AVAILABILITY OF POTASSIUM AND SECONDARY NUTRIENTS FROM POLY4 AND THEIR SIGNIFICANCE FOR SOYBEAN PRODUCTION

ASA & CSSA Annual Meeting 2018
Enhancing productivity in a changing climate
Presentation by Rachel Fields
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INTRODUCTION TO POLY4 – POLYHALITE-BASED FERTILIZER
\((K_2SO_4.MgSO_4.2CaSO_4.2H_2O)\)

A single source of bulk nutrients as foundation for effective, efficient, flexible and sustainable fertilization.

Characteristics

• Improves yield and quality
• Straight or as part of a fertilizer blend
• Efficient nutrient release profile
• pH neutral

Notes: 1) Based on 90% polyhalite grade. Macro nutrients based on w/w % and micro nutrients based on mg/kg; micro nutrients’ content: B 1.69, Zn 1.9, Mn 3.1, Mo 0.3, Se>0.5, Fe>0.5, Cu 1.1, Sr 1414. 2) POLY4 is the trademark name for polyhalite products from the Sirius Minerals polyhalite project in North Yorkshire, *48% SO₃, B – boron, Cu – copper, Se – selenium, Zn – zinc, Fe – iron, Sr – strontium, Mo – molybdenum, Mn – manganese.
LEACHING COLUMN STUDIES – MARCEL, UNIVERSITY OF FLORIDA

Methods

Leaching columns: made from PVC pipe (400 mm long and 50.8 mm internal diameter).

Soil: Ankona sandy loam from Florida.

Fertilizers: POLY4, muriate of potash (MOP), sulphate of potash (SOP) and sulphate of potash magnesium (SOP-M).

Fertilizer rate: 61 K$_2$O mg column$^{-1}$ (300 K$_2$O kg ha$^{-1}$). Mixed into the top 10 mm of soil and covered with a filter paper.

Water applied: Water drip fed onto the column filter paper at a rate that emulated two years rainfall (117 mL every three days x 24 events) in Florida (Mean annual rainfall:1385 mm).

Columns were maintained at 21 ± 1 °C (70 ± 34°F).
POTASSIUM AVAILABILITY

• Over 100% of K added as POLY4 was leached over 24 leaching events.

Source: 1000-UOF-1024-14.
All of the S supplied by POLY4 was leached.
MAGNESIUM AVAILABILITY

- Over 100% of Mg added as POLY4 was leached over 24 leaching events
- Only 75% of Mg added as SOP-M was leached

Source: 1000-UOF-1024-14
SOYBEAN NUTRITION

Potassium
Increases pods per plant and seed weight.

Sulphur
Improves thousand grain weight and protein content.

Magnesium
Many critical physiological and biochemical processes in plants are adversely affected by Mg deficiency, leading to impairments in growth and yield.

Calcium
Soybean deficient in Ca can have reduced leaf expansion, brown spots on young leaves, and can cause premature leaf senescence.
POTASSIUM AND MAGNESIUM FROM POLY4

- Study conducted at Weslaco, TX in partnership with Texas A&M
- The use of POLY4 was compared with the use of MOP, SOP and SOP-M at various K₂O rates from 50 – 250 kg ha⁻¹ (average 138 kg ha⁻¹)
- Soils were predominately calcareous with a sandy clay loam texture
- Soybean variety used was Vernal 36

<table>
<thead>
<tr>
<th>Treatment¹</th>
<th>K₂O</th>
<th>S</th>
<th>CaO</th>
<th>MgO</th>
</tr>
</thead>
<tbody>
<tr>
<td>N + P (control)</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>MOP</td>
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<tr>
<td>SOP</td>
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<td>0</td>
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<tr>
<td>SOP-M</td>
<td>138</td>
<td>138</td>
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<td>25</td>
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<tr>
<td>POLY4</td>
<td>138</td>
<td>187</td>
<td>167</td>
<td>59</td>
</tr>
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</table>

Notes: 1) Values are averaged across the K₂O rates of 50, 100, 150 and 250 kg ha⁻¹. All plots received 35 kg ha⁻¹ of nitrogen and 45 kg ha⁻¹ of P₂O₅. 2) Initial soil analysis: pH 7.4; 19 mg P kg⁻¹, 242 mg K kg⁻¹, 177 mg S kg⁻¹, 213 mg Mg kg⁻¹, 1029 mg Ca kg⁻¹.

Sources: Texas A&M (2014) 0000-TAM-0027-14
**GRAIN YIELD**

A) USA – Texas A&M (2014)

Notes: Initial soil analysis pH 7.4; 19 mg P kg⁻¹, 242 mg K kg⁻¹, 177 mg S kg⁻¹, 213 mg Mg kg⁻¹, 1029 mg Ca kg⁻¹.
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GRAIN AND LEAF SULPHUR

A) USA – Texas A&M (2014)

Notes: Initial soil analysis pH 7.4; 19 mg P kg\(^{-1}\), 242 mg K kg\(^{-1}\), 177 mg S kg\(^{-1}\), 213 mg Mg kg\(^{-1}\), 1029 mg Ca kg\(^{-1}\).
Sources: Texas A&M (2014) 0000-TAM-0027-14
GRAIN AND LEAF MAGNESIUM

A) USA – Texas A&M – 2014

R2 leaf Mg (g kg\(^{-1}\))

Grain Mg (g kg\(^{-1}\))

Grain Mg uptake (kg ha\(^{-1}\))

Control MOP SOP SOP-M POLY4

Control MOP SOP SOP-M POLY4

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Notes: Initial soil analysis pH 7.4; 19 mg P kg\(^{-1}\), 242 mg K kg\(^{-1}\), 177 mg S kg\(^{-1}\), 213 mg Mg kg\(^{-1}\), 1029 mg Ca kg\(^{-1}\).

Sources: Texas A&M (2014) 0000-TAM-0027-14
SULPHUR IN POLY4

- Study conducted at Staples, MN in partnership with University of Minnesota
- The use of MOP + POLY4 was compared with the use of MOP
- The soil was a Verndale sandy loam and the soybean variety was W3080
- Sulphur is not usually recommended in the Midwest, but there is growing recognition and occurrence of S deficiencies

<table>
<thead>
<tr>
<th>Treatment</th>
<th>K2O</th>
<th>S</th>
<th>CaO</th>
<th>MgO</th>
</tr>
</thead>
<tbody>
<tr>
<td>N + P (control)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>MOP</td>
<td>67</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>MOP + POLY4</td>
<td>67</td>
<td>23</td>
<td>21</td>
<td>7</td>
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Notes: 1) All plots received 23.4 kg N ha⁻¹ and 60 kg P₂O₅ ha⁻¹; 2) Initial soil analysis: pre-trial pH 7.50, pre-trial P (21 mg kg⁻¹), pre-trial K (237 mg kg⁻¹), pre-trial S (6.9 mg kg⁻¹), pre-trial Mg (239 mg kg⁻¹), pre-trial Ca (5,536 mg kg⁻¹).
YIELD

USA – Staples UMN 17

- This site was not K responsive (P > 0.1)
- Grain yield was increased (P = 0.004) in S-treated plots
- Thousand grain weight was also increased with S application (P < 0.001)

Notes: 1) All plots received 23.4 kg N ha$^{-1}$ and 60 kg P$_2$O$_5$ ha$^{-1}$; 2) Initial soil analysis: pre-trial pH 7.50, pre-trial P [21 mg kg$^{-1}$], pre-trial K [237 mg kg$^{-1}$], pre-trial S [6.9 mg kg$^{-1}$], pre-trial Mg [239 mg kg$^{-1}$], pre-trial Ca [5,536 mg kg$^{-1}$].

A) USA – Staples UMN 17

- Potassium fertilizer increased (\( P < 0.001 \)) R2 leaf K.
- K did not affect grain K content (\( P = 0.670 \)).
- Grain K uptake was greater in the MOP+POLY4 treated plots (\( P = 0.012 \)) as they produced a greater yield.

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LEAF AND GRAIN SULPHUR

A) USA – Staples UMN 17

Notes: 1) All plots received 23.4 kg N ha\(^{-1}\) and 60 kg P\(_2\)O\(_5\) ha\(^{-1}\); 2) Initial soil analysis: pre-trial pH 7.50, pre-trial P (21 mg kg\(^{-1}\)), pre-trial K (237 mg kg\(^{-1}\)), pre-trial S (6.9 mg kg\(^{-1}\)), pre-trial Mg (239 mg kg\(^{-1}\)), pre-trial Ca (5,536 mg kg\(^{-1}\)).

SUMMARY

• POLY4 is a multi-nutrient fertilizer containing 14% $K_2O$, 17% CaO, 6% MgO and 19% S
• Leaching column studies indicated higher and quicker accumulated K in leachate from POLY4 treatment than other K treatments in sandy loam soils
• Evidence for availability and response from K, Mg, and S was obtained in soybeans highlighting the value of multi-nutrient POLY4 in these systems
ACKNOWLEDGEMENTS

Sirius Minerals thanks those involved in our POLY4 research

<table>
<thead>
<tr>
<th>Institute</th>
<th>Research Partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texas A&amp;M</td>
<td>Dr. John Jifon</td>
</tr>
<tr>
<td>University of Minnesota</td>
<td>Dr. Daniel Kaiser</td>
</tr>
<tr>
<td>University of Florida</td>
<td>Dr. Marcel Barbier and Dr. Yuncong Li</td>
</tr>
</tbody>
</table>
THANK YOU

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