Assessing the Agronomic Value of Hog Manure-Derived Struvite as a Phosphorus Source for Spring Wheat

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Introduction

- Hog manure disposal challenges
- Eutrophication
- Strict regulations
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  - Eutrophication
  - Strict regulations

- Management options
  - Feed
  - Solid-liquid separation
  - Crop choices
  - Phosphorus extraction from manure
Introduction

- Recovered from sewage, poultry, dairy and swine manures

Struvite

\((\text{MgNH}_4\text{PO}_4 \cdot 6\text{H}_2\text{O})\)
Introduction

How effective is it as a P fertilizer?

<table>
<thead>
<tr>
<th>Spring wheat</th>
<th>Canola</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Massey et al., 2009)</td>
<td>(Ackerman et al., 2013)</td>
</tr>
</tbody>
</table>

Struvite

(MgNH₄PO₄·6H₂O)
Objectives

- Evaluate the effectiveness of hog manure-derived struvite on spring wheat (grown in rotation with canola):
  - Dry matter yield (DMY)
  - Phosphorus uptake (PU)
Hypotheses

✓ H₀: $\text{DMY}_{\text{struvite}} = \text{DMY}_{\text{commercial fertilizers}}$

✓ H₀: $\text{PU}_{\text{struvite}} = \text{PU}_{\text{commercial fert.}}$
# Experimental Setup

<table>
<thead>
<tr>
<th>Cycle 1</th>
<th>Cycle 2</th>
<th>Cycle 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>Canola</td>
<td>Wheat</td>
</tr>
<tr>
<td>Canola</td>
<td>Wheat</td>
<td>Canola</td>
</tr>
</tbody>
</table>
Experimental Design

- **CRD – factorial plus 2 controls (3 replicates)**
  - **P source**
    - Struvite, CMAP, and MAP
  - **P rate**
    - 25 and 50 kg P₂O₅ ha⁻¹
  - **P placement**
    - Seedrow and side-band
  - **Soil**
    - Sand (3.5 mg Olsen P kg⁻¹)
    - Clay loam (6 mg kg⁻¹)
Methodology

~60% WFPS

5.7: 23: 0.4

Struvite

CMAP

MAP

2.5 cm

362 plants m⁻²
Red wheat (cv. AC Barrie)
Statistical Analyses

- ANOVA - Proc MIXED (SAS Inc. 2012)
- Mean separation - Tukey-Kramer
- Significant at $P < 0.05$

$y_{ijkl} = \mu + S_i + A_j + R_k + P_l + SA_{ij} + \ldots \ldots + e_{ijklm}$
Results

Harvest at 39 – 43 DAE
(Zadock stages 39-57)
First Cycle
Biomass Yield

- Struvite similar to commercial fertilizers
First Cycle

**Biomass Yield**

<table>
<thead>
<tr>
<th></th>
<th>Struvite</th>
<th>CMAP</th>
<th>MAP</th>
<th>control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield</td>
<td>1.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>

**P uptake**

<table>
<thead>
<tr>
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<th>CMAP</th>
<th>MAP</th>
<th>control</th>
</tr>
</thead>
<tbody>
<tr>
<td>P uptake</td>
<td>b</td>
<td>a</td>
<td>a</td>
<td>c</td>
</tr>
</tbody>
</table>

- **Significantly lower P uptake from struvite**
First Cycle

Biomass Yield

- No response in CL
- No differences between placement methods
- $\text{Yield}_{\text{high rate}} > \text{Yield}_{\text{low rate}}$
First Cycle

P Uptake Efficiency

- $\text{PUE}_{\text{struvite}} = \text{PUE}_{\text{fert.}}$ in CL
- $\text{PUE}_{\text{str}} < \text{PUE}_{\text{MAP}}$ in Sand
Second Cycle

Biomass Yield

- Struvite comparable to MAP/CMAP
- $\text{Yield}_{\text{CL}} > \text{Yield}_{\text{Sand}}$
- No yield response to P applied in first cycle
Second Cycle

Biomass Yield

- Struvite comparable to MAP and CMAP
- Yield/PU_{CL} > Yield/PU_{Sand}
Third Cycle

Biomass Yield

- Struvite comparable to MAP/CMAP
- \( \text{Yield}_{\text{CL}} > \text{Yield}_{\text{Sand}} \)
- No yield response to P
Third Cycle

Biomass Yield

- No significant amendment differences
- Yield/PU_{high rate} > Yield/PU_{low rate}
Conclusions

- Struvite was as effective as MAP and CMAP in improving wheat DMY
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- Although less P was taken up from struvite in the first cycle, yield was not significantly lowered
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- No significant residual benefits were observed from the slow release fertilizers (CMAP and struvite).
Conclusions

- Struvite was as effective as MAP and CMAP in improving wheat DMY.
- Although less P was taken up from struvite in the first cycle, yield was not significantly lowered.
- No significant residual benefits were observed from the slow release fertilizers (CMAP and struvite).
- Struvite is a promising P source for wheat and certainly deserves field testing.
Acknowledgements

Thank you

• Sponsors
• Advisory committee
• Colleagues, friends and family