Urea Formaldehydes and Triazones: What We Know
Overview

- The agronomic case
- What it is
- How it works
- How it is used
- Results
Nitrogen management matters

• N is the most widely limiting nutrient for non-legume crops
• N is a building block for protein and part of chlorophyll
• Adequate levels required for optimal growth and seed production
• Nitrogen can be lost through volatilization, leaching and denitrification
Nitrogen Uptake Demand

V10-V18 (20 days)
6.7 lb N per day
134 lbs N

V18-R5 (50 days)
2.1 lb N per day
105 lbs N

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NITROGEN UPTAKE AND APPLICATION TIMING

Generalized nitrogen uptake pattern in corn.

Adapted from: Soil and Water Conservation Unit, USDA, ARS and Univ. of Nebraska
CORN RESPONSE TO N APPLICATIONS IN KENTUCKY - 2011

\[ y = 0.5689x + 135.6 \]

\[ R^2 = 0.99902 \]

Source: Grove, 2011
Enhanced efficiency fertilizers reduce the influence of weather on nitrogen loss.
CUMULATIVE NITROGEN LOSS VIA VOLATILIZATION

Compilation of university lab and field volatilization studies

Sources: North Dakota State University, Oregon State University, Auburn University, University of Florida
Leaching and Denitrification
Nitrification: Ammonium ($\text{NH}_4^+$) transforms to Nitrate ($\text{NO}_3^-$)
Nitrate can move below the root zone with water because it does not adsorb to soil.
In heavy clay soils that are flooded with water, microbes convert nitrate to N$_2$O gas, which floats away into the air.
Recognize the opportunity

• Optimal year – “top off the tank”
• Wet year – Nitrogen loss needs to be replaced
• Moderate drought – foliar is a direct path
• Other stresses – cold, pests, delay maturity
• CPC activity
• Uptake of other nutrients
Treated with 3 qts/A

Untreated
Treated  Untreated

Individual plants randomly pulled from each side of the field
Overview

• The agronomic case
• What it is
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UF’s and triazones – batch process

\[
\begin{align*}
\text{H}_2\text{N} & \text{C} - \text{NH}_2 \\
\text{H} & \text{C} - \text{H} \\
\text{H}_2\text{N} & \text{C} - \text{NH}_2 \\
\end{align*}
\]

\[
\begin{align*}
\text{H}_2\text{N} & \text{C} - \text{NH}_2 \\
\text{H} & \text{C} - \text{H} \\
\text{H}_2\text{N} & \text{C} - \text{NH}_2 \\
\end{align*}
\]

\[
\text{pH} \approx 7 \\
\text{H}_2\text{O} \\
\text{(HOCH}_2\text{CH}_2)_3\text{N}
\]

\[
\begin{align*}
\text{H}_2\text{N} & \text{C} - \text{NH}_2 \\
\text{H} & \text{C} - \text{H} \\
\text{H}_2\text{N} & \text{C} - \text{NH}_2 \\
\end{align*}
\]

I

II

III

IV

V

VI

Urea Formaldehyde
Microbes break down methylene urea and triazone by methylene urease enzyme, feeding on the carbon linking the urea molecules.

Once urea molecules are cleaved by urease enzyme, they are converted to ammonium and nitrate.
Release Curves for Various Methylene Urea Chains

- Slow Release Nitrogen
  - Delay N availability
  - N available through chemical/biological breakdown

- Release rate determined by:
  - Chemical structure
  - Molecular weight
  - Environmental conditions
Nitamin® enhanced efficiency fluid N fertilizer

- Liquid, slow-release N fertilizer
- Patented urea-based polymer
- Clear water soluble solution
- Nitrogen released by methylene urease enzyme
- Release rate is dependent on temperature and biological activity

- $Q_{10} = 2$
Overview

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Fluid foliar applications

• Low rates
• Aerial or high-clearance equipment
• Typically combined with fungicide application
• Stress recovery or supplemental N
Drip fertigation – high value crops

Standard

Standard

30L

30L
FOLIAR UPTAKE MECHANISM

- Stomata aperture
- Urea and MU
- cuticle
- epidermal cells
- mesophyll cells

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FOLIAR UPTAKE MECHANISM

- Foliar applied fertilizers uptake is through leaf cuticle.

- Nonpolar molecules (e.g., UF and Triazones) pass easier through leaf cuticle than polar molecules (e.g., $\text{NH}_4^+$, $\text{NO}_3^-$).

- Leaf cuticle pores diameter range between 1–5 nm while urea molecule has a diameter of 0.42 nm.

- Methylene urea and Triazones have diameter ranging at 0.84–1.26 nm.
FOLIAR APPLICATION

MU/Triazone fertilizer 30-0-0

Liquid Urea 20-0-0

30 minutes after application

*Only nutrients in solution can be absorbed by leaf surface
Nitamin® 30L fertilizer vs. urea solution
From day 3 to 14 Nitamin fertilizer treated leaves had up to a 33% increase in total N
• 115 lbs N/acre was deep banded at planting through conventional fertilizer
• Within time of application, bars followed by the same letter are not statistically different
Corn Yields in Missouri

Source: Dr. Kelly Nelson, U of Missouri

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Foliar on corn - Iowa

All treatments applied at VT/R1
Headline applied at 6 oz/A
Disease pressure was ~ 1%

Source: Dr. Robertson, Iowa State University, 2008
Cotton Defoliation Trial

Treatments:
1. Mepiquat Cl alone at 3.2 fl oz/acre, or
2. Mepiquat Cl combined with Nitamin® 30L at 8 or 16 fl oz/acre

Measurements:
• Defoliant applied Sept. 7, 2006
• Defoliation % measured 6 and 11 dat
• Regrowth evaluated 18 dat
• Harvested 19 dat (9/26/06)

Source: Dr. Charles Burmester, Auburn University, 2006
## Cotton Defoliation Trial

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Defoliation (%)</th>
<th>Defoliation (%)</th>
<th>Regrowth (%)</th>
<th>Yield lb./acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6 DAT</td>
<td>11 DAT</td>
<td>18 DAT</td>
<td>19 DAT</td>
</tr>
<tr>
<td>Mepiquat Cl 3.2 fl oz/ac</td>
<td>43.3</td>
<td>66.7</td>
<td>31.7</td>
<td>924</td>
</tr>
<tr>
<td>Mepiquat Cl 3.2 fl oz/ac + NITAMIN® 30L</td>
<td>60.0</td>
<td>76.7</td>
<td>25</td>
<td>1023</td>
</tr>
<tr>
<td>8 fl oz/ac</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mepiquat Cl 3.2 fl oz/ac + NITAMIN® 30L</td>
<td>66.7</td>
<td>88.3</td>
<td>28.3</td>
<td>1020</td>
</tr>
</tbody>
</table>

Source: Dr. Charles Burmester, Auburn University, 2006
Improved Nutrients Absorption of Foliar treatments applied on snap beans at R1

Calcium %

Zinc ppm

Potassium %

Source: Russ Wallace, Ph.D, Texas A&M

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Nitamin® 30L – 60 lb. N foliar applied from 30L in two equal sprays at bloom and five weeks later. Plus 120 lb. N was applied using a conventional fertilizer source (8-2-8) in two ground applications (Feb & Oct.). A total of 180 lb. N/acre/year was applied. Conventional program - 8-2-8 was ground applied in three equal split applications (Feb, April & Oct.) to supply a total of 180 lb. N/acre/year.

Location: Flatwoods grove

Source: Dr. Albrigo and Dr. Syvertsen, UF/IFAS, 2005-2006
Nitamin® 30L – 60 lb. N foliar applied from 30L in two equal sprays at bloom and five weeks later. Plus 120 lb. N was applied using a conventional fertilizer source (8-2-8) in two ground applications (Feb & Oct.). A total of 180 lb. N/acre/year was applied.

Conventional program - 8-2-8 was ground applied in three equal split applications (Feb, April & Oct.) to supply a total of 180 lb. N/acre/year.

Year to year change: Hurricane recovery and biennial yield cycle (Albrigo and Syvertsen)

Source: Dr. Albrigo and Dr. Syvertsen, UF/IFAS, 2005-2006
Bermudagrass leaching trial results: NH$_4^+$ + NO$_3^-$

NH$_4^+$-N + NO$_3^-$-N leached through a USGA-spec profile over 13 weeks following split applications of 0.5 lb N/1000 ft$^2$ every two weeks

Total applied: 88 lb N per acre

Source: Dr. John Cisar, UF/IFAS, 2006
Ammonia Volatilization Study

Source: Dr. Miguel Cabrera, University of Georgia, 2006
Fletcher, NC – Sept 15, 2005
Prior to 2\textsuperscript{nd} harvest

\textit{Nitamin\textregistered 30L left} \quad \textit{grower standard right}

\textit{(both applied at 200 lb. N/acre)}

Source: Dr. Doug Sanders and Dr. Luz Reyes, NC State U., 2005
Tomato yields, Clinton, NC 2005 (25# boxes/Acre)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total</th>
<th>Marketable</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 Std</td>
<td>1621</td>
<td>1441</td>
</tr>
<tr>
<td>300 Std</td>
<td>2004</td>
<td>1766</td>
</tr>
<tr>
<td>150 30L</td>
<td>1995</td>
<td>1789</td>
</tr>
<tr>
<td>200 30L</td>
<td>2121</td>
<td>1857</td>
</tr>
<tr>
<td>250 30L</td>
<td>1984</td>
<td>1779</td>
</tr>
<tr>
<td>LSD &lt; 0.05</td>
<td>265</td>
<td>302</td>
</tr>
</tbody>
</table>

Std – NaN0₃ injected in weekly applications providing 150 or 250 lb. N per acre during the growing season

Source: Dr. Doug Sanders and Dr. Luz Reyes, NC State U., 2005
## Tomato Nutrient Removal
NC State Trial, Fletcher, NC, 2005

### Nitrogen

<table>
<thead>
<tr>
<th>TMT.</th>
<th>g/plant</th>
<th>lb./acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 Std</td>
<td>6.4</td>
<td>70.5</td>
</tr>
<tr>
<td>300 Std</td>
<td>6.9</td>
<td>76.1</td>
</tr>
<tr>
<td>175 30L</td>
<td>10.1*</td>
<td>111.3</td>
</tr>
<tr>
<td>250 30L</td>
<td>10.0*</td>
<td>110.2</td>
</tr>
<tr>
<td>175 Dry</td>
<td>10.9*</td>
<td>120.1</td>
</tr>
<tr>
<td>250 Dry</td>
<td>10.4*</td>
<td>114.6</td>
</tr>
<tr>
<td>LSD 0.05</td>
<td>2.2</td>
<td></td>
</tr>
</tbody>
</table>

Nitamin® 30L Grower Standard

Source: Dr. Doug Sanders and Dr. Luz Reyes
Fletcher, NC – Sept 15, 2005
Before 2\textsuperscript{nd} harvest top, after harvest bottom
Nitamin® Foliar Fertilizer on Corn

- Replicated research results from two years of trials at four Midwestern universities show
  - Foliar application of 2 gallons per acre at tasseling increased corn yield an average of 7 bushels per acre

Columns followed by the same letter are not significantly different (p=0.10)
Benefits of Foliar Applications of Methylene Urea

- Higher N concentration than liquid urea
- Lower leaf burn potential
- Humectant properties (keeps leaf wetter longer)
- Good tank mix partner for other CPC’s
- Effective nitrogen delivery at critical growth stages
BLENDING “WATCH-OUTS”

• Jar blends should always be performed at the customer site and monitored for required stability

• Do not make UF & Triazone blends that are below pH 5

• Blends with a pH below 7 will not be stable for extended periods (depends on pH)

• Blends with pH 5-7 should be used quickly