Demonstrating phosphorus fertilizer rates and placement options for increased canola production, crop safety, and building soil phosphorus levels

2020 Project Report

for the Saskatchewan Canola Development Commissions and the Morris Sebulsky Endowment Fund

Objectives and Rationale

Project Objective: The first objective of the demonstration was to illustrate the benefits of increased phosphorus fertility in canola to work towards building soil phosphorus levels. The second objective was to demonstrate the relative benefits of placing high levels of phosphorus fertilizer in a side or midrow-band to improve crop safety.

Project Rationale: Soils in Saskatchewan are slowly becoming phosphorus deficient, as replacement rates of the nutrient are not balanced to what is being removed from high yielding crops. With declining soil P levels, producers must decide how to most efficiently increase soil P levels without damaging the crop. Phosphorus containing fertilizer can result in seedling damage when placed in the seed row. Previous research has indicated that rates of up to 25 lbs of P_2O_5/ac can be safely placed with canola seed. However, soil test recommendations often exceed the 25 lbs/ac limitation, and P fertilizers must be placed in the side-band to further meet crop demands. Although, side-banding places the P fertilizer further from the seed, there is still some speculation from producers that placing high rates in the side-band may still diminish seedling emergence. Mid-row banding is another alternative option for P fertilizer placement, as it allows P to be placed even further from the seed. This diminishes the chance of seedling damage, but may place the P too far from the seed if required for the current production year. This demonstration intended to evaluate side-banding and midrow-banding high rates of P to assess the effects different placement options and P rates have on plant establishment, maturity, and canola seed yields.

Methodology and Results

Methodology:

This small plot demonstration was located at NW-20-44-18 W2 in RM no. 428 near Melfort, SK. The demonstration was arranged in a split-block design with 4 replicates. Treatments varied by phosphorus placement options and phosphorus rate. Midrow-banding, side-banding, or a split application in the side-band and midrow-band were combined with 20, 40, 60, 80, and 100 kg/ha of P_2O_5 to create 15 treatments (Table 1).

Table 1. Treatments used in Demonstrating phosphorus fertilizer rates and placement options for increased canola production, crop safety, and building soil phosphorus levels in Melfort, SK 2020.

Treatment #	Placement	P_2O_5 (kg/ha)
1	Side-band	20
2		40
3		60
4		80
5		100
6	Midrow-band	20
7		40
8		60
9		80
10		100
11	Side-band + Midrow	10+10
12		20+20
13		30+30
14		40+40
15		50+50

At Melfort plots were 2-m wide by 7-m long. Prior to seeding, the test was soil sampled for residual nutrient levels (Table 2). Results of the soil test were used for N, K and S fertilizer recommendations, and to provide base phosphorus levels. On May 25th L233P canola was seeded at a 0.5-inch depth into wheat stubble. Seeding was completed using a 6-row Fabro plot seeder on 12-inch row spacing. The seeding rate targeted 120 seeds/m^2, while adjusting for a 99% germination and a 5-gram thousand kernel weight. Nitrogen was applied in the midrow at 134 kg/ha of N, and was applied as 46-0-0. Sulphur was broadcasted at 19 kg/ha prior to seeding as 21-0-0-24. Phosphorus was applied as 11-52-0 and placement and rate were as per treatment requirements.

Table 2: Residual soil nutrient levels (0-12”) found in Demonstrating phosphorus fertilizer rates and placement options for increased canola production, crop safety, and building soil phosphorus levels in Melfort, SK 2020.

Residual Soil Levels			
Nitrogen (lb/ac)	*Phosphorus (ppm)*	*Potassium (ppm)*	*Sulphur (lb/ac)*
37	24	736	16

The trial received crop protection products as required. The seed was treated with a pre-applied seed treatment. A tank mix of Liberty at 1.35L/ac and Centurion at 75 mL/ac was applied on June 16th for in-crop weed control. Acapella was applied at 485mL/ac on July 16th for sclerotinia protection. Lastly, Glyphosate 540 was applied at 670mL/ac on August 26th as a desiccant, and all plots were harvested on September 11th, in which 5 full crop rows were collected.

To assess treatment differences, data collection consisted of plant density, maturity and seed yield. Methodology for this data collection is described below. The single site year of data was analyzed using Split-plot in Statistix 10.

Results:

Environmental Conditions:

Average growing season temperature was comparable to the long-term average, while total precipitation was 42.5mm less than the long-term average (Table 3). May and June were 0.6°C and 1.6°C cooler than the long-term average whereas July and August were 1.3°C and 0.8°C warmer, respectively. The slightly cooler temperatures in May and June coincided with similar to wet conditions, particularly in June where precipitation was much greater than the long-term average. Reduced precipitation in both August and September, and above average temperatures in August, allowed for early to normal crop maturity, dry down, and harvesting conditions with minimal delays.

Table 3: Mean temperatures and precipitation collect from the Environment Canada Weather Station at Melfort SK., from May to September 2020.

	May	**June**	**July**	**August**	**September**	**Average/Total**
			--- Mean Temperature (°C) ---			
2020	10.1	14.3	18.8	17.6	10.8	14.3
Long-Term^x	10.7	15.9	17.5	16.8	10.8	14.3
			--- Total Precipitation (mm) ---			
2020	26.7	103.7	52.4	18.5	21.2	222.5
Long-Term^x	42.9	54.3	76.7	52.4	38.7	265.0

^{x} Long-term climate normal from Environment Canada Weather Station located at Melfort SK., from 1981-2010

Plant Density:

Plant density was assessed on June 22nd where the seedlings along 2 1-meter crop rows per plot were counted. Plant densities were only significantly different when comparing placement options (Table 4). Plant density was significantly less when phosphorus was side-band as compared to midrow-band and split applications. However, the plant density in all treatments were still adequate for producing a high yielding crop. Phosphorus rate and the interaction between placement and rate had no significant effect on plant establishment with plant density similar or trending slightly upwards as the rate increased. These results suggest that seedling damage occurred from side-banding, regardless of applied rate, as plant density was lower in these treatments compared to their midrow and split application counterparts. Plant density was overall higher across each rate of midrow and split applied P. Results also suggest that split applications can be just as effective for reducing the risk of seedling damage as midrow banding because it allows for greater fertilizer and seed spread, but also allows some fertilizer to be readily available for the growing roots.

Table 4. Statistical analyses and treatment means for Demonstrating phosphorus fertilizer rates and placement options for increased canola production, crop safety, and building soil phosphorus levels in Melfort, SK 2020.

	Plant Density (plants/m^2)	Yield (Kg/ha)	Yield (bu/ac)
Placement	0.0091**	0.0363*	0.0363*
Rate	0.5762	0.0122*	0.0122*
Rate*Place	0.9636	0.6051	0.6051
Grand Mean	100.4	2933.2	52.3
CV	10.51	3.65	3.65
Split	105.8a	3078.6a	54.9a
Midrow	101.2a	2861.2b	51.0b
SB	94.3b	2859.7b	50.9b
20kg	97.1a	2857.7c	50.9c
40kg	98.7a	2917.5abc	52.0abc
60kg	101.2a	2903.7bc	51.8bc
80kg	101.3a	3003.0a	53.5a
100kg	103.9a	2983.9ab	53.2ab
SB 20kg	90.0d	2794.0b	49.8b
SB 40kg	99.3abcd	2800.2b	49.9b
SB 60kg	91.7cd	2807.4b	50.0b
SB 80kg	93.5bcd	2917.3ab	52.0ab
SB 100kg	97.2abcd	2979.5ab	53.1ab
MB 20kg	96.2abcd	2795.3b	49.8b
MB 40kg	100.1abcd	2898.1ab	51.7ab
MB 60kg	99.7abcd	2794.7b	49.8b
MB 80kg	101.9abcd	2945.5ab	52.5ab
MB 100kg	108.1ab	2872.3ab	51.2ab
Split 10+10kg	105.2abc	2983.9ab	53.2ab
Split 20+20kg	104.2abcd	3054.2ab	54.5ab
Split 30+30kg	104.8abc	3109.1a	55.4a
Split 40+40kg	108.5a	3146.2a	56.1a
Split 50+50kg	106.4ab	3099.8a	55.2a

Maturity:

Maturity was assessed on August 26th when all plot had reached 60% seed colour change. All treatments had reached 60% seed colour change on August 26th, with no maturity differences being noticed between the treatments. This was somewhat expected as plant density was fairly similar between the treatments. Increased rates of fertilizer are often known to prolong maturity, however due to the dry conditions in August the effect was likely minimized by the lack of water, and resulted in early dry down.

Yield:

Yield was assessed by weighing and cleaning each harvested plot sample, and converting these weights into kg/ha and bu/ac equivalents, while correcting to 10% seed moisture. Yield was significantly affected by phosphorus rate and phosphorus placement, but the two-way interaction was not significant (Table 4). This indicates that yield responded significantly to rate and placement, but the placement of any rate did not impact its efficacy. Yields were greatest when P was applied in a split application and 3 to 4 bu/ac greater when compared to the side-band or midrow-band application, respectively. This yield increase is likely supported by the increased plant populations in this treatment. The significant difference in yield between the split and midrow treatments, despite having comparable plant densities, suggests that having some P in the side-band is required to support increased final yields while diminishing seedling damage. Increasing rate also increased yields, yet yields only differed by 1 to 2 bu/ac. The greatest yields were observed at 80 and 100 kg/ha, but were only significantly greater than the 20kg/ha rate. However, the highest rate of 100 kg/ha had comparable yields to 40, 60, and the 80 kg/ha rates as well. Residual levels of phosphorus were relatively high (24ppm) and thus a yield response to high rates of phosphorus was unlikely. This is likely the reasoning for the minimal yield differences between each treatment, and why rates beyond 20 kg/ha were often statistically similar. Had residual phosphorus levels been limiting yield responses may have been different. Furthermore, because residual p levels were high and average yields were similar to increasing with increasing p rate, it may be that all options demonstrated were useful for building phosphorus. However, one could only confirm, with a post harvest soil sample to see the new residual levels.

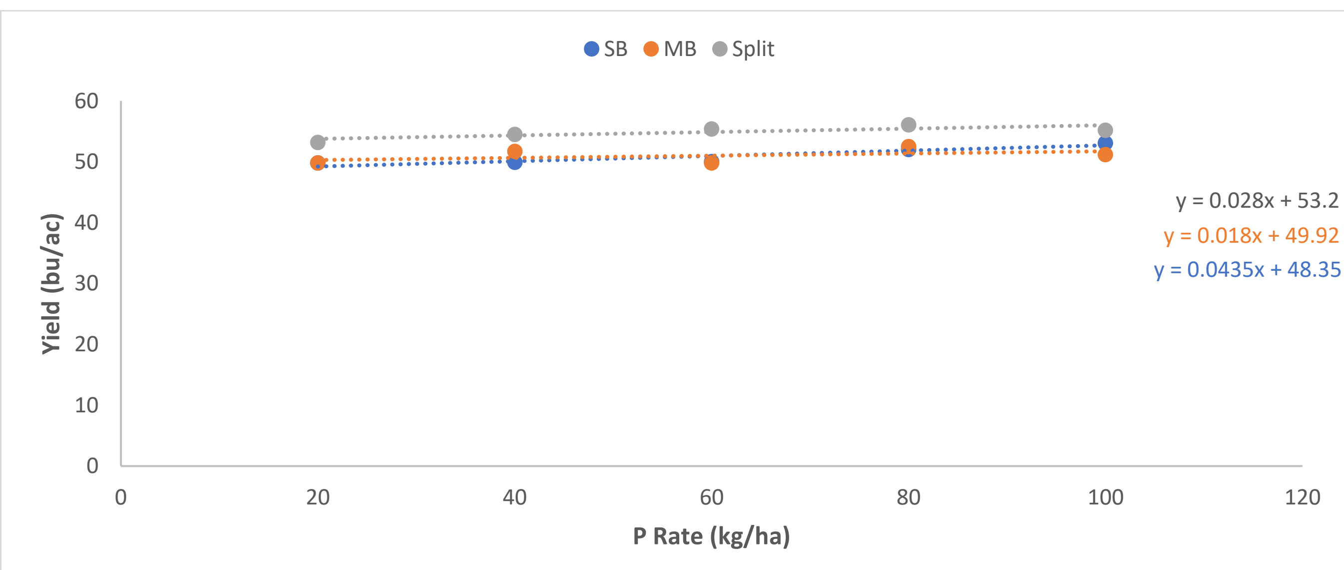

Figure 1: Phosphorus place and rate effect on canola yield.

Conclusions and Recommendations

Due to the high soil residual levels in this demonstration significant responses were less likely. Yet, increasing rates of phosphorus in conjunction with various placement options had significant effects on plant establishment and seed yields in canola. Plant stands were significantly reduced when all P was placed in the side-band as compared to midrow-band and split applications; however, increasing P application rates, regardless of placement, up to 100 kg/ha had no effect on plant emergence. Canola seed yields were significantly increased in split applications as compared to both midrow-band and side-band applications. Yields in the split applications allow for some phosphorus to be available to the seed, while increasing fertilizer spread and reducing seedling damage. As plant density was similar between midrow and split application, yields in the midrow applications were lower likely due to reduced phosphorus availability in the early stages of growth. Overall, split applications of phosphorus appear to be the best approach for minimizing seedling damage and maximizing yields, when trying to apply high rates of phosphorus in order to build soil P levels.

Extension Activities:

Due to the unfortunate circumstances involving the Covid-19 pandemic, our annual in-person field day was cancelled, however this demonstration was still showcased at our virtual field day on July 22nd, 2020. A video clip highlighting the demonstration was posted to our twitter account @NARF_Melfort, which received 418 views. The final project report will also be made available on our website at neag.ca.

Supporting Information

Acknowledgements

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Abstract

Abstract/Summary

Phosphorus levels in Saskatchewan soils are slowing declining, as recommended application rates do not meet or exceed crop removal rates from high yielding cultivars. Current safe recommendations for seed-placed phosphorus in canola production are 25 lbs/ ac of P_2O_5. Recommended application rates for high yielding canola crops often exceed 25 lbs/ac, therefore some P must be placed in the side-band to reduced seedling damage while still meeting crop demands. Some producers still have concerns as to whether or not high rates in the side-band may cause seedling damage, however placing the P even further from the seed in the midrow-band causes concerns for decreased availability, as P has low mobility in the soil. To evaluate placement options of phosphorus at increasing rates in canola production a small plot demonstration was conducted at Melfort, SK in 2020 to assess the effects of midrow-banding, side-banding and split applications at rates of 20, 40, 60, 80,

and 100 kg/ha of P_2O_5. Data collection consisted of plant densities, days to maturity, and canola seed yields. Plant densities were only significantly reduced when all P was placed in the side-band. Increasing rate had no significant effect to plant density. Phosphorus placement and rate had no effect on days to maturity as all plots matured on the same day. Canola seed yields were greatest from split applications of P, as the midrow-band and side-band applications had significantly reduced yields in comparison. Yields were also increased as P rate increased, however yield gains were quite small due to high residual phosphorus levels. Overall, split applications of phosphorus appear to be the best approach for minimizing seedling damage and maximizing yields, when trying to apply high rates of phosphorus in order to build soil P levels.