2018 Annual Report for the Agriculture Demonstration of Practices and Technologies (ADOPT) Program

Project Title: Implementing herbicide layering techniques to improve weed control in peas

Project Number: 20170393

Producer Group Sponsoring the Project: Western Applied Research Corporation

Project Location(s):

- Scott Saskatchewan, R.M. #380 Legal land description: NE 17-39-20 W3

Project start and end dates (month & year): May 2018 and completed January 2019

Project contact person & contact details:

Jessica Weber (General Manager)

Western Applied Research Corporation

P.O. Box 89, Scott, SK S0K 4A0

Phone: 306- 247-2001

Email: jessica.weber@warc.ca

Objectives and Rationale

Project objectives:

The objective of this project was to provide producers with a demonstration of available weed control options in peas to promote the use of multiple modes of action herbicide strategies.

Project Rationale:

Research trials conducted at the University of Saskatchewan, led by Dr. Christian Willenborg, have studied the practice of herbicide layering. Herbicide layering utilizes two to three herbicides in sequence to control difficult weeds and to slow weed resistance. Herbicide tank mixtures and/or using multiple modes of action herbicides in sequence are now the recommended practices for delaying herbicide resistance. Dr. Christian Willenborg has determined several benefits associated with herbicide layering, particularly in peas (Top Crop Manager, 2017). U of S researchers are currently focusing on managing Group 2 resistant cleavers in field peas, noting that pre-emergent applications suppressed cleavers; however, treatments followed by post-emergent applications resulted in control up to 80%.

Methodology and Results

Methodology:

The demonstration was arranged as a randomized complete block design (RCBD) with four replicates and ten treatments at Scott, SK 2018 (Table 1). Treatment applications combined with glyphosate were made 3 to 5 days prior to seeding. Prior to seeding, soil samples were collected at three depth increments (0-15 cm, 15-30 cm and 30-60 cm) in order to determine fertilizer rate recommendations (Table A1). The following target weeds were cross seeded: cleavers (250 seeds m^2), kochia (200 seeds m^2) and stinkweed (100 seeds m^2). The trial was sown on canola stubble using an R-tech drill with 10-inch row spacing. Further details regarding treatment applications can be found in Appendix A1.

Table 1. Demonstration treatment list of PRE-seeding herbicides for field pea production

Trt#	PRE- Seed	Post- Emergence
1	None	Viper ADV
2	Valtera Roundup Weathermax	Viper ADV
3	Valtera Roundup Weathermax Edge	Viper ADV
4	Edge	Viper ADV
5	Heat WG Roundup Weathermax Edge	Viper ADV
6	Heat WG Roundup Weathermax	Viper ADV
7	Express SG *(WDG)* Roundup Weathermax	Viper ADV
8	Authority Roundup Weathermax	Viper ADV
9	Authority Charge Authority AIM Roundup Weathermax	Viper ADV
10	Goldwing Roundup Weathermax	Viper ADV

Data Collection:

Plant densities were determined by counting numbers of emerged plants on 2 x 1 meter row lengths per plot approximately two weeks after crop emergence. Weed control was rated on a scale of 0-100. 0 meaning the chemical had no effect on weed growth and development and 100 meaning complete control of the weeds. The visual weed control ratings were conducted approximately 7-14, 21-28 and 56 days after post application of the chemical based on the Canadian Weed Science Society ratings scale (0-100%). Emergence of the cross seeded target weeds of cleavers, stinkweed and kochia had poor emergence and variable distribution within the plots. Volunteer canola and wild oats were used as the target weeds, as distribution was more even across the study and was therefore used for visual assessments. Dockage was determined from calculating the difference between the un-cleaned grain and cleaned grain. Yields were determined from cleaned harvested grain samples and corrected to the required moisture content. Seed protein was also collected as an additional seed quality indicator. Weather data was collected and recorded from an on-site station provided by FarmersEdge®. Long-term weather data was collected from Environment Canada.

Growing Conditions:

The 2018 growing season started out moderately dry in April with only 8.5 mm of precipitation. May, June, and August were far below the long-term average, while July and August were above. Overall, when looking at the accumulated amount of precipitation in 2018 from April to October, there was 12.2 mm less than the long-term total. Throughout the growing season, May and September 2018 were both 5°C colder than the long-term average while May and June were 2-3°C warmer. The temperature was very similar to the long-term average in July and August. Growing degree days were higher than the long-term average for the months of April – June, and lower for the remaining months (Table 2). Two destructive environmental events occurred during the growing season: a wind storm of 157 km/hr gust on June 9th and a hail storm on July 21st.

Table 2. Mean monthly temperature, precipitation and growing degree day accumulated from April to October 2018 at Scott, SK

Year	April	May	June	July	August	Sept.	Oct.	Average
				Temperature (°C)				
2018	-2.2	13.6	16.6	17.5	15.9	6.4	1.6	11.3
Long-term[z]	3.8	10.8	14.8	17.3	16.3	11.2	3.8	12.4
				Precipitation (mm)				
2018	8.5	35.6	58	85.8	20.2	57.3	8.2	265.4
Long-term[z]	24.4	38.9	69.7	69.4	48.7	26.5	17	277.6
				Growing Degree Days				
2018	32.5	268	436.5	306.7	346.9	86.2	12	1476.8
Long-term[z]	44	170.6	294.5	380.7	350.3	192.3	12.5	1432.4

[z]Long-term average (1985 - 2014)

Analysis

The data was statistically analysed using the PROC MIXED in SAS 9.4. The residuals were tested for normality and equal variance to meet the assumptions of ANOVA. The means were separated using a Tukey's Honestly Significant Difference (HSD) test with level of significance at 0.05. Replications were treated as random effect factor whiles treatments were fixed effect factors.

Results & Discussion

Plant Density

Field peas were seeded at a target density of 80 seeds per m^2. No differences among plots were observed (P=0.1905), indicating that the PRE-seed herbicide applications did not influence overall plant stand. Average means of individual treatments are shown in Table 3 as a guide.

Visual Weed Control Ratings

Broadleaf weed control assessment was based on the target weed of volunteer canola. Visual weed control ratings for volunteer canola varied among herbicides. Broadleaf targeted herbicides such as Heat WG, Express SG, Authority, Authority Charge and Goldwing provided excellent volunteer canola control (Figure 1). Applications of Heat WG and Goldwing had excellent prolonged control of volunteer canola (98%) up to 56 DAA. Despite having excellent control (98%) up to 21 DAA, both Authority Charge and Authority exhibited a slight decline to 96% and 91% control at 56 DAA, respectively (Figure 1). Valtera applied alone and in combination with Edge provided very good control of volunteer canola, however, over time control was reduced to good suppression (75%) at 56 DAA.

Grassy weed control assessment was based on the target weed of wild oat. Weed control for wild oat with spring applied Edge alone and in combination with Valtera was very effective (98%) up to 21 DAA. Wild oat control of both Edge and Edge + Valtera tended to decline throughout the growing season (56 DAA) to 91% and 87%, respectively (Figure 2). Edge applied with Heat WG also provided good control of wild oats throughout the growing season (85%). Authority Charge was also very effective (≥ 94%) throughout the entire growing season (Figure 2).

Treatments with more than one PRE- seed herbicide such as Edge + Valtera, Edge + Heat WG, and Authority Charge were able to very effectively control both grass and broadleaf target weeds. This trend highlights the benefits of herbicide layering with multiple modes of action, particularly with herbicides that target both broadleaf and grass weed species. For example, Edge and Heat WG demonstrated excellent weed control of both volunteer canola and wild oat. In contrast, Edge only provided wild oat control and Heat WG only controlled broadleaf weeds.

Similarly, the combination of Valtera + Edge provided increased and consistent control compared to either herbicide applied alone throughout the growing season. Similarly, Authority Charge did well on both grassy and broadleaf weeds, while Authority alone provided excellent broadleaf weed control and poor control of grasses. The benefit of PRE-seed herbicides used in combination with an in-crop herbicide application is three-fold: 1) reduce reliance on Group 2 herbicides for weed control, 2) better early season weed control, and 3) reduces the pressure for Gr. 2 herbicide resistant weeds. Overall, visual ratings indicated that herbicide layering in all cases resulted in increased weed control compared to a single in-crop herbicide application.

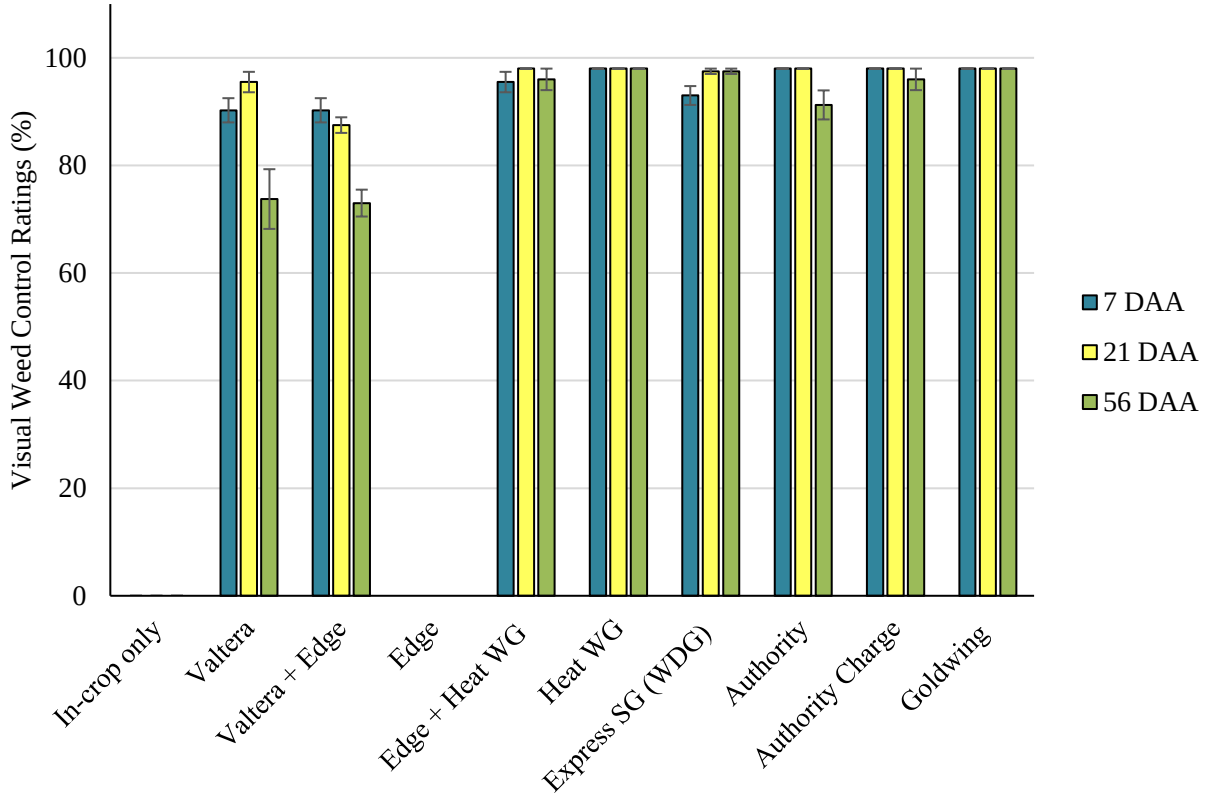

Figure 1. The effect of pre-seed herbicides on volunteer canola applied 3 to 5 days prior to seeding field peas. Visual weed control ratings are based on a scale of 0 to 100% with <60% considered poor control; 60 to 69% considered not acceptable; 70% considered suppression; 75% considered good suppression; 80% considered acceptable control; 85 to 90% is considered good to very good control, and 92 to 100% is considered very good to excellent control. Visual ratings were assessed 7, 21 and 56 days after in-crop herbicide application (DAA). Values were derived from the means (n=4) of four replications at Scott, 2018.

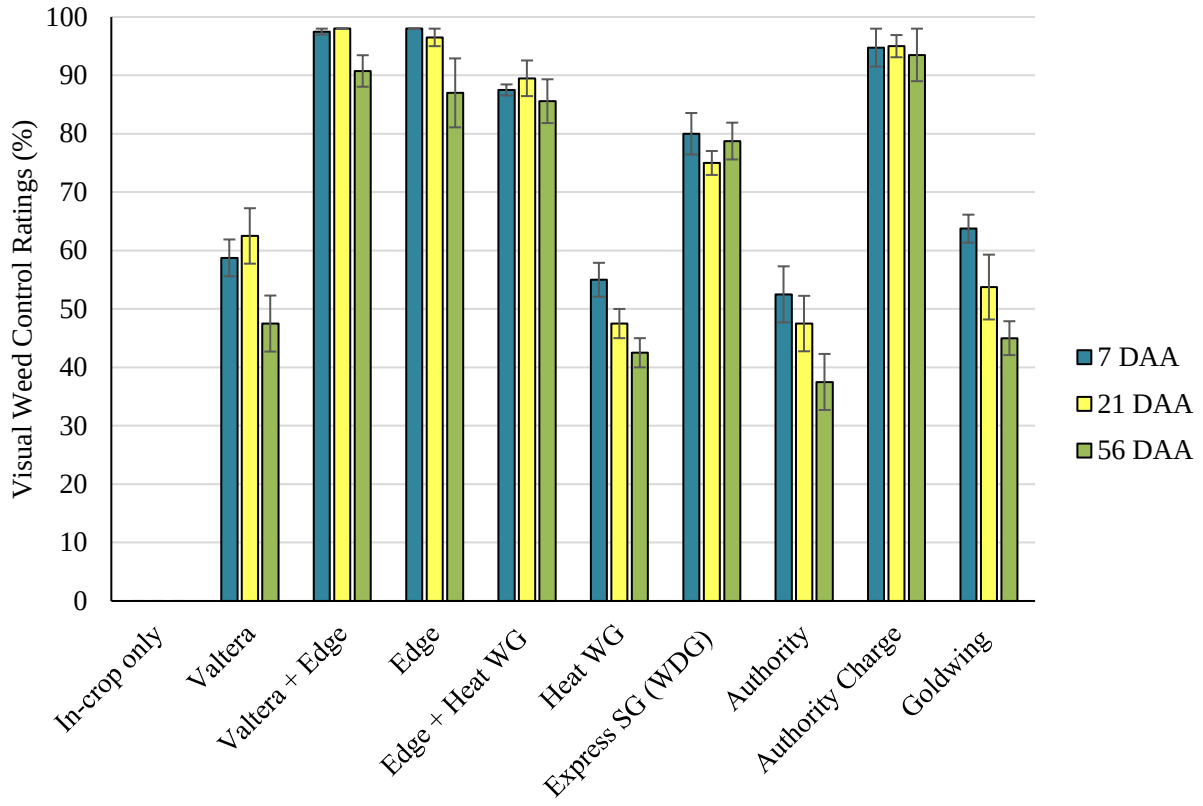

Figure 2. The effect of pre-seed herbicides on wild oats applied 3 to 5 days prior to seeding field peas. Visual weed control ratings are based on a scale of 0 to 100% with <60% considered poor control; 60 to 69% considered not acceptable; 70% considered suppression; 75% considered good suppression; 80% considered acceptable control; 85 to 90% is considered good to very good control, and 92 to 100% is considered very good to excellent control. Visual ratings were assessed 7, 21 and 56 days after in-crop herbicide application (DAA). Values were derived from the means (n=4) of four replications at Scott, 2018.

Yield

Yield was positively influenced by multiple PRE- seed herbicides compared to the check. Field peas grown under applications of Edge + Heat WG and Authority Charge resulted in a yield gain of 4 and 3.6 bu per acre compared to the check (Table 3). This could be attributed to the excellent weed control that occurred during the critical period of weed control (CPWC) and throughout the remaining growing season. The CPWC is the period of time in which weed control is necessary to avoid significant yield loss (Nazarko et al., 2005). The critical period for field pea can vary depending on the year and location but generally begins as early as emergence to the 6th node stage (Harker et al., 2001). Multiple PRE-seed herbicide layering may have

provided greater weed control earlier on than most treatments and therefore may have resulted in a greater yield. An exception to this trend occurred when field peas were grown with Express SG. This field pea yield with Express SG was on average only 0.7 bu per ac less than Edge + Heat WG and Authority Charge and equal to the treatment of Valtera + Heat WG.

The remaining PRE-seed herbicide treatments of Edge, Heat WG and Authority also out-yielded the check with the exception of Valtera applied alone. Although most field peas grown under PRE-seed herbicide applications out-yielded the single in-crop herbicide check, it's important to note that the yield overall was relatively similar with an average range between 31.6 to 35.6 bu per ac (Table 3). Furthermore, yield was very low due to environmental conditions that included a damaging wind and hail storm.

Protein

Protein was collected and remained relatively unchanged regardless of treatments.

Dockage

Percent dockage was collected as an indicator of percent weed seed present within the plots. Dockage indicated that the check had a greater weed population (6% dockage) compared to all other treatments. Overall dockage was relatively low (<4%) among all PRE-seed treatments. This indicates that although there was a slight difference between the PRE-seed treatments and the check, overall weed population were quite low despite being cross seeded in the spring. These results should be taken with caution as results were variable and were only conducted for one year at Scott, 2018. A further demonstration is recommended to validate results.

Table 3. Plant density, yield, protein and dockage of field pea seeded in different PRE- seed herbicide applications at Scott, SK in 2018. Values represent means (n = 4).

Herbicide Applications	Plant density (plants/m^2)	Yield (kg/ha)	Yield (bu/ac)	Protein (%)	Dockage (%)
None	49	2123.3	31.6	23.25	6.1
Valtera	48	2123.4	31.6	23.275	4.0
Valtera + Edge	47	2301.0	34.3	23.125	3.5
Edge	48	2176.4	32.4	23.05	3.9
Edge + Heat WG	51	2360.5	35.2	23.25	3.6
Heat WG	54	2289.1	34.1	22.95	3.9
Express SG *(WDG)*	54	2330.2	34.7	23.375	3.7
Authority	54	2213.3	33.0	23.15	4.0
Authority Charge	55	2389.8	35.6	22.775	3.3
Goldwing	55	2271.7	33.8	23.35	3.8

Conclusions and Recommendations

The results of this demonstration have provided insights to alternative herbicide management techniques for weed control in field peas. The results indicated that multiple mode of action PRE- seed herbicide layering resulted in the most comprehensive broadleaf and grass weed control. PRE-seed applications of Edge + Heat WG, Valtera + Heat WG and Authority Charge demonstrated prolonged weed control of both volunteer canola and wild oats (>85%). A yield increase of 4 and 3.6 bu per ac from PRE-seed applications of Authority Charge and Edge + Heat WG compared to the in-crop herbicide check were also recorded. In most cases except for Valtera applied alone, PRE-seed herbicide applications resulted in an increased yield and reduced dockage compared to the check. It should be noted that overall yield differences were minimal and were not significantly different. Furthermore, as weed populations were sparse and variable within the plots, interpretation of results should be taken with caution.

Supporting Information

Acknowledgements

We would like to thank the Ministry of Agriculture for the funding support on this project. We would like to acknowledge Herb Schell and our summer staff, Jaden Kapiniak and Jolene Gruber, for their technical assistance with project development and implementation for the 2018 growing season. This report will be distributed through WARC's website and included in WARC's and Agri-ARM annual reports.

Appendices

Appendix A

Table A1. Agronomic and treatment application information during the growing season at Scott, 2018.

	Product	Rate	Date
Fertilizer	blend of 17-40-6-10	80 lb/ac sideband	-
Variety	Arbarath	80 seeds/ m2	May 18th
		221 lb/ ac	
Herbicide	Viper ADV	0.4 L/ac	June 18th
	UAN	0.81 L/ac	
	PRE-seed treatments		May 15th
Fungicide	Priaxor	180 ml/ ac	July 9th
Desiccation	Heat LQ	43mL/ac	August 13th
	Glyphosate 540	0.67L/ac	
	Merge	0.2L/ac	

Abstract

Abstract/Summary

A main concern identified for producers is limited weed control in field peas. There are limited herbicide options for weed control in field peas. Weed control in field peas relies strongly on in-crop applications of Group 2 herbicides. However, many problematic weeds are Group 2 resistant. Therefore, the objective of this study was to demonstrate effective weed control strategies by utilizing herbicide layering techniques. The demonstration was arranged as a randomized complete block design with four replicates at Scott in 2018. The treatments consisted of nine PRE-seed herbicides and one check. All treatments had a single in-crop herbicide application. The result indicated that multiple mode of action PRE- seed herbicide layering resulted in the most comprehensive broadleaf and grass weed control. PRE-seed applications of Edge + Heat WG, Valtera + Heat WG and Authority Charge demonstrated prolonged weed control of both volunteer canola and wild oats (>85%). A yield increase of 4 and 3.6 bu per ac from PRE-seed applications of Authority Charge and Edge + Heat WG compared to the in-crop herbicide check were also recorded. In most cases except for Valtera applied alone, PRE-seed herbicide applications resulted in an increased yield and reduced dockage compared to the check. It should be noted that overall yield differences were minimal and were not significantly different. Furthermore, as weed populations were sparse and variable within the plots, interpretation of results should be taken with caution.

Extension Activities:

This project was featured in the Scott Field Day pamphlet and posters that were distributed throughout the surrounding Wilkie, Landis, and Unity areas. Signs stating the objective of this demonstration with acknowledgement of the ADOPT program and the Saskatchewan Ministry of Agriculture were posted in front of the plots. A fact sheet will be generated and distributed on the WARC website as well as all Agri-ARM and WARC events to ensure the information will be transferred to producers.

References

Harker, K.N., R.E. Blackshaw and G.W. Clayton. 2001. Timing weed removal in field pea (*Pisum sativum*). Weed Tech. 15:277-283.

Top Crop Manager. 2017. Managing weeds with herbicide layering. https://www.topcropmanager.com/herbicides/herbicide-layering-to-manage-weeds-19229

Nazarko, O.M., R.C. Van Acker and M.H. Entz. 2005. Strategies and tactics for herbicide use reduction in field crops in Canada: A review. Can. J. Plant Sci. 85:457-479.