FLUID NITROGEN/SULFUR FORMULATIONS TO MITIGATE SULFUR DEFICIENCIES AND MAXIMIZE COTTON YIELDS IN THE UPPER SOUTHEAST COASTAL PLAIN

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Sulfur is an essential plant nutrient, though required in smaller quantities than N, P and K.
- Used to create proteins which regulated photosynthesis and N metabolism.

Sulfur is mobile in soil systems and is taken up by plants as sulfate, $\text{SO}_4^{2-}$, thus making it prone to leaching like nitrate ($\text{NO}_3^-$).

Sulfur in immobile in plants, therefore remobilization of S will not occur and deficiencies will be observed in the upper portion of the canopy.

The Clean Air Act has resulted in cleaner air with lower S deposition and more common S deficiencies occurring in cotton.
WET SULFATE DEPOSITION

1989

2013
1519 lbs of lint per acre

1863 lbs of lint per acre
OBJECTIVES

• Evaluate granular and fluid N sources with varying S application rates on in-season NDVI measurements, petiole and leaf S status during the first week of bloom, and lint yield of cotton in the upper southeast coastal plain.

• Determine the effect of high N:S ratios in side-dress fluid N sources at varying N application rates on NDVI, petiole and leaf N:S ratios, and lint yield in the upper southeast coastal plain.
MATERIALS AND METHODS

• Three locations during 2016
• Randomized complete block design with 17 treatments and 4 replications
• Compared granular and fluid side-dress sources
  • Urea + ammonium sulfate (AMS)
  • UAN32 + ammonium thiosulfate (12-0-0-26S)
    • 24-0-0-3S
    • 24-0-0-6S
    • 24-0-0-9S
• NDVI measured from a week after fertilizer application for five weeks (data not shown)
• Petiole and leaf tissue samples were collected from each plot during the first week of bloom
• Yield was measured from the center two rows of the four row plot
• PROC GLIMMIX was used for ANOVA with an alpha = 0.05.
  • Treatment design was
    • 2 S Sources x 4 S rates
    • 4 Fluid Formulations x 3 N rates
<table>
<thead>
<tr>
<th>Trt</th>
<th>N-S Formulations</th>
<th>Total N</th>
<th>Side-dress N</th>
<th>Sulfur</th>
<th>Total N:S</th>
<th>Fluid Fertilizer N:S</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>---------</td>
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<td>--------</td>
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</tr>
<tr>
<td>1</td>
<td>No Applied N or S Control</td>
<td>-</td>
<td>-</td>
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<tr>
<td>2+</td>
<td>Urea</td>
<td>100</td>
<td>80</td>
<td>0</td>
<td>100:0</td>
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<tr>
<td>3+</td>
<td>Urea + AMS†</td>
<td>100</td>
<td>80</td>
<td>10</td>
<td>10:1</td>
<td>-</td>
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<tr>
<td>4+</td>
<td>Urea + AMS</td>
<td>100</td>
<td>80</td>
<td>20</td>
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<tr>
<td>5+</td>
<td>Urea + AMS</td>
<td>100</td>
<td>80</td>
<td>30</td>
<td>3:1</td>
<td>-</td>
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<tr>
<td>6</td>
<td>32-0-0</td>
<td>60</td>
<td>40</td>
<td>0</td>
<td>60:0</td>
<td>32:0</td>
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<tr>
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<td>32-0-0</td>
<td>100</td>
<td>80</td>
<td>0</td>
<td>100:0</td>
<td>32:0</td>
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<tr>
<td>8</td>
<td>32-0-0</td>
<td>140</td>
<td>120</td>
<td>0</td>
<td>140:0</td>
<td>32:0</td>
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<tr>
<td>9</td>
<td>24-0-0-3S</td>
<td>60</td>
<td>40</td>
<td>5</td>
<td>12:1</td>
<td>8:1</td>
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<tr>
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<td>24-0-0-3S</td>
<td>100</td>
<td>80</td>
<td>10</td>
<td>10:1</td>
<td>8:1</td>
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<tr>
<td>11</td>
<td>24-0-0-3S</td>
<td>140</td>
<td>120</td>
<td>15</td>
<td>9:33:1</td>
<td>8:1</td>
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<td>24-0-0-6S</td>
<td>60</td>
<td>40</td>
<td>10</td>
<td>6:1</td>
<td>4:1</td>
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<td>24-0-0-6S</td>
<td>100</td>
<td>80</td>
<td>20</td>
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<td>4:1</td>
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<td>14</td>
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<td>120</td>
<td>30</td>
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<td>40</td>
<td>15</td>
<td>4:1</td>
<td>2.66:1</td>
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<td>16+</td>
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<td>80</td>
<td>30</td>
<td>3:1</td>
<td>2.66:1</td>
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<td>17</td>
<td>24-0-0-9S</td>
<td>140</td>
<td>120</td>
<td>45</td>
<td>3.11:1</td>
<td>2.66:1</td>
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</tbody>
</table>

†AMS = granular ammonium sulfate (21-0-0-24S)
‡ Treatments to be compared to evaluate sulfur application rates and granular vs fluid N-S sources.
## PLANTING AND TREATMENT APPLICATION DATES

<table>
<thead>
<tr>
<th>Location</th>
<th>Planting Date</th>
<th>Side-dress</th>
<th>N/S Application Date</th>
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<tbody>
<tr>
<td>Southampton, VA (SHC)</td>
<td>5/10/2016</td>
<td></td>
<td>7/5/2016</td>
</tr>
<tr>
<td>Lewiston, NC (LEW)</td>
<td>5/19/2016</td>
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<td>7/7/2016</td>
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## PRE-PLANT SOIL AMMONIUM AND NITRATE-N

<table>
<thead>
<tr>
<th>Sampling Depth</th>
<th>TAREC</th>
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<tbody>
<tr>
<td>in.</td>
<td>NH$_4^+$-N</td>
<td>NO$_3^-$-N</td>
<td>NH$_4^+$-N</td>
<td>NO$_3^-$-N</td>
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<tr>
<td>Total</td>
<td>8.63</td>
<td>6.93</td>
<td>8.50</td>
<td>5.63</td>
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<tr>
<td>0-6</td>
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<td>2.55</td>
<td>1.15</td>
<td>1.81</td>
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<td>6-12</td>
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<td>0.99</td>
<td>0.96</td>
<td>1.59</td>
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<td>12-24</td>
<td>2.11</td>
<td>1.14</td>
<td>1.08</td>
<td>1.16</td>
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<tr>
<td>24-36</td>
<td>2.65</td>
<td>2.25</td>
<td>5.31</td>
<td>1.08</td>
</tr>
</tbody>
</table>
RESULTS

GRANULAR N/S FORMULATIONS
VERSUS
FLUID N/S FORMULATIONS
PETIOLE S CONCENTRATION AND FERTILIZER SOURCE

- Suffolk
- SHC
- LEW

Petiole Sulfur (ppm)

- Urea + AMS
- UAN32 + ATS
PETIOLE SULFUR DURING 1ST WEEK OF BLOOM

![Graph showing the relationship between Sulfur Application Rate and Petiole Sulfur concentration for various locations.]

- Suffolk, VA
- Southampton, VA
- Lewiston, NC

Sulfur Application Rate (lb. S ac⁻¹) vs. Petiole Sulfur (ppm)
PETIOLE SULFUR AND LEAF SULFUR CONTENT

Lint Yield = 0.32 + 3.4e^{-4} \times \text{SRate} - 1.14e^{-7} \times (\text{SRate})^2

R^2 = 0.42
FERTILIZER SOURCE AND PETIOLE NITRATE-N AT 100 LB N ACRE$^{-1}$

![Bar chart showing comparisons between different fertilizer sources and petiole nitrate-N levels for Suffolk, SHC, and LEW regions.](chart.png)
PETIOLE NITRATE-N AND SULFUR RATE DURING THE 1ST WEEK OF BLOOM

![Graph showing petiole nitrate-N levels for Suffolk, SHC, and Lew plots with different sulfur rates and their corresponding letters indicating significant differences.](image-url)
Lint Yield and N/S Source
Suffolk, VA

Lint Yield = 1115 + 14\cdot SRate - 0.39\cdot (Srate)^2
R^2 = 0.99

Lint Yield = 1208 + 5.66\cdot SRate - 0.11\cdot (Srate)^2
R^2 = 0.99

Sulfur application rate (lb. S ac\(^{-1}\))
LINT YIELD AND N/S SOURCE

Southampton, VA  
Lewiston, NC

![Graph showing lint yield and Sulfur Application Rate for Southampton, VA and Lewiston, NC.](image-url)
RESULTS

FLUID N/S FORMULATIONS AND VARYING NITROGEN RATES
PETIOLE NITRATE-N AND NITROGEN RATE

The chart illustrates the petiole nitrate-N levels for three different locations: Suffolk, SHC, and LEW. The nitrogen rates are represented as 60 lb. N ac⁻¹, 100 lb. N ac⁻¹, and 140 lb. N ac⁻¹. The graph shows significant variation in nitrate-N levels across the different nitrogen rates and locations.
PETIOLE SULFUR FOR FLUID N/S FORMULATIONS

- Suffolk
- SHC
- LEW

Comparison of Petiole Sulfur (ppm) across different formulations:

- 32-0-0
- 24-0-0-3S
- 24-0-0-6S
- 24-0-0-9S

Bar chart showing the sulfur levels with letters indicating statistical comparisons.
FLUID N/S FORMULATIONS AND LINT YIELD

Graphs showing the lint yield in pounds per acre (lb. ac\(^{-1}\)) for different formulations and nitrogen rates. The graphs compare Suffolk, SHC, and LEW varieties with treatments labeled A and B, indicating statistical significance. The nitrogen rates include 60 lb. N ac\(^{-1}\), 100 lb. N ac\(^{-1}\), and 140 lb. N ac\(^{-1}\).
WEATHER DATA FOR LOCATION

TAREC

SHC
WEATHER DATA FOR LOCATION

TAREC

Lewiston

Max. Daily Temperature
Min. Daily Temperature
Daily Precipitation (Season Total = 32.2 inches)
Cumulative DD60 (Season Total = 2,453 DD60)