2016 Annual Report for the Agriculture Demonstration of Practices and Technologies (ADOPT) Program

Project Title: Evaluating the cost-benefit of canola input recommendations

Project Number: 20150374

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

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Objectives and Rationale

Project objectives:

This objective of this project was to demonstrate to producers the economic value of canola inputs that are readily available to aid in decision making.

Project Rationale:

Canola is one of the primary crops grown in Saskatchewan but has one of the highest input costs associated with production (Ministry of Agriculture, Food and Rural Affairs, 2015). Canola production costs can exceed \$185 ac^{-1} depending on input selection. These costs are approximately 4 %, 18 %, 49 %, 40 %, and 57 % higher than soft white wheat, hard red spring wheat, oats, flax and lentils, respectively (Ministry of Agriculture, 2015; Government of Manitoba, 2015). Canola production costs can be further increased through the addition of multiple inputs.

There are several options that producers can pursue to achieve greater yields including improved nutrient availability, enhanced plant health, and increased competitive ability. Foliar fertilizer and micronutrient applications are commonly used to improve yields by facilitating the uptake of nutrients at targeted application timings. Foliar fertilizer can be applied prior to reproductive growth rather than at seeding to improve nutrient availability to result in greater seed production. Similarly, boron can reduce pod abortion caused by high temperatures during flowering to ensure proper seed production occurs during stressed environmental conditions.

Many producers utilize available products to curatively and proactively ensure plant health in order to achieve higher canola yields. Fungicide applications are an effective strategy for both preemptive and curative disease management in canola. There are several reports indicating the efficacy of fungicide to improve plant health, however, the high input cost can deter producers from utilizing such measures. Seed treatments are also another available option to ensure plant health against pest infestations. However, as seed treatment efficacy can fade over time and result in poor crop protection, producers may have to rely on additional input applications. Thus, the decision to utilize additional seed treatments when based on economics can be difficult.

Improving a crops ability to compete with weeds via increased competitive ability, is a common cultural control strategy that producers can easily implement. One example of a cultural control strategy that was found to improve crop competitive ability was increased seeding rates.

Increased seeding rates result in accelerated canopy closure, reduce time of critical period of weed control, reduced crop-weed competition, and overall crop uniformity (Beckie et al. 2008; Harker et al. 2003).

Overall, there are many options that producers can utilize to improve canola yields. However, as each additional crop input diminishes net profit returns, it is critical for producers to understand the benefits and costs associated with each input in order to obtain the greatest net returns. The results of this trial will therefore provide insights to improve canola production by demonstrating the costs and benefits associated with different agronomic practices that are commonly used for canola production.

Methodology and Results

Methodology:

The demonstration was arranged as a randomized complete block design (RCBD) with four replicates at Scott, SK 2016. The demonstration consisted of seven treatments that focused on five various aspects of canola inputs strategies (Table 1). 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 rates recommendations (Table A1). The trial was sown on wheat stubble using an R-tech drill with 10-inch row spacing. Further details regarding treatment applications can be found in Appendix A.

Table 1: Treatment list including description of each treatment for canola production

	Treatments	**Description**
1	Control "Basic"	"Basic": seeding rate (100 seeds m^2); fertilizer based on soil test recommendations; one in-crop herbicide
2	Foliar Fertilizer	Basic + additional foliar fertilizer application
3	Boron	Basic + boron application
4	Additional Seed Treatment	Basic + Lumiderm
5	Seeding Rate	Basic (seeding rate of 150 seeds m^2 vs. 100 seeds m^2)
6	Fungicide	Basic + fungicide application @ 2-4 leaf + 20% + 50% flower
7	Stacked	Seeding rate (150 seeds m^2) + basic fertilizer soil test recommendations + additional foliar fertilizer + boron + additional seed treatment+

fungicide applications + one in-crop herbicide application

Data Collection:

Plant densities were determined by counting numbers of emerged plants on 2 x 1 meter row lengths per plot about a week after the first rows became visible. Vigour ratings were used to determine overall early season vigour based on a standardized scale from 1 to 5. Disease ratings were conducted prior to and after fungicide applications based on protocol timing. Days to maturity (DTM) were also determined based on 60 % seed colour change. Yields were determined from cleaned harvested grain samples and corrected to the required moisture content. Seed quality analyses were done to determine thousand kernel weight and test weights. The economics of each treatment was calculated to determine profit return. Weather data was recorded from the online database of Environment Canada weather station.

Growing Conditions:

The 2016 growing season started out very dry in April with only 1.9 mm of precipitation. May, July, and August were far above the long-term average, with 40 %, 21 %, and 50 % increase, respectively. Overall, when looking at the accumulated amount of precipitation in 2016 from April to October, there was 38.5 mm more than the long-term total. Throughout the growing season, the temperature was very similar to the long-term average. Growing degree days were higher than the long-term average for the months of April – July, and lower for the remaining months (Table 2).

Table 2. Mean monthly temperature, precipitation and growing degree day accumulated from April to October 2016 at Scott, SK

Year	April	May	June	July	August	Sept.	Oct.	Average /Total
----------*Temperature (°C)*----------								
2016	5.9	12.4	15.8	17.8	16.2	10.9	1.6	11.5
Long-term[z]	3.8	10.8	14.8	17.3	16.3	11.2	3.4	11.1
----------*Precipitation (mm)*----------								
2016	1.9	64.8	20.8	88.1	98.2	22.2	33.1	329.1
Long-term[z]	24.4	38.9	69.7	69.4	48.7	26.5	13	290.6
----------*Growing Degree Days*----------								
2016	58.9	224.9	303	398.7	343.8	176.2	12.5	1518.0
Long-term[z]	44	170.6	294.5	380.7	350.3	192.3	42.5	1474.9

[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

Seeding rate significantly influenced the plant density ($P = 0.0125$) as 100 and 150 seeds/ m^2 resulted in a corresponding average plant density of 65 and 93 plants m^{-2}, respectively. These plant densities are relatively close the recommended plant population of 70 to 100 plants m^{-2} set by the Canola Council of Canada (Canola Council of Canada, 2017).

Overall plant vigour was assessed early in the growing season to determine if additional inputs would influence plant vigour, however, based on visual assessments there was no significant differences between treatments. Plant vigour was initially rather low, due to stressed environmental conditions caused by a lack of precipitation throughout June (Table 2).

Disease ratings were conducted at several points during the growing season, to determine the level of incidence and severity of disease. Disease ratings were relatively similar between treatments, with the exception of the high seeding rate, in which disease severity was slightly greater.

Maturity ratings were conducted to determine if the additional inputs influenced overall plant maturity. Maturity ratings were based on 60 % seed colour change defined by the Canola Council of Canada. Plant maturity varied slightly between treatments with a 2-day maximum difference between treatments with fungicide and boron has the longest DTM of 100 days.

Grain seed yield and thousand kernel weights were significantly influenced ($P = 0.0172$; 0.008) by the addition of the canola inputs treatments (Table 3). The "stacked" treatment resulted in a 10 % yield boost compared to treatments that received a boron application, additional seed treatment, and a higher seeding rate (Figure 1).

Table 3. The P values were generated using the Tukey's HSD test (P< 0.05) to determine the effect of agronomic inputs (treatments) on canola seed yield (bu ac^{-1}), thousand kernel weights (TKW) (g 1000 seed^{-1}), and test weight (TW) (kg hL^{-1}) at Scott, 2016.

	Yield	TKW	TW
	bu ac^{-1}	g 1000 seed^{-1}	kg hL^{-1}
Treatment	0.017	0.008	0.359

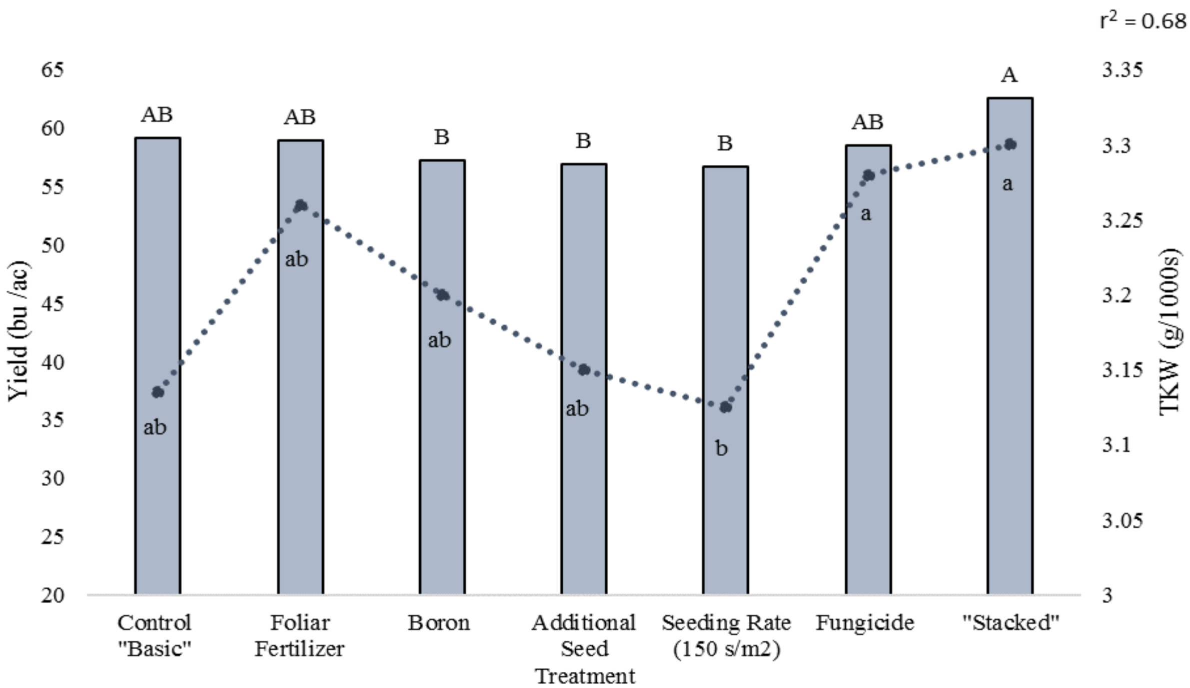

Figure 1. The effect of treatments on canola yield (bu/ac) and thousand kernel weight (TKW) (g/1000seeds) at Scott, SK in 2016 growing season. Different lettering indicates significant difference between treatments, respectively).

The addition of boron to improve canola yields has been much debated within the past several years, however, there is strong evidence suggesting that boron applications on canola in western Canada is ineffective. Karamonas et al. (2003) reported that there was no significant yield increase due to boron application in canola in any of the 22 experiments that were conducted throughout the western Canadian prairies. It was concluded that regardless of soil and environmental conditions, yield responses to boron application on the prairies are rare and are unlikely to contribute to overall yield gains. Similarly, the Ultimate Canola Challenge reported that there was no significant yield difference between boron treated and untreated canola plots on both small and large scale production (Canola Council of Canada, 2015). Our results correspond with that of Karamonas et al. (2003) and Canola Council of Canada (2015), as yield and thousand kernel weights were not influenced by the application of foliar boron. Foliar boron applications resulted in a net loss of $ 6 per ac and a loss of $ 44 per acre when fuel costs were considered compared to the untreated "basic" check (Table 4). Overall, the application of foliar boron is unlikely to have attributed to the success of the "stacked" treatment and is not a financially feasible option in most canola production systems.

Table 4. Economic analysis of the treatments applied during the growing season on canola at Scott, 2016.

	Control "Basic"	Foliar Fertilizer	Boron	Additional Seed Treatment	Seeding Rate	Fungicide	Stacked
Yield (bu/ac)	59[¥]	59	59	59	59	59	63
Price ($/bu)	11.5	11.5	11.5	11.5	11.5	11.5	11.5
Gross Income ($/ac)	*678.50*	*678.50*	*678.50*	*678.50*	*678.50*	*678.50*	*724.50*
Inputs Costs ($/ac)							
Seed cost	55	55	55	63	82	55	94
Fertilizer cost	78.99	78.99	78.99	78.99	78.99	78.99	78.99
Foliar Fertilizer		3.00					3.00
Boron			6.00				6
Fungicides						36.25	36.25
Herbicide	13.13	13.13	13.13	13.13	13.13	13.13	13.13
Fuel Cost [Z]		38.13	38.13			38.13	
Total Cost ($/ac)	147.12	150.12	211.25	155.12	174.12	183.37	231.37
NET Gain ($/ac)	**531.38**	**528.38**	**525.38**	**523.38**	**504.38**	**495.13**	**493.13**

[¥] Yield values for all treatments except stacked were not statistically different; values based on control yield
[Z] Fuel cost of sprayer was not calculated into total cost per treatment (Government of Saskatchewan, 2016)

Seed treatments are used as an additional line of defence against many pests, in particular cutworms and flea beetles, in canola production. However, the high costs associated with seed treatments often deter most producers. In this demonstration, the effect of an additional seed treatment was negligible, as a yield response was not detected (Figure 1). This could be attributed to the delayed arrival of cutworms resulting in pest damage after the activation period of the seed treatment. The cost of an additional seed treatment resulted in a net loss of $ 8 per acre (Table 4). Although, the addition of a seed treatment was not statistically effective in this particular study, it is important to note that seed treatments have the potential to reduce the need for additional insecticide applications, which are environmentally and economically costly. For example, if you were to use a basic agronomic approach with the application of a single insecticide application compared to a seed treatment you would result in net loss of $ 37 per acre due to increased fuel and product costs.

There are several benefits associated with increased seeding rates; however, such benefits were not demonstrated in this trial due to several underlying factors. A denser canopy due to increased seeding rates resulted a higher prevalence of disease within the crop canopy, which was likely the underlying factor that limited yield production in this demonstration. Although this treatment did not influence yield, the stacked treatment, which included a higher seeding rate did result in the greatest yield production. This could be attributed to the combination of a higher seeding rate and the addition of multiple fungicide applications. A second negative consequence of higher seeding rates is higher input costs. In this demonstration, a net loss of $ 27 per acre was attributed to a higher seeding rate compared to the control “basic” management treatment (Table 4). Overall, seeding rates should be considered as a cultural weed management strategy as previous research has shown the benefits of increased seeding rates. However, seeding rates need to be balanced with best management practices, which may include fungicide applications, as well as net profit returns in order for producers to remain cost effective.

Fungicide applications can be used as a proactive and curative management strategy for canola production, and can be found to be cost-effective under certain environmental conditions. In the 2016 growing season, the addition of fungicides was found to reduce the incidence and severity of disease within the treated plots. However, yield was not statically different compared to the unsprayed “basic” check, indicating that although disease was reduced, a fungicide application was not cost effective. A net loss of approximately $ 36 per acre was calculated for sprayed treatments and a net loss of $74/ ac when fuel costs were considered (Table 4). Therefore, when deciding to spray fungicides, it is important to determine the benefit and costs associated with the application.

Foliar fertilizer is an effective fertilizer application strategy that could be utilized when fertilizer requirements at time of seeding exceed recommended application rates. Split application in the form of either granular or foliar can be a beneficial tool to overcome such challenges. In this demonstration, available soil nitrogen was marginal to deficient while phosphorous was slightly better than marginal. Therefore, foliar fertilizer applications were a feasible option that was used to provide additional required nutrients. However, foliar fertilizer applications resulted in similar yields compared to the control “basic” management strategy, indicating that the addition of foliar fertilizer was not cost effective. A net loss of $ 3 per acre was associated with foliar fertilizer applications (Table 4).

When comparing the “stacked” to “basic” canola input treatments, the stacked treatment resulted in a non-significant, yet higher yield of 63 bu/ ac compared to 59 bu/ ac, respectively (Figure 1). Although the stacked treatment resulted in an overall greater yield, when determining the overall net return, the “basic” treatment was more cost effective. The “stacked” treatment compared to the “basic” resulted in a net loss of $ 38.25 per acre (Table 4).

Conclusions and Recommendations

The results of this trial have provided insights to improve canola production by demonstrating the costs and benefits associated with different agronomic practices that are commonly used for canola production. The application of both foliar fertilizers and fungicides, while not statistically significant, provided slightly greater yields compared to treatments with boron, additional seed treatment and higher seeding rates. However, compared to the untreated “basic” check, neither of these options resulted in an economic benefit. A significant difference was detected between the “stacked” treatment and the treatments of boron, additional seed treatment and higher seeding rates, as well as resulted in a 6 % yield boost compared to the untreated “basic” check. However, due to the high input costs associated with the “stacked” treatment, the returns were 7 % less compared to the untreated “basic” check. Overall, it appears that the simplest, yet efficient management strategy that most producers follow may provide the best profit return.

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 for their technical

assistance with project development and implementation for the 2016 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, 2016.

	Product	Rate	Stage
Fertilizer	blend of 41-11-19-29	110 lbs/ ac mid-row	-
	MAP	20lb/ ac seed placed	-
Variety	D3155C with Helix Vibrance +	110 seeds/ m2	-
	D3155C with Helix Vibrance + Lumiderm	150 seeds/m2	-
Boron	Microbolt B	0.75L/ac	4 - 6 leaf stage
Foliar fertilizer	CRN-S	4L/ac	3 - 4 leaf stage
Herbicide	Liberty and Centurion	1.08L/ac	2 - 4 leaf stage
	Amigo	25.5mL/ac	
		0.5L/100L	
Fungicide application	Quadris	200 ml/ ac	2 - 4 leaf stage
	Lance WDG	140g/ ac	20% ; 50% flower
Desiccation	Reglone Ion	0.69L/ac	maturity

Abstract

Abstract/Summary

Canola is one of the primary crops grown in Saskatchewan but has one of the highest input costs associated with production (Ministry of Agriculture, Food and Rural Affairs, 2015). Production costs can be further increased through additional application costs associated with typically production strategies. This trial was designed to demonstrate to producers the economic value of canola inputs that are readily available to aid in decision making. The demonstration was set up at Scott as a randomized complete block design with four replicates and seven treatments: (1) untreated "basic" production, (2) foliar fertilizer application, (3) boron application, (4) additional seed treatment, (5) increased seeding rate, (6) fungicide applications,

and (7) “stacked”. The results showed that, the application of both foliar fertilizers and fungicides, while not statistically significant, provided slightly greater yields compared to treatments with boron, additional seed treatment and higher seeding rates. However, compared to the untreated “basic” check, neither of these options resulted in an economic benefit. A significant difference was detected between the “stacked” treatment and the treatments of boron, additional seed treatment and higher seeding rates, as well as resulted in a 6 % yield boost compared to the untreated “basic” check. However, due to the high input costs associated with the “stacked” treatment, the returns were 7 % less compared to the untreated “basic” check. Overall, it appears that the simplest, yet efficient management strategy that most producers follow may provide the best profit return.

Extension Activities:

This project was shown to producers and agronomists at the Scott Field Day in July 2016, with an attendance of approximately 175 people. Jessica Weber discussed the effects of inoculants and the different inoculant formulations, as well as the possible changes in recommended seeding rates. It was also 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.

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