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Performance of Soybean-based Rotations in Manitoba: Soil P and K

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Introduction

- *Soybeans have become an integral part of Manitoba cropping systems over the past 15 years, with a seeded acreage of over 1.5 million acres in 2023.*
- *Both the crop species grown in rotation, and also the frequency with which a given crop is grown, may affect the nutrient balance within a rotation.*
- *Soybean may remove higher amounts of P and K than some other crops, with a 40 bu/ac soybean crop removing ~34 lb P_2O_5/ac and 56 lbs K_2O/ac (Manitoba Pulse and Soybean Growers 2023).*
- *To determine the effect of the P and K management practices used in rotations over time, soil P and K levels were measured annually over 8 years.*

Materials and Methods

In 2014, a field experiment was established on a Newdale clay loam soil north of Brandon, Manitoba to investigate five rotations ranging in duration from 2 to 3 years, and consisting of various combinations of soybean (S), wheat (W) and canola (C) (Table 1).

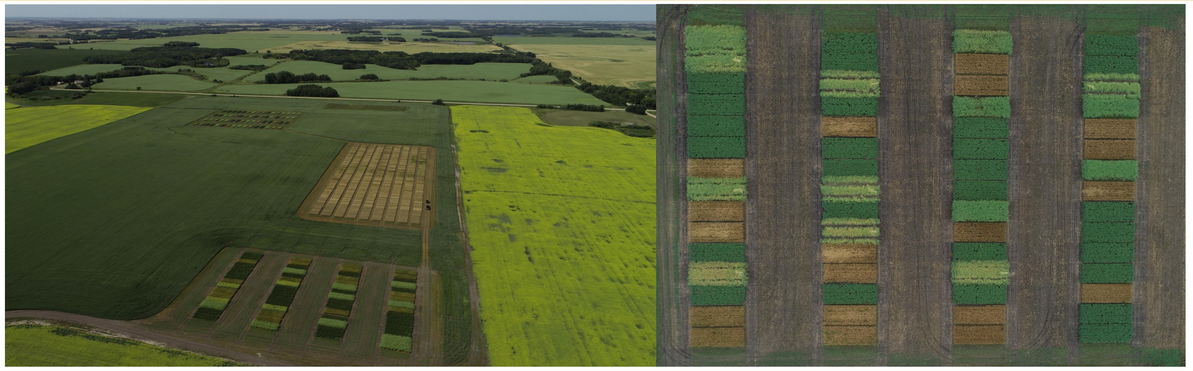
Table 1: Rotation Treatments

2-year	soybean-canola	SC
	soybean-wheat	SW
3-year	soybean-wheat-canola	SWC
	soybean-canola-wheat	SCW
	soybean-soybean-wheat	SSW

Treatments were arranged in a Randomized Complete Block Design (RCBD) with each phase of each rotation present in each year (Fig. 1). All crops were direct-seeded into stubble and managed using generally-accepted agronomic practices.

Due to low initial soil test P levels, P management practices were established to slowly build soil P over time. Soil K levels were sufficient for crop growth; therefore, no fertilizer K was applied during the study.

Figure 1. Rotation study located north of Brandon, MB at AAFC's Phillips Farm



Because of the longer-term nature of this rotation experiment, it provided an opportunity to monitor the effect of these P and K management practices on soil nutrient reserves over time.

To do this, several soil cores were collected from each plot each fall and composited, and Olsen P and K were determined in the surface soil (0-15 cm depth).

Available data for the period 2014 through 2021 are reported herein. The study is continuing, and soil test data will continue to be monitored over time.

Results and Discussion

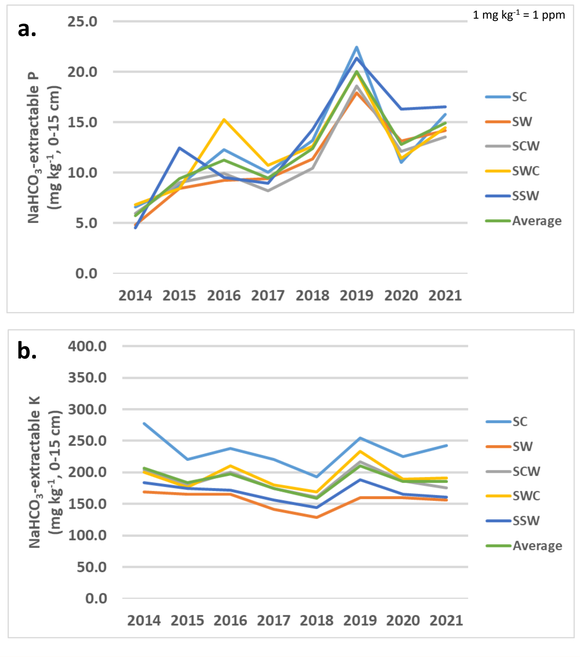
Soil P

- Soil test P (Olsen) in the surface soil (0-15 cm) increased over the 8-year period of the study from an average of about 6 to 15 mg P kg^{-1} (Fig. 2a).
- While annual testing revealed some year-to-year variability, a general upward trend was evident over the course of the study.
- Elevated levels of soil test P were noted in all rotations in 2019, however. This coincided with wet fall conditions prior to soil sampling in 2019, with 210 mm of precipitation received in September.

Soil K

- Soil test K level varied somewhat from year-to-year over the period 2014-21, but remained in the same general range for all rotations (Fig. 2b).

Figure 2. Fall soil test P and K (Olsen, 0 to 15 cm) in five crop rotations of soybean (S), canola (C) and wheat (W) over an 8-year period (2014-2021)*, (Reported soil test values are the average of all phases of a given rotation in a given year.)**



*Each year, P in the form of monoammonium phosphate was side-banded at a rate of about 76, 57 and 50 kg P_2O_5 ha^{-1} for canola, soybean and wheat, respectively. This was estimated to be equivalent to 1.5 times the P removal rate of each crop based on historical yields for the area and the book value for P removal in the harvested grain of each crop.

**No K-containing fertilizer was applied over the course of the study as soil test levels were considered adequate for crop production.

- As noted for P, soil test K appeared to be slightly higher overall under the wet fall conditions in 2019.
- Annual assessments of fall soil test P and K after each of soybean, canola and wheat showed no differences among rotations following a given crop during the period 2016-21 (data not presented).

Summary

- Regular soil testing provides a useful tool for monitoring the effects of nutrient management practices on soil P and K levels over time.
- In the current study, annual applications of fertilizer P (as side-banded MAP) at a rate equivalent to ~1.5 times the estimated P removal rate in harvested grain were effective in increasing soil test P from about 6 to 15 mg Olsen P kg^{-1} over an 8-yr period.
- This type of 'long term sustainability approach' provides one strategy for building soil P reserves from a low to medium/high level in order to support long-term productivity (Heard et al. 2015).
- For K, while year-to-year variability was evident, none of the rotations appeared to markedly deplete soil K in this Newdale clay loam over the 8-year study period even though no fertilizer K was applied.

References:
Heard, J., Grant, C., and Flaten, D. 2015. Phosphorus fertilization strategies for long-term agronomic and environmental sustainability. Online. https://www.manitobapulse.ca//wp-content/uploads/2015/03/Phosphorus-Recommendation-Strategies-for-Manitoba-v5-2.pdf
Manitoba Pulse and Soybean Growers. 2023. Soybean fertility factsheet. Online. https://www.manitobapulse.ca/production/soybeans/crop-nutrition/

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