Best Soil Fertility Practices for No-Till Wheat

Best of the Best program
Minot, ND
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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.

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

Select Nearest Wheat Price ($/bushel) $5.00

Please indicate the crop previously planted in the field.

Nitrogen provided by previous crops: 0

Please indicate the previous tillage method used in the field.
$y = -0.0115x^2 + 4.5992x + 1486.1$

$R^2 = 0.0267$

Why is the aggregated relationship of yield and available N so ‘diffuse’, when the relationships within sites are so highly related?
Example—Combining all sites with actual yield at N rate looks like this
When it really looks like this-
To get a better idea of what the data look like without showing all the curves is to ‘Standardize’ the data—putting it all in the same scale.

For example—

A spring wheat site with high yield 100 bu/acre, divide all yields by 100, and we end up with values from 0 to 1.

A spring wheat site with high yield 30 bu/acre, divide all yields by 30, and we end up with values from 0 to 1.

A spring wheat site with high yield 60 bu/acre, divide all yields by 60, and we end up with values from 0 to 1.
Standarding yields at all sites ends up looking like this:
Western ND Conventional Till wheat sites raw yields

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

\[ r^2 = 0.16 \]

Western ND Conventional Till wheat sites, normalized yields

\[ y = -2E-05x^2 + 0.0064x + 0.5518 \]

\[ r^2 = 0.53 \]
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

\[ y = -1E-05x^2 + 0.0041x + 0.5842 \]

\[ r^2 = 0.62 \]
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.
There is a new phone app for Android phones for the 3 N calculators.  
Go to app store and search for North Dakota Crop Nitrogen Calculator and follow the instructions.  
It’s free to download. 

We also have an app for IPhones-  
Go to the Iphone app store and look up North Dakota Crop Nitrogen Calculator, then follow instructions.
Conventional Till

Most N lingers in the soil and is susceptible to leaching/denitrification

No-Till

N is taken up by microorganisms. Microorganism life cycle is measured in days and weeks. Nutrient cycling is continuous and rapid.
N credit likely comes from increased efficiency of N use compared to conventional till
Also, 2018 spring paired soil sampling and incubation analysis by colleague at University of Florida showed much greater asymbiotic N-fixing activity in long-term no-till.

Conventional Till

Most N lingers in the soil and is Susceptible to leaching/denitrification

No-Till
Challenges of N application in no-tillage-
No-till in the fall?

Fall ammonia application not an option in SE Minnesota

Fall ammonia with N-Serve® is an option for NW Minnesota, North Dakota and South Dakota.

Coulters necessary to cut residue
No-till options preplant or at planting

Ammonia? Separation of at least 3 lateral inches in ammonia band and seed band.

At an angle? If residue allows. Mid-row band for ammonia also works well. In dry years, no as much for urea.
Other no-till preplant options-

Urea with NBPT (Agrotain)?

UAN with NBPT (Agrotain)?
Urea is acted on in the ‘keyhole’ structure of the urease enzyme.
N-(N-Butyl)thiophosphoric triamide

Has same tri-atom configuration as urea

NPPT has same tri-atom structure, but tail has an additional C group.
Yield for side-dressed no-till corn in Hardin County, KY. (From Schwab and Murdock, 2009)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield, bushels per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check (50 lb N/acre preplant N only)</td>
<td>117d*</td>
</tr>
<tr>
<td>Urea</td>
<td>158c</td>
</tr>
<tr>
<td>Urea + Agrotaim</td>
<td>201b</td>
</tr>
<tr>
<td>SuperU</td>
<td>201b</td>
</tr>
<tr>
<td>UAN</td>
<td>150c</td>
</tr>
<tr>
<td>UAN + Agrotaim</td>
<td>179bc</td>
</tr>
<tr>
<td>UAN + Agrotaim Plus</td>
<td>175bc</td>
</tr>
<tr>
<td>Ammonium nitrate</td>
<td>239a</td>
</tr>
</tbody>
</table>
Ammonia volatilization from surface and incorporated urea at various depths -
Rochette et al., 2014, J. Env. Q.

<table>
<thead>
<tr>
<th>Period-hours</th>
<th>Surface (% loss)</th>
<th>1 inch (% loss)</th>
<th>2 inch (% loss)</th>
<th>3 inch (% loss)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0- 1 week</td>
<td>2.2</td>
<td>18.4</td>
<td>2.6</td>
<td>0.0</td>
</tr>
<tr>
<td>1-2 weeks</td>
<td>29.5</td>
<td>15.2</td>
<td>3.2</td>
<td>0.1</td>
</tr>
<tr>
<td>2-3 weeks</td>
<td>15.2</td>
<td>3.8</td>
<td>1.8</td>
<td>0.5</td>
</tr>
<tr>
<td>3-4 weeks</td>
<td>3.4</td>
<td>1.0</td>
<td>1.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>50.3</td>
<td>38.4</td>
<td>8.6</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Slightly acid silt loam soil
Intensive crop growth, application of any ammonia-based fertilizer, including manure, results in surface soil acidification.

The remedy is ‘liming’, which is the application of any amendment that reacts with \( H^+ \) ions to form \( CO_2 \) and water.

In conventional till systems, the liming material is incorporated into the soil during tillage passes.
Wheat growing in pH > 5.2
Wheat growing in soil after 20 years with urea application near/at surface, pH 4.5
Wheat growing in soil after 1 year surface liming

Soil surface

pH 6.0

pH 5.0
Equipment is available to apply N/P/K/other in no-till

Make every effort to apply fertilizer under the soil surface.
Make full use of banding and use planters that enable banding
Lime effects, no-till surface application, after 4 years
Kansas Agronomy Journal Godsey et al., 2007

<table>
<thead>
<tr>
<th>Depth inch</th>
<th>pH</th>
<th>0.5tP</th>
<th>2T</th>
<th>4T</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>5.8</td>
<td>6.1</td>
<td>6.7</td>
<td>7.3</td>
</tr>
<tr>
<td>1-2</td>
<td>5.5</td>
<td>5.8</td>
<td>6.1</td>
<td>6.6</td>
</tr>
<tr>
<td>2-3</td>
<td>5.7</td>
<td>5.8</td>
<td>6.0</td>
<td>6.2</td>
</tr>
<tr>
<td>3-4</td>
<td>5.8</td>
<td>5.8</td>
<td>6.0</td>
<td>6.1</td>
</tr>
<tr>
<td>4-5</td>
<td>5.9</td>
<td>5.9</td>
<td>5.9</td>
<td>6.0</td>
</tr>
<tr>
<td>5-6</td>
<td>5.9</td>
<td>5.9</td>
<td>6.0</td>
<td>6.0</td>
</tr>
</tbody>
</table>
Pennsylvania- Beegle

Initial pH 0-6 inches was 5.1
Initial pH 0-2 inches was 4.5

3 T/acre CCE lime increased pH in 0-2 in 2 months to 6.2  2-4 and 4-6 inch depths also increased.

Winter wheat yield increased from 52 bu/a to 71 bu/a in first year.
<table>
<thead>
<tr>
<th>Depth, inches</th>
<th>pH</th>
<th>Ext Al ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2</td>
<td>5.1 ± 0.8</td>
<td>28</td>
</tr>
<tr>
<td>2-4</td>
<td>4.7 ± 0.5</td>
<td>55</td>
</tr>
<tr>
<td>4-6</td>
<td>5.5 ± 0.3</td>
<td>7</td>
</tr>
<tr>
<td>6-8</td>
<td>5.9 ± 0.3</td>
<td>5</td>
</tr>
</tbody>
</table>
### Washington State, Palouse Region
Brown et al. 2008 2 years after broadcast lime 3 T/a CCE lime

<table>
<thead>
<tr>
<th>Depth, inches</th>
<th>pH w/lime</th>
<th>Al activity after lime</th>
<th>Al in check</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2</td>
<td>7.0</td>
<td>$10^{-14}$</td>
<td>$10^{-7}$</td>
</tr>
<tr>
<td>2-4</td>
<td>5.2</td>
<td>$10^{-8}$</td>
<td>$10^{-7}$</td>
</tr>
<tr>
<td>4-6</td>
<td>5.7</td>
<td>$10^{-10}$</td>
<td>$10^{-8}$</td>
</tr>
<tr>
<td>6-8</td>
<td>5.9</td>
<td>$10^{-11}$</td>
<td>$10^{-11}$</td>
</tr>
</tbody>
</table>
Summary-

Use N calculator
Apply N below soil surface when possible
Always use some starter P

If urea applied to the surface, use NBPT/NPPT and leave it alone.

Check surface acidity, 0-2 inches, 2-6 inches
Lime if necessary.