Seed Placed Phosphorus Products and Rate with Side-band vs. Mid-row Nitrogen
Scott, SK. 2020

Project Location(s): Scott Saskatchewan, R.M. #380 Legal land description: SE-19-39-20-W3

Project start and end dates (month & year): May 2020 to January 2021

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Project Objective:

This trial was conducted to evaluate the effects of different seed-placed phosphorus products and rates with mid-row vs. side-band nitrogen on seed safety and yield.

Project Rationale:

Many studies have been conducted with seed safety in canola across Saskatchewan. The application of phosphorus (P) shows great benefits to Saskatchewan soils as a vast majority of soils show low levels of P (Government of Saskatchewan, n.d.). A large amount of these studies have shown successful results with seed-placed P products. However, producers often show concern with new products on the market and their safety when seed-placed. Furthermore, there is a growing interest in applying increased rates of P products. Therefore, this trial displays the effects of product formulations applied with the seed at two different rates (50 lbs/ac and 100 lbs/ac). It is very important to consider other factors that are often overlooked when applying P fertilizers. P is immobile in the soil and is best placed near the seed for nutrient uptake. Early uptake of P improves early growth and vigor, also known as the "popup effect". The risk of seedling toxicity also needs to be considered when evaluating the use of different fertilizer products. Lastly each product has a different salt index which can impact germination and crop emergence. The products in this trial (MAP, MES15, and Crystal Green) have different levels of salt indices which is considered when looking at the results to determine seedling safety. Using these products at different rates will help producers determine appropriate applications for seed-placed P products and help maximize crop quality and yield.

Methodology:

The trial was arranged as a randomized complete block design (RCBD) with four replicates of twelve treatments at Scott, SK. 2020 (Table 1). Phosphorus was applied in three different formulations including Microessentials S15® (MES15; 13-33-0-15), monoammonium phosphate (MAP; 11-52-0-0) and Crystal Green® (5-28-0), at two rates of 50 and 100 lbs/ac of actual total P. Nitrogen (N) was applied as urea (46-0-0) at a rate of 100 lbs of actual N/ac, as either side-band or mid-row placement. No other fertilizers were applied. Prior to seeding, an application of Glyphosate 540 at 1 L/ac and Aim at 35 ml/ac was applied on May 19th, 2020. The canola variety, L255PC, was seeded into wheat stubble on May 25th, 2020 using a Fabro knife opener with 10

inch spacing. On June 26th, 2020 there was an in-crop herbicide application of Liberty at 1.62 L/ac with Centurion at 75 ml/ac and Amigo at 0.5 L/ac. Foliar fungicide, Priaxor, was applied at a rate of 120 ml/ac on July 16th, 2020. The data was analyzed by averaging data collection among treatments to see treatment results.

Table 1. Treatment list for Seed Placed Phosphorus Products and Rate with Side-Band vs. Mid-Row Nitrogen in Scott SK, 2020.

Treatment	P Products	Rate lbs/ac	N Placement	Rate lbs/ac
1	MES15	25	Side-band	100
	MAP	25		
2	MES15	75	Side-band	100
	MAP	25		
3	MES15	50	Side-band	100
4	MES15	100	Side-band	100
5	Crystal Green	50	Side-band	100
6	Crystal Green	100	Side-band	100
7	MES15	25	Mid-row	100
	MAP	25		
8	MES15	75	Mid-row	100
	MAP	25		
9	MES15	50	Mid-row	100
10	MES15	100	Mid-row	100
11	Crystal Green	50	Mid-row	100
12	Crystal Green	100	Mid-row	100

Data Collection:

Soil samples were collected in the spring of 2020 at two depth increments of 0-6 inches and 6-24 inches to determine residual soil nutrient levels. Plant establishment counts were conducted two and four weeks after crop emergence (WAE) by counting 4 x 1 meter row lengths per plot. Whole canola plants were collected at the rosette stage and submitted to Agvise Laboratories to determine phosphorus concentration in the plant tissues. Maturity date was recorded when seed colour change reached 60% to determine relative days to maturity (DTM). Yields were determined from cleaned harvested grain samples and corrected to 10% moisture content. Green seed was evaluated by crushing 500 seeds per plot, counting distinctly green seeds,

and converting the value to percent green seed. Weather was collected by a Farmers Edge® on-site weather station. Long-term weather data was collected from Environment Canada.

Weather:

The 2020 growing season was overall 1°C cooler and had 59 less growing degree days than the long-term average (Table 2). This growing season received increased amounts of rain in the months of May (48.3 mm) and July (129.4 mm) compared to the long-term average. Overall, the 2020 growing season averaged 33.2 mm more precipitation than the long-term average. Although the growing degree days were less this year, the harvesting period had some exceptionally warm days which was ideal for ripening of crops and harvesting.

Table 2. Mean monthly temperature, precipitation, and growing degree day accumulated from April to September 2020 at Scott, SK.

Year	April	May	June	July	August	Sept.	Average / Sum
----------*Temperature (°C)* ----------							
2020	-0.9	10.2	14.6	17.1	16.0	10.6	11.3
Long-term[z]	3.8	10.8	14.8	17.3	16.3	11.2	12.4
----------*Precipitation (mm)*----------							
2020	7.8	48.3	70.2	129.4	25.8	29.3	310.8
Long-term[z]	24.4	38.9	69.7	69.4	48.7	26.5	277.6
----------*Growing Degree Days*----------							
2020	40.0	159.0	289.0	376.0	342.0	167.0	1373.0
Long-term[z]	44.0	170.6	294.5	380.7	350.3	192.3	1432.4

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

Results

Soil Sample

Soil sample results showed medium levels of P in the soil (12 ppm), indicating application of phosphorus fertilizer would be beneficial. Nitrate (NO_3-N) levels at 0-6 inches were 13 lbs/ac and at 6-24 inches were 21 lbs/ac indicating medium levels. The soil pH was ideal for P availability at the 0-6 inch depth increment at 6.4, but increased to 7.7 at the 6-24 inch depth increment. Organic matter levels were at 4%.

Plant Densities

Among all treatments plant densities ranged from 26-84 plants/m^2. The highest plant density, 84 plants/m^2, was achieved with the application of 50 lbs/ac of Crystal Green with mid-row N at 2 WAE (Figure 1). When applied at 50 lbs/ac with side-band N, Crystal Green had a plant density of 63 plants/m^2. Side-banding Crystal Green at 50 lbs/ac resulted in a decrease in plant density of 21 plants/m^2 compared to mid-row banding N at 2 WAE. The lowest plant densities at 26 plants/m^2 were observed with the blend of MES15:MAP at 100 lbs/ac with side-band N. Shirtliffe (2009) conducted a meta-analysis of 35 previous canola seeding rate studies and concluded that plant densities below 50 plants/m^2 consistently experienced yield losses. In Figure 1, the red line represents the threshold of 50 plants/m^2. Only 6 treatments are above this threshold, including all four Crystal Green treatments, MAP:MES15 at 50 lbs/ac with mid-row N, and MES15 at 50 lbs/ac with mid-row N. Furthermore, the salt index is 8 for Crystal Green, 21 for MES15, and 27 for MAP. Crystal Green has the lowest salt index and all treatments resulted in plant densities above 50 plants/m^2. At the lower rate (50 lbs/ac) with mid-row N, MES15 was above the 50 plants/m^2 threshold, and even when in combination with MAP. However, when the rate increased to 100 lbs/ac and/or N was side-band, the plant densities dropped below 50 plants/m^2. This indicates that with higher rates and with N placed closer to the seed-row, products with higher salt index resulted in fertilizer toxicity and reduced plant densities.

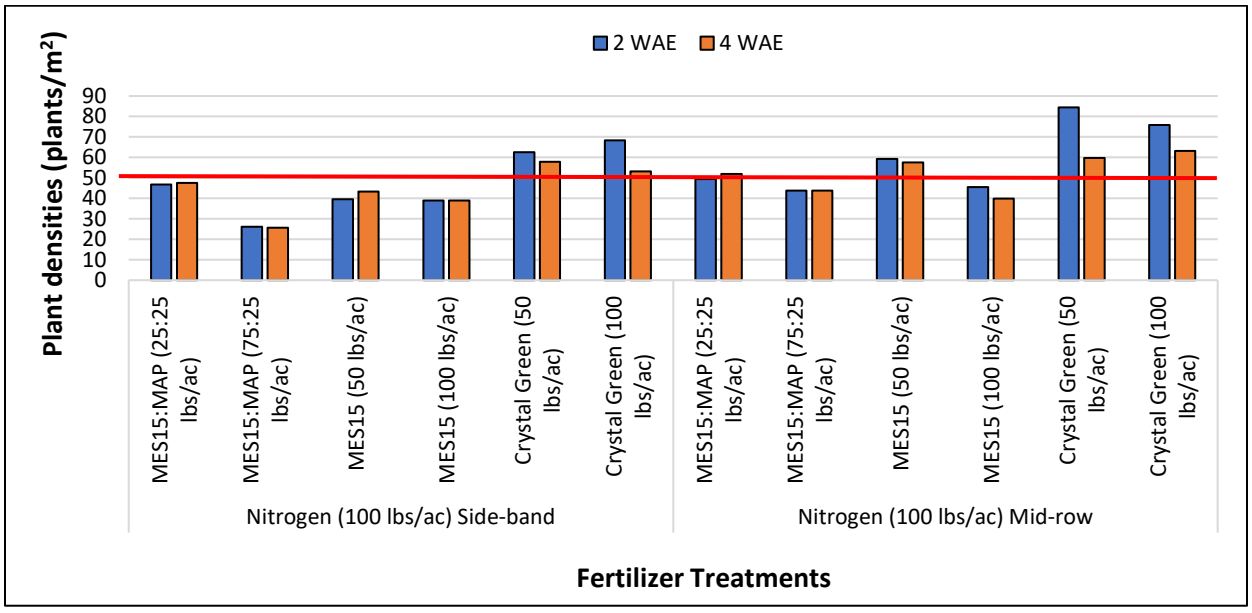

Figure 1. Canola plant densities (plants/m^2) recorded at two and four weeks after crop

emergence in response to phosphorus products and rates in combination with nitrogen placement at Scott SK, 2020.

Phosphorus Levels in Plant Tissues

Canola plants were sampled at the rosette stage to determine the tissue concentration of P and the relative P uptake of each treatment. Phosphorus products applied at 100 lbs/ac on average resulted in 0.06% higher P in the plant tissue compared to the rate of 50 lbs/ac. This is likely due to a higher supply of P with the rate of 100 lbs/ac than 50 lbs/ac, which gives the plants the ability to uptake more P. The application of Crystal Green resulted in the lowest P concentrations on average at 0.26%. The low concentration in plant tissues may be attributed to the slow-release characteristic of the fertilizer product. There may be less amounts of P available to the plant at the rosette stage than MAP or MES15, which are more water soluble than Crystal Green. If there were multiple tissue sampling times in this study over the course of the season, we likely would see changes and/or increases in P concentration in the Crystal Green treatments. Furthermore, the highest concentration of P in the plant tissues was the application of MES15:MAP at 100 lbs/ac at 0.46% with side-band N, and 0.45% with mid-row N.

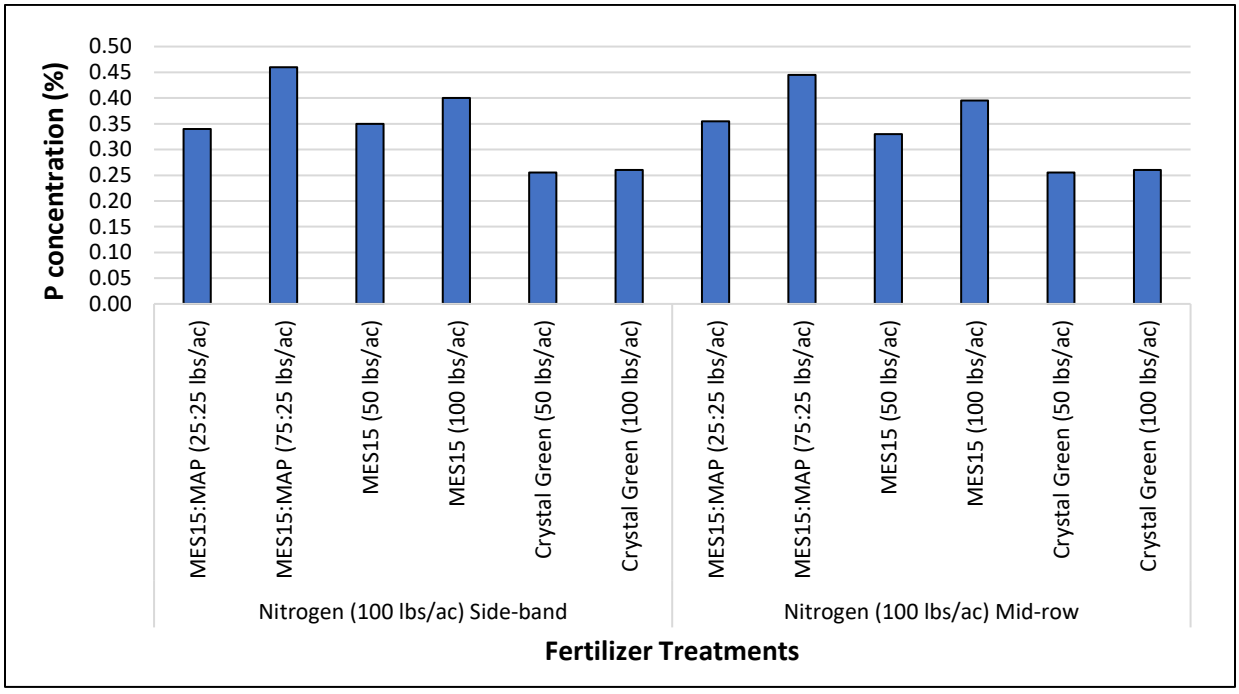

Figure 2. Percent phosphorus in canola plant tissues at the rosette growth stage in response to phosphorus fertilizer product and rates in combination with nitrogen placement at Scott SK, 2020.

Days to Maturity

Overall, there was a four-day difference between the earliest maturing treatments and the latest maturing treatments. The earliest maturing treatments at 98 DTM were the blend of MES15:MAP and MES15 alone, each at 50 lbs/ac with mid-row N. The latest maturing treatments at 102 DTM include MES15 and the blend of MES15:MAP both applied at 100 lbs/ac with side-band N. The difference in maturity observed between treatments could be caused by variability in plant densities or the availability of nutrients. The earliest maturing treatments, MES15:MAP and MES15 at 50 lbs/ac with mid-row N, observed high plant densities at 49 and 59 plants/m^2, respectively. In comparison, the late maturing treatments, MES15:MAP and MES15 at 100 lbs/ac with side-band N, observed lower plant densities at 26 and 39 plants/m^2, respectively. The higher rate of P fertilizer and N placed closer to the seed in the side-band, may have resulted in fertilizer toxicity and reduced plant densities. A lower plant density would cause canola plants to branch more, which may delay maturity. In addition, the late maturing treatments also observed higher P concentration in plant tissues (0.4-0.46%) compared to the early maturing treatments (0.33-0.36%). This is likely due to the higher rate of P fertilizer, with the late maturing treatments being applied at 100 lbs/ac compared to 50 lbs/ac. The higher P uptake and concentration would elicit more growth which may also extend the maturity. Overall, the higher P rates caused higher P uptake and more growth, as well as fertilizer toxicity when combined with side-band N to reduce plant densities and increase branching. Both increased plant growth and branching resulted in delayed maturities.

Yield

There were significant yield differences between products and application rates. There was a 6 bu/ac difference between the highest yielding treatment and the lowest yielding treatment. The highest yielding treatment was 67 bu/ac with MES15:MAP at 50 lbs/ac and mid-row N. The lowest yield was 61 bu/ac with the application of Crystal Green at 50 lbs/ac and mid-row N. On average, mid-row N combined with P at 100 lbs/ac yielded higher than P at 50 lbs/ac. In contrast, when N was side-banded; the lower rate of P at 50 lbs/ac tended to yield higher than the rate of 100 lbs/ac, excluding Crystal Green treatments.

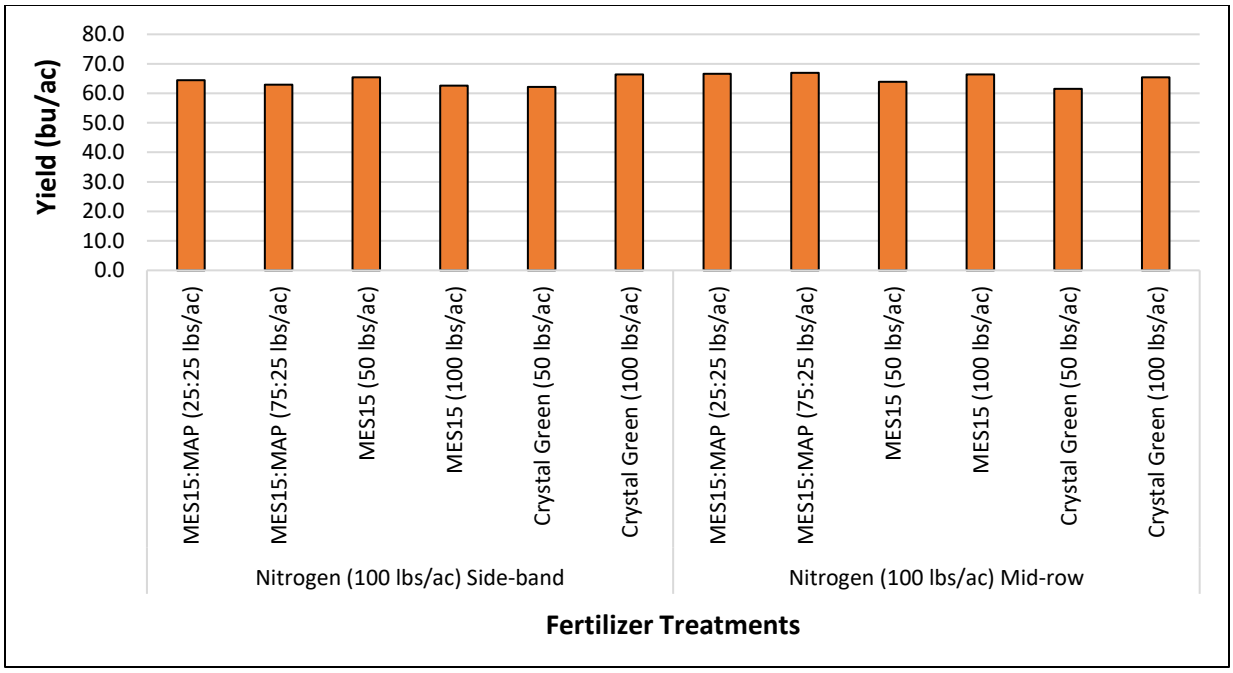

Figure 3. Yield (bu/ac) of canola in response to phosphorus fertilizer products and rates in combination with nitrogen placement at Scott SK, 2020.

Green Seed Content

Green seed was assessed to determine quality of the seed. There were minimal differences between treatments. The highest green seed was 0.2% for treatments of MES15:MAP and MES15 at 50 lbs/ac, MES15 at 100 lbs/ac each with side-band N. The lowest green seed was 0% for treatments of Crystal Green at 50 lbs/ac with side-band N, and Crystal Green at 50 and 100 lbs/ac with mid-row N. The remaining treatments had a green seed of 0.1%.

Conclusions

Overall, there were treatment differences in response to the various P products used in this study. Crystal Green treatments tended to result in the highest plant densities. According to a meta-analysis by Shirtliffe in 2009, plant densities below 50 plants/m^2 resulted in significant yield losses. All Crystal Green treatments observed plant densities above this threshold, ranging from 53-84 plants/m^2; however, Crystal Green treatments tended to result in lower yields. These results could be attributed to Crystal Green resulting in the lowest P concentrations in the plant (0.26%). P supply during the first two to six weeks of canola growth is critical to achieve optimal yields (Canola Council of Canada, 2020). The low P concentrations observed in Crystal Green treatments may be due to the slow-release quality of the product compared to MES15 and MAP, which are both more water-soluble. When the treatments were sampled at the rosette stage

Crystal Green may not have been available for plant uptake to the same degree as MES15 and MAP. While Crystal Green was able to maintain plant densities compared to MES15 and MAP, the uptake of P in early growth stages was lacking, which may have resulted in reduced yields. Therefore, if Crystal Green was not available yet due to its slow-release qualities, canola may not have been able to uptake the nutrient when it was most critical to yield.

Furthermore, treatment differences were observed for rates of P fertilizer and placement of N. As rates of P fertilizer increased from 50 lbs/ac to 100 lbs/ac, plant densities decreased for all treatments except Crystal Green with side-band N. MAP and MES15 contain higher salt indices, 27 and 21, respectively, and Crystal Green has a salt index of 8. The higher salt indices of MAP and MES15 experienced lower plant densities with increased fertilizer rates when compared to the lower salt index product Crystal Green. In addition, plant densities were reduced when N was placed as a side-band rather than a mid-row for all treatments. Higher rates of P (100 lbs/ac) resulted in 0.06% higher concentration of P in the plant compared to the lower rate (50 lbs/ac), suggesting higher rates were able to supply more P to the plant for uptake. The blend of MES15:MAP and MES15 alone resulted in the earliest maturing treatments (98 DTM) when applied at rates of 50 lbs/ac with mid-row N. However, these products also resulted in the latest maturing treatments (102 DTM) when applied at rates of 100 lbs/ac with side-band N. Thus, indicating the effect on maturity was in response to rates of P and placement of N rather than P products. Higher rates of P (100 lbs/ac) with mid-row banded N resulted in higher yields when compared to side-banding N. Additionally, when N was side-banded, lower rates of P (50 lbs/ac) yielded higher compared to higher rates of P (100 lbs/ac), this is likely caused by higher rates in the seed-row in combination with side-band N increasing the risk of fertilizer toxicity and overall reducing yield potential.

Overall, Crystal Green exhibited the greatest seed safe qualities; however, the slow-release quality of the product resulted in lower P concentrations in the plants and lower yields. MES15 alone and with MAP at lower rates (50 lbs/ac) resulted in plant densities above 50 plants/m^2, earlier maturity, and higher yields. These treatments at higher rates (100 lbs/ac) with mid-row N followed similar trends. However, when applied at higher rates (100 lbs/ac) with side-band N treatments resulted in decreased plant densities, later maturity, and lower yields. Overall, the highest yield was observed by MES15:MAP at 100 lbs/ac with mid-row N at 67 bu/ac.

Acknowledgments

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