



Agriculture and Fisheries

Determining Phosphorus Fertilization Requirements for Potatoes based on Phosphorus Saturation Index for PEI

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Phosphorus (P) supply to a crop can be difficult to manage due to its immobility and ability to form strong complexes with aluminum and iron. Over time, if more P is applied than crop requirements, the extra P remains and will build up in the soil. If this P builds up to high levels it can cause environmental issues as it can be lost to water bodies by soil erosion.

There has been recent work outlining P availability within PEI agricultural soils to provide more information on P fertility for potatoes. From 2000-2015, over 42 different P fertilization tests were conducted within PEI, NS and NB with three different potato cultivars. The results from these tests have led to development of both an agronomic and an environmental index for PEI, along with new phosphorus recommendations for potatoes. The environmental index and the basis of the P-Saturation Index have been discussed in a recent factsheet (see the PEI Department of Agriculture and Fisheries' Factsheet "Understanding the factors controlling phosphorus availability for crop production on PEI" available at: <https://www.princeedwardisland.ca/en/information/agriculture-and-fisheries/understanding-factors-controlling-phosphorus-availability-crop>).

The environmental P-Saturation Index estimates the critical values of the risk of P transport to the surrounding environment. The six environmental P risk classes based on soil pH for PEI are found in the following table (Table 1). It was observed that soils with soil pH below 5.5 retain more P than those above soil pH 5.5.

Table 1. Environmental P risk classes for PEI.

Risk Class	P-Saturation Index (% P/Al)	
	For soils with pH < 5.5	For soils with pH > 5.5
Very Low Risk	0-7	0-4
Low Risk	7-11	>4-7
Moderate Risk	11-19	>7-14
High Risk	19-21	>14-16
Very High Risk	21-30	>16-23
Extremely High Risk	>30	>23

An agronomic index has since been developed to provide updated crop recommendations for potato varieties to better reflect crop uptake in PEI soils. Phosphorus availability to crops in acidic soils is based on a P-Saturation Index, which is derived from a function of the total amount of soil P (in ppm) by the total amount of aluminium within the soil. The P-Saturation Index is reported on the bottom left hand side of the PEI Analytical Laboratories soil report as "% P/Al". All P, aluminum (Al) and iron (Fe) elements are extracted with Mehlich-3 extraction solution at the PEI Analytical Laboratory (PEIAL). See P Saturation Index equation below.

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$$\text{P-Saturation Index}_1 (\%) = \frac{\text{P (ppm)}}{\text{(Al ppm)}} \times 100$$

Note: The P value used within the P-Saturation Index equation is calculated using elemental P. To convert the P₂O₅ value on the PEIAL soil report to elemental P, multiply the P₂O₅ value on the report by 0.436.

Iron is sometimes included in calculating the P-Saturation index (see P-Saturation Index₂, below) for soils that are very acidic (such as those found in Quebec used to grow cranberries) or for peat or boggy soils. In PEI, the relationships between P-Saturation Index₁ (without Iron) and P-Saturation Index₂ (including Iron) were assessed and found to be highly correlated (P-Sat₁= 1.26 x P-Sat₂), and so the new P recommendations are based only on P-Saturation Index₁ without Iron.

$$\text{P-Saturation Index}_2 (\%) = \frac{\frac{\text{P (ppm)}}{31}}{\left(\frac{\text{Al (ppm)}}{27} + \frac{\text{Fe (ppm)}}{56}\right)} \times 100$$

New P recommendations for soils with pH above 5.5 have been developed for PEI based on well-established trial results (Table 2). **Because the new P recommendations were developed on a plot scale, they need to be validated at larger scale, and are proposed here as a guideline for field trials to assess.** However, these new P rates developed for PEI appear to be comparable with those developed for New Brunswick and Quebec (CRAAQ 2010; New Brunswick Department of Agriculture 2010). Before implementing the new P recommendations for potato based on the P-Saturation index, we recommend their validation in commercial fields to reflect large scale variation in comparison to current P fertilization rates.

Table 2. Comparison of current potato P recommendations versus those based on P saturation index

Previous P Recommendations (before 2018, based on soil levels)		Updated P Recommendations (2018 onward, based on P- Saturation Index)		P Savings
Soil Level	Recommended Rate (kg P ₂ O ₅ /ha)	P-Saturation Index (P/Al %)	Recommended Rate (kg P ₂ O ₅ /ha)	(kg P ₂ O ₅ /ha)
L-	400	0-2.5	240-300	100-160
L	275	> 2.5- 5	185	90
M	200	> 5-10	160	40
M+	200	> 10-14	100	100
H	135	> 14-16	75	60
H+	135	> 16-23	50	85

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