Cover Crops and Phosphorus Speciation in Ohio

Why so much SRP in Surface Water?

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Source: http://www.glerl.noaa.gov/res/Centers/HABS/graphics/wle_hab2_%20072211.jpg
Grand Lake St. Marys 2010
Maumee River, Dissolved Reactive Phosphorus, Flow Weighted Mean Concentration

Source: Hiedelberg University
Phosphorus in Crop Production

Phosphorus Losses to the Environment
"P stabilizes the OM and forms a bridge to the clay. Our current P use efficiency is 10-25-50%.\"
Phosphorus Speciation: How Soil P is tied up

- Microbial – $P_o$  \(P_o\)-Organic P
- Soluble Reactive (SRP) $P_i$  \(P_i\)-Inorganic P
- Exchangeable (EP) $P_o$  Active Carbon
- Ca\(^{2+}\) /Mg\(^{2+}\)  Calcium/Magnesium
- Fe\(^{3+}\) /Al\(^{3+}\)  Iron/Aluminum
- Res P\(_o\)  Residual P\(_o\)-Humus
- Total P  \(= \text{All } P_o + \text{All } P_i\)
- Murphy & Riley Standard P Extraction (1962)
<table>
<thead>
<tr>
<th>Oxidized State</th>
<th>Reduced State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron (III) - Fe(^{3+}) (Ferric Fe)</td>
<td>Iron (II) - Fe(^{2+}) (Ferrous Fe)</td>
</tr>
<tr>
<td>Yellow-Red</td>
<td>Yellow-Grey</td>
</tr>
<tr>
<td>Manganese – MN(^{4+})</td>
<td>Manganese - MN(^{2+})</td>
</tr>
<tr>
<td>Pinkish Color</td>
<td>Grey-Black</td>
</tr>
<tr>
<td>Copper – Cu(^{3+})</td>
<td>Copper - Cu(^{2+})</td>
</tr>
<tr>
<td>Light Blue</td>
<td>Green</td>
</tr>
</tbody>
</table>
SRP in Surface Water

Two Key factors:
a) Soil P concentration
b) Transport Factor

Soil P concentration
* Transport Factor
= Pounds of P Lost to Surface Water
Cover crops had significantly lower soil concentration of P in the SRP (4.2x less), Res P, and Total P but much higher EP (8.8X), CaP, and FeP.

<table>
<thead>
<tr>
<th></th>
<th>SRP</th>
<th>EP</th>
<th>CaP</th>
<th>FeP</th>
<th>Res P</th>
<th>Total P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover Crops</td>
<td>0.34b</td>
<td>1.23a</td>
<td>21.2a</td>
<td>25.7a</td>
<td>147.7b</td>
<td>196.1b</td>
</tr>
<tr>
<td>Control</td>
<td>1.42a</td>
<td>0.14b</td>
<td>18.0b</td>
<td>27.1b</td>
<td>162.8a</td>
<td>209.5a</td>
</tr>
</tbody>
</table>

8.8X

4.2X

1.1X

1.07
Cover crops (Red clover) had significantly lower soil stratification of P in the SRP fraction but significantly higher EP and TP fractions.

<table>
<thead>
<tr>
<th></th>
<th>SRP</th>
<th>EP</th>
<th>CaP</th>
<th>FeP</th>
<th>Res P</th>
<th>Total P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover Crops</td>
<td>0.4b</td>
<td>61.7a</td>
<td>1.6a</td>
<td>1.4a</td>
<td>1.5b</td>
<td>2.0a</td>
</tr>
<tr>
<td></td>
<td>9.1X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.25X</td>
</tr>
<tr>
<td>Control</td>
<td>1.8a</td>
<td>6.8b</td>
<td>1.4a</td>
<td>1.4a</td>
<td>1.6a</td>
<td>1.6b</td>
</tr>
<tr>
<td></td>
<td>4.5X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Long Term No-Till vs. Rotational Tillage

Both Fields are a Corn/Soybean Rotation

These pictures are of a newly emerging corn crop

NoTill soybeans then StripTill Corn  NoTill Soybeans then Tilled corn

Same rain event on May 15
¾” less than 1/8 mile apart
Bulk Density and Compaction

Depth

0 inches
New Tillage Pan at 3-4”
7 inches
8 inches
9 inches
10 inches

Bulk Density (g/cm³)

1.43
1.90
1.87
1.84
1.80
1.60
2.20

Plow layer
Compacted zone
Uncompacted subsoil
Till

Data from Camp and Lund
Benefits of Cover Crops

- Increase water infiltration – Move SRP$_i$ down into soil profile.
- Decrease bulk density and increase pore space for both air and water – Less saturated soils.
- Increase soil organic matter content which improves soil structure and holds P tighter SRP$_i$ < EP$_o$ and FeP$_i$ < Res P$_o$
N0-TILL creates macropores

ECO Farming & live roots acts like a biological valve to absorb N and P.

Illustrated by Cheryl Bolinger-McKirnan & Jim Hoorman
Managing plant roots affects nutrient recycling.
• FeP$_i$ Mediated or changed by soil microbes (Hedley, 1982)
• FeP$_i$ can be reservoir of P when soil P is low (Kuo, 2003; Zhang 1997) and is considered to be plant available (Zhang, 1997).
• At high fertilization, SRP$_i$ can easily be converted to FeP$_i$ (Kuo, 2003; Zhang, 1997).
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