Nitrogen Management in Direct Seeding Operations

Golden Triangle  January 3-4, 2011

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Objectives

• Discuss nitrogen fertilizer placement and timing to meet 2011 crop needs with a focus on in-row placement and top-dressing
• Show amounts of urea volatilization occurring in the Triangle
• Discuss ways to minimize volatilization
In-row Nitrogen (N) Placement

- Germination and emergence are impacted if N is applied too close to seed.
- Sandy dry soils result in highest amounts of germination problems.
- The rate of N fertilizer that can be applied increases as seed bed utilization (SBU) increases.
  \[ SBU = 100 \times \left( \frac{\text{width of seed row}}{\text{row spacing}} \right) \]
- Ex: Opener = 1 in. row spacing = 12 in.
  \[ SBU = 100 \times \left( \frac{1}{12} \right) = 8\% \]
Effects of SBU and Soil Moisture on Emergence

Figure 1. Seed-placed urea (60 lb N/A) reduces emergence under dry soil conditions and low SBU (Alberta data).
Approximate safe rates of urea N (lb N/acre) that can be applied with the seed of cereal grains.

<table>
<thead>
<tr>
<th>Soil texture</th>
<th>1 inch spread</th>
<th>3 inch spread</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Row spacing</td>
<td>Row spacing</td>
</tr>
<tr>
<td>Light (sandy loam)</td>
<td>6” 12”</td>
<td>6” 12”</td>
</tr>
<tr>
<td></td>
<td>20 15</td>
<td>40 25</td>
</tr>
<tr>
<td>Medium (loam to clay loam)</td>
<td>30 20</td>
<td>50 35</td>
</tr>
<tr>
<td>Heavy (clay to heavy clay)</td>
<td>35 30</td>
<td>60 40</td>
</tr>
</tbody>
</table>

Effect of N source applied with the seed on dryland spring wheat yield

![Grain yield (bu/acre) vs. Application rate (lb N/acre)]

- **Urea**
- **Urease inhibitor**
- **Polymer-coated**

Saskatchewan Malhi et al. 2003
Topdressing and Split Applications

• How do I decide when to topdress if I don’t want to hurt yields and want to maximize protein?

• First need to know how much the plant needs and when it needs it.
N application timing effects on yield and protein

Nitrogen early
Number of tillers and kernels/head

Grain protein from remobilized N

Nitrogen late
Weight/kernel

Higher grain protein
Cumulative N uptake by wheat

Nutrient Uptake Timing by Crops: to assist with fertilizing decisions
http://landresources.montana.edu/soilfertility/publications.html
Use Nutrient Uptake figure to time top-dress

Example on per acre basis:

- 200 lb N total need, 40 lb N in soil, 60 lb preplant N
- soil and preplant supply 100 lb N = 50% total N required
- \((200 - 100) = 100\) lb N top-dress
Top-dress amount and timing based on plant growth stage

50% required N used up by mid tillering
must topdress 100 lb N by early- to mid-tillering
Foliar Applications

- Biggest advantage – can use a herbicide sprayer with only minimal stand damage
- Most foliar applied N ends up being washed off and taken up by roots:
  - Only 8-11% of foliar applied liquid urea was taken up by leaves, whereas 37-67% of soil applied N was taken up by plant in same study (Rawluk et al., 2000).
- Generally only about 20 lb N/ac can be applied on leaves without getting some burn. Though up to 60 lb N/ac have been applied without excessive burn.
Questions?
Factors Increasing Volatilization

1. High Soil pH and Temperature
2. Windy
3. Low Cation Exchange Capacity (CEC). WHY?
4. Low buffering capacity (resistance to pH change)
5. High soil moisture/humidity
6. Little Rainfall/Irrigation following fertilization
7. High Ground cover/vegetation/residue. WHY?
8. Low Soluble and Exchangeable Calcium

Bottom line: Large number of factors make volatilization amounts VARIABLE and difficult to predict.
A first look at ammonia volatilization losses from surface-applied urea

Richard Engel, Clain Jones, Jeff Whitmus
Montana State University
Project Objectives

- How much N as ammonia are we losing from applications of surface urea (fall, winter, and early spring)?

- Is this a significant economic loss to Montana producer?

- If losses are significant, then how do we mitigate losses?
Integrated horizontal flux method

- preferred approach for quantifying gas loss
- moderate size plots (~0.3 acre)
- continuous measurement of NH$_3$(g) loss over time

mast and shuttles
Circular plots (22 yard radius)

- urea (90 lbs N/acre)
- urea + NBPT (Agrotain @ 4 quarts/ton)
- large unfertilized buffer areas around plots
Shuttles

- traps for collecting ammonia

Stainless steel spiral coated with oxalic acid rotate on pivot & face into wind
Two examples of field trial results from west Havre field site (Kaercher farm)

- Hill County
- Phillips-Elloam silt loam
- pH 6.0
- no till winter wheat
- Campaigns 2 and 5 - conducted in the identical field

Campaign 2: October 9, 2008.
Air temp = 45 F, Soil temp = 43 F

Campaign 5: March 26, 2009. Air temp = 21 F, Soil temp = 34 F
October 9, 2008 application, air-temp. 45 °F, dry soil surface

no rain for 24 days and then Nov. 2-5 field site received 0.98”ppt.

1 wk post-fertilization prills not dissolved
Campaign #2 - Kaercher farm

- Urea (3.1%)
- Urea + NBPT (1.4%)

Percentage of applied N lost vs. Weeks post-fertilization

Mean Air Temp ~ 42 F
Mean Soil Temp ~ 41 F
Campaign #5 - high NH$_3$ losses observed

Fertilizer applied on Mar 26, 2009
light snow on soil surface and air temp = 21 F

soil surface with fertilizer prills beginning to dissolve
Campaign #5 - Kaercher farm

Conclusion: High losses observed even though temperatures were cold!
Peterson farm site - background

- 28 miles NW of Havre
- Telstad-Joplin loam
- pH 5.5
- no till winter wheat
- Campaigns 3, 4, and 8
Campaign #4 – Peterson farm

Fertilized applied – March 25, 2009
“light snow & air-temp. 18 °F”

soil surface frozen, 30 °F
Campaign #4 – Peterson farm

Precipitation

0.01” = 0-2 wks
0.89” = 2-8 wks

Percentage of applied N lost

Weeks post-fertilization

Soil temp = 30 F
Air temp. = 18 F

Urea (35.6%)
Urea + Agrotain (18.0%)
## Campaign Summary (% N loss)

<table>
<thead>
<tr>
<th>Campaign</th>
<th>Fertilization date</th>
<th>Urea</th>
<th>NBPT-urea</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>April 3, 2008</td>
<td>8.4</td>
<td>4.4</td>
</tr>
<tr>
<td>2</td>
<td>Oct 8, 2008</td>
<td>3.1</td>
<td>1.4</td>
</tr>
<tr>
<td>3</td>
<td>Nov 14, 2008</td>
<td>31.5</td>
<td>4.0</td>
</tr>
<tr>
<td>4</td>
<td>March 25, 2009</td>
<td>35.6</td>
<td>18.0</td>
</tr>
<tr>
<td>5</td>
<td>March 26, 2009</td>
<td>39.9</td>
<td>18.1</td>
</tr>
<tr>
<td>6</td>
<td>Oct 6, 2009</td>
<td>10.7</td>
<td>3.3</td>
</tr>
<tr>
<td>7</td>
<td>Oct 13, 2009</td>
<td>10.4</td>
<td>4.8</td>
</tr>
<tr>
<td>8</td>
<td>Oct 19, 2009</td>
<td>15.7</td>
<td>3.4</td>
</tr>
<tr>
<td>9</td>
<td>Jan 27, 2010</td>
<td>24.3</td>
<td>9.3</td>
</tr>
<tr>
<td>10</td>
<td>Feb 26, 2010</td>
<td>44.1</td>
<td>11.9</td>
</tr>
<tr>
<td>11</td>
<td>March 29, 2010</td>
<td>6.3</td>
<td>1.7</td>
</tr>
<tr>
<td>12</td>
<td>April 20, 2010</td>
<td>14.7</td>
<td>1.4</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td><strong>20.4</strong></td>
<td><strong>6.8</strong></td>
</tr>
</tbody>
</table>

*wide range in N loss amounts*
Ammonia volatilization and urea fertilizer

A micrometeorological study to quantify volatilization losses of ammonia from surface urea applications to no-till wheat

In Montana, farmers often fertilize wheat by applying urea to the soil surface during the fall, winter, or early spring. The question of how much nitrogen is lost from this application strategy seems to be raised by growers and fertilizer dealers every season. Surface urea applications are known to be susceptible to nitrogen losses as a result of ammonia volatilization (lost to the air). However, the importance of this process in cold soils is not known and is the focus of an investigation I am currently leading. To answer this question, I am using a micrometeorological system referred to as the integrated horizontal flux (picted in photograph below) method to quantify ammonia losses from the soil. Micrometeorological are widely recognized as providing the most accurate measures of gas losses from soils. This method is not disruptive of the soil environment and provides for continuous collection of ammonia gas over time. This is a first of its kind study in Montana. Field studies are presently being conducted at two farms in northern Montana, with a third farm site to be added in the fall 2009. I have constructed this web site to keep people up-to-date on the progress of this study.

Recent presentations

August 6, 2009 - CCA and Dealer Training, Huntley, Montana

Updated: 08/29/2009
Summary – take home messages

- Significant ammonia losses (30-40% of applied N) from surface-applied urea can occur even though soil temperatures are near freezing!

- Soil moisture conditions at surface that dissolve urea granules (i.e. prolonged damp) without rain promote high ammonia losses (more common to find these conditions in MT during late fall or early spring)

- NBPT (Agrotain) reduced losses 62% over untreated urea
Support

- WSARE
- MT Fertilizer Advisory Committee
- MT Wheat and Barley Committee
- NRCS-CIG program
- International Plant Nutrition Institute
- Agrotain International
If ~20% of broadcast urea is lost, why didn’t MT research from the 1990s show large yield/protein losses compared to ammonium nitrate and/or subsurface banding? (Jones et al. 2007)

1. Adequate precipitation may have occurred after application.
2. Urea takes 2 - 5 weeks to become available whereas AN is immediately available for plants and for other losses-urea’s ‘slow release’ property may increase its efficiency, making up for loss.
3. About 50% of N uptake comes from fertilizer (rest from soil). So 20% of 50% is 10% difference in N availability-might not make a statistically SIGNIFICANT difference (though still a bottom line difference).
4. With longer term no-till could ‘urease’ enzyme concentrations have increased? It is known that residue contains more urease than soil.
5. With longer term no-till, some calcium has likely leached out of surface soil. Calcium is known to decrease volatilization and most source studies were conducted last decade.
Effect of Urea Placement on Hays Barley (Annual Forage) Yield

Forage yield (tons/acre)

Angvick et al. unpub data

Froid, MT

subsurface band
broadcast

2009 2010

a b a b
2009 (apparent low volatilization)

1.8 inches

2010 (apparent high volatilization)

0.5 inches
Light ppt events (≤ 0.4”) are common along the Highline
Size and frequency of precipitation events
Havre Airport (last 5 years)

91% of all events
What should you do to minimize volatilization?

1. Do not apply urea on moist ground UNLESS a snow or rainstorm is forecast to drop at least ½ inch of rain in a day. Preferably more (unlikely unfortunately!).

2. If you irrigate, apply ½ inch of irrigation after urea application.

3. Apply urea below the surface – either in a midrow band, 2 inches from the seed or with the seed with a ‘protected’ product or a wide opener.

4. Consider seeding right after urea application to cover some urea; wider openers will help with this. (We’re currently testing effectiveness of this practice)

5. Consider using Agrotain or ammonium nitrate (if available) if can’t apply during a low risk time.
Other Resources

• Soil Fertility information: http://landresources.montana.edu/soilfertility
• Above link contains an Economic N rate calculator, Fertilizer Fact sheets, Press Releases, and Extension documents like Nutrient Uptake Timing by Crops and Enhanced Efficiency Fertilizers
• Link also will contain this presentation in a couple days
Questions?