The Fundamentals of Nitrogen Requirement

Brian Arnall
Precision Nutrient Management
Oklahoma State University
Panhandle Soils

<table>
<thead>
<tr>
<th>N rate lb ac⁻¹</th>
<th>Pre-plant N</th>
<th>N applied</th>
<th>Total N</th>
<th>NDVI</th>
<th>Yield Bu ac⁻¹</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>70</td>
<td>0</td>
<td>70</td>
<td>0.80</td>
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<tr>
<td>50</td>
<td>92</td>
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<td>92</td>
<td>0.82</td>
<td>207ᵃᵇ</td>
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<td>240</td>
<td>0</td>
<td>240</td>
<td>0.82</td>
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<td>110</td>
<td>95</td>
<td>205</td>
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<td>230</td>
<td>135</td>
<td>365</td>
<td>0.84</td>
<td>244ᶜ</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>N rate lb ac⁻¹</th>
<th>Nupt lb ac⁻¹</th>
<th>N- Balance lb ac⁻¹</th>
<th>2014 Preplant N lb ac⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>134</td>
<td>-64</td>
<td>30</td>
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<tr>
<td>50</td>
<td>145</td>
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<td>44</td>
</tr>
<tr>
<td>100</td>
<td>158</td>
<td>82</td>
<td>40</td>
</tr>
<tr>
<td>150</td>
<td>165</td>
<td>40</td>
<td>54</td>
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<tr>
<td>200</td>
<td>172</td>
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<tr>
<td>250</td>
<td>171</td>
<td>194</td>
<td>140</td>
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</tbody>
</table>
N Rate

- Stanford Eq.
  - J EQ Vol 2 No 2 1973 pgs 159-166
- N rate from Three Simple numbers
- Nitrogen Uptake by plant
- Nitrogen Supplied by Soil
- Efficiency of Fertilizer
Nitrogen Uptake by plant

- In short:
- Identify the final yield.......... 
- Account for N in grain/biomass.
Yield

- Yield Goal
- Use of Averages or Soil Capabilities
Yield goal/Expected /Proven

- Undefined
- Realistic target yield that is achievable with favorable growing conditions (MD)
- 5-year average
- 5-year avg. + 5-10% (NE)
- Expected yield in 3-4 years of 5 under good management (NY)
Proven yield – South Dakota

- Proven Yield (5 year data minus outliers)
- Proven Yield +10%
- Proven Yield Modified for Soil Moisture (+10-20%)
- Modified County Averages
- Avg. yield increase about 1.8 bu/a/year annually (<2% per year and diminishing)
Yield goals should be sufficiently greater than long-term average yields to insure nitrogen will not be the factor limiting crop production during years with better than average growing conditions. As a rule of thumb, the average yield from the last five years plus 20 percent is an appropriate yield goal.
<table>
<thead>
<tr>
<th>Crop</th>
<th>Average %N</th>
<th>Test wt, lb/bu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn (USA)</td>
<td>1.25</td>
<td>56</td>
</tr>
<tr>
<td>Winter Wheat</td>
<td>2.39</td>
<td>60</td>
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<tr>
<td>Winter Wheat Forage</td>
<td>2.46</td>
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<tr>
<td>Spring Wheat (Dakota's)</td>
<td>2.4</td>
<td>60</td>
</tr>
<tr>
<td>Wheat Argentina</td>
<td>2.2</td>
<td>60</td>
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<tr>
<td>Sorghum</td>
<td>1.95</td>
<td>56</td>
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<tr>
<td>Bermudagrass</td>
<td>2</td>
<td>na</td>
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<tr>
<td>Cotton Lint</td>
<td>8.637</td>
<td></td>
</tr>
<tr>
<td>Durum Wheat</td>
<td>2.24</td>
<td>60</td>
</tr>
<tr>
<td>Canola (Canada)</td>
<td>3.3</td>
<td>50</td>
</tr>
</tbody>
</table>
Grain yield, bu/ac

Exp. 502, 1971-2011

N-P2O5-K2O

2.0-40-60

100-40-60

Response Index

Grain yield, bu/ac


Response Index


Response Index
Theoretical optimum rate
Economical Optimum N Rate, lb ac⁻¹

Exp. 502, 1971-2011

Optimum N Rate
Avg. 62 lb N/ac  +/-  34
EONR

- Often set as the rate that is correct 90-95% of the time.
- Minimal risk of not reaching maximum yield
- Economics
- Environment
EONR over 10yrs

<table>
<thead>
<tr>
<th>N-Rate</th>
<th>Freq.</th>
<th>% Oc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>20</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>40</td>
<td>0</td>
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<tr>
<td>60</td>
<td>0</td>
<td>0</td>
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<tr>
<td>80</td>
<td>4</td>
<td>40</td>
</tr>
<tr>
<td>100</td>
<td>3</td>
<td>30</td>
</tr>
</tbody>
</table>
Nitrogen Supplied by Soil

- Residual and Additions
- Mineralization
- Immobilization
- Credits – Legumes, Cover crops, Manures,
  - Mineralization of these
- Loss Pathways
N-Cycle

- **OM**
- **2 OM Processes**
- **2 N Processes**
- **3 Sinks**
- **4 losses**
- **5 additions**
Central point of the Nitrogen Cycle
In an acre furrow slice 1000 lbs N per 1% OM
A continuous flow of N into and out of OM.
Organic Matter Processes

- **Immobilization**
  - NO$_3$ and NH$_4$ tied up into OM

- **Mineralization**
  - OM decomposed into NO$_3$ and NH$_4$

- High Carbon (straw) = Immobilization

- Low Nitrogen (alfalfa) = Mineralization
4 Losses

- **Leaching**
  - NO$_3$ – follows water flow.

- **Ammonia Volatilization**
  - NH$_4$ at a pH > 7 H is stripped off and NH$_3$ (gas) formed.

- **Denitrification**
  - NO$_3$ in waterlogged soil. Microbes strip O off

- **Plant Loss**
  - NO$_3$ and NH$_4$ converted to NH$_3$ in plant, in stress NH$_3$ gassed off.
Nitrogen Processes

- Ammonization and Ammonification
  - OM converted to $\text{NH}_4$
- Nitrification
  - $\text{NH}_4$ converter to $\text{NO}_3$
- Ammonium + charge and Immobile
- Nitrate - charge and mobile
Efficiency of Fertilizer

- What percentage applied can be used.
- Source
- Timing
- N-Cycle
Source and Timing

- Source by method by timing.
N-Cycle

- Immobilization
  - Applied N can be immobilized.

- Losses
  - Some soils and environments have guaranteed losses.
Organic Matter is the Driver
Annual N need is determined by Mineralization and Immobilization
Environment, temp and rainfall, drives Mineralization and Immobilization
Applications within The N-Cycle post Drought

- Fields had High N in October and N deficient by Dec.
Reference Strips

• Are Very Visual..
• Definite Yes or No
• Risk Aversion?
• Sales and Service?
Reference Strips

- **What:** A high rate of N applied in, across, through, over or under each and every field

- **How Much:** Grain only 40 to 60 lbs
  Dual purpose 60-100 lbs Above Pre-plant

- **How and Where:** Min 10 ft wide, 100 yds long, anywhere representative.

- **When:** Winter crops; before or after sowing (up to 30 days),
How does it work

- Two Readings
  - N-Rich Strip
  - Farmer Practice
- Predict Yield of Each
  - N-Rich Strip YP 40 bu/ac
  - Farmer Practice YP 30 bu/ac
- Difference 10 Bu/ac
- 2 lbs N per bushel
- Rec is 20 lbs N / ac
Yield Prediction

Lahoma 502, Winter Wheat

Yield Goal, 57 bu/ac

SBNRC (YP0*RI =YPN)
100 Pre (100 lbs N/ac applied preplant)
Applicators
Thank you!!!

Brian Arnall
373 Ag Hall
405-744-1722
b.arnall@okstate.edu
Presentation available @
www.npk.okstate.edu
Twitter: @OSU_NPK
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YouTube Channel OSUNPK