Management of Phosphorus and Potassium for Alfalfa Production

For the 2016 CA Alfalfa and Forage Symposium
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Goals for this talk

• Review literature for P and K needs of alfalfa
• Methods for identifying P and K deficiency
• Corrective methods for P and K deficiency
• Closer look at P and K on yield components
Alfalfa Symposium P & K: Recent History

Since 2002...

• Koenig, R., & Barnhill, James, 2006. K mgmt. in alfalfa: A summary of 8 yrs. of rsrch. in an arid environment.

Interpreting soil and tissue – recommended fertilization
Later, in the US and abroad…

Recent studies have looked more deeply into causes of P & K fertility effects on yield and quality

• Berg et al., 2005, 2007, & 2009 – P & K effects on individual yield components and plant physiology…Wisconsin

• Lissbrant et al., 2009 – P & K on quality:yield trade-off…Wisconsin

• Divito & Sadras, 2014 – P, K & S on nodulation and yield…Meta-Analysis
Importance of P and K in plants

**Phosphorus**
- Nucleic acids (RNA, DNA)
- Phospholipid bi-layer (cellular membranes)
- ATP, ADP (energy transfer, metabolism)

**Potassium**
- Osmoregulation (cell turgor – stomata guard cell movement, cell division)
- pH stabilization (within cells)
- Enzyme activation and protein synthesis (photosynthesis)
# P and K needs of CA alfalfa

<table>
<thead>
<tr>
<th>Source (pub year)</th>
<th>P (P2O5)</th>
<th>K+ (K2O)</th>
<th>P:K</th>
</tr>
</thead>
<tbody>
<tr>
<td>WFH 9th ed. (2002)</td>
<td>6.5 (15)</td>
<td>50 (60)</td>
<td>1:7.7</td>
</tr>
<tr>
<td>IAM Medit, Desert (2008)</td>
<td>5.3 (12)</td>
<td>40 (48)</td>
<td>1:7.5</td>
</tr>
<tr>
<td>Intermtn AM (1995)</td>
<td>5.1 (11.9)</td>
<td>36 (43)</td>
<td>1:7.1</td>
</tr>
</tbody>
</table>
Visually IDing P and K deficiency in alfalfa

- Less easy to visually identify
- Generally stunted plants
- Slow to establish
- Wiry stems

- Very distinctive symptom
- Can advance to leaf burning
- Reduced stand persistence
Tests are always best

**Soil**
- Preplant, top 6-8 inches
- Mid-season comparison to tissue
- Dormancy
- Critical P $\sim < 5$ ppm, response up to 10 ppm (marginal analysis)
- Critical K $\sim < 40$ ppm, response up to 80 ppm

**Tissue**
- 1$^{st}$ cutting, 1/10 bloom*
- Mid-season diagnosis
- Middle 3$^{rd}$ of stem
- Critical PO4-P $\sim 300$ ppm, response up to 800 ppm
- Critical K $\sim 0.4\%$, response up to 0.8%

*At mid-bud stage, PO4-P should be 50% higher, and K should be 10% higher
## Correcting P & K deficiencies

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Yield (tons/acre)</th>
<th>Soil or tissue test result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Deficient</td>
</tr>
<tr>
<td>Phosphorus (P2O5)</td>
<td>8</td>
<td>120-180</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>180-270</td>
</tr>
<tr>
<td>Potassium (K2O)</td>
<td>8</td>
<td><strong>300-400</strong></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td><strong>400-600</strong></td>
</tr>
</tbody>
</table>

From *Irrigated Alfalfa Management for Mediterranean and Desert Zones*
Applying P & K

**Phosphorus**
- Shallow incorporation up to 2 year supply, pre-plant
- Banding more efficient than broadcasting
- Topdressing in winter or dormancy

**Potassium**
- Split application rates over 300 lbs K2O/acre between dormancy and summer
- Topdressing anytime OK
- Avoid foliar applications (apply between cuttings or dormant)
Manure application to alfalfa: BMPs

**SOLIDS**
- Apply early dormant or preplant
- Incorporate to 6-8 inches at preplant
- Limit 300-300-400 lbs N-P-K preplant or dormant – Clayey
- 200-200-300 lbs N-P-K preplant or dormant – Sandy

**LAGOON**
- Limit to 60 lbs N and K/ton alfalfa/cutting
- Don’t apply in hot weather
- Blend with fresh irrigation water
- Screen/settle/separate solids
Why are P & K important? The simple view

- Persistence
- Yield
- Yield and stand
- Time

Potassium
Phosphorus
Potassium + Phosphorus
A closer look at yield components: Berg et al. 2007 findings

- P fertilization reduced plants/area, but not yield
- K fertilization increased plants/area and yield
- Shoots/area was more predictable of yield, but mass/shoot was even more so
- Shoots/plant was inversely related to plants/area, independent of fertilization when accounting for yield
- K and P both increased mass/shoot and had a synergistic effect
  - Three shoot mass improvement possibilities: Rapid regrowth, rapid elongation, higher leaf:stem
Points to take home

• P and K fertility are both absolutely critical for high yielding, long standing alfalfa
• Testing is always best; compare soil and tissue to calibrate your environment and cultural practices
• Shoots/area may be a better indicator of yield potential than plants/area
• Mass/shoot points toward areas for yield improvement research
Thanks for listening.