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/acre soybean crop removing ~34 lb P₂O₅/ac and 56 lbs K₂O/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>
<thead>
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<th>Table 1: Rotation Treatments</th>
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<tr>
<td>2-year soybean-canola</td>
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<tr>
<td>soybean-wheat</td>
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<td>3-year soybean-wheat-canola</td>
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<td>soybean-canola-wheat</td>
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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.

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).

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.

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

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 monosodium phosphate was side-banded at a rate of about 76, 57 and 50 kg P₂O₅/ac 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-year 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.

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References: