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 depicting % Max Yld vs. Soil Test P (Bray P\textsubscript{1} or Mehlich-3)]
How we Do Phosphorus

Soil Testing
Multiple Extractions because of pH
  Bray
  Olsen
  Mehlich
  Resin
How we Do Phosphorus

Soil Testing
More Recent P Loss
P-Index – East coast early then “Poo” states.
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.
## Phosphorus Recs – Suff Does work

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>OSU Rate (kg P ha⁻¹)</th>
<th>OSU 0</th>
<th>4.9</th>
<th>9.8</th>
<th>14.7</th>
<th>19.6</th>
<th>24.5</th>
<th>29.4</th>
<th>34.3</th>
<th>39.2</th>
<th>44.1</th>
<th>48.9</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>yield Mg ha⁻¹</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2014</td>
<td>Stillwater</td>
<td>36.2</td>
<td>2.93</td>
<td>2.84</td>
<td>2.71</td>
<td>2.57</td>
<td>3.01</td>
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<td>3.02</td>
<td>3.00</td>
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<tr>
<td></td>
<td>Red Rock 1</td>
<td>19.5 *</td>
<td>2.02</td>
<td>1.34</td>
<td>1.46</td>
<td>1.44</td>
<td>2.02</td>
<td>2.30</td>
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<td>10.2 *</td>
<td>3.46</td>
<td>2.97</td>
<td>2.84</td>
<td>3.19</td>
<td>3.21</td>
<td>3.93</td>
<td>3.59</td>
<td>3.75</td>
<td>3.83</td>
<td>3.68</td>
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<td></td>
<td>Waukomis 1</td>
<td>0 *</td>
<td>2.06</td>
<td>1.86</td>
<td>2.39</td>
<td>1.94</td>
<td>2.06</td>
<td>2.02</td>
<td>2.22</td>
<td>1.92</td>
<td>2.05</td>
<td>2.08</td>
<td>2.16</td>
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<tr>
<td></td>
<td>Waukomis 2</td>
<td>19.6</td>
<td>1.82</td>
<td>1.29</td>
<td>1.58</td>
<td>1.68</td>
<td>1.72</td>
<td>1.84</td>
<td>1.81</td>
<td>2.03</td>
<td>1.83</td>
<td>1.84</td>
<td>1.97</td>
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<tr>
<td></td>
<td>Stillwater</td>
<td>29.4</td>
<td>2.23</td>
<td>2.34</td>
<td>2.53</td>
<td>2.24</td>
<td>2.75</td>
<td>2.60</td>
<td>3.74</td>
<td>2.72</td>
<td>2.68</td>
<td>2.97</td>
<td>2.84</td>
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<tr>
<td></td>
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<td>7.4 *</td>
<td>3.31</td>
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<td>3.57</td>
<td>3.29</td>
<td>3.48</td>
<td>3.41</td>
<td>3.72</td>
<td>3.59</td>
<td>3.65</td>
<td>3.56</td>
<td>3.80</td>
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</tbody>
</table>

Means in each row with different lettering beneath are significantly different at \( p \leq 0.05 \). OSU Rate with * indicates that current recommendations would have required an additional 14.68 kg P ha⁻¹ application due to soil pH.
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>
Phosphorus Recs – Suff Does work

L. Haag, Wheat U - 10 Aug 2016 Wichita
How we Do Phosphorus Recs

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

![Fertilizer recommendation scheme used in the tri-state region](image1)

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

![Nutrient response curve based on soil test](image2)

Nutrient response curve based on soil test, Rutgers Cooperative Extension.
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:
  \[ P \text{ Rec} = (\text{Optimum P} - \text{Observed P}) \times 16 / \text{build years} + \text{Crop Removal} \]

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

- For Soils in High Range
  \[ \text{Prec} = \text{Crop Removal} \times ((\text{Optimum P level} + 12.5) - \text{observed P}) / 7.5 \]
  - 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

- P2O5 REC (LBS/AC) vs. Soil Test P (M3P ppm)
- Graphs for different BPA levels:
  - 100 bpa
  - 150 BPA
  - 200 BPA
  - 250 BPA
  - Sufficiency

- Graph shows the relationship between P2O5 REC and Soil Test P for different BPA levels.
How we Do VRT Phosphorus Recs

- I requested grid sample data straight from producers.
- Have entered 400 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>
</tr>
</thead>
<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>
</tr>
<tr>
<td>Average</td>
<td>266</td>
<td></td>
<td>257</td>
</tr>
<tr>
<td>Min</td>
<td>4.6</td>
<td>0.4</td>
<td>5.9</td>
</tr>
<tr>
<td>Max</td>
<td>7.7</td>
<td>3.8</td>
<td>13</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>OM</th>
<th>Ca</th>
<th>Mg</th>
<th>S</th>
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</thead>
<tbody>
<tr>
<td>Count</td>
<td>Mean</td>
<td>Range</td>
<td>Mean</td>
</tr>
<tr>
<td>176</td>
<td>2.6</td>
<td>2.0</td>
<td>1546</td>
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<tr>
<td>Average</td>
<td>199</td>
<td></td>
<td>233</td>
</tr>
<tr>
<td>Min</td>
<td>0.5</td>
<td>0.3</td>
<td>396.1</td>
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<tr>
<td>Max</td>
<td>123</td>
<td>121</td>
<td>5099</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>cm</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
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
Fine and Course Control

- Making high resolution decisions using low resolution recs.
- Recommendation maps are at < 1 acre resolution and critical value that represents a whole state.
- How Precise is that.
Why is Lime most Accurate VRT?

- Buffer Index
  - It measures soil response
- P Buffer???
- Change Soil Sampling intensity from Spatial to Temporal
- Adjust P rate based on expected response and soil response.
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
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