-31	2007-09-04
Rating Data Type		CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	CONTROL	kg/ha
Rating Unit		%UNCK	%UNCK	%UNCK	%UNCK	%UNCK	%UNCK	
Trt No.	Treatment Name / Growth Stage	1	2	3	4	5	6	7
1	UNTREATED	0 c	0 c	0 b	0 c	0 c	0 c	1140 ab
2	Albux AXI 11003 2-3 LEAF	98 ab	96.5 ab	100 a	98 a	100 a	99.33 a	1180 ab
3	Albuz ADI 11003 2-3 LEAF	98.5 a	99 a	100 a	99 a	99 a	96.67 ab	1150 ab
4	Albuz AVI 11003 2-3 LEAF	97 ab	97.5 ab	100 a	98 a	99 a	98.67 ab	1090 b
5	TwinJet 8003 2-3 LEAF	93 b	95 ab	100 a	98.5 a	99 a	99.33 a	1150 ab
6	DG TwinJet 11003 2-3 LEAF	98.5 a	97 ab	97 a	99 a	99 a	96.67 ab	1130 ab
7	Turbo TeeJet Duo, 2 x 110 2-3 LEAF	99 a	99 a	100 a	99 a	99 a	99.33 a	1190 ab
8	Albuz AVI Twin 11003 2-3 LEAF	99 a	97 ab	99 a	99 a	99 a	93.33 b	1260 a
9	TwinCap with Hypro ULD, 2 2-3 LEAF	99 a	93 b	100 a	93.5 b	97 b	96 ab	1190 ab
	LSD (P=.05)	5.158	5.595	3.625	2.996	1.438	5.865	133
	CV	4.07	4.46	1.73	2.36	0.71	3.91	7.86
	Grand Mean	86.89	86	88.44	87.11	87.89	86.59	116.31
	Treatment Prob(F)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.3971

Concluding Remarks on Twin Nozzles

The five studies conducted from 2006 to 2009 (2009 data is not presented) indicate no clear advantage to using a twin nozzle in terms of improving weed control efficacy with contact herbicides, compared to single nozzle configuration. Therefore, the hypothesis that a twin nozzle will provide superior efficacy with contact herbicides due to improved coverage is rejected.