Institute of Ag Professionals

Proceedings of the

2015 Crop Pest Management Shortcourse &

Minnesota Crop Production Retailers Association Trade Show

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Mineralization of Soil Nitrogen as a Component for Economically and Environmentally Sustainable Crop Production

Fabián G. Fernández
Nutrient Management & Water Quality Specialist
Department of Soil, Water, and Climate
fabiangf@umn.edu

CPM Short Course
08-10 DEC. 2015, Minneapolis, MN

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What’s the Right Rate?

[Bar chart showing the relationship between N rate and yield with annotations indicating similar rate and similar yield.]
How Much N is Naturally in the Soil and Available to Crops?

• About 5% of OM is N

• Each 1% OM in top 7 inches = 20,000 lb OM/acre

• Annually, about 1 to 3% of the organic N converts into plant-available N

• Soil with 3.5% OM = 3,500 lb organic N
  – 35 to 105 lb of N per acre per year

• Deeper soils can provide more
• 3.5% OM = 3,500 lb N/a x 3% release ≈ 105 lb N/A
• 100 lb N/a in residue x 50% plt. avail. ≈ 50 lb N/A
• N deposited by precipitation ≈ 10 lb N/A
• Non Fertilizer N supply ≈ 165 lb N/A
• 200 bu/a crop ≈ 240 lb N/A
• N needed from fertilizer ≈ 75 lb N/A
  – 55-65% taken up by crop
  – 20-25% goes to OM
  – 15-20% denitrified, leached, volatilized, weed uptake
• If efficiency is 60% ≈ 125 lb N/A to supply 75 lb N/A
• 25% reduction in OM supply ≈ 169 lb N fertilizer/A
• 25% increase in total natural supply ≈ 56 lb N fertilizer/A
How Much Yield Can We Get Through Mineralization in MN?
Percent of Corn Yield at EONR Obtained from the 0-N Check 53% C-C, 71% C-S

52 bu/a 58 lb N/a
218 bu/a 244 lb N/a
Ave:116 bu/a 130 lb N/a
Corn Grain Yield at Zero N as a Function of Yield at the EONR (0.1 corn:N price ratio)

<table>
<thead>
<tr>
<th>State</th>
<th>Corn-corn</th>
<th>Corn-soybean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>54</td>
<td>64</td>
</tr>
<tr>
<td>Iowa</td>
<td>45</td>
<td>75</td>
</tr>
<tr>
<td>Minnesota</td>
<td>60</td>
<td>76</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>71</td>
<td>77</td>
</tr>
<tr>
<td>Mean</td>
<td>56 (271 sites)</td>
<td>70 (427 sites)</td>
</tr>
</tbody>
</table>
Marna silty clay loam and Nicollet silty clay loam
<table>
<thead>
<tr>
<th>Trt</th>
<th>Soybean</th>
<th>Corn</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N rate in lb N/acre and application time</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0*</td>
<td>0*</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>40 pre-plant</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>80 pre-plant</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>120 pre-plant*</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>160 pre-plant</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>200 pre-plant</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>40 pre-plant/80 sidedress at V4*</td>
</tr>
<tr>
<td>8</td>
<td>40 pre-plant</td>
<td>120</td>
</tr>
<tr>
<td>9</td>
<td>40 at V4</td>
<td>120</td>
</tr>
<tr>
<td>10</td>
<td>40 at R1</td>
<td>120</td>
</tr>
<tr>
<td>11</td>
<td>40 at R3</td>
<td>120</td>
</tr>
</tbody>
</table>

Treatments with * will be measured for nitrous oxide emissions; Gray-shaded treatments for the specific crop will be measured for mineralization potential.
• In-situ mineralization study
• Lab incubation study

“The man who is a pessimist before 48 knows too much; if he is an optimist after it he knows too little.”

*Mark Twain*
2014

Marna silty clay loam and Nicollet silty clay loam

Soybean yield (bu/ac)

Nitrogen rate (lb N/ac) - Time of application

Check | 40-PP | 40-V4 | 40-R1 | 40-R3

Drained | Undrained

65a | 61b | 60b | 61b | 58b
2015

Marna silty clay loam and Nicollet silty clay loam

Soybean yield (bu/ac)

Nitrogen rate (lb N/ac) - Time of application

- Check
- 40-PP
- 40-V4
- 40-R1
- 40-R3

Drained
Undrained
Marna silty clay loam and Nicollet silty clay loam
2015

Marna silty clay loam and Nicollet silty clay loam

Graph showing corn yield (bu/ac) vs. N rate (lb N/ac) for Drained and Undrained conditions. The graph includes data points at (212, 108).

Note: The University of Minnesota Extension logo is present at the bottom right corner, but not relevant to the content of the document.
End of Season Soil N

Marna silty clay loam and Nicollet silty clay loam

Drained

$\Delta = 0.25 \text{ lb TIN/lb of fertilizer}$

$\Delta = 1.05 \text{ lb TIN/lb of fertilizer}$

Corn yield (bu/ac)

TIN 0-36" (lb/ac)

N rate (lb N/ac)
End of Season Soil N

Marna silty clay loam and Nicollet silty clay loam
2014

Marna silty clay loam and Nicollet silty clay loam

Nutrient Management
2015

Marna silty clay loam and Nicollet silty clay loam
2014

Nutrient Management

Drained, Corn, 0N

Drained, Corn, 120N

Undrained, Corn, 0N

Undrained, Corn, 120N

Nitrate-N
Ammonium-N

Date

Nitrogen (lb/a)

6/5 6/12 6/19 6/26 7/3 7/10 7/17 7/24 7/31 8/7 8/14 8/21

Nitrogen (lb/a)

6/5 6/12 6/19 6/26 7/3 7/10 7/17 7/24 7/31 8/7 8/14 8/21

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stands for Piled higher and Deeper

or...

A license to keep learning
Potentially Mineralizable N

N mineralization described by first order kinetics with the one-pool model of Stanford and Smith (1972) with a nonlinear curve fitting procedure PROC NLIN (SAS Institute Inc., 2002).

The one-pool model is:

\[ N_m = N_0 \left[ 1 - \exp\left( -kt \right) \right] \]

where

- \( N_m \) = mineralized N in \( \mu g \) N g\(^{-1}\) soil
- \( N_0 \) = potentially mineralizable N in \( \mu g \) N g\(^{-1}\) soil
- \( k \) = rate constant of mineralization in day\(^{-1}\)
- \( t \) = time in days

<table>
<thead>
<tr>
<th>Site</th>
<th>Series and Taxonomic Classification</th>
<th>Sand</th>
<th>Silt</th>
<th>Clay</th>
<th>CEC</th>
<th>OM</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Becker</td>
<td>Hubbard loamy sand (Sandy, mixed, frigid Entic Hapludoll)</td>
<td>90</td>
<td>5</td>
<td>5</td>
<td>7.6</td>
<td>1.5</td>
<td>7.2</td>
</tr>
<tr>
<td>Crookston</td>
<td>Bearden-Colvin silty clay loam (Fine-silty, mixed, superactive, frigid Aeric Calciaquolls)</td>
<td>24</td>
<td>29</td>
<td>47</td>
<td>42.7</td>
<td>4.6</td>
<td>8.0</td>
</tr>
<tr>
<td>Lamerton</td>
<td>Sandy Clay Loam (Fine-loamy, mixed, superactive, mesic Typic Calciaquolls)</td>
<td>46</td>
<td>21</td>
<td>33</td>
<td>16.2</td>
<td>4.2</td>
<td>5.6</td>
</tr>
<tr>
<td>Rosemount</td>
<td>Waukegan silt-loam (Fine-silty over sandy or sandy-skeletal, mixed, superactive, mesic Typic Hapludolls)</td>
<td>22</td>
<td>51</td>
<td>27</td>
<td>15.7</td>
<td>4.8</td>
<td>6.6</td>
</tr>
<tr>
<td>St. Charles</td>
<td>Seaton silt loam (Fine-silty, mixed, superactive, mesic Typic Hapludalfs)</td>
<td>20</td>
<td>59</td>
<td>21</td>
<td>15.4</td>
<td>3.6</td>
<td>7.0</td>
</tr>
<tr>
<td>Waseca</td>
<td>Canisteo clay loam (Fine-loamy, mixed, superactive, calcareous, mesic Typic Endoaquolls)</td>
<td>44</td>
<td>21</td>
<td>35</td>
<td>27.1</td>
<td>5.4</td>
<td>6.7</td>
</tr>
<tr>
<td>Wells</td>
<td>Marna silty clay loam (Fine, smectitic, mesic Vertic Endoaquolls) and Nicollet silty clay loam (Fine-loamy, mixed, superactive, mesic Aquic Hapludolls)</td>
<td>36</td>
<td>29</td>
<td>35</td>
<td>21.2</td>
<td>5.3</td>
<td>5.6</td>
</tr>
<tr>
<td>Westport</td>
<td>Arvilla sandy loam (Sandy, mixed, frigid Calcic Hapludolls)</td>
<td>70</td>
<td>17</td>
<td>13</td>
<td>16.1</td>
<td>4.6</td>
<td>7.1</td>
</tr>
</tbody>
</table>
Wells; Marna silty clay loam and Nicollet silty clay loam
Wells; Marna silty clay loam and Nicollet silty clay loam
Mineralized N (lb T/N/a)

Days of incubation

Westport; Arvilla sandy loam
Westport; Arvilla sandy loam
Westport; Arvilla sandy loam
Nutrient Management

Westport; Arvilla sandy loam

Mineralized N (lb TN/a)

Days of incubation

CS 0-N
CS 280-N
SC 0-N
SC 280-N
St Charles; Seaton silt loam
Rosemount; Waukegan silt-loam

The graph shows the mineralized N (lb TIN/ha) over the days of incubation for two different treatments: Rosemount NT (solid blue line) and Rosemount CT (dashed red line). The graph indicates a gradual increase in mineralized N over time for both treatments, with some fluctuations.
Loamy sand, sandy clay loam, clay loam, silty clay-loam
Nutrient Management

PLOT 816 (30 FT long by 10 FT wide)

2,200 cores
940 individual samples
Area = 0.8 acres
400 samples
0-12” deep
Every 6” distance ½ acre linear transect
TIN Spatial Variability

180 samples (0-6”, 6-12”, 12-24”)
10-core composite
Each dot is a 10x10’ area
Overall, 20 samples per 2.5 acres are needed to achieve a TIN estimate with 10% error margin at 0.05 significance level.
Can a shallow sample estimate a deeper sample?

0-6” soil samples can be good predictors of 0-12” soils, but the predicting power for 6-12”, 12-24”, and 0-24” soils is limited.
Take Home Message

• N mineralization is a very important source of N
  – Impacted by soil, drainage, crop, and N management
  – Impacted by growing season conditions

• Soil N variability is large

• Can we use “standard” mineralization values?

• Use Best Management Practices proven by years of unbiased research
Above All

Image Credit: http://www.fi-frontiercities.eu/call-status/

Nutrient Management
AGENDA

Nitrogen: Minnesota's Grand Challenge & Compelling Opportunity Conference
Tuesday February 23, 2016, International Events Center, Rochester, MN

GENERAL SESSION

8:15 to 9:15  Registration
9:15 to 9:20  Welcome, Dr. Fabián Fernández, University of Minnesota
9:20 to 10:10  Climate Trends and Their Implications On Agriculture, Dr. Mark Saasly, University of Minnesota
10:10 to 11:00  Will Changing Weather Patterns Affect Nitrogen Management? Dr. Gyles Randall Emeritus, University of Minnesota
11:00 to 11:50  Nitrogen Use Efficiency For OLD vs. MODERN Corn Hybrids, Dr. Ignacio Ciampitti, Kansas State University
11:50 to 12:00  The Nitrogen Smart Program. Mr. Brad Carlson, University of Minnesota
12:00 to 1:00  Lunch

BREAKOUT SESSION #1

1:00 to 1:50  Cover Crops And Nitrogen Management, Ms. Jaimie West, University of Wisconsin
1:50 to 2:40  Improved Nitrogen Efficiency Through Nitrogen Source, Additives, And Time Of Application, Mr. Jeff Vatsch, University of Minnesota
2:40 to 3:30  In-Season N Predictions Using Canopy Sensors, Dr. Dan Kaiser, University of Minnesota
3:30  Adjourn

BREAKOUT SESSION #2

1:00 to 1:50  Nitrogen Losses in Manured Systems, Mrs. Ambar Radatz, University of Wisconsin Discovery Farms
1:50 to 2:40  Anhydrous Ammonia, Soil, & CEC: Myths and Management, Mr. Fred Vocasek Servi-Tech Laboratories, Kansas
2:40 to 3:30  Nitrate in Our Drinking Water—What 10,000 Wells Are Telling Us, Mr. Bruce Montgomery, Minnesota Department of Agriculture
3:30  Adjourn

http://z.umn.edu/Nconference

Feb. 23 Rochester. N Conference
Feb. 9 Jackpot Junction. Nutrient Conference
Thank You!

- U of M Nutrient Management Group
- Graduate & Undergraduate Students, post Docs
- Research Center Personnel and Farmers
- Funding entities:

![Logos of funding entities]
Best Wishes for the 2016 Growing Season