Nutrient Management for Hay Production and Quality

by Clain Jones, Extension Soil Fertility Specialist
clainj@montana.edu; 406 994-6076
http://landresources.montana.edu/soilfertility

Sweet Grass County Forage Program
January 30, 2012
Goals

1. To review use of Fertilizer Guidelines to determine N and P rates on forages.
2. To present yield and economic responses of hay to N and P fertilizer
3. To provide an update on new fertilizer products that could benefit forage producers
4. To illustrate some benefits of potassium and sulfur on forages
Estimated pounds of nutrients removed by a ton of alfalfa or grass hay

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P$_2$O$_5$</th>
<th>K$_2$O</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>48</td>
<td>11</td>
<td>53</td>
<td>5.5</td>
</tr>
<tr>
<td>Grass</td>
<td>25</td>
<td>10</td>
<td>38</td>
<td>2</td>
</tr>
</tbody>
</table>

(Fertilizer Guidelines for Montana Crops - EB 161)
How much N should be applied to alfalfa-grass stands?

Can use Fertilizer Guidelines for Montana Crops (EB 161)

<table>
<thead>
<tr>
<th>Yield Potential (t/a)*</th>
<th>ALFALFA/GRASS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>80/20</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>6</td>
<td>30</td>
</tr>
</tbody>
</table>

Need to divide by fraction of N in fertilizer to find total fertilizer need.
How much N should be applied to grass?

Fertilizer Guidelines for Montana Crops (EB 161):

<table>
<thead>
<tr>
<th>Yield Potential (t/a) *</th>
<th>Available N (lbs/a) **</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>75</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>125</td>
</tr>
</tbody>
</table>

http://www.montana.edu/wwwpb/pubs/eb161.html
Effect of N rate on irrigated Western wheatgrass, Blaine county

![Graph showing the effect of N rate on yield of irrigated Western wheatgrass.](image-url)
N for timothy hay yield

On irrigated timothy hay in Alberta (Pfiffner et al. 2007)
Both green color and brown leaf ratings improved with N fertilization. 89 to 134 lb N/ac for optimal color in first cutting.

Digestibility was unaffected by N unless very deficient.
Placement

- Granular: On established forage, surface broadcast is essentially only option.
- Liquid (UAN; 32-0-0 or 28-0-0): Surface broadcast including fertigation, surface band, or knifed.

<table>
<thead>
<tr>
<th>Method</th>
<th>Forage Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broadcast</td>
<td>2.9 t/ac</td>
</tr>
<tr>
<td>Knife</td>
<td>2.8 t/ac</td>
</tr>
<tr>
<td>Surface Band</td>
<td>3.4 t/ac</td>
</tr>
</tbody>
</table>

N. Central Regional Extension Pub #326, KSU
Timing

- Yield and quality are affected by timing

- Because urea may take days to weeks to become available, urea should be applied earlier than AN historically was for fast green-up (AN simply dissolves, urea requires a chemical reaction to become available).
Volatilization losses

Applied to grass sod, avg. air temp 50 °F (Horneck and Holcomb)
Forage production lacks incorporation, and plant residue intercepts fertilizer, increases volatilization, and microbes can tie up N.

EEFs retain N on site by reducing loss to volatilization, leaching and N-gas:

- Stabilize or inhibit soil processes to extend N availability (NSN®), reduce urea conversion to ammonia (Agrotain®: urease inhibitor ~ 14 days) or ammonium to nitrate (DCD)
- Slow release of urea through a coating (polymer coated – PCU such as ESN®, sulfur coated - SCU)
- Calcium ammonium nitrate (CAN) isn’t enhanced but isn’t explosive either (like ammonium nitrate)
Effect of N source on volatilization losses

Applied to grass sod, avg. air temp 50 °F (Horneck and Holcomb)
PCU on timothy yield

PCU may be too slow release for early cuttings. (Pfiffner et al. 2007)
PCU on timothy quality

Protein was not affected by fertilizer type

Pfiffner et al. 2007
Nitrogen EEF and forage production

- Environmentally responsible but more $

- Conservation Stewardship Program incentive

*Enhanced Efficiency Fertilizers (EB0188)*

http://landresources.montana.edu/soilfertility
QUESTIONS?
Phosphorus (P)

Why often deficient in Montana soils?

Binds with calcium to form poorly soluble calcium phosphate minerals
Advantages of phosphorus (and potassium, sulfur) fertilization on alfalfa-grass stand?

- Helps with N fixation in nodules
- Favors alfalfa over grass
- P improves alfalfa regrowth and recovery after cutting (IPNI)
Alfalfa yield relative to soil P and P applied

Data from Koenig et al. 1999
Single P application increases alfalfa yield for several years

One single application

Wichman unpubl. data
P fertilization strategy

- At $80/ton hay and $0.40/lb P, net revenue of P fertilization = $22/acre/year

- At $80/ton hay and $1.20/lb P, net revenue of P fertilization = $2/acre/year
P rate and source on alfalfa yield

Koenig et al. 2009 - Iron County, UT, 2 site-years
P rate = lb P₂O₅/acre
spring broadcast/sprayed

Olsen P = 7.8 ppm (0-12 in.)

2002

0 P
MAP - 68
MAP - 138
APP - 68
APP - 138

2003

0 P
MAP - 95
MAP - 188
APP - 95
APP - 188

Olsen P = 4.0 ppm (0-12 in.)
Marginal return on P by rate and source

Koenig et al. 2009 - Iron County, U, 2 site-years
P rate = lb P₂O₅/acre, spring broadcast/sprayed
$400/ton MAP and APP, $100/ton hay

2002
Olsen P = 7.8 ppm (0-12 in.)

2003
Olsen P = 4.0 ppm (0-12 in.)
P rate and source on yield

<table>
<thead>
<tr>
<th>Year</th>
<th>Yes</th>
<th>No P</th>
<th>No MAP</th>
<th>Full P</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>yes</td>
<td>P &gt; no P</td>
<td>MAP &gt; APP</td>
<td>full P &gt; $\frac{1}{2}P$</td>
</tr>
<tr>
<td>2003</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>
What would you do?

@ $400/ton MAP and $100/ton hay
@ $1050/ton MAP and $100/ton hay

Single large or smaller annual applications?
P fertilization for timothy hay

- On irrigated timothy hay in Alberta (Pfiffner et al. 2007)

- If P deficient then yield response equal with 5 annual broadcast applications of 26 lb $\text{P}_2\text{O}_5$/ac or single pre-seeding application of 174 lb $\text{P}_2\text{O}_5$/ac
QUESTIONS ON NITROGEN OR PHOSPHORUS?
Potassium (K)

Needed in Montana?

• Useful on many soils, even some having high K values (especially in spring due to cool temperatures)

• Improved alfalfa stand persistence, shoots per plant and rhizobia bacteria activity

• Reduces leaf drop of alfalfa

• Improved resistance to plant diseases
How might lack of K affect an alfalfa-hay field?
Relative alfalfa yield and soil test K

![Graph showing the relationship between % Maximum Yield and Soil Test Potassium (ppm). The correlation coefficient, r², is 0.82.](image)
Alfalfa yield relative to tissue K

soil tests appear better indicator than tissue tests

Koenig 2001 WNMC

$r^2 = 0.14$
K for alfalfa yield

- K applied in early April with or without additional application after 1\textsuperscript{st} and/or 2\textsuperscript{nd} cuttings
- >400 lb K\textsubscript{2}O/acre may cause salt induced yield reduction

Koenig 2001 WNMC
Sulfur (S)

Needed in Montana?

- Useful on sandy, acidic or low organic matter soils, especially in spring due to cool temperatures

- Tissue sampling is more reliable than soil testing. If < 0.22 to 0.25% S in top 6 inches of alfalfa during early bud stage then should get a yield increase with S.
In Iowa, alfalfa yield increase with gypsum (calcium sulfate) after first cutting varied by site - 0.3 ton/acre with 12 lb S/ac to 2 ton/acre with 29 lb S/ac

40 lb S/acre after 1st cutting, before regrowth, increased 2nd cutting and 1st cutting the following year
S influence on forage quality

- N conversion to protein requires S
- Increased S can lead to increased protein, digestibility and reduced nitrate concentration
- 25 lb S/ac on dryland alfalfa and alfalfa/grass mix increased forage protein 0.8 points
Sulfur (S)

Responses seen in alfalfa-grass fields?

Note: Yield increased 30% at Moccasin (See Fert. Fact 27)
Special considerations for grass fertilization

- If sub-irrigated, fertilize for high yield potential but apply P in fall
- Irrigated/wet meadows apply nutrients in spring
- Do not exceed 60 lb N/acre in the first year
- If N is banded or seed placed do not exceed 10-15 lb N/acre, also for P as ammonium-phosphate
General considerations for forage fertilization

- In dryland consider ‘build up’ of P and K prior to seeding
- Split N generally does not increase total yield
- Late fall/early spring timing for cool season mix (except on sandy soil), mid-May for warm season mix
Advantages of soil testing (even if only occasionally)

- Allows you to optimize fertilizer rates, especially in case where soil nutrient availability has been depleted or is in excess
- Can increase yield and/or save on fertilizer costs
Conclusions

- Nitrogen, phosphorus, potassium, and sulfur can all produce growth responses in Montana forage.
- Economic benefits often aren’t realized in the first year (so don’t trust 1 year studies!)
- Soil testing is essential for determining fertilizer needs.
Questions?

Additional info at http://landresources.montana.edu/soilfertility