Variable Rate Phosphorus Application: What you need to know

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Overview

• Share current on goings in US
• Phos Management Concepts
• VRT recs How and Why
• There is NOT a consensus

• Hopefully sometime down the road it causes some thought.
• Don’t Be complacent
Overview

• In past
  • Chesapeake Bay
  • Oklahoma Sues Arkansas
• News is about Lake Erie
  • Was bad,
  • Then good
  • No bad again
  • The Problem
  • The Fix?
• Impact elsewhere
**How we Do Phosphorus**

**Soil Testing** was the basis

Determine immediately and potentially available P.

Relate back to Correlation Calibration work. (50s-60s)

“Critical” Values Est.

![Graph showing correlation between soil test P and yield]
How we Do Phosphorus

Soil Testing
Multiple Extractions because of pH

Bray
Olsen
Mehlich
Resin
How we Do Phosphorus Recs

• Sufficiency program

Feed the Plant

• Intended to estimate the long-term average amount of fertilizer P required to, on average, provide optimum economic return in the year of application. There is little consideration for future soil test values
How we Do Phosphorus Recs

- **Build-Maintain (Replacement)**
  - Apply enough P to or K to build soil test values to a target soil test value over a planned timeframe (e.g. 4-8 years), then maintain based on crop removal and soil test levels
  - NOT intended to provide optimum economic returns in a given year, but minimize the probability the P or K will limit crop yields while providing for near maximum yield potential

<table>
<thead>
<tr>
<th>Crop</th>
<th>Harvest unit</th>
<th>P in yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>Bushel</td>
<td>.38</td>
</tr>
<tr>
<td>Soybean</td>
<td>Bushel</td>
<td>.8</td>
</tr>
<tr>
<td>Wheat</td>
<td>Bushel</td>
<td>.5</td>
</tr>
</tbody>
</table>
How we Do Phosphorus Recs

• Build-Maintain (Replacement)
• Sounds good and makes sense right.
• If we are using this approach.
• Does rate matter.

Build-up maintain fertilizer scheme suggested by the Ohio State University.

Nutrient response curve based on soil test, Rutgers Cooperative Extension.
Understanding Crop Response to Fertilizer Low Soil Test Levels

- Low yields without additional fertilizer
- EOR range is narrow
- Optimum rate is minimally affected by grain:nutrient price ratio
Understanding Crop Response to Fertilizer Medium Soil Test Levels

- Expected yield without fertilizer is higher
- Range of potentially optimal rates is wider
- In a single-year decision framework, EOR is very sensitive to grain: nutrient price ratio
- As price ratio $\downarrow$ EOR $\uparrow$
Understanding Crop Response to Fertilizer High Soil Test Levels

- No or minimal response to added fertilizer
Example of the relationship between number of soil cores per composite sample and error.

Mean soil P = 19 ppm
Economics of Accuracy

Profits from soil sampling at different number of points relative to an all-point composite

$/acre

5 10 15 20
Number of points in sample

wheat
corn
How we Do VRT Phosphorus Recs

• How is it done?
• Soil : Yield : Soil x Yield: Yield : Soil

• Grid/Zone Sample, Yield Goal 3-5 yr
• Grid/Zone, Multi Year Yield, 3 yr
• Grid/Zone, Update Yield each year.
How we Do VRT Phosphorus Recs

- Equation for soils below optimum is:
  \[ P_{Rec} = \frac{(Optimum\ P - Observed\ P) \times 16}{\text{build years}} + \text{Crop Removal} \]

- For soils test in the optimum range:
  \[ Prec = \text{Crop Removal} \]

- For Soils in High Range
  \[ Prec = \text{Crop Removal} \times \left(\frac{(Optimum\ P\ level + 12.5) - \text{observed\ P}}{7.5}\right) \]
  - This gradually tapers the rec to 0 once we are 12.5 ppm above optimum

- Optimum Range is 22.5-27.5 ppm for Row Crops, 20-25ppm for cool season grass and similar, 15-20ppm for Warm Season grass and similar
How we Do VRT Phosphorus Recs

- Soil Test P (M3P ppm)
- P2O5 REC (LBS/AC)

- 100 bpa
- 150 BPA
- 200 BPA
- 250 BPA
- Sufficiency
How we Do VRT Phosphorus Recs

• I requested grid sample data straight from producers.
• Have entered 300 fields
• The data you see is 268
• Goal 500+ fields
• Multiple Labs
• Still Requesting data
## How we Do VRT Phosphorus Recs

<table>
<thead>
<tr>
<th>Soil pH</th>
<th>Buffer Index</th>
<th>P</th>
<th>K</th>
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<tbody>
<tr>
<td>Count</td>
<td>Mean</td>
<td>Range</td>
<td>Mean</td>
</tr>
<tr>
<td>268</td>
<td>6.0</td>
<td>1.9</td>
<td>6.8</td>
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<tr>
<td>Average</td>
<td>4.6</td>
<td>0.4</td>
<td>5.9</td>
</tr>
<tr>
<td>Min</td>
<td>7.7</td>
<td>3.8</td>
<td>13</td>
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<tr>
<td>Max</td>
<td></td>
<td></td>
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<table>
<thead>
<tr>
<th>OM</th>
<th>Ca</th>
<th>Mg</th>
<th>S</th>
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<tbody>
<tr>
<td>Count</td>
<td>Mean</td>
<td>Range</td>
<td>Mean</td>
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<tr>
<td>176</td>
<td>2.6</td>
<td>2.0</td>
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<tr>
<td>Average</td>
<td>0.5</td>
<td>0.3</td>
<td>396.1</td>
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<tr>
<td>Min</td>
<td>123</td>
<td>121</td>
<td>5099</td>
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<tr>
<td>Max</td>
<td></td>
<td></td>
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How we Do VRT Phosphorus Recs

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>Sampling Depth</th>
<th>Mehlich III Extractable P</th>
<th>Soil pH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>2014</td>
<td>Stillwater</td>
<td>0 -5</td>
<td>2.2</td>
<td>41.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 -10</td>
<td>2.9</td>
<td>43.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 -15</td>
<td>2.3</td>
<td>12.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 -30</td>
<td>1.5</td>
<td>5.3</td>
</tr>
</tbody>
</table>
How we Do VRT Phosphorus Recs

How we Do VRT Phosphorus Recs

Efaw Phosphorus 1x1 Experiment

Distance, ft

- 60.0-65.0
- 55.0-60.0
- 50.0-55.0
- 45.0-50.0
- 40.0-45.0
- 35.0-40.0
- 30.0-35.0
- 25.0-30.0
- 20.0-25.0
- 15.0-20.0
- 10.0-15.0
- 5.0-10.0
- 0.0-5.0
Soil pH ranged from 4.37 to 6.29 within the 2.12 by 21.33 m area at Burneyville and 5.37 to 6.34 at Efaw. Significant differences in surface soil test analyses were found when samples were <1 m apart for both mobile and immobile nutrients.
How we Do VRT Phosphorus Recs

Field Boundary
P Mehlich III lbs/ac lb/ac
- 30 - 56 (42.6 ac ) (41.9 %)
- 56 - 86 (43.1 ac ) (42.4 %)
- 86 - 133 (12.4 ac ) (12.2 %)
- 137 - 178 (1.7 ac ) (1.7 %)
- 180 - 215 (1.9 ac ) (1.8 %)
How we Do VRT Phosphorus Recs

Mehlich III extractable phosphorus (Mg P kg$^{-1}$)

Soil pH

Sampling depth (cm)

Stillwater '14
Red Rock 1
Red Rock 2
Red Rock 3
Waukomis 1
Waukomis 2
Stillwater '15
Garber '15
Waukomis '15
How we Do VRT Phosphorus Recs

2016 Water Soluble Phosphorus Extraction Data

Chickasha: $R^2 = 0.61$

Efaw: $R^2 = 0.38$

Lahorna: $R^2 = 0.45$

Perkins: $R^2 = 0.088$
How we Do VRT Phosphorus Recs

• Likelihood of VRT based on Sufficiency being off is high.
• Interpolation of P based on grid is a stretch.
• Yield monitor data has a higher resolution of positional accuracy.
• Current VRT using a Course Knob to adjust P.
• If replacement rates are used soil testing is essential
Thank You

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