Alfalfa Fertility and Manure Management

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Wyoming Society for Range Management Annual Meeting
Cheyenne, WY
November 19, 2008
Overview

- The Queen of forages;
- Alfalfa in Wyoming;
- Constraints on production;
- Fertilizing Alfalfa:
- Applying manure to irrigated alfalfa & grass;
Queen of Forages

- High yield, low input forage adapted to Wyoming soil types and weather;
- Great for reducing fertilizer needs in crop rotations;
- Symbiotic relationship with *Rhizobium meliloti* bacteria that infects roots and fixes N₂ gas from soil air for conversion to organic N in plant tissue;
- N becomes available to other plants upon decomposition or animal excretion;
- Alfalfa can fix up to 200 lbs/ ac/ yr, half of which is removed with harvest;
- 80 to 90 percent passes through livestock but 50% in urine is lost to volatilization.
Considered soil builder because of N fixation, but high yields rapidly deplete soils of other nutrients;

Not suited to saturated soils with high water tables;

Prone to compaction because of multiple trips with heavy equipment;
- On fine-texture clay or silt soils often should deep till or rip before reestablishment or rotation to grain.
Number of Wyoming Farms, 2002

- wheat, 315
- barley, 364
- oats, 197
- dry beans, 227
- sugar beets, 181
- Potatoes, 11
- Vegetables, 18
- Irrigated pasture, 2,570
- All hay, 4,680
Acres Harvested in Wyoming, 2002

- All hay: 581,258 acres
- Wheat: 120,471 acres
- Barley: 30,151 acres
- Oats: 7,111 acres
- Beans: 3,399 acres
- Sugar beets: 1,399 acres
- Potatoes: 1,27 acres
- Vegetables: 711 acres
- Irrigated pasture: 120,471 acres
Cash Receipts in Million Dollars, 2006

- Hay: 48.3
- Sugarbeets: 34.3
- Wheat: 16.5
- Corn: 13.1
- Dry Beans: 12.9
- Barley: 12.8
- Other Crops: 12.1
- Greenhouse and Nursery: 6.5
- Oats: 1
- Oil Crops: 0.9
- Fruits and Nuts: 0.2
Historic Alfalfa Production

From Wyoming Agricultural Statistics, 2006
Production Constraints

- Nutrient availability: low organic matter, high $\text{CaCO}_3$ and pH;
- Water management;
- High costs and limited options for fertilizers;
- Cold weather;
- Water quality;
Role of SOM

- Soil organic matter improves soil tilth, or structure and the soils ability to hold and release moisture and nutrients;
**pH**

- High pH increases Ca & Mg to point that can restrain P availability;

- Limits availability of micronutrients, especially Fe and Zn;

- Testing soil for micronutrient availability pays.
Water Management

- Proper water management with clean water optimizes fertilizer applications;
- Improper management can make it a waste of time and money:
  - Too much water leaches away plant available nutrients and concentrates Na and salts at the surface;
  - Too little water or bad timing can lead to losses through volatilization or failure to move nutrients into root zones;
  - Water with even small amounts of salts or Na can degrade soils in ways that are impossible to reverse;
- Can water management improve on Wyoming hay meadows and pastures?
High Costs and Limited Options for Fertilizer

- Cost and N and P fertilizers have skyrocketed to levels that can make their use cost-ineffective on low-yield hay meadows;

- Ammonium-nitrate, the best N formulation for perennial crops, is no longer available;
  - Urea requires careful management to incorporate with water before volatilization - high pH exacerbates;
  - UAN and other liquids are most effective if incorporated with coulter or spoke-wheel injector - equipment investment;

- P is rapidly tied up so needs must be met each year:
  - Advantages of liquid P products generally don’t offset higher costs on alfalfa applications.
### Fertilizing Alfalfa

Average nutrient removal by established alfalfa at harvest

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Lbs/ ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>55</td>
</tr>
<tr>
<td>P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt;</td>
<td>15</td>
</tr>
<tr>
<td>K&lt;sub&gt;2&lt;/sub&gt;O</td>
<td>60</td>
</tr>
<tr>
<td>Sulfur</td>
<td>5</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.04</td>
</tr>
<tr>
<td>Boron</td>
<td>0.05</td>
</tr>
</tbody>
</table>
Nitrogen

- Fixes all the N it needs, even for following crop;
- Inoculation boosts fixation early on;
- 10-15 lbs at planting can speed establishment, but residual N should be enough;
- Added N reduces fixation and favors grasses, shortening stand life;
- However, for livestock production nutrient management, alfalfa can take up huge amounts of N.
Phosphorus

- Most often deficient, especially in high-yield management;
- Many important functions, including stimulating nodule production and N fixation;
- Soil test crucial; symptoms difficult to detect;
  - Sample >6 months prior to planting: takes time;
  - Test soil at least every 2 or 3 years (see UW ext pub on sampling);
- Apply additional P to total about 10 lbs/ac/ton of expected yield;
- We recommend annual applications, but UNeb and USU claim best results from applications every other year on calcareous soils;
Phosphorus, cont.

- On soils with pH 7 or less can apply 2-3 years worth. Only in SE and NE Wyoming: Laramie, Weston, Crook, & Campbell Counties;

- Preplant applications should be banded for better root access; but broadcast just as effective on established stands: lots of near surface roots;

- On established stands apply in fall or early spring, but avoid soft soils;
  - Fall best for furrow irrigated stands;

- Source does not matter: choose by availability, ease of application, and price per unit $\text{P}_2\text{O}_5$;
  - Liquid can be easier to apply but costs more;
  - No yield difference between spraying and applying with irrigation;

- Split application beneficial for high-yield, long growing season (not Wyoming).
Potassium

- Can be deficient on sandy soils, irrigation with clean water low in K, and long-term, high yield production;
  - If need is determined annual applications are necessary since alfalfa will luxury consume and end up with very high K concentrations;
  - Several sources available; choose same as P.
Occasionally deficient on sandy low OM soils with clean, low-S irrigation water;

- Sulfate-sulfur soil test < 8 ppm indicate need;
- Utah State recommends: 50 lbs SO$_4$-S as ammonium sulfate, potassium sulfate, or gypsum plus 100 lbs/ac of elemental S will correct deficiencies for two to three years.
Micronutrients

- Deficiencies sometimes occur: apply according to soil test recommendations;
- Liquid forms work well;
- Fe chlorosis can occur in early spring but often disappears with warmer temperatures.
Other fertilizer considerations

- Fertilize right after harvest, before regrowth, avoid fertilizer contact with wet foliage;
- Topdress after first cutting to improve regrowth; after last cutting to improve winter hardiness;
- Avoid soft soils, like in early spring, due to compaction and physical damage to root crowns;
- Split application if using > 500 lb/a to avoid salt damage;
- Base source choice on price per unit; they don’t perform differently;
- Don’t use foliar spray for mod-high rates of macro nutrients: causes salt damage and uptake is no better than soil application. Great for micronutrients though.
Using manure to supplement fertility

- About 25 percent of N is available the first year;
- 100 lbs N per acre requires about 33 tons/acre of cow manure or 44 tons/acre of horse manure;
- If a manure spreader holds 4 yards, that’s 12 spreader loads of cow manure or 16 loads of horse manure;
- **SOM contribution in long-term is more important than immediate nutrient contributions.**

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**Table 1. Typical nutrient content, solids content, and bulk density of uncomposted animal manures at the time of application.**

<table>
<thead>
<tr>
<th>Type</th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Solids</th>
<th>Bulk density</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lb per ton as-is</td>
<td>lb/cu yard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broiler with litter</td>
<td>73</td>
<td>28</td>
<td>55</td>
<td>70</td>
<td>900</td>
</tr>
<tr>
<td>Laying hen</td>
<td>37</td>
<td>25</td>
<td>39</td>
<td>40</td>
<td>1400</td>
</tr>
<tr>
<td>Sheep</td>
<td>18</td>
<td>4.0</td>
<td>29</td>
<td>28</td>
<td>1400</td>
</tr>
<tr>
<td>Rabbit</td>
<td>15</td>
<td>4.2</td>
<td>12</td>
<td>25</td>
<td>1400</td>
</tr>
<tr>
<td>Beef</td>
<td>12</td>
<td>2.6</td>
<td>14</td>
<td>23</td>
<td>1400</td>
</tr>
<tr>
<td>Dry stack dairy</td>
<td>9</td>
<td>1.8</td>
<td>16</td>
<td>35</td>
<td>1400</td>
</tr>
<tr>
<td>Separated dairy solids</td>
<td>5</td>
<td>0.9</td>
<td>2.4</td>
<td>19</td>
<td>1100</td>
</tr>
<tr>
<td>Horse</td>
<td>9</td>
<td>2.6</td>
<td>13</td>
<td>37</td>
<td>1400</td>
</tr>
</tbody>
</table>

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1. Dairy manure data and some horse manure data were collected in the Pacific Northwest. Other data sources are listed in Additional Resources.

2. Manure analyses are usually reported in terms of P and K, while fertilizer labels use P₂O₅ and K₂O. To convert from P to P₂O₅, multiply P by 2.3. To convert from K to K₂O, multiply K by 1.2.

3. As-is is typical moisture content for manure stored under cover.
Applying manure to irrigated alfalfa & grass

- Excellent source of P, K and micronutrients, but N favors grass & weeds, reduces fixation, and shortens stand life;
- Rates should not exceed 3000 to 5000 gal/ac liquid or 10 t/ac dry in any one application to avoid salt damage;
- Apply uniformly and break up large chunks;
- Three timing considerations:
  - Before Establishment: >6mos prior; avoid seed contact;
  - On established stands: ASAP after harvest, before regrowth, and on dry soil to avoid compaction and crown damage;
  - Before plow down for next crop: Recommend light application because on top of N fixed by alfalfa, will create excess.
Other manure considerations

- Best to apply to grass stands or mixed grass alfalfa because grass will respond dramatically; again, ASAP after harvest to avoid salt damage;

- Avoid ammonia losses by avoiding warm, windy days to apply;
Alfalfa and Nutrient Management

Application of manure to alfalfa offers several advantages for livestock producers:

- Wider window of opportunity than corn;
- Can remove twice as much N as corn, but fixation still provides 20-25% of N, so apply at 75-85% of removal;
- Can remove N down to 12 feet, much deeper than corn.
Summary

- Alfalfa is Wyoming’s most important crop;
- Several constraints to production should be considered, especially high pH soils, low SOM, and cold weather;
- Alfalfa doesn’t require N but removes large amounts of P, most often responds to P fertilization;
- Fertilizer should be chosen based on availability, ease of application, and price per unit: research shows no yield differences from different sources;
- Manure is a valuable source of nutrients for alfalfa if salt damage, compaction, and crown damage avoided:
  - Less than 10t/ac or ~4000 gal/ac;
  - Applied immediately after harvest before regrowth;
  - Stay off soft, moist soils;
- Building SOM is likely most important contribution;
- Advantages for nutrient management in livestock production.