FERTILIZER TIMING AND PLACEMENT
Extension Agent Agronomy College
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Clain Jones
clainj@montana.edu 994-6076
Goal

• Describe optimal fertilization timing and placement for different nutrients, sources, and production objectives
## Mobility in soil of selected nutrients

<table>
<thead>
<tr>
<th>Mobile (and soluble)</th>
<th>Relatively immobile</th>
<th>Very immobile (and insoluble)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (as nitrate)</td>
<td>Potassium Nitrogen (as ammonium)</td>
<td>Phosphorus Copper Iron Manganese Zinc</td>
</tr>
<tr>
<td>Sulfur</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boron</td>
<td></td>
<td></td>
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<tr>
<td>Chloride</td>
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</tbody>
</table>

**Why important?**

Indication of leaching potential which influences timing and affects optimum fertilizer placement
Timing depends on source

- Slowly available (Manure, slow-release N, phosphate rock, Ca-phosphate, elemental sulfate, Ca-sulfate, oxysulfate forms of microminerals)
  - take time to become available
  - apply well before needed – e.g. fall
  - can build soil levels
  - less expensive per unit (except with N)
- Readily available (urea, ammonium, chelated or sulfate forms, phosphate)
  - Apply when needed – e.g. spring
  - foliar/liquid options
  - more expensive per unit (except with N)
Timing depends on source – N must be available to benefit yield and protein.

More info in *Nutrient Uptake Timing* (EB0191)
N availability affects yield and protein

- Added N increases the number of tillers and kernels per head.
- Grain will use N from stems/leaves to make protein.
- Added N goes to protein.

Diagram:
- Early Leaf
- Tillering
- Stem Elongation
- Heading
- Ripening
Use Nutrient Uptake figure to time top-dress

Example on per acre basis:

- 165 lb N total need
- 40 lb N in soil + 60 lb preplant N = 100 lb N
  = 60% total N required (100/165)
- (165 – 100) = 65 lb N needed to top-dress
Top-dress amount and timing based on wheat growth stage

- 60% required N used up by late tillering
- For yield should top-dress 65 lb N more by mid-tillering to give time for N to become available
Your turn: It rains 6 more inches in May than average

How much N needs to be added?
By when should N be added?

Yield potential was 30, now 60 bu/ac
3.3 lb N/bu for SW
Available N at seeding = 35 lb N/ac preplant
+ 40 lb N/ac soil test = 75 lb N/ac
How much N needs to be top-dressed and by when if just do one top-dress?

1. 125 lb N/ac by early tillering
2. 125 lb N/ac by mid-tillering
3. 125 lb N/ac by mid-stem elongation
4. You are tough out of luck
60 bu/ac @ 3.3 lb N/ac = 200 lb N/ac
200 lb N/ac – 75 lb N/ac = 125 lb N/ac more needed
75/200 = 37.5%
added by early tillering to avoid N deficiency

For more uptake curves and calcs, see Nutrient Uptake Timing (EB0191)
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 2\textsuperscript{nd} application if dry
  - Apply large 2\textsuperscript{nd} application if wet

- Later applications:
  - less chance of causing lodging
  - Potential to increase protein rather than yield
When should late-season N be applied to maximize grain protein?

![Graph showing the relationship between top-dress timing of 30 lb N/ac and winter wheat grain protein. The graph indicates that applying nitrogen 2 days after flowering maximizes grain protein.](image)

*Finney et al. 1957*
In-season N rate, timing, and dryland vs. irrigation affects protein boost.

Ability to incorporate with rain or irrigation more important than exact timing at flowering.
Broadcast before rain or irrigation (to minimize volatilization loss)

\[ R^2 = 0.92 \]

Echo, Oregon
Soil Temp = 46°F
Holcomb et al. 2011

Surface soils was pre-moistened
Take home message on N timing

• Need sufficient N at tillering/stem elongation because of high N demand

• For protein boost, consider applying additional N
  ▪ If you have a way to apply without physically damaging crop
  ▪ If indicated by flag leaf N level (see Fertilizer Fact #12)
  ▪ Irrigated – ideally during flowering
  ▪ Dryland – more important to get incorporation with > 0.5” rain event than “correct” timing

• In-season foliar – minimize leaf burn (see Sources presentation)
Questions on N timing?
Phosphorus

• P is immobile and gets tied up in soil
• For cereal grains, consider starter (pop-up)
• For legumes:
  ▪ Build P up before seeding perennials, or in the alternate crop year for annual legumes
  ▪ On established alfalfa stands
    • Apply several years worth at one time
    • Apply after last cutting yet before fall period of regrowth to feed root reserves
Impact of starter P in a cool spring on spring wheat emergence

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

10 lb of starter P$_2$O$_5$ with seed  No starter P
K timing

Is relatively immobile – what is best timing?

• For cereal grains: subsurface band or broadcast at seeding

• For legumes:
  ▪ split between first and after last cutting to minimize luxury consumption of first harvest
  ▪ apply after last cutting and before fall period of re-growth to feed root reserves
S timing

- In-season applications of ammonium thiosulfate and ammonium sulfate, can rapidly correct sulfur deficiency.

- Sulfate fertilizers not suggested for fall application. May leach overwinter.

- Elemental S slow to supply plant available S. Apply in fall or before seeding to become available before peak demands. Will supply crop for > 2-3 years.
Questions on P, K and S timing?
Placement
N placement

• In general, subsurface placement/incorporation of N fertilizer decreases losses and increases availability
Incorporation depth on volatilization

Urea Rate = 100 lb N/ac
Texture = silt loam
Soil pH = 6.5
Temp. = 75° F

Ernst & Massey 1960, lab
N seed placed

- Fertilizer is salty and can prevent germination if too close to seed
- As opener width goes up, or row spacing goes down, safe rates increase
  - A larger opener spreads out fertilizer, decreasing salt concentrations
  - Narrow rows = less N per row (10 lb N/ac max at wide row spacing)
## Approximate safe rates of urea N (lb N/acre) to seed place with cereal grains

<table>
<thead>
<tr>
<th>Soil texture</th>
<th>1” spread (disk or knife)</th>
<th>2” spread (spoon or hoe)</th>
<th>3” spread (sweep)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Row spacing</td>
<td>Row spacing</td>
<td>Row spacing</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>%SBU&lt;sup&gt;1&lt;/sup&gt;</td>
<td>17</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Light (sandy loam)</td>
<td>20</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td>Medium (loam to clay loam)</td>
<td>30</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>Heavy (clay)</td>
<td>35</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

From: Saskatchewan Ministry of Ag

1. SBU = (seed row width/row spacing) x 100

How compare with MSU guideline’s?
A note on legumes and N

10 – 20 lb N/acre can be top-dressed or placed away from the seed to boost seedlings towards N-fixation, especially if soil N < 15-20 lb N/acre
Placement of phosphate and KCl

• Incorporate prior to seeding
• Place in rooting zone at seeding
  ▪ Advantage – fast uptake in spring
  ▪ Disadvantage – dry out soil and can cause poor germination

• Avoid seedling burn
  ▪ <20 lb P$_2$O$_5$/acre MAP
  0 DAP with seed
  ▪ <10-15 lb N plus K$_2$O
  with seed
P band vs. broadcast

Band better than broadcast:
- Low soil P
- Dry soils
- Reduced tillage

(Randall & Hoeft 1988)
Micronutrient fertilizer application timing and method

Timing
• Borate, chelated or sulfate forms: Spring
• Oxysulfate forms: Fall

Method
• Preferred method is broadcast and incorporated – except iron is best as chelated, foliar
• Seed-placed and subsurface band is generally not recommended (due to toxicity)
• Foliar applications use less than ½ the suggested rate. Can be done with borate, and chelated copper, iron, manganese and zinc

Karamanos 2000, Gerwing and Gelderman 2005
Copper Rate, Method and Timing Effects
SW Grain Yield

Metal micronutrient deficiencies can be better corrected with foliar application. WHY?

Dryland, NE Saskatchewan
Sandy loam, Annual application
Soil Cu 0.4 ppm
Malhi et al. 2005

Cu rate/method/timing
Summary

- Slowly available sources - apply well before early plant growth
- Readily available sources - apply just before rapid plant growth
- N for grain protein - apply near flowering
- Build up P and K to supply legumes
- Mobile nutrients can be broadcast
- Urea should be incorporated, watered or placed beneath soil surface
- Non-mobile nutrients should be placed near rooting area
Questions?

For more information see MSU Extension’s

*Fertilizer Placement and Timing* (4449-11)
[http://landresources.montana.edu/nm/](http://landresources.montana.edu/nm/)

*MT Cool-Season Pulse Production Guide* (EB0210)

*Nutrient Uptake Timing* (EB0191)

*Practices to Increase Wheat Grain Protein* (EB0206)
[http://landresources.montana.edu/soilfertility/](http://landresources.montana.edu/soilfertility/)

*Flag Leaf Diagnosis of Grain Protein Response to Late-season N application in Irrigated Spring Wheat* (FFact # 12)
[http://landresources.montana.edu/fertilizerfacts/](http://landresources.montana.edu/fertilizerfacts/)