The Basics of Profitable Fertilization of Wheat

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Welcome to the

North Dakota Wheat Nitrogen Calculator

You will need to know the location of the farm, the general productivity of the soils, the price you contract for wheat, the cost per pound of N, the soil test nitrate-N to a depth of 2 feet, and the previous crop.

Please select the location of the farm. The map of North Dakota on this site will help you determine the region of the farm. Click on the map for a detailed view.

Please select the historical productivity of the farm from the options below.

- Low Productivity
- Medium Productivity
- High Productivity

Select Nearest Wheat Price (Bushel):

Nitrogen provided by previous crops: 0

Please indicate the previous tilling method used in the field.

- No Nitrogen-supplying crop
- Soybean, Field Pea, Dry Bean, Lentil, Chickpea, or harvested Sweet Pea
- Sugarbeet with yellow-green leaves
- Sugarbeet with green leaves
- Harvested Alfalfa or unharvested Sweet Clover (36002.5 plants/sq-ft)
- Harvested Alfalfa or unharvested Sweet Clover (3-4 plants/sq-ft)
- Harvested Alfalfa or unharvested Sweet Clover (1-2 plants/sq-ft)
The final Nitrogen recommendation is the average optimal rate. Growers may choose to apply up to 30 lb N/acre more or less than the calculated N rates due to protein traits of a variety, special soil conditions such as susceptibility to spring denitrification, application techniques that may not be most efficient or historical experiences from the field or part of a field that may influence N uptake and efficiency. For wheat after small grains, we assume about 2,000 lb/acre of straw residue. For every 2,000 lb/acre straw greater than this, add 30 lb N/acre.
West Wheat Yield Under Conventional Tillage

\[ y = -0.0007x^2 + 0.1904x + 18.888 \]
\[ R^2 = 0.156 \]

West Wheat Yield Under Long-term No-Till

\[ y = -0.0007x^2 + 0.2601x + 23.085 \]
\[ r^2 = 0.19 \]
Why is the aggregated relationship of yield and available N so ‘diffuse’, when the relationships within sites are so highly related?
Combining all sites with actual yield at N rate looks like this.

![Graph showing yield vs. total known available N.](image)
When it really looks like this-

Yield

Total known available N
To get a better idea of what the data look like without showing all the curves is to ‘Normalize’ the data- putting it all in the same scale

For example-
A wheat site with high yield 80 bu/acre, divide all yields by 80, and we end up with values from 0 to 1

A wheat site with high yield 40 bu/acre, divide all yields by 40, and we end up with values from 0 to 1

A wheat site with high yield 60 bu/acre, divide all yields by 60, and we end up with values from 0 to 1
Normalizing yields at all sites ends up looking like this.
If N rate and Yield were related between sites, the graphs would look like this after they were normalized.
West Wheat Yield Under Conventional Tillage

\[ y = -0.0007x^2 + 0.1904x + 18.888 \]

\[ R^2 = 0.156 \]

West Normalized Wheat Yield
Conventional Tillage

\[ y = -3E-05x^2 + 0.0066x + 0.5416 \]

\[ R^2 = 0.5428 \]
Western ND No-Till wheat sites raw yields

\[ y = -0.0007x^2 + 0.2601x + 23.085 \]

\[ r^2 = 0.19 \]

Western ND No-Till wheat sites normalized yields

\[ y = -1 \times 10^{-5}x^2 + 0.0041x + 0.5842 \]

\[ r^2 = 0.62 \]
Low yield environment-
usually drier (sometimes excessive wetness)
  Lower N use efficiency and crop uptake
  Less N mineralization

High yield environment-
  Moisture near ideal- not too wet or too dry
  Higher N use efficiency and crop uptake
  Greater N mineralization

Net result is that rate to produce economic max yield
is similar in both environments.
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Low productivity is defined in Eastern ND as historical yields below 40 bushels per acre
Medium productivity is defined in Eastern ND as historical yields from 41 to 60 bushels per acre
High productivity is defined in Eastern ND as historical yields over 60 bushels per acre

Please indicate the crop previously planted in the field.

Please select the historical productivity of the farm from the options below.

Select Nearest Wheat Price
(Per bushel)

Nitrogen provided by previous crops: 0

Please indicate the previous tillng method used in the field.
North Dakota Wheat Nitrogen Recommendation Calculator - Mozilla Firefox

Select Nearest Wheat Price ($/bu) $5.00

Select Nearest N Cost (cents/lb) $0.29

Nitrogen Recommendation Before Credits 100

Please indicate the amount of nitrates in the soil. (Enter the analysis result in the box.) Soil test for Nitrogen analysis (lbs/acre 2-4 ft depth)

Nitrogen provided by previous crops

Please indicate the previous tilling method used in the field.

Nitrogen recommendations assume conventional tillage and no adjustment in N rates are made.

Please indicate the percent of organic matter in the soil. (Enter the percentage in the box.) Organic matter

The final Nitrogen recommendation is the average optimal rate. Growers may choose to apply up to 30 lb N/acre more or less than the calculated N rates due to protein traits of a variety, special soil conditions such as susceptibility to spring denitrification, application techniques that may not be most efficient or historical experiences from the field or part of a field that may influence N uptake and efficiency. For wheat after small grains, we assume about 2,000 lb/acre of straw residue. For every 2,000 lb/acre straw greater than this, add 30 lb N/acre.
There is a new phone app for Android and iPhones for the 3 N calculators, including wheat.

Go to app store and search for North Dakota Crop Nitrogen Calculator follow the instructions.

It’s free to download.
Questions-

Is the protein increase with the recipe real?

Are N applications after the water-ripe stage real?
Wheat yield with 30 lb N timing relative to flowering period, from Finney et al., 1957

\[ y = 0.0002x^3 + 0.0021x^2 - 0.3343x + 34.185 \]

\[ R^2 = 0.6099 \]

Finney et al., 1957, Agronomy Journal
Real Bread Protein % with post-N timing relative to flowering period

\[ y = -2E-05x^3 - 0.0014x^2 - 0.0059x + 12.912 \]

\[ R^2 = 0.8413 \]

Days relative to flowering period (day 0 represents all days of flowering)

Finney et al., 1957, Agronomy Journal
Relationship of Loaf Volume with Grain Protein from Post-N

\[ y = 11.177x + 673.91 \]

\[ R^2 = 0.3063 \]

Finney et al., 1957, Agronomy Journal
The bottom-line of this research, and follow-up work conducted at Carrington, Minot, Langdon during the late 1990’s is

- Protein increase is maximized when N is applied immediately post-anthesis (watery-ripe stage).

- Profitable protein enhancement is maximized with a rate of 30 lb N/acre (UAN or urea solution if biuret content is low)

‘The Recipe’ is:

10 gallon UAN with 10 gallon water
Apply immediately post-anthesis
Apply cool of the day (mornings preferably to evenings)
Do not apply with fungicide
Use flat-fan nozzles, broadcast
Expect leaf burn, but it’s not important
Valley City protein response to 5-leaf N-Pact application over preplant urea rates, 2008.
Protein response of post-anthesis N-Pact application, 3 gal/acre. Valley City, 2008
2009 Carrington, ave. 2 sites, post-anthesis application for protein enhancement. Schatz

Faller yields over 100 bu/acre

Slide courtesy of Greg Endres, NDSU, Carrington REC
Don’t skimp on starter P for wheat and barley

Apply chloride for malting barley especially if soil test is low. Increases plump and helps to reduce effect of lower barley yield due to reduced kernel size.
Wheat yield increase from broadcast or Banded P. Average of six sites, Zubriski,

<table>
<thead>
<tr>
<th>$\text{P}_2\text{O}_5$ applied, lb/a</th>
<th>Banded with seed</th>
<th>Broadcast</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>24</td>
<td>48</td>
</tr>
<tr>
<td>3.8</td>
<td>5.0</td>
<td>5.5</td>
</tr>
<tr>
<td></td>
<td></td>
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</table>
Banded P vs Broadcast in Wheat, Rasc, MB

<table>
<thead>
<tr>
<th>Rate of P$_2$O$_5$, lb/a</th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>25 banded</td>
<td>25 brdcst</td>
<td>50 banded</td>
<td>50 brdcst</td>
</tr>
<tr>
<td>Wheat yield, bu/a</td>
<td>35</td>
<td>40</td>
<td>39</td>
<td>43</td>
</tr>
</tbody>
</table>

Similar in size of response (2-4 bu/acre) higher than broadcast in SD, ND. (about 10% yield increases, consistently)
Summary-

- Use of the N calculator for wheat for most profitable N rates. Use common sense to determine the rate best suited to your farm and variety.
- Yield goal is not a factor in N rate
- Protein enhancement is possible with the proper rate and timing of in-season N
- Use of slow-release liquids at reduced rates are no more efficient than UAN
- Band apply P