NUTRIENT MANAGEMENT AND PLANT DENSITY RECOMMENDATIONS FOR LA PAZ COUNTY ALFALFA GROWERS

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Parker, Arizona
Law of the Minimum

- Plants will grow and produce only as much as the least available nutrient will allow them to.
Diagnosing a Nutrient Deficiency

Age of Leaves with Symptoms

Old Leaves
- Symptoms on entire plant
  - Plant light green. Lower leaves yellow, drying to brown
  - Nitrogen
- Symptoms on lower leaves only
  - Plant dark green with red or purple color. Lower leaves yellow, drying to dark green
  - Phosphorus

New Leaves
- Leaves distorted and/or necrotic
  - Terminal bud dies
    - Boron
    - New leaves distorted. Tips and edges necrotic.
  - Terminal bud does not die
    - Copper
    - Plant stunted. Leaves bluish green, small and distorted.
- Leaves chlorotic
  - Sulfur
  - Entire leaf chlorotic, spreading to entire plant
  - Zinc
  - Stems shortened and rosetted
  - Leaves without necrotic spots
  - Iron
  - Stems not shortened or rosetted
  - Leaves develop necrotic spots
  - Manganese
Primary, secondary and micro-nutrients

- Primary nutrients: N, P, K
- Secondary nutrients: Ca, Mg, S
- Micro-nutrients: B, Zn, Fe, Cu, Mn, Mo, Cl

Water (H₂O), Oxygen (O₂), Carbon Dioxide (CO₂)
# Alfalfa fertilizer requirements in arid regions

<table>
<thead>
<tr>
<th>Element</th>
<th>Symbol</th>
<th>Fertilizer required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphorus</td>
<td>P</td>
<td>More than 25% of acreage</td>
</tr>
<tr>
<td>Potassium</td>
<td>K</td>
<td>Less than 25% of acreage</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Mg</td>
<td>Less than 25% of acreage</td>
</tr>
<tr>
<td>Sulfur</td>
<td>S</td>
<td>Less than 25% of acreage</td>
</tr>
<tr>
<td>Molybdenium</td>
<td>Mo</td>
<td>Less than 25% of acreage</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>N</td>
<td>Less than 1% of acreage</td>
</tr>
<tr>
<td>Boron</td>
<td>B</td>
<td>Less than 1% of acreage</td>
</tr>
<tr>
<td>Other</td>
<td>--</td>
<td>Never</td>
</tr>
</tbody>
</table>

(Source: Meyer et al., 2008)
Nutrients in 8 T/A Alfalfa

The chart shows the nutrient levels of various elements in 8 T/A Alfalfa. The nutrients are categorized into Macro-nutrients, Secondary nutrients, and Micro-nutrients.

- **Macro-nutrients**: N (Nitrogen), P (Phosphorus), K (Potassium)
- **Secondary nutrients**: Ca (Calcium), Mg (Magnesium), S (Sulfur), Fe (Iron), Mn (Manganese), Cl (Chlorine), B (Boron), Zn (Zinc)
- **Micro-nutrients**: Cu (Copper), Mo (Molybdenum)

The nutrient levels are measured in lbs/acre.
**pH and Nutrient Availability**

- Maximum nutrient availability: $6.0 > \text{pH} > 7.0$
- Nutrient toxicity at low pH
- Nutrient deficiency at high pH

### Raising Soil pH
- Add lime (usu. calcium carbonate)
- Neutralizes acidity & supplies calcium

### Lowering Soil pH
- If the high (alkaline) soil pH is a natural condition, little can be done to lower it
- Marginally-alkaline soils can be acidified with elemental sulfur
Pre-plant Soil Sampling

• Uniform field:
  • 25 soil cores for a composite soil sample per field
  • 6-8 inch depth (2 ft?)

• Non-uniform field

(A) Soil sampling pattern within a relatively uniform field, and (B) soil sampling pattern within three distinct zones of a field, each having unique characteristics warranting a separate sample (approximately 25-30 cores/sample).
Levels of N, P, K, Mg and Ca are reported here. Also pH and lime results.

Nutrient levels reported in parts per million (ppm)

Can be doubled to approximate nutrient levels on pounds per acre basis
<table>
<thead>
<tr>
<th>Soil Test Rating</th>
<th>Probability of Response (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L= Low</td>
<td>95 to 100</td>
</tr>
<tr>
<td>M= Medium</td>
<td>65 to 95</td>
</tr>
<tr>
<td>H= High</td>
<td>30 to 65</td>
</tr>
<tr>
<td>VH= Very High</td>
<td>10 to 30</td>
</tr>
</tbody>
</table>

# Soil Test Interpretations

<table>
<thead>
<tr>
<th></th>
<th>Alfalfa</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{NO}_3\text{-N}$</td>
<td></td>
</tr>
<tr>
<td>Deficient</td>
<td>0 – 5</td>
</tr>
<tr>
<td>Sufficient</td>
<td>6 – 10</td>
</tr>
<tr>
<td>High</td>
<td>&gt; 10</td>
</tr>
<tr>
<td><strong>P</strong></td>
<td></td>
</tr>
<tr>
<td>Deficient</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>Sufficient</td>
<td>5 – 15</td>
</tr>
<tr>
<td>High</td>
<td>&gt;15</td>
</tr>
<tr>
<td><strong>K</strong></td>
<td></td>
</tr>
<tr>
<td>Deficient</td>
<td>50 - 100</td>
</tr>
<tr>
<td>Sufficient</td>
<td>100 - 175</td>
</tr>
<tr>
<td>High</td>
<td>&gt; 175</td>
</tr>
</tbody>
</table>
Tissue Testing

• Minimum of 10 whole plants- prefer 30 or more from field

• Collect at early bloom

• Sample healthy plants

• Keep samples cool and transport to lab ASAP
Nitrogen

- Utilizes about 56 lb N/ton of yield
- Seldom Recommended
- New Stand-
  - 15-25 lbs/ac
- Inhibit Rhizobium activity
Nitrogen Deficiency

- **Conditions**
  - Poor nodulation

- **Diagnosis**
  - Few nodules on roots
  - Small yellow planted mixed with tall green plants

- **Correction**
  - Adjust pH > 6.3
  - N fertilizer < 50 lbs N/acre/cutting
  - Inoculate
    - Top-dress: Drill (3-5 lbs N/acre) 205x inoculated seed
    - Inoculant in irrigation water

<table>
<thead>
<tr>
<th>Fertilizer Form</th>
<th>Maximum Nutrient Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>UAN32, urea</td>
<td>50 lbs/a per cutting</td>
</tr>
</tbody>
</table>
Conditions Favoring N Deficiency

- Seedling alfalfa
- Cold weather
- Problem soils
  - Low pH
  - Waterlogged
  - Shallow
  - Sandy
Nitrogen Deficiency
Phosphorus

- Alfalfa contains approximately 12 lbs/ton of P
- P fertilizer rate based on soil testing

<table>
<thead>
<tr>
<th>Soil test values-extractable P</th>
<th>( \text{P}_2\text{O}_5 ) lbs/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 15 ppm</td>
<td>0</td>
</tr>
<tr>
<td>11-15</td>
<td>50-150</td>
</tr>
<tr>
<td>6-10</td>
<td>140-250</td>
</tr>
<tr>
<td>&lt;6</td>
<td>200-300</td>
</tr>
</tbody>
</table>

- At 10% of bloom stage of growth, leaves and stem should contain 0.18% P or more
Phosphorus Deficiency

• Conditions
  • Cold soil, high pH soil

• Diagnosis
  • Soil test
  • Tissue Test
  • Small, dark blue-green leaves
Phosphorus Deficiency
Phosphorus Application

- Timing - before spring growth
- High P rates
- Spoon feeding a problem if always borderline deficient
- Split applications for long growing season
- Banding

<table>
<thead>
<tr>
<th>Fertilizer Form</th>
<th>Maximum Nutrient Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-52-0</td>
<td>100 lbs P₂O₅/a per year</td>
</tr>
<tr>
<td>10-34-0</td>
<td></td>
</tr>
</tbody>
</table>
Potassium

- Soil content usually adequate

- K applications to alkaline soils in AZ did not increase yield
  - When plant contains 1.5% or more K, application of K does not increase yield
Potassium Deficiency

• Conditions
  • Sandy Soil

• Diagnosis
  • Soil or tissue test
  • White spots on leaf margins

<table>
<thead>
<tr>
<th>Fertilizer Form</th>
<th>Maximum Nutrient Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium chloride or sulfate</td>
<td>300 lbs K$_2$O/a</td>
</tr>
</tbody>
</table>
Potassium Deficiency
Sulfur

- **Conditions**
  - Low S in irrigation water, sandy soil, low OM soil

- **Diagnosis**
  - Tissue or soil test
  - Yellow, stunted plants

- **Fertilizer**
  - Gypsum (15-17% S)
  - Max. = 15 to 50 lbs S/acre/year

<table>
<thead>
<tr>
<th>Fertilizer Form</th>
<th>Maximum Nutrient Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur, gypsum</td>
<td>15 to 50 lbs S/a per year</td>
</tr>
</tbody>
</table>
Sulfur Deficiency
Boron

- Seldom Observed
- Conditions
  - Low OM, sandy, high pH soil
- Diagnosis
  - Tissue or soil test
  - Yellow and reddish top
- Fertilizer
  - Solubor (18%B)
  - Max.= 1 to 3 lbs B/acre/year

<table>
<thead>
<tr>
<th>Fertilizer Form</th>
<th>Maximum Nutrient Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borax, borosilicate, boric acid</td>
<td>1 to 3 lbs B/a</td>
</tr>
</tbody>
</table>
Boron Deficiency
Zinc

• Conditions
  • Sandy, low OM soil

• Diagnosis
  • Tissue or soil test
  • Light green leaves, rosette top

• Fertilizer
  • Zinc sulfate (36% Zn)
  • Max. = 2 to 16 lbs Zn/acre/life of stand
Molybdenum Deficiency

- **Conditions**
  - Low pH soil

- **Diagnosis**
  - Tissue test
  - Yellow, stunted plants

- **Fertilizer**
  - Sodium Molybdate (40% Mo)
  - Max. = 0.1 to 0.5 lbs Mo/acre/life of stand

<table>
<thead>
<tr>
<th>Fertilizer Form</th>
<th>Maximum Nutrient Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium or sodium molydate</td>
<td>0.1 to 0.5 lbs Mo/a</td>
</tr>
</tbody>
</table>
Molybdenum Deficiency
## Electrical Conductivity (EC)

<table>
<thead>
<tr>
<th>EC (dS/m)</th>
<th>Soil Salinity Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 1.5</td>
<td>Very sensitive plants can tolerate</td>
</tr>
<tr>
<td>1.6 to 3.0</td>
<td>Moderately sensitive plants must be used</td>
</tr>
<tr>
<td>3.1 to 6.0</td>
<td>Moderately tolerant plants must be used</td>
</tr>
<tr>
<td>6.1 to 10.0</td>
<td>Tolerant plants must be used</td>
</tr>
<tr>
<td>Above 10.0</td>
<td>Very tolerant plants must be used</td>
</tr>
</tbody>
</table>

From Carrow and Duncan. 1998. Salt Affected Turf Sites
Salinity tolerance of alfalfa

- Crop tolerance and yield potential of selected crops as influenced by irrigation water salinity (EC$_W$) and soil salinity (Ec$_e$)

<table>
<thead>
<tr>
<th></th>
<th>100%</th>
<th>90%</th>
<th>75%</th>
<th>50%</th>
<th>0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>Ec$_e$</td>
<td>EC$_W$</td>
<td>Ec$_e$</td>
<td>EC$_W$</td>
<td>Ec$_e$</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>1.3</td>
<td>3.4</td>
<td>2.2</td>
<td>5.4</td>
</tr>
</tbody>
</table>

Fig. 4. Salinity tolerance curves for alfalfa, almond, cotton and pistachio. (Ayers and Westcott, 1985. Sanden, et. al., 2004)
Misdiagnosis

- Can exhibit symptoms that mimic nutrient deficiencies
- Insects
  - Three cornered leaf hopper can girdle stems and cause leaves to turn purple (P deficiency)
- Diseases
  - Alfalfa mosaic virus can cause leaf yellowing that may be confused with micronutrient decency
- Weather
  - Cold weather can also cause some purpling or yellowing
Manure

- **Advantages**
  - Soil improvement
  - Nutrients

- **Disadvantages**
  - Salt
  - Weeds
  - Not a balanced fertilizer
  - Nutrients not immediately available
  - High K in alfalfa
  - Manure in bales
  - Pre-plant primarily
  - Effluent needs dilution (salt, Cu2SO4, BOD, ammonia)
**Table 4.1. Average Nutrient Values for Various Manures**

<table>
<thead>
<tr>
<th>Manure Type</th>
<th>Total N</th>
<th>NH4+</th>
<th>P2O5</th>
<th>K2O</th>
<th>Ca</th>
<th>Mg</th>
<th>% H2O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid Dairy</td>
<td>22.61</td>
<td>9.57</td>
<td>12.07</td>
<td>18.92</td>
<td>10.90</td>
<td>4.55</td>
<td>94.30</td>
</tr>
<tr>
<td>Dry Broiler Litter</td>
<td>62.58</td>
<td>11.75</td>
<td>62.12</td>
<td>28.57</td>
<td>40.97</td>
<td>8.44</td>
<td>28.43</td>
</tr>
<tr>
<td>Dry Turkey Litter</td>
<td>61.75</td>
<td>15.18</td>
<td>63.68</td>
<td>24.36</td>
<td>43.11</td>
<td>7.02</td>
<td>34.72</td>
</tr>
<tr>
<td>Layer or Breeder</td>
<td>36.46</td>
<td>8.98</td>
<td>65.06</td>
<td>24.22</td>
<td>123.38</td>
<td>7.67</td>
<td>43.28</td>
</tr>
<tr>
<td>Liquid Poultry</td>
<td>51.08</td>
<td>32.95</td>
<td>41.01</td>
<td>30.53</td>
<td>40.05</td>
<td>5.19</td>
<td>93.49</td>
</tr>
<tr>
<td>Semi</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solid Dairy</td>
<td>10.54</td>
<td>3.16</td>
<td>6.12</td>
<td>8.67</td>
<td>6.90</td>
<td>2.50</td>
<td>82.56</td>
</tr>
<tr>
<td>Semi</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solid Beef</td>
<td>12.79</td>
<td>2.57</td>
<td>6.67</td>
<td>11.30</td>
<td>7.43</td>
<td>2.69</td>
<td>73.08</td>
</tr>
<tr>
<td>Swine Lagoon</td>
<td>10.04</td>
<td>5.34</td>
<td>5.68</td>
<td>5.72</td>
<td>2.49</td>
<td>0.89</td>
<td>99.01</td>
</tr>
<tr>
<td>Mixed Swine</td>
<td>1.13</td>
<td>26.93</td>
<td>29.75</td>
<td>18.18</td>
<td>16.44</td>
<td>4.86</td>
<td>94.97</td>
</tr>
</tbody>
</table>

1 Values presented in lbs/1000 gallons. All other values in lbs/ton.
The above table is a compilation of average values for 1090 manure samples.
Planting Rate

• General Recommendation
  15-20 pounds per acre

• Broadcast vs. drill
  Increase 10-20%

• Higher seeding = higher yields??
Replanting?

- Left: One year old alfalfa stand; Right: Four year old alfalfa stand.
- Thickening declining or thin stands seldom successful
- Autotoxicity
Questions?