Efficient Management of Nitrogen in Wheat

Daniel Kaiser
Albert Sims
Jochum Wiersma
Nitrogen Management in Wheat

• Important for two key components
  – Yield
  – Protein
• Starch production is more efficient in terms of N use
  – Plant would rather use N for starch
• Yield is typically maximized prior to protein maximum
• N assimilation in some grasses is high
  – Lbs taken up per day
Physiology of Grain Fill

Typical Nitrogen Uptake Per Acre for a 45 bu/a Hard Red Spring Wheat

![Bar graph showing nitrogen uptake in May, June, and July]

- May: 25 lbs of Nitrogen
- June: 65 lbs of Nitrogen
- July: 45 lbs of Nitrogen

Adapted from Wiersma U of M - 2009
Grain Yield 2 yr. Average NW MN - var. Knudson

Relative Grain Yield (%)

RelYld = 31.82 + 0.8668(total N) + -0.0028(total N)^2

\( r^2 = 0.69 \quad P < 0.0001 \)

Hallock, 2008
Perley, 2008
Strathcona, 2008
Perley, 2009
Foxhome, 2009

CL - 155 lbs N


Fertilizer N Applied + 2' Soil N (lb/acre)
Relative Grain Protein Content (%) vs. Fertilizer N Applied + 2' Soil N (lb/acre)

Graph showing the relationship between relative grain protein content and fertilizer nitrogen applied, including data from Hallock, Perley, Strathcona, and Foxhome in 2008 and 2009. The graph includes a linear regression line with the equation:

\[ \text{RelProtein} = 82.5 + 0.0854(\text{total N}) \]

The coefficient of determination, \( r^2 \), is 0.54, and the significance level, \( P \), is less than 0.0001. The critical line (CL) is set at 208 lbs N.

The title of the graph indicates that the data are from a 2-year average of grain protein in NW MN - var. Knudson.
Relative Protein Yield (%)

\[ \text{RelPyld} = 32.6 + 0.6170(\text{Total N}) - 0.0014(\text{Total N})^2 \]

\[ r^2 = 0.74 \quad P \leq 0.0001 \]

Hallock, 2008
Perley, 2008
Strathcona, 2008
Perley, 2009
Foxhome, 2009

Protein Yield 2 yr. Average
NW MN - var. Knudson
Do you use an N test?
Relative Grain Yield (%)

\[
\text{RelYld} = 76.2 + 0.1766(\text{Total N})
\]

\[r^2 = 0.23 \quad P < 0.0001\]

2008-2009 Grain Yield 2 yr. Average
Southern Minnesota

Fertilizer N Applied + 2’ Soil N (lb/acre)

Kilkenny, 2008
Norseland, 2008
Waseca, 2008
Lamberton, 2009
Norseland, 2009
Waseca, 2009

CL - 135 lbs N
2008-2009 Grain Protein 2 yr. Average Southern Minnesota

Protein = 81.4 + 0.0875(Total N)

$r^2 = 0.43 \quad P \leq 0.0001$

CL - 214 lbs N
Protein Yield 2 yr. Average
Southern Minnesota

Fertilizer N Applied + 2' Soil N (lb/acre)

Relative Protein Yield (%) - CL - 162 lbs N

RelPyld = 61.8 + 0.2248(Total N)
\[ r^2 = 0.43 \quad P \leq 0.0001 \]

2008-2009
Protein Yield 2 yr. Average
Southern Minnesota

Kilkenny, 2008
Norseland, 2008
Waseca, 2008
Lamberton, 2008
Norseland, 2009
Waseca, 2009
y = 0.65x + 29.2
\( r^2 = 0.72, P < 0.0001 \)

y = 0.12x + 12.1
\( r^2 = 0.25, P = 0.001 \)

Samples taken prior to jointing
Underwood N Rate Response

Nitrogen Rate Applied (lbs N/ac)

Grain Yield (bu/ac)

- No Fall N
- 30 lbs N Fall
- 60 lbs N Fall
- 90 lbs N Fall
- 120 lbs N Fall
- All N Fall

Grain Yield (bu/ac) vs. Nitrogen Rate Applied (lbs N/ac)
Underwood Protein Response to N

No influence of Fall N on Grain Protein
FIG. 1. CHANGES IN GRAIN PROTEIN CONCENTRATION WITH INCREASING N RATE: COMPARISON OF METHODS / TIMING OF N APPLICATION, CROOKSTON, 1993. (N APPLIED IS IN ADDITION TO 150 LBS N FROM SOIL + FALL-APPLIED N).
N Supply

• Maintaining N supply is important
  – Early N will help set the yield potential
  – Temperature or other stresses will control the yield potential
• If N is taken up and yield potential is not maintained then it will be used for protein
• If yield potentials are high the plant will sacrifice protein
• Late season applications of N around anthesis have been found to increase protein
Summary

• 2.5 x yield goal likely will not work on most irrigated ground in central MN
  – Use table values

• Fertigation may be beneficial to help maintain N supply
  – Not much supporting data in MN
  – Stick within recommended rates
  – Wheat likes 70 degree temps for optimum growth

• Some N upfront and the rest should be applied @ tillering to jointing
  – About 60% of the total N was needed to maximize yield
<table>
<thead>
<tr>
<th></th>
<th>&lt;40</th>
<th>40-49</th>
<th>50-59</th>
<th>60-69</th>
<th>70-79</th>
<th>80+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>0</td>
<td>0</td>
<td>30</td>
<td>55</td>
<td>80</td>
<td>95</td>
</tr>
<tr>
<td>SoyB</td>
<td>35</td>
<td>60</td>
<td>85</td>
<td>110</td>
<td>135</td>
<td>150</td>
</tr>
<tr>
<td>Edibles</td>
<td>45</td>
<td>70</td>
<td>95</td>
<td>120</td>
<td>145</td>
<td>160</td>
</tr>
<tr>
<td>Group1</td>
<td>0</td>
<td>30</td>
<td>55</td>
<td>80</td>
<td>105</td>
<td>120</td>
</tr>
<tr>
<td>Group2</td>
<td>55</td>
<td>80</td>
<td>105</td>
<td>130</td>
<td>155</td>
<td>170</td>
</tr>
</tbody>
</table>