Nitrogen Management Options

2003 Wisconsin Fertilizer, Aglime and Pest Management Conference

Allen R. Sutton

AGROTAIN International
Nitrogen Management Options

Best Management Practices Must Include:

- Realistic Nitrogen Recommendations
- Proper Timing of Application
- Consideration of Nitrogen Materials
- Concern for Environment
- Urease Inhibitors
- Nitrification Inhibitors
Methods of Improving Nitrogen Efficiency

• **Enhanced Nitrogen Feeding**
  There are opportunities to enhance nitrogen feeding by helping nitrogen to be at the right place, right time, and in the most advantageous form when the crop needs it.

• **Minimized Nitrogen Loss**
  There are five major avenues of nitrogen loss. Mechanical and chemical technology exists to reduce these losses of applied nitrogen.
FATE OF FERTILIZER NITROGEN AFTER APPLICATION (Crop Uptake 40-70%)

<table>
<thead>
<tr>
<th>Process</th>
<th>Formulate</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immobilization</td>
<td>NH$_4$NO$_3$</td>
<td>10 – 40%</td>
</tr>
<tr>
<td>Erosion</td>
<td>NH$_4$</td>
<td>0 – 20%</td>
</tr>
<tr>
<td>Denitrification</td>
<td>NO$_3$</td>
<td>5 – 35%</td>
</tr>
<tr>
<td>NH3 Volatilization</td>
<td>Urea</td>
<td>0 – 30%</td>
</tr>
<tr>
<td>Leaching</td>
<td>NO$_3$</td>
<td>0 – 20%</td>
</tr>
</tbody>
</table>
## Consideration of Nitrogen Materials

<table>
<thead>
<tr>
<th></th>
<th>FY 2000</th>
<th>FY 2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH₃</td>
<td>4.4</td>
<td>3.6</td>
</tr>
<tr>
<td>UAN</td>
<td>10.4</td>
<td>9.5</td>
</tr>
<tr>
<td>Urea</td>
<td>4.7</td>
<td>5.0</td>
</tr>
<tr>
<td>NH₄SO₄</td>
<td>1.0</td>
<td>1.1</td>
</tr>
<tr>
<td>NH₄NO₃</td>
<td>1.7</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Commercial Fertilizer 2001
## Wisconsin Nitrogen Consumption 2001

<table>
<thead>
<tr>
<th>Nitrogen Form</th>
<th>Consumption (Urea)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH₃</td>
<td>39,180</td>
</tr>
<tr>
<td>NH₄NO₃</td>
<td>17,965</td>
</tr>
<tr>
<td>NH₄SO₄</td>
<td>47,173</td>
</tr>
<tr>
<td>UAN</td>
<td>223,011</td>
</tr>
<tr>
<td>Urea</td>
<td>110,350</td>
</tr>
</tbody>
</table>

AAPFCO-2001
Ammonium $\text{NH}_4^+$ (bacteria) $\rightarrow$ Nitrite $\text{NO}_2^-$ $\rightarrow$ Nitrate $\text{NO}_3^-$
Nitrification Inhibitors

• Slow the conversion of $\text{NH}_4^+$ to $\text{NO}_3^-$ by controlling the population of Nitrosomonas and Nitrococcus bacteria.

• By controlling these bacteria populations, the conversion process of ammoniacal ($\text{NH}_4^+$) nitrogen to nitrate ($\text{NO}_3^-$) nitrogen is reduced.
Immobilization

- Can account for 10-40% tie up of applied nitrogen.
- The nitrogen isn’t lost however often is not available to the growing crop.
- Placing nitrogen below the carbon rich zone can reduce immobilization.
- Urea containing compounds can be leached by rainfall thru the carbon rich zone.
- Urease inhibitors can aid in this process.
Erosion

- Nitrogen is lost when soil erodes.
- Losses of Nitrogen can be as high as 20%.
- Conservation tillage is our best deterrent to erosion losses.
Denitrification Losses

The amount of nitrogen lost through denitrification depends on temperature and time.

<table>
<thead>
<tr>
<th>Soil Temperature</th>
<th>Days Waterlogged</th>
<th>Loss of Applied N(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>55-60 °F degrees</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>75-80 °F degrees</td>
<td>3</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>95</td>
</tr>
</tbody>
</table>
Leaching Loss

- Can be reduced by:
  » Maintaining nitrogen in the stable NH₄ form
  » Multiple applications
  » Slow release fertilizers
- Timing of application
  » Using nitrification inhibitors
Figure 10-1. Nitrate is more likely to move downward in sandy soil than in clay soil.
NH$_3$ Volatilization

- Occurs with surface applied Urea containing fertilizers
- Losses can exceed 30%
- Losses begin within hours of application
- Loss is facilitated by the enzyme urease
WHY UREA VOLATILIZES

When urea is applied to the soil it rapidly hydrolyzes (a chemical reaction resulting in breakdown of susceptible chemical bonds) to ammonium carbonate.

\[ \text{Urea} \ (\text{NH}_2)_2 \text{CO} + \text{H}_2\text{O} \rightarrow \text{(NH}_4)_2 \text{CO}_3 \]

Urease

\[ \text{(NH}_4)_2 \text{CO}_3 + \text{H}_2\text{O} \rightarrow 2\text{NH}_3 + \text{H}_2\text{O} + \text{CO}_2 \]

Ammonium carbonate is unstable and breaks down to ammonia and carbon dioxide. The ammonia is either absorbed by the soil or volatilizes. The hydrolysis reaction is increased by the urease enzyme.
Volatilization Losses

- Can be reduced by:
  - Incorporating Nitrogen immediately following application.
  - Using non Urea containing fertilizers
  - Injecting nitrogen in a band
  - Using a urease inhibitor
Urease Inhibitors

- Volatilization can occur anytime atmospheric moisture and urease are available in temperatures that range from 11° F to 105° F.
- Urease inhibitors block the conversion of urea to ammonia for a period of one to two weeks allowing time for incorporation by rainfall or other means.
Summary

• Increasing nitrogen efficiency:
  » increases of 40-70% are possible
  » Nitrogen management options include:
    • Multiple applications
    • Placement of nitrogen material
    • Use of nitrification inhibitors
    • Timing of application
    • Use of urease inhibitors