Fluids and P Management to Minimize Loss to Surface Waters

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Overview

• The Issue
  • Transport of different P fractions (soluble and sediment-bound)
  • Managing Loss Pathways (Source and Placement)
    • How does source impact transport?
    • How does placement impact transport?
P Transport and The Issue in Ohio
Figure 4 - Factors affecting the input, fate, and transport of P in agricultural systems. Numbers in parentheses are based on approximate farm inputs of P in animal feed and fertilizer and output in animal produce (A) and manure and fate in soils, crops, and transport in runoff (B). Adapted from Howarth et al. (2000) and Sims and Sharpley (2005).
Generalized Model

Figure 4 - Factors affecting the input, fate, and transport of P in agricultural systems. Numbers in parentheses are based on approximate farm inputs of P in animal feed and fertilizer and output in animal produce (A) and manure and fate in soils, crops, and transport in runoff (B). Adapted from Howarth et al. (2000) and Sims and Sharples (2005).
Lake Erie (A Very Brief History)

Target total P load of 11,000 metric tons per calendar year set by International Joint Commission in early 70s.
Changes in Phosphorus Loading

Annual Flow Weighted Mean DRP Concentration

Data from Heidelberg University, 2015
Loading of DRP
Ohio Potassium and Phosphorus Consumption

Source: AAPFCO
Animal Numbers in Ohio

Source: USDA
Ohio Potassium and Phosphorus Removal

Source: USDA, IPNI
Phosphorus Balance in Ohio (1975-2012)

Percentage of Soils Below the Critical Level

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2010</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>23%</td>
<td>36%</td>
<td>35%</td>
</tr>
<tr>
<td>P</td>
<td>42%</td>
<td>42%</td>
<td>48%</td>
</tr>
</tbody>
</table>

Nutrient Balance Data

Potassium balance trends are down 76%.

Phosphorus balance trends are down 160%.

Source: eKonomics
Soil Test Changes Over Time

- Are soil test levels too high?

**Phosphorus sample distribution: Ohio**

<table>
<thead>
<tr>
<th>Year</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>69,385</td>
</tr>
<tr>
<td>2005</td>
<td>85,777</td>
</tr>
<tr>
<td>2010</td>
<td>248,760</td>
</tr>
<tr>
<td>2015</td>
<td>327,580</td>
</tr>
</tbody>
</table>

73% of soils less than 40ppm
The Issue

• Still not clear what the central, driving issue is

• Increased loading of phosphorus to the lake? - No

• Increased loading of dissolved reactive phosphorus? (blamed on conservational tillage and increased use of drainage tile) – Maybe (stratification?)

• Increased use of tile risers? Unknown

• Delayed incorporation of fertilizer applications? Maybe

• Sins of the past, sediment loaded with P occupying intermittent streams that gets resuspended during rainfall events? – Maybe

• Shunting of historic retention areas to avoid flooding of cities? - Maybe
Managing Loss Pathways – Source/Placement
Phosphorus Loss

- Incorporation versus surface application

Phosphorus Loss

- Incorporation of manure versus surface application
- Tillage done with disk harrows (3 locations), chisel plow (1 location), and rotary tiller (4 locations)

Phosphorus Loss

Looking at the previous study another way

Phosphorus Loss

- Incorporation versus surface application over a rotation (cumulative load over 2-years)
Phosphorus Loss

- Incorporation versus surface application over a rotation (cumulative load over 2 years)
Phosphorus Loss

- Incorporation versus surface application
- Two fertilizer materials (commercial and poultry litter) (conducted in Wauseon)
Phosphorus Loss

- Incorporation versus surface application
- Conducted at NWARS

Source: Ohio State field research
## Phosphorus Loss

Table 1. Fertilizer treatments used for rainfall simulations, including the rate of each fertilizer applied, soluble P (SP) lost, and relative loss compared with applied.

<table>
<thead>
<tr>
<th>Fertilizer source</th>
<th>Placement</th>
<th>Nomenclature</th>
<th>Rate</th>
<th>SP load</th>
<th>Relative loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monoammonium phosphate</td>
<td>Surface</td>
<td>MAP</td>
<td>112</td>
<td>89.3 a</td>
<td>17.4 a</td>
</tr>
<tr>
<td>Diammonium phosphate</td>
<td>Surface</td>
<td>DAP</td>
<td>127</td>
<td>84.6 a</td>
<td>16.5 a</td>
</tr>
<tr>
<td>Triple super phosphate</td>
<td>Surface</td>
<td>TSP</td>
<td>127</td>
<td>97.3 a</td>
<td>19.0 a</td>
</tr>
<tr>
<td>Polyammonium phosphate</td>
<td>Surface</td>
<td>Poly</td>
<td>172</td>
<td>2.1 d</td>
<td>0.17 d</td>
</tr>
<tr>
<td>Single super phosphate</td>
<td>Surface</td>
<td>SSP</td>
<td>324</td>
<td>66.8 b</td>
<td>13.0 b</td>
</tr>
<tr>
<td>Bone meal</td>
<td>Surface</td>
<td>Bone</td>
<td>417</td>
<td>8.6 d</td>
<td>1.45 d</td>
</tr>
<tr>
<td>Rock phosphate</td>
<td>Surface</td>
<td>Rock</td>
<td>1945</td>
<td>3.0 d</td>
<td>0.37 d</td>
</tr>
<tr>
<td>Poultry litter</td>
<td>Surface</td>
<td>PL</td>
<td>1459</td>
<td>25.5 c</td>
<td>4.80 c</td>
</tr>
<tr>
<td>Unfertilized control</td>
<td>–</td>
<td>Unfert</td>
<td>–</td>
<td>1.2 d</td>
<td>–</td>
</tr>
<tr>
<td>MAP</td>
<td>Banded</td>
<td>Sub/MAP</td>
<td>112</td>
<td>1.8 d</td>
<td>0.13 d</td>
</tr>
<tr>
<td>Poly</td>
<td>Banded</td>
<td>Sub/Poly</td>
<td>172</td>
<td>1.5 d</td>
<td>0.07 d</td>
</tr>
<tr>
<td>PL</td>
<td>Banded</td>
<td>Sub/PL</td>
<td>1459</td>
<td>4.0 d</td>
<td>0.57 d</td>
</tr>
</tbody>
</table>

Source: Smith et al., Ag & Environ. Letters, 2016.
Importance of Intensity of Rainfall Events

Source: Josh McGrath, University of Kentucky (research he did in Maryland)
Summary

- Managing two different fractions
- Particulate P
  - Conservation tillage keeps soil in place
  - Manages particulate P transport quite well
Summary

- Dissolved P (as a result of fertilization)
- Surface applications without incorporation (except maybe liquid sources – at least poly?) can increase dissolved P transport because fertilizer has less interaction with soil
- Applications that place fertilizer material below soil surface are preferred
- Knife/injection will decrease transport potential (at least for surface flow), but this can create other issues (soil testing specifically)
Thank you

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