Updated Phosphorus Rate Guidelines for Manitoba

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Background

- Phosphorus (P) fertilization rate guidelines have not been updated since the early 1990's.
- The following is a proposal to retain the existing short-term sufficiency rate approach and to offer a longer term, sustainability strategy to build and maintain soil test P (STP) levels in a medium-high range.
- These approaches are used by others[1] and the rationale for these options are provided.

Rationale:

- Prairie crop response to P application is difficult to predict year by year (Figure 1) and is better portrayed as a probability of response (Table 1).

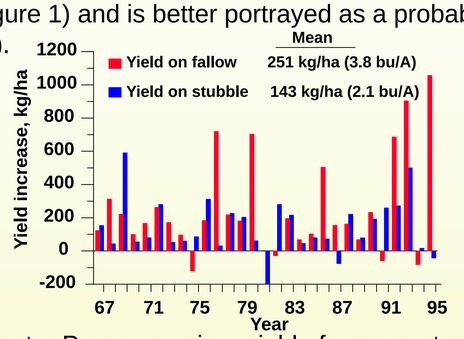


Figure 1.Starter P response is variable from year to year and one rotation phase to another. Roberts et al. 1999.[2] with 20 kg P_2O_5/ha applied yearly to a fallow-wheat-wheat rotation near Swift Current, SK

Table 1. Manitoba crop response to P by soil test P (Hedlin, 1962[3]).

Available Soil Test P ppm Olsen and Rating		Number of Experiments	% Responding to Fertilizer P
0-5	Very Low	15	100
5-12	Low - Med	50	62
12-18	Medium - High	16	56
>18	High	14	29
Overall		95	63

- Where crop response occurs about half the time, it is rated a medium to high soil test range and is generally considered a desirable STP range for economical crop production.

- Between 2001 to 2015 the portion of Manitoba soils testing Medium declined while the portion testing Very Low increased (IPNI, 2015).
- This is concerning since studies have shown greater crop productivity on soils built to higher P levels than where annual applications of P were made alone on low test soil (Figure 2).

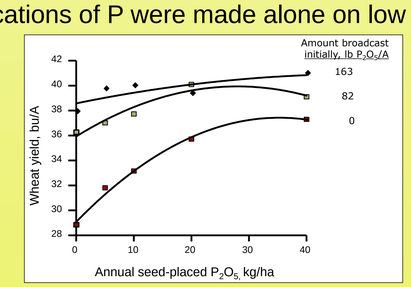
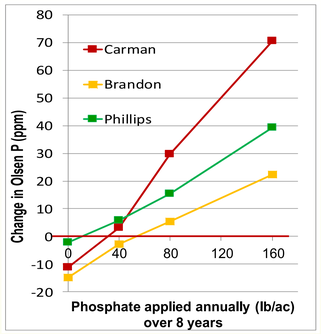


Figure 2. Wheat response to a single batch application of P and annual P applications over 5 crop years (Wager et al, 1986[4]).

- Similar studies of large batch P applications which built STP were economically advantageous to annual applications alone in the moister Prairie region under continuous cropping (Jose, 1981[5]).

Rationale (cont):

- Recent research illustrates that some 40 lb P_2O_5 /acre year was required to meet P crop removal and maintain STP levels (Figure 3).
- Manitoba soils differed in their P buffering capacity (BC) , ie the amount of P_2O_5 removal or addition to change the STP by 1 ppm.



At Carman a sandy loam soil with neutral pH had a BC of about 15 lb P_2O_5 to increase STP 1 ppm
Two Brandon area sites of calcareous clay loam soils had a BC between 25-35 lb P_2O_5 to increase STP 1 ppm

Figure 3. Soil P changes with varying P application rates over 8 years in a durum wheat-flax rotation (Grant et al, 2014[6])

- Increasing crop yields would be expected to increase P removal amounts (Table 2).

Table 2. Current* and proposed** crop P removals.

Crop		Yield Bu/ac	P conc. Lb P_2O_5/bu	Removal Lb P_2O_5/ac
Spring wheat	Current*	40	0.6	24
	Proposed**	60	0.57	34
Barley	Current	80	0.42	34
	Proposed	80	0.4	32
Oats	Current	100	0.25	25
	Proposed	120	0.28	34
Corn	Current	100	0.44	44
	Proposed	140	0.35	49
Canola	Current	35	1.04	37
	Proposed	45	0.8	36
Soybeans	Current	35	0.83	29
	Proposed	40	0.73	29

- *Current values from the Manitoba Soil Fertility Guide (2007)[7] based on CFI, 2001[8]
- **proposed values are recent 3 year average MASC[9] yields rounded to nearest 5 bu/ac and P concentrations published by IPNI (2014)[10].

- Despite large yield increases of some crops (corn, canola), lower P concentration produced only slight changes in removal

(We plan to verify these P uptake and removal values with field trials in 2019).

- A model to build very low and low testing soils into a medium-high range and draw down very high testing soils is presented below.
- Such a model requires estimates of P crop removals (Table 2) and the soil P buffering capacity (BC)(Figure 3).

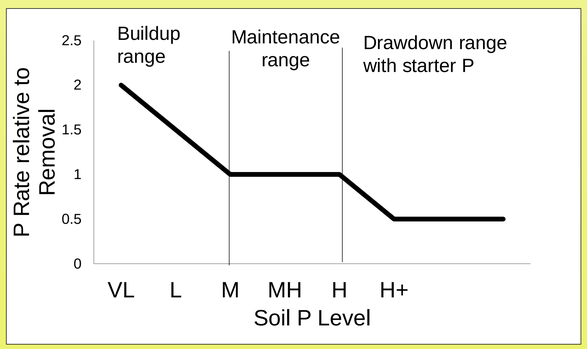


Figure 4. A conceptual model to move soil test values to a Medium - High range (modified from Ontario Soil Fertility Handbook[11])

Proposed P Rate Guidelines

1) retain current P rate guidelines stated as the SUFFICENCY APPROACH (Table 3), which:

- offers good short-term returns on P application
- generally leads to P deficiency with STP stabilizing in the low category over the long-term.
- appropriate for short-term management of rented land, short land tenure or years with poor crop prices and/or high fertilizer P costs.
- no recent research would support increasing these rates.

2) The BUILD and MAINTENACE APPROACH (Table 3), which:

- should be considered an investment in long-term productivity.
- is not intended to provide optimum economic returns in a given year but to minimize the probability of P limiting yields by providing high yield potential.
- builds low STP, maintains medium STP level with removal rates, and draws down very high STP by using starter P rates (perhaps 1/3 to 1/2 crop removal) with STP levels eventually stabilizing in that medium-high range
- Regular soil testing is used to monitor progress.
- Approach should be flexible and modified for grower's economic situation, farm goals, land tenure, soils, yield levels and time frame.

- Rates in Table 3 are derived as follows:

$$\text{Application rate} = \frac{(\text{Target STP} - \text{Current STP}) \times \text{BC}}{\text{Years to Build}} + \text{CR}$$

- Example for 60 bu/ac wheat, current STP = 5 ppm and 5 years to build:
- Target STP (15 ppm)
- Crop removal (CR) = yield x P concentration (Table 2)
- Typical P buffering capacity (BC) by soil characteristics (assuming 25 lb P_2O_5 /ac to increase 1 ppm STP from Figure 3)
- Time frame to build, assuming 5 years

$$= \frac{(15-5) \times 25}{5} + 34 = \frac{(250)}{5} + 34 = 84 \text{ lb } P_2O_5 \text{ ac}$$

Table 3. Proposed guidelines for phosphorus fertilization.

Soil test Olsen P ppm	Sufficiency Wheat, Canola Oats, Soybeans	Build and Maintenance Approach Wheat	Canola	Oats	Soybeans
	lb P_2O_5/ac				
0	40	110	110	110	105
5	40	85	85	85	80
10	30	60	60	60	55
15	15	35	35	35	30
20	10	10	10	10	0
20+	10	10	10	10	0

This concept will be presented to the 2019 Manitoba Soil Fertility Advisory Committee meeting.

- It is critical that other 4R Nutrient Management components of Source, Placement and Timing be utilized to optimize P efficiency, seed safety, etc.
- Rotational fertilization, including batch P applications such as manure utilization, will be encouraged.

References: attached