SOIL NUTRIENTS AND SMALL GRAIN DISEASE
Custer County
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MSU Soil Fertility Extension
Goal

- Present relationship between soil nutrient management and disease potential
- Suggest N management for healthy plants to minimize disease and lodging
- Present management considerations for other nutrients to consider in disease prevention
Nutrients and disease interaction

• Healthy plants are less likely to have substantially reduced yields because of disease
• Insufficient nutrients can leave plants stressed and more susceptible to attack by insect and disease pests
• Over fertilizing (especially N) can create:
  ▪ environment favorable to diseases (rusts, septoria, powdery mildew, and some viruses)
  ▪ Lodging
  ▪ Excess foliage with light kernels
• The key is nutrient balance with right rate, time, placement, source and rotations
How does one recognize excess N?

- With lodging resistant varieties, presence of lodging is no longer a very useful indicator of excess N.
- Grain protein and flag leaf N are not good indicators of excess N in irrigated hard red winter wheat (Brown and Petrie, 2006).
- Soil test.
How do I determine N fertilizer amount?

Basic steps for all crops

1. Determine yield potential

2. Determine available soil nutrient level – soil test

3. Look up suggested nutrient guidelines for given crop and yield in *Fertilizer Guidelines for MT Crops* or crop specific bulletins (e.g. pulse, forage)

4. Calculate difference between what is available in soils and what is needed to get fertilizer recommendation

*Online tool for MSU fertilizer recommendations @ www.sarc.montana.edu*
Example N rate calculation

• Based on field history, example reasonable yield goal is 50 bu/acre
• Soil N test from top 2 feet
• Soil test in spring if possible. Why? Soils can:
  ▪ Gain N over winter, especially in high organic matter soils with moderate precipitation
  ▪ Lose N over winter, especially in soils with >60 lb N/acre
• Look up N guidelines in *Fertilizer Guidelines for MT Crops*

<table>
<thead>
<tr>
<th>Nutrient In The Soil</th>
<th>Interpretation</th>
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<tbody>
<tr>
<td>0-6&quot;</td>
<td>15 lb/ac</td>
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<tr>
<td>6-24&quot;</td>
<td>24 lb/ac</td>
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<tr>
<td>24-42&quot;</td>
<td>63 lb/ac</td>
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<tr>
<td>0-24&quot;</td>
<td>39 lb/ac</td>
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Soil N = 39 lb/ac

<table>
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<tr>
<th>WHEAT- WINTER</th>
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<tr>
<td><strong>Yield Potential (bu/a)</strong></td>
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<tr>
<td>-----------------</td>
</tr>
<tr>
<td>30</td>
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<td>40</td>
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<td>80</td>
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N rate adjustments

- Suggested rate –residual N: 130 – 39 = 91 lb N/acre needed
- Stubble: small grains stubble is high in carbon to N (C:N). Adjust fertilizer N up by 10 lb N/1000 lb stubble up to 40 lb N
- After fallow: assume ½ of stubble has decomposed over previous year, cut additional N for stubble in ½
- After cover crop/legume rotation: Adjust fert N rate down, they add N to soil

<table>
<thead>
<tr>
<th>Crop</th>
<th>N credit (lb N/acre)</th>
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<tbody>
<tr>
<td>Alfalfa</td>
<td>~40</td>
</tr>
<tr>
<td>Annual legume 1x</td>
<td>~10</td>
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<tr>
<td>&gt;3x</td>
<td>~20</td>
</tr>
<tr>
<td>Legume cover crop 1x</td>
<td>~20-30</td>
</tr>
<tr>
<td>&gt;3x</td>
<td>~30-50</td>
</tr>
</tbody>
</table>
N rate adjustments (cont)

- SOM
  - <1% SOM, add 15-20 lb N/acre
  - >3% SOM, reduce 15-20 lb N/acre
- Tillage – No-till may require extra N for 6 to 15 years
Danger of aggressive N fertilization?

- Increased disease and lodging risk
- Hot dry season, low protein discounts, lower net returns, and higher leaching/volatilization N losses.
- In wet year if all N is applied early can lead to excess tiller production and decreased yields.
- Risk of high forage nitrates

Strategy to avoid these possibilities?

- Use a conservative pre-plant N rate
- Apply a 2\textsuperscript{nd} application if needed
Split/In-season N Applications

• Fall broadcast supplies early growth needs
• In-season adjustment for estimated yield potential based on precip to date
  ▪ Don’t apply 2nd application if dry
  ▪ Apply large 2nd application if wet

• Later applications:
  ▪ Less chance of causing lodging
  ▪ Potential to increase protein rather than yield
Timing

• To reduce disease and lodging
• To optimize uptake of fertilizer N
• To reduce economic and environmental risk
Example: Soil N increases wheat streak mosaic virus susceptibility

Miller et al., 2015
Gallatin Valley
Mite population growth rate with N rate

Management option:
Time N application

At high N, mites with virus increase more than mites w/out virus

Miller et al., 2015
Gallatin Valley
Timing depends on source

- **Slowly available (Manure and slow-release N)**
  - take time to become available
  - apply well before needed – e.g. in fall and incorporate

- **Readily available (urea, ammonium)**
  - Apply when needed – e.g. spring
  - foliar/liquid options
Timing depends on source – N must be available to benefit yield and protein.

More info in *Nutrient Uptake Timing* (EB0191)
Timing considerations

• In-season N needs to be ‘incorporated’ with water – a ½ inch in one event as rain or irrigation.

• If there is risk of scab do not irrigate within 5 days of flowering, so do not fertilize within that time.

• In irrigated systems delay N until early stem elongation or later to reduce lodging.
Timing and N rate on lodging with irrigation

Total N 180 lb/ac, ≈ 96 lb N as fertilizer
Pre-plant incorporated urea
Post emergent 28% UAN streamer bar

Hendrickson et al., 2003
Carrington, ND
Questions?
N source

- Urea and ammonium based N must be incorporated by tillage or water to reduce volatilization loss
  - \(\text{CO(NH}_2\text{)}_2 + \text{H}_2\text{O} \rightarrow 2(\text{NH}_3) + \text{CO}_2\); \(\text{NH}_3 + \text{H}_2\text{O} \rightarrow \text{NH}_4^+ + \text{OH}^-\)
- UAN has lower volatilization loss
- Addition of NBPT, active ingredient of Agrotain® reduces volatilization loss for a few weeks
- Foliar N fertilizer burn can reduce yield. Foliar should be moved to soil by water to be effective
- Polymer coated and controlled release fertilizers release N too slow if applied late winter or spring
Crop rotations to manage disease

- Break disease cycles
- Increase soil health
- Use excess nutrients
- Legumes provide N
Legumes in rotation

• The increased soil microbial diversity and activity following legumes usually promotes biological pest control

• When is soil N and economic benefit realized?
  ▪ Legumes provide N credit after 1 year but wheat yield goal is lower than after fallow
  ▪ Protein benefit comes before yield benefit
  ▪ Economic benefit comes after several rotations
    more stability and less dependence on N fertilizer
Potentially mineralizable N (PMN)
Cover crop (pea)-wheat vs fallow-wheat (April of 8th yr)

This equates to an 80 lb N/ac benefit of CC in just top 6 inches!

Gallatin Valley
O’Dea et al. (2015)
Economics

Pea-wheat:
Same return with less N input and more stability

Gallatin Valley
Miller et al., 2015
Other nutrients to consider

- Sufficient but not excess nutrients and healthy soils are the best approach
- Specifically consider
  - Phosphorus (P)
  - Potassium (K)
  - Chloride (Cl)
  - Copper (Cu)

Illustration courtesy Government of Western Australia Dept. of Agriculture and Food
Starter P gives spring wheat a strong start

Both sides received fall-banded 70-30-10-10

10 lb of starter $P_2O_5$ with seed

No starter P

Incorporate prior to seeding or place in rooting zone at seeding

P helps winter wheat resist winterkill
Potassium (K), chloride (Cl) and disease

- K increases plant strength and ability to resist disease
- Leaf rust, leaf spot, powdery mildew, root rot reduced in part by Cl portion of KCl fertilizer (Sweeney et al., 2008; Karamanos and Flore, 2000).
- 20 lb KCl/acre prior to seeding may provide enough Cl
- If soil test K > 125 ppm in top 6” still get yield benefit from 25 lb K$_2$O seed-placed KCl (Karamanos and Flore, 2000). Recommended especially for varieties susceptible to disease.
Chloride Deficiency Symptoms

Interveinal chlorosis

Appears on new leaves (not translocated)

From: Nutrient Deficiencies & Toxicities In Crop Plants, Ed. W.F. Bennett, 1993
Copper effect on wheat disease

• Cu has little effect on leaf rust or tan spot in spring wheat (Franzen et al., 2008).

• Cu applied pre-plant reduced Fusarium head blight incidence and severity, increased yield, especially in sandy soils, organic matter < 2%, or soil Cu < 0.5 ppm (Franzen et al., 2008).

• If soil Cu < 0.4 ppm, Cu may increase spring wheat yield in Canadian Prairies (Karamanos et al., 2003), but not found in N. Dakota (Franzen et al., 2008).

• Broadcast and incorporate 3.5 lb/acre as Cu sulfate better yields and economics for 4 years than annual seedrow 3.5 lb/acre (sulfate or chelate; Karamanos et al., 2005)
73. Leaf tips of wheat discolored and distorted from Cu deficiency.
Summary

- Use soil testing and published suggested nutrient rates
- Split N application
- Timing depends on source, if intended for yield or protein, potential for incorporation, and disease/lodging risk
- Crop rotations break disease cycles and can be excellent source of N
- Adequate amounts of P, K, Cu and Cl early on help build strong plants and reduce disease
Questions?

For more information on soil nutrient management see Clain’s website

http://landresources.montana.edu/soilfertility/