How Quickly Will Soil Test P Levels Increase?

Introduction

A good supply of phosphorus (P) is necessary for optimum crop yield and producers strive to take care of their land by building P fertility. Building fertility is commonly accomplished by adding P in excess of plant needs so that soil test P increases over time (building a soil fertility "bank"). Manure has served as a major source of many nutrients for meeting crop needs while building fertility. However, matching crop nitrogen (N) and P needs with manure can be challenging. One issue is that without incorporation of the manure, the ammonia portion of manure-N will be lost, resulting in a usable N to P ratio of just 1:1, while corn needs a 2:1 ratio of N:P. Thus, surface application of manure to meet N needs leads to P application about twice what the corn plant will remove through harvest. This management has served to satisfy the goal of building P fertility level over time; but, many fields now exceed critical agronomic P response levels. While high P fertility is not necessarily bad, eventually, environmental risk indices will call for a reduction in application rate or even elimination of P applications in some situations. Producers and planners want to know how long it may be before soil test P increases to such levels that alternative manure application sites need to be found. In this fact sheet we summarize the major findings of a laboratory incubation study to address this question and include guidance for manure management for non-calcareous soils.

Research

We conducted a laboratory incubation study using monoammonium phosphate (MAP) and liquid dairy manure as P sources, 0.01 *M* $CaCl_2$ P as environmental P indicator, and Morgan and Mehlich-3 P as agronomic soil tests. The study was conducted with non-calcareous New York soils and findings should not be applied to calcareous soils (additional research is needed for these soils).

Findings

- Extractable P decreased over 60 days; $CaCl_2$ extractable P decreased more rapidly over time than Morgan P which decreased quicker and to a greater extent than Mehlich-3 P.
- Soils that are high in P exhibited a faster increase in soil test P when additional P was supplied, showing there is a lower capacity to bind P as soil test P increases.
- Extractable Al was a good indicator of the amount of P required to raise Morgan soil test P level one unit. Extractable iron had no effect on soil test P increase (Figure 1).

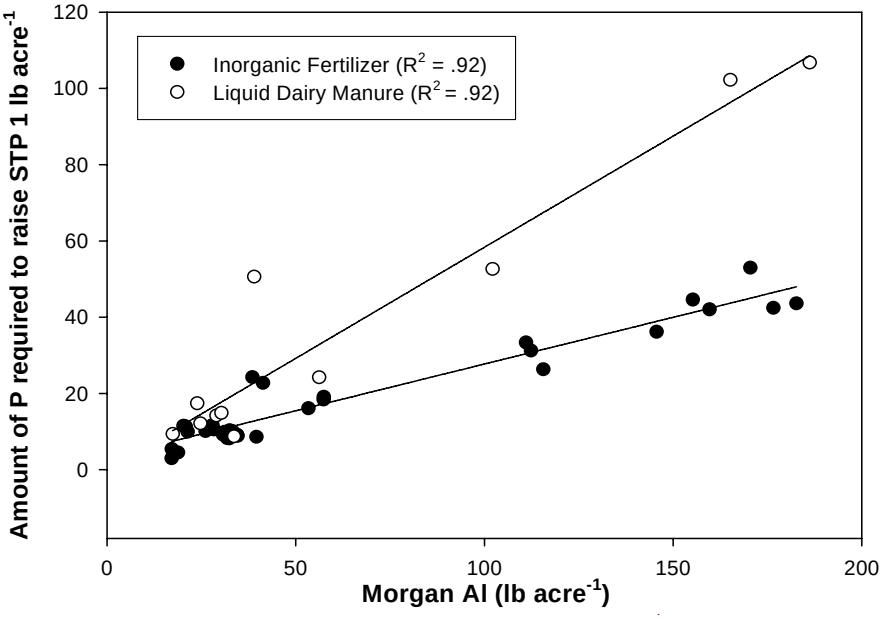

Figure 1. The increase in Morgan soil test P upon fertilizer and manure application (rates given in lbs P_2O_5/acre without plant uptake) depends on the amount of Morgan extractable Al in the soil and the P source (fertilizer or liquid dairy manure).

- In contrast to Morgan-based predictions, the Mehlich-3 data offered relatively poor estimates of the amount of P required to raise soil test P most likely reflecting the fact that the Mehlich-3 test extracts Al from a range of more stable compounds not directly associated with P sorption. The Morgan extraction releases Al from a readily available pool likely to bind with P.
- The increase in soil test P was affected by P source; MAP raised P levels more efficiently than liquid dairy manure. This shows that not all P in liquid dairy manure is plant available within 2 months after application.

Implications

- All other factors (such as transport risk and soil test P) being equal, soils with a higher amount of Morgan extractable Al will store more P over time.
- For planners that wish to reduce agronomic risk associated with converting Mehlich-3 data to Morgan values, it is important to avoid sampling within 2 months of manure application.

Caution

The results of this study apply to non-calcareous soils and granular MAP and liquid (untreated) dairy manure only. Additional studies are currently being conducted using 15 Northern New York (non-calcareous) soils and 10 different P sources (Table 1). The focus of this study is on the impact of form of fertilizer (ammonium or calcium based, liquid or granular) and manure separation and/or chemical treatment on plant available P. Results of this study will be published in a future fact sheet.

Table 1: Treatments in currently ongoing soil test P research. This work is focusing on non-calcareous soils from Northern New York Counties.

Treatments		
1	Control (no P added)	
2	APP (10-34-0)	liquid
3	MAP (13-52-0)	granular
4	MAP (13-52-0)	liquid
5	Raw dairy manure	
6	Raw dairy manure	+ alum
7	Raw dairy manure	+ Al chloride
8	Separated liquids	
9	Separated liquids	+ alum
10	Separated liquids	+ Al chloride
11	Separated solids	

These studies are being conducted in the absence of growing plants. Field studies are needed to determine soil test P increase in the presence of plant roots and with P removal through harvest.

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Soil Testing and Phosphorus Application Decisions

- All other factors (such as transport risk and soil test P) being equal, soils with a higher amount of Morgan extractable Al will store more P over time.
- For planners who wish to reduce the agronomic risk associated with converting Mehlich-3 soil test data to Morgan values, it is important to avoid sampling within 2 months of application.

Additional Resources

- Cornell University Agronomy Fact Sheet #10 (The New York Phosphorus Runoff Index), #12 (Phosphorus Basics – The phosphorus Cycle), #13 (Managing P Runoff with the Phosphorus Runoff Index): http://nmsp.css.cornell.edu/publications/factsheets.asp.
- New York Phosphorus Runoff Index webpage: http://msp.css.cornell.edu/publications/pindex.asp.

Full Research Reference

Haden, V.R., Q.M. Ketterings, and J.E. Kahabka (2007). Factors affecting the change in soil test P levels following manure and fertilizer application. Soil Science Society of American Journal 71:1225-1232.

Disclaimer

This fact sheet reflects the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of particular discharge levels from agricultural land.

For more information

Cornell University Cooperative Extension

Nutrient Management Spear Program
http://nmsp.css.cornell.edu

Ryan Haden, Quirine Ketterings, Jason Kahabka and Karl Czymmek

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