Alfalfa Fertility

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Goals?

• 1.
• 2.
• 3.
• 4.
• 5.
• 6.
Table 4.6 Soil Fertility Handbook.
Primary nutrient soil test calibration tables for legumes.

**NITROGEN REQUIREMENTS**

**ALFALFA**

10-20 lb/A for establishment.
None needed for maintenance.

**PHOSPHORUS REQUIREMENT**

<table>
<thead>
<tr>
<th>P SOIL TEST INDEX</th>
<th>Percent Sufficiency</th>
<th>P$_2$O$_5$ lb/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>20</td>
<td>200</td>
</tr>
<tr>
<td>10</td>
<td>50</td>
<td>150</td>
</tr>
<tr>
<td>20</td>
<td>70</td>
<td>100</td>
</tr>
<tr>
<td>40</td>
<td>90</td>
<td>60</td>
</tr>
<tr>
<td>65+</td>
<td>100</td>
<td>none</td>
</tr>
</tbody>
</table>

**POTASSIUM REQUIREMENT**

<table>
<thead>
<tr>
<th>K SOIL TEST INDEX</th>
<th>Percent Sufficiency</th>
<th>K$_2$O lb/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>20</td>
<td>280</td>
</tr>
<tr>
<td>75</td>
<td>50</td>
<td>210</td>
</tr>
<tr>
<td>125</td>
<td>70</td>
<td>140</td>
</tr>
<tr>
<td>200</td>
<td>90</td>
<td>80</td>
</tr>
<tr>
<td>250-350</td>
<td>100</td>
<td>40</td>
</tr>
<tr>
<td>350+</td>
<td>100</td>
<td>none</td>
</tr>
</tbody>
</table>
P and K

• Sufficiency = How much you can get.
• P and K both Deficient?
  – Multiplication Effect

• Example: 5 ton Potential
  – P is 80 %
    • 4 ton potential  Lost 1 ton
  – K is 80 %
    • 4 ton potential  Lost 1 ton
  – P and K  :  .80 * .80 = .64%
    • 3.2 ton potential  Lost 1.8 ton
Our Soils

- Survey in 1995 75 percent of the alfalfa fields in OK sampled had low pH or were deficient in P2O5 or K2O, or both
- Survey repeated in 2000 (434 samples) 92 percent of the 434 soil samples analyzed for alfalfa production by the SWFAL at OSU needed lime, P, or K for good production
Alfalfa Response to Soil pH

Follet and Wilkinson, 1995
Alfalfa Root Development

- Most lateral roots are near the soil surface for the first year, but more deep lateral roots develop as the plant ages.
- Alfalfa has lower root density than many grasses and a deeper rooting zone.
- P and K application increase root growth, enabling roots to obtain moisture and nutrients from greater volume of soil.
P Functions in Plants

• Energy storage and transfer
  – Phosphate compounds are “energy currency”
  – (such as ADP and ATP)

• Structural component of biochemicals
  – Seed formation
  – Calcium and magnesium phytate

• Maintenance and transfer of genetic code

• Root growth, rapid crop establishment

• Early maturity, quicker recovery
P Fertilization Increases Nodule Growth

Gates, 1974

- Nodule dry weight, mg/plant
- P application, lb P$_2$O$_5$/A

- 0 lb P$_2$O$_5$/A: 0 mg
- 64 lb P$_2$O$_5$/A: 64 mg
- 126 lb P$_2$O$_5$/A: 126 mg
- 254 lb P$_2$O$_5$/A: 254 mg
- 510 lb P$_2$O$_5$/A: 510 mg
K Fertilization Increases Nodule Activity

K$_2$O added, lb/A

- 0
- 21
- 43
- 64
- 86
- 107

Grewal and Williams, 2002 (Australia)
K Fertilization Improves Hay Quality

Grewal and Williams, 2002 (Australia)
K Helps Reduce Winterkill in Alfalfa

Plant counts taken in May as % of those previous September

Year


Stand density (%)

No K 100 lb K₂O/yr

Bailey, 1983 (MB)
Balanced P and K Nutrition Is Essential for Optimal Yields and Stand Maintenance

Berg et al., 2005; IN

Balanced P and K Nutrition Is Essential for Optimal Yields and Stand Maintenance

Alfalfa hay yield, ton/A/yr

Year 1 Year 2 Year 3

No P or K
K only
P only
P and K

Low P and K
High P and K

Berg et al., 2005; IN
From Table 4-1. Alfalfa Guide: Approximate Nutrient Content and Removal in 1 Ton of Alfalfa Hay.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Average Composition (%)</th>
<th>Pounds in 1 ton of Hay</th>
</tr>
</thead>
<tbody>
<tr>
<td>N (Nitrogen)</td>
<td>3</td>
<td>60</td>
</tr>
<tr>
<td>$P_{2}O_{5}$ (Phosphorus)</td>
<td>0.55</td>
<td>10.8</td>
</tr>
<tr>
<td>$K_{2}O$ (Potassium)</td>
<td>2.5</td>
<td>50</td>
</tr>
<tr>
<td>Ca (Calcium)</td>
<td>1.2</td>
<td>24</td>
</tr>
<tr>
<td>Mg (Magnesium)</td>
<td>0.4</td>
<td>8.4</td>
</tr>
<tr>
<td>S (Sulfur)</td>
<td>0.28</td>
<td>5.6</td>
</tr>
</tbody>
</table>
Guide to Nutrient Deficiency Symptoms

CHEMICALS: may sometimes burn tips, edges of leaves and at other contacts. Tissue death, leaf becomes whitish.

DISEASE: Helminthosporium blight, starts in small spots, gradually spreads across leaves.

DROUGHT: Causes the corn to have a grayish-green color and the leaves roll up nearly to the size of a pencil.

MAGNESIUM: deficiency causes yellowing that starts at tip and moves along midrib of leaf.

NITROGEN: hunger sign is yellowing that starts at tip and moves along midrib of leaf.

POTASH: deficiency appears as a ring or strip along the tips and edges of leaves.

PHOSPHATE: shortage masks leaves with reddish-purple, particularly on young plants.

HEALTHY: leaves shine with a rich dark green color when adequately fed.
Diagnosis of P Deficiencies

• **Visual Observation:**
  – Distinct P deficiencies are seldom observable on alfalfa – not an effective diagnostic method!

• **Soil Testing**
  – Soil test prior to planting and regularly afterwards

• **Tissue Analysis**
  – Best way to monitor plant performance and prevent hidden hunger and yield loss

• **Recommended tissue concentration:**
  – 0.25 to 0.40% P in top third of plant
In K-deficient alfalfa, small white or yellowish spots first appear around the outer edges of older leaves.
K Deficiency in Alfalfa

Moderate K Deficiency

Severe K Deficiency
Micro Nutrients

- **Secondary and Micronutrients**—Deficiencies of the secondary elements (calcium, magnesium, and sulfur) and micronutrients (iron, zinc, manganese, copper, boron, molybdenum, and chlorine) are usually not a problem with alfalfa production in Oklahoma. Some magnesium, boron, sulfur, and zinc deficiencies have been reported in the extreme southeastern part of Oklahoma. Response to sulfur-containing fertilizers can only be expected under high-yielding dryland production.

- Special fertilizers containing secondary and micronutrients should not be applied to alfalfa unless there is strong evidence of a deficiency. However, it is critical that soil pH and levels of phosphorus and potassium have been corrected before trying to confirm a secondary or micronutrient deficiency.
Sulfur

• Especially in
  – High yielding
  – Sandy soil
  – Irrigated land

• Soil sample to 18” for first year.

• Fields history.

• May or may not respond until stand is older.
Fertilization Strategy

• One lump sum vs little each time.

• Spreading the $, or getting it over with.
### Table 4-4. Alfalfa Guide: Alfalfa response to surface broadcast phosphorus fertilizer as diammonium phosphate, 18-46-0.

<table>
<thead>
<tr>
<th>P₂O₅ Rate (lb/acre)</th>
<th>First Year Year-1 Yield (tons/acre)</th>
<th>6-year P₂O₅ Applied (lb/acre)</th>
<th>Year-6 P₂O₅ Applied (tons/acre)</th>
<th>Average over 6 years (lb/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4.9</td>
<td>0</td>
<td>3.6</td>
<td>4.9</td>
</tr>
<tr>
<td>100</td>
<td>5.4</td>
<td>600</td>
<td>4.4</td>
<td>5.5</td>
</tr>
<tr>
<td>200</td>
<td>4.9</td>
<td>600</td>
<td>4.4</td>
<td>5.7</td>
</tr>
<tr>
<td>600</td>
<td>6.1</td>
<td>600</td>
<td>3.8</td>
<td>5.7</td>
</tr>
</tbody>
</table>

### Table 4-5. Alfalfa Guide: Alfalfa yield response to P₂O₅ application timing, placement, and form of phosphorus to check plots that received no P₂O₅ during the study and total of 29.7 tons/acre.

<table>
<thead>
<tr>
<th>P₂O₅ Fertilizer Application (lb/acre)</th>
<th>Application Method</th>
<th>Yield Increase During 6 Years (tons/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 lb/acre/year</td>
<td>Broadcast as DAP</td>
<td>3.4</td>
</tr>
<tr>
<td>200 lb/acre/2 years</td>
<td>Broadcast as DAP</td>
<td>4.2</td>
</tr>
<tr>
<td>600 lb/acre/6 years</td>
<td>Broadcast as DAP</td>
<td>4.7</td>
</tr>
<tr>
<td>200 lb/acre/2 years</td>
<td>Knifed as APP</td>
<td>5.8</td>
</tr>
<tr>
<td>600 lb/acre/6 years</td>
<td>Knifed as APP</td>
<td>6.8</td>
</tr>
</tbody>
</table>

DAP = diammonium phosphate, 18-46-0.
APP = ammonium polyphosphate, 10-34-0.
Fertilization Strategy

• P as one lump sum
  – Good at first
  – P ties up over time.
  – Ex. Check of STP15, annually applied STP 80, one time 600lbs STP 40

• Surface app less efficient but often needed to maintain Max yield and qaul.

• Best to apply P and K Nov to Jan.
Years 3-6

• Thinning Stand Fertilization?

• Beware, if you fertilize a thin stand the competition may respond more!!!
Thank you!!!

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www.extensionnews.okstate.edu
434 Alfalfa Soil samples (2000)

- Adequate P, K & pH: 23
- Deficient in 1: P, K & pH: 27
- Deficient in 2: P, K & pH: 8
- Deficient in 3: P, K & pH: 42