Fertility Research Updates

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2012 Fertility Research Trials (16)

1. USDA Conservation Innovation Grants (3)
   ✓ Cotton: Variable-rate N applications within a field

2. Fluid Fertilizer Foundation (1)
   ✓ Corn (3): P, S, Zn: MAP (11-52-0), MES (12-40-0-10S), MESZ (12-40-0-10S-1Zn), MESB (10-46-0-6S-0.4B)
   ✓ Cotton (2): K, S, Zn: DAP vs. MESZ; MOP vs. K-Mag

3. The Mosaic Company (5)
   ✓ Corn (3): P, S, Zn: MAP (11-52-0), MES (12-40-0-10S), MESZ (12-40-0-10S-1Zn), MESB (10-46-0-6S-0.4B)
   ✓ Cotton (2): K, S, Zn: DAP vs. MESZ; MOP vs. K-Mag

4. Advanced Microbial Solutions (2)
   ✓ Corn (1) & Soybean (1): SoilBuilder AF & Titan

5. AgXplore International (2)
   ✓ Corn (1): NZone, Nutrisphere, Agrotain
   ✓ Cotton (1): NZone

6. The Nachurs Company (2)
   ✓ Cotton: Foliar fertilizers: 6-24-6, N-Rage, 3-0-20,13-0-13

7. Internal Funding (1)
   ✓ Cotton: N application timing: pre-planting, at-planting, early side dress, & late side dress under early, normal, & late planting dates
Sulfur Effects on Cotton Yields and Quality
Plant S Concentration and S Uptake

Plant Composition:
S: 0.1% – 0.5%
P: 0.3% – 0.5%

Plant Uptake:
Soil: SO$_4^{2-}$
Air: SO$_2$
Sulfur Roles in Plant

- Essential component of some amino acids (methionine, cysteine)
- Essential for production of protein
- Promotes activity and development of enzymes and vitamins
- Helps in chlorophyll formation
- Improves root growth and seed production
- Helps with vigorous plant growth and resistance to coldness
**S Input to Soil and Loss from Soil**

**S Input to Soil**
- S Fertilizers
- Animal manures and biosolids
- Plant residues
- Atmospheric deposition

**S Loss from Soil**
- Crop harvest
- Leaching
- Volatilization
- Runoff and erosion
Probable Causes for S Deficiency

- Low soil S: Sandy soils, low organic matter
- Excessive rainfall
- Increased use of S free fertilizers
- Declined use of S containing pesticides
- Greater S removal from soil by crops
- Less S deposition to soil from the atmosphere
Sulfur Deficiency in Plant

**Symptoms:**
- Yellow plants
- Slow growth
- Low vigor
- Delayed maturity
- Low yield and quality

**Critical S Concentrations (U of G):**
- Corn: 0.13% in leaf
- Cotton, soybean: 0.20 - 0.25% in leaf
Sulfur Deficiency vs. N Deficiency

**S deficiency:**
begins in the young, upper leaves first. A severe sulfur deficiency causes the entire plant to turn yellow.

**N deficiency:**
begins in the older leaves and progresses up the plant.
Soil Test and Plant Analysis

- **Soil Test of S**
  - Soil available S

- **Plant Tissue Analysis of S**
  - Total S concentration
Sulfur Fertilizers and Applications

**S Fertilizers:**
- Ammonium sulfate (24% S)
- Potassium sulfate (18% S)
- Potassium-magnesium sulfate (22% S)
- Magnesium sulfate (13% S)
- Gypsum (19% S)
- Elemental sulfur (90-100% S)

**Application Rate:** 15 to 25 lb S/acre

**Application Timing:** At planting or along with post-plant nitrogen applications
More Research on S Needed

- Increased use of S free fertilizers; greater S removal from soil by crops; less S deposition to soil from the atmosphere; and less use of S-containing pesticides.

- Information about the effects of S on cotton production was limited.

- No guidelines were available in TN for correcting S deficiencies in cotton.
Field Trial

• Location: Jackson
• Duration: 2007-2010
• Soil: No-tilled, non-irrigated Dexter loam
• Soil Test S: Low (14 lb/a)
• S Rate: S: 0, 10, 20, & 30 lb S/a, K$_2$SO$_4$, before planting
• N & K Rates: 80 lb/a N & 120 lb K$_2$O/a
• Cultivar: PHY375WRF
Weather Conditions (2007-2010)
S Deficiency Symptoms
## Leaf S Responses to S Applications at Early Bloom

<table>
<thead>
<tr>
<th>S Rate (lb/a)</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.233c</td>
<td>0.275d</td>
<td>0.309b</td>
<td>0.231d</td>
</tr>
<tr>
<td>10</td>
<td>0.291c</td>
<td>0.310c</td>
<td>0.379ab</td>
<td>0.314c</td>
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<tr>
<td>20</td>
<td>0.364b</td>
<td>0.348b</td>
<td>0.415a</td>
<td>0.366b</td>
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<tr>
<td>30</td>
<td>0.405a</td>
<td>0.384a</td>
<td>0.448a</td>
<td>0.401a</td>
</tr>
<tr>
<td>Sig.</td>
<td>***</td>
<td>***</td>
<td>*</td>
<td>***</td>
</tr>
</tbody>
</table>

Notes: Values followed by different letters within a column are significantly different. Sig. indicates statistical significance: *** indicates p < 0.001, * indicates p < 0.05.
# Soil S Contents at Mid-Bloom

<table>
<thead>
<tr>
<th>S Rate (lb/a)</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>21.3b</td>
<td>27.4b</td>
<td>20.8</td>
<td>36.0c</td>
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<tr>
<td>10</td>
<td>22.8b</td>
<td>25.8b</td>
<td>23.0</td>
<td>39.2bc</td>
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<tr>
<td>20</td>
<td>30.5b</td>
<td>28.0b</td>
<td>24.0</td>
<td>40.2b</td>
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<tr>
<td>30</td>
<td>40.2a</td>
<td>30.6a</td>
<td>27.6</td>
<td>44.6a</td>
</tr>
<tr>
<td>Sig.</td>
<td>**</td>
<td>*</td>
<td>ns</td>
<td>**</td>
</tr>
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## Lint Yield Responses to S Applications

<table>
<thead>
<tr>
<th>S Rate (lb/a)</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>657</td>
<td>2083b</td>
<td>1280</td>
<td>1463</td>
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<tr>
<td>10</td>
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<td>2160ab</td>
<td>1307</td>
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<td>20</td>
<td>720</td>
<td>2221a</td>
<td>1413</td>
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<tr>
<td>Sig.</td>
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<td>**</td>
<td>0.0504</td>
<td>ns</td>
</tr>
</tbody>
</table>

**Significance Levels:**
- ns: Not Significant
- **: Significant at 0.05 level
Lint Yield Responses to S on 3-Yr Averages

![Graph showing relative lint yields (%)](image)

- **S application rate (lb/acre)**: 0, 10, 20, 30
- **Relative lint yields (%)**: 60, 70, 80, 90, 100
- **Letters**: b, ab, a, a
# Fiber Quality Responses to S on 3-Yr Averages

<table>
<thead>
<tr>
<th>S Rate</th>
<th>GTO</th>
<th>Fuzzy Seed Index</th>
<th>Mic</th>
<th>UHM</th>
<th>Uniformity</th>
<th>Strength</th>
<th>Elongation</th>
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</thead>
<tbody>
<tr>
<td>lb/a</td>
<td>%</td>
<td>g/100</td>
<td>in.</td>
<td>%</td>
<td>g/tex</td>
<td>%</td>
<td></td>
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<tr>
<td>0</td>
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<td>9.52</td>
<td>3.91b</td>
<td>1.15</td>
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<td>27.9</td>
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<tr>
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<td>42.2</td>
<td>9.55</td>
<td>4.05a</td>
<td>1.14</td>
<td>82.2</td>
<td>27.5</td>
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<td>20</td>
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<td>4.07a</td>
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<tr>
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<td>42.2</td>
<td>9.51</td>
<td>4.09a</td>
<td>1.13</td>
<td>82.2</td>
<td>27.4</td>
<td>5.24</td>
</tr>
<tr>
<td>Sig.</td>
<td>ns</td>
<td>ns</td>
<td>**</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

** indicates a significant difference.
Lint Yield Responses to S at Milan REC in 2012

S Application (lb/a)

Lint Yield (lb/a)

0 20
Take Home

• Application of 20 lb S/a may be beneficial for cotton on soils tested low for S in TN and similar environments.

• More attention needs to be paid to S requirements of cotton in TN and similar environments where S deficiencies may become more common due to increased use of S free fertilizers, adoption of high yielding cultivars and more intensive cropping systems, and lower atmospheric S deposits.
References


Acknowledgments

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