Canola Agronomic Research Program (CARP)

Research Abstract

Project Name: Reducing toxicity of seed-placed phosphorus fertilizer in canola.
CARP Code: 2018.28
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Extension Material:

Mooleki, S.P. 2021. Reducing toxicity of seed-placed phosphorus fertilizer in canola. *In* Virtual Soils and Crops 2021 Proceedings, University of Saskatchewan, Saskatoon SK.

Schoenau, J.J., Shao, M. and Mooleki, S.P. 2021. Response of Canola to Fertilizer Phosphorus Forms and Rates. SaskCanola Soil Webinar, March 4, Saskatoon, SK.

Shao, M. 2021. Response of canola to different seed-row placed fertilizer phosphorus forms, opener configurations and rates of application. MSc Thesis submitted to the College of Graduate Studies, University of Saskatchewan, Saskatoon, SK.

Shao, M, Schoenau, J.J. and Mooleki, S.P. 2021. Response of Canola to Different Seed Placed Fertilizer Phosphorus Forms, Opener Configurations and Rates of Application, *In* Virtual Soils and Crops 2021 Proceedings, University of Saskatchewan, Saskatoon SK.

Shao, M., Schoenau, J.J. and Mooleki, S.P. 2020. A Comparison of Struvite Versus Mono-Ammonium Phosphate Fertilization on Growth and Recovery of Phosphorus in a Canola-Wheat-Pea Rotation. Proceedings of 2020 Soils and Crops, on-line, Saskatoon, SK.

Key Findings

Increasing rate of seed-placed phosphorus fertilizer can cause significant reduction in plant density due to increased toxicity of the P fertilizer to canola seeds and seedlings. This can be mitigated by increasing the width of the openers, and/or using narrow row spacing; thus increasing seedbed utilization (SBU). However, the impact on yield and quality of the canola is small, reflecting the compensatory capability of canola under reduced plant density. This confirms the anecdotal belief among producers that higher rates of seed-placed P fertilizer can be applied without hurting canola yield and quality. The seed bed utilization was not a major factor affecting uptake of the seed-row placed P fertilizer by canola.

Translation of Key Findings to the applied community

Producers seeding at 12" row spacing should avoid using openers less than 2" wide if seed-placing P fertilizer. At 12" row spacing, using 4" wide openers could help reduce toxicity of seed -placed P fertilizer. If seeding at 9" row spacing, opener width should not exceed 2" as doing so could result in too much soil being thrown over rows seeded by front row openers. Producers who are placing nitrogen (N) and sulphur (S) fertilizers away from the seed have more room to increase seed-placed P fertilizer without causing significant reduction in plant density and grain yield of canola. Opener configuration does not greatly influence P fertilizer recovery from seed-row placed P fertilizer.

Catchy opening paragraph showing the benefit/impact of the project

Phosphorus requirements of canola can be met through seed row placement without significant reduction in grain yield and quality as long as N and S fertilizers are not placed in the seed row. The safety of the seed-placed P can be enhanced by using 2" to 4" openers for those using 12" row spacing. For producers using 9" row spacing, opener width should not exceed 2", unless slower seeding speed is used. Alteration of SBU will not significantly affect P fertilizer recovery by the canola.

Purpose/Objectives

Current maximum safe rate of seed-placed P fertilizer guidelines are based only on one configuration (1" opener and 9" row spacing. At this configuration, the safe rates of seed-placed P (in lb P_2O_5/ac) for canola are 15, 20 and 25 for Alberta, Manitoba and Saskatchewan, respectively. However, these rates are not adequate to meet P requirements of canola. Hence, the objectives of this project were to determine the maximum safe rate of seed-placed P fertilizer with different opener widths and row spacing, and to develop guidelines for producers and crop advisors to use.

Methodology

We conducted a two-year (2018 & 2019) field study at five locations: Saskatoon, Melfort and Scott in Saskatchewan, and Brooks and Lethbridge in Alberta using the following treatments: Row Spacing at 9" and 12"; Opener Width at 1", 2" & 4"; and phosphorus rate at 20, 35, 50 and 65 lb P_2O_5 per acre. The treatments were arranged in a randomized complete block design with four replications at each location. The treatments were applied by a custom-built drill fitted with Morris Contour 1 shanks and rollers and Dutch Universal openers with the flexibility of changing opener width and type as well as row spacing easily. In 2018 plot size was 3 m x 10 m. In 2018 a blend of urea (46-0-0) and ammonium sulphate (21-0-0-24) was banded to a depth of three inches at 140 lb N per acre and 20 lb S per acre using 1" knife openers on the plot drill. To avoid compaction observed in 2018, in 2019, plot size was reduced to 1.2 m x 15 m, so that plots could fit within the breadth of tractor tire tracks, single disk openers were fitted on the front bar of the plot drill as mid-row openers and used to band the blend of urea and ammonium sulphate. In both 2018 and 2019, P fertilizer was seed-placed at the treatment rate. As well, in 2019, a check plot at 0 lb P_2O_5 per acre was included, bringing the total of treatments per rep to 30.

Important conditions during the research

Lack of precipitation at most locations contributed to the reduced treatment effects. Under very dry conditions in both 2018 and 2019, the seeds did not have sufficient moisture to initiate the germination process. This may have been exacerbated by the presence of phosphorus fertilizer. It is speculated that this lag in time may have resulted in gradual reduction in P toxicity, resulting in a lower reduction in plant density with increasing P rate than expected. This may sound ironic because guidelines indicate that P fertilizer toxicity may be exacerbated by low soil moisture conditions. Under dry conditions of 2019 in particular, canola seed simply remained dormant and did not germinate until soil moisture became available.

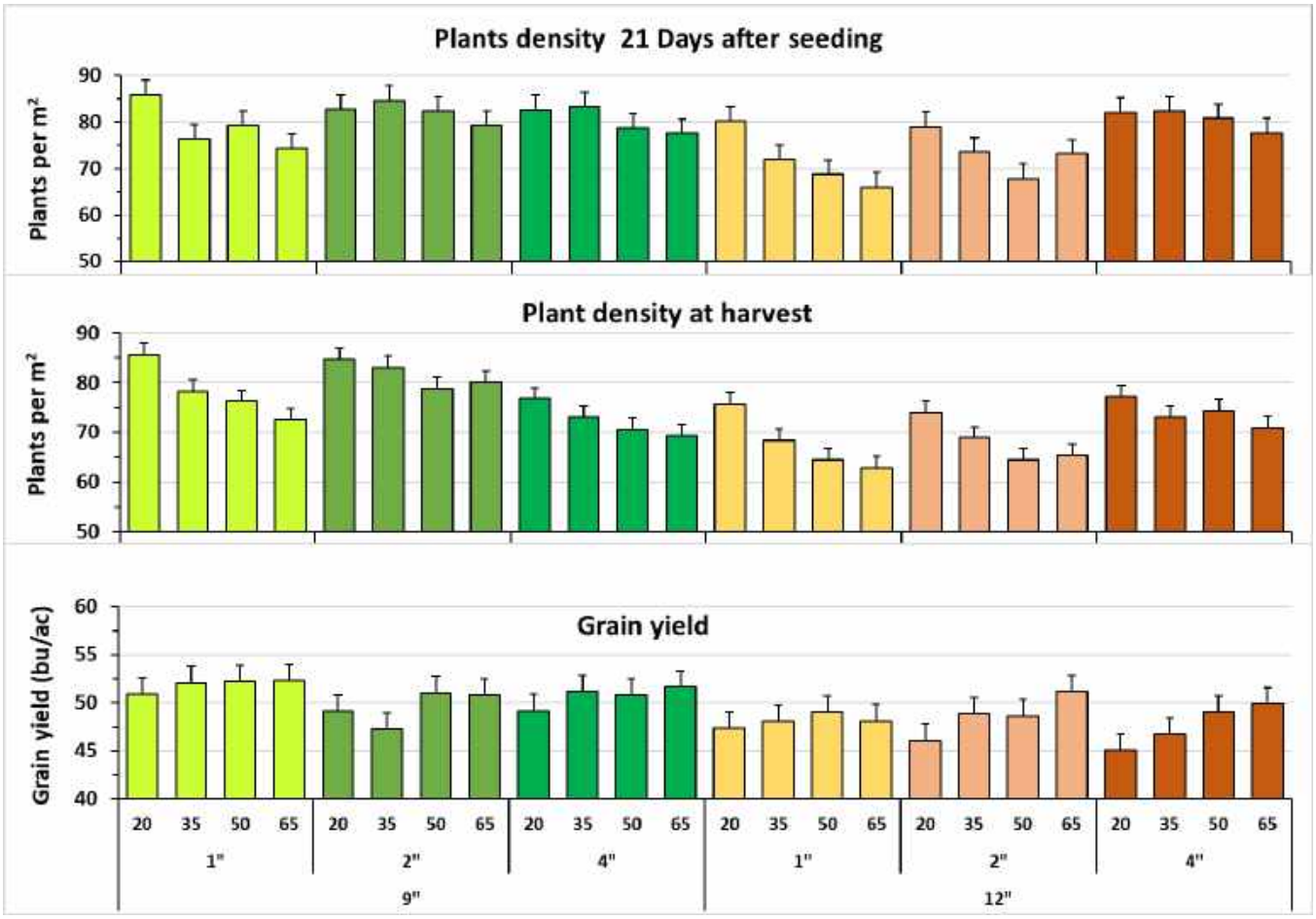
In this study, we observed less toxic effects of seed-placed P fertilizer at different SBU ratios than expected, indicating that, canola can tolerate higher levels of seed-placed P when N and S are not placed with the seed. By banding the N and S fertilizer away from the seed, we removed a significant source of toxicity which, otherwise, would enhance toxicity of seed-placed P in canola.

We suspect that the seeding speed was a little too high for the 9" row spacing and 4" opener width combination. This affected, in particular, 2019 results at a few locations.

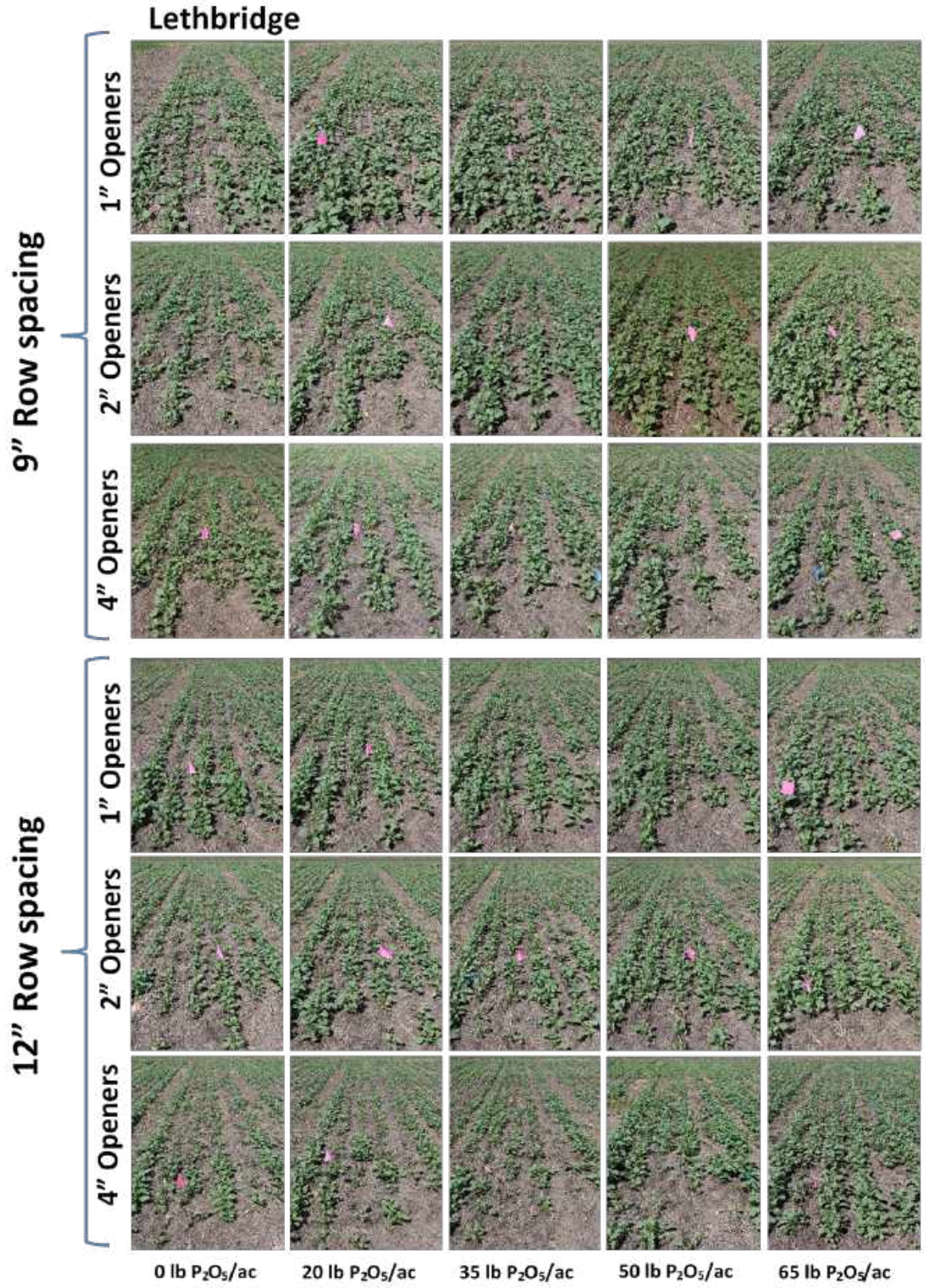
Results

Results of this study indicate that increasing seed bed utilization (SBU) by either narrowing row spacing from 12" to 9" and/or increasing opener width from 1" to 4" results in reduced P toxicity of seed-placed P fertilizer, leading to increased number of plants per unit area. Alteration of SBU did not consistently influence the plant recovery of fertilizer P for a given rate of P application, and SBU does not appear to be a major factor affecting utilization of fertilizer P by canola. Increasing the rate of seed-placed phosphorus increases the toxic effect on seed and seedlings, leading to reduced plant population. This toxicity was reduced by increasing SBU thus, reducing the concentration of P fertilizer near the seed. Despite the reduction in plant population with increasing rate of seed-placed P fertilizer, significant increase in grain yield was observed in response to phosphorus, albeit small absolute increments. This is usually attributed to the compensatory abilities of the canola plant which takes advantage of the reduced plant population by branching out more such that the individual plants that survive produce more than they would at a higher plant population. However, it's speculated that while increasing P rate resulted in increased P toxicity, leading to death of some seed and seedlings, the increased amount of available P helped surviving plants at higher rates of P yield better than the more numerous plants at low rates of P.

Figure/table/image:



Effect of increasing rate of seed-placed P fertilizer at various row spacing and opener width on plant density and grain yield of canola averaged over five locations (Melfort, Saskatoon, Scott [SK], Brooks and Lethbridge [AB]), and over two years 2018 and 2019.



Effect of increasing rate of seed-placed P fertilizer at various row spacing and opener width on plant density at Lethbridge, AB in 2019.

Highly Qualified Personnel (HQP)

A MSc student (Mr. Mingxuan Shao) was assigned to this project to work on the P uptake aspect of the project. As part of the thesis requirements for the graduate program, Mr. Shao used the biomass data from the field study to determine P uptake. Mr. Shao's work has been completed and his thesis is appended to the final report as Appendix 2. Two of the extension messaging was prepared and delivered by Mr. Shao.

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- Mr. Alick Mulenga and Mr. Arlen Kapiniak (AAFC) - Scott
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- Mr. Alan Davies and Mr. Leonard Chester (AAFC) - Saskatoon
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References:

Grenkow, L. 2013. Effect of Seed-Placed Phosphorus and Sulphur Fertilizers on Canola Plant Stand, Early Season Biomass and Seed Yield. Thesis. University of Manitoba Winnipeg, MB. https://mspace.lib.umanitoba.ca/bitstream/handle/1993/22150/Grenkow%20MSc%20Thesis%20(July%2030)%20df2.pdf?sequence=1

McKenzie, R. 2014. Determining safe rates of seed-placed fertilizer - Understanding fertilizer injury is the first step https://www.topcropmanager.com/fertility-nutrients/determining-safe-rates-of-seed-placed-fertilizer-16268

Lemke, R. L., Mooleki, S. P., Malhi, S. S., Lafond, G., Brandt, S., Schoenau, J. J., Wang, H., Thavarajah, D., Hultgreen, G. and May, W. E. 2009. Effect of fertilizer nitrogen management and phosphorus placement on canola production under varied conditions in Saskatchewan. Can. J. Plant Sci. 89: 2948.

Malhi, S. S. and Gill, K. S. 2004. Placement, rate and source of N, see-drow opener type and seeding depth effects on emergence, yield, seed quality and N uptake of canola. Can. J. Plant Sci. 84: 719-729.

Mooleki, S.P. 2016. Seed safety at high rates of seed-placed phosphorus fertilizer with increased seedbed utilization. Final Report submitted to Saskatchewan Ministry of Agriculture. ADOPT Project #: 20140399.

Qian, P., Schoenau, J. J., King, T. and Fatteicher, C. 2005. Preliminary Study on Impact of Seed-row Place P Fertilizer on Emergence and Yield of 10 Crops Under Controlled Environment Conditions. http://www.usask.ca/soilsncrops/conference-proceedings/previous_years/Files/2005/2005DOCS/081.pdf