Management of Alfalfa Nutrients & Pests in Alfalfa

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Agricultural Production Seminar
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## Alfalfa: Importance & Issues

<table>
<thead>
<tr>
<th></th>
<th>AZ</th>
<th>USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvested acres</td>
<td>260,000 (~1.6%)</td>
<td>16.6 millions</td>
</tr>
<tr>
<td>Production (Tons)</td>
<td>2.16 M (~13%)</td>
<td>52.6 millions</td>
</tr>
<tr>
<td>Average yield (tons/acre)</td>
<td>8.4</td>
<td>3.2</td>
</tr>
<tr>
<td>Value (at $175 / ton)</td>
<td>$451 M</td>
<td>$9.2 billion</td>
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</tbody>
</table>
Low Desert Alfalfa: Importance & Issues

- Non-dormant varieties
- Multiple harvests per year
- High productivity
- Cutting cycle
- Alfalfa stand life
- Intensive production system
- Aging associated problems
- Require replacement
- Production continuity.
- 6 to 10 cuttings a year.
- Average of 8.4 tons/acre.
- 28 to 32 days schedule.
- > 3 years.
- Remove various resources.
- Yield, quality, autotoxicity.
- High establishment cost.

Importance of balanced fertilizer management

N – P – K
Objectives

• Determine the yield response of irrigated alfalfa to various blend of P and K fertilizers.
• Assess the effects of different P & K levels on soil and plant tissues.
Trials at Maricopa Ag Center (MAC)

- **Soil Analysis:**
  - Texture: Sandy Clay loam
  - K (ppm): 320
  - Na (ppm): 250
  - Olsen-P (ppm): 6.6
  - Nitrate-N (ppm): 1.1
  - pH: 8.2

- **Sources of fertilizers:**
  - MAP (11-52-0)
  - KCL (0-0-60)

- **Rates (lb acre⁻¹):**
  - MAP (0, 192, 240); P₂O₅ (0, 100, 125)
  - KCL (0, 167, 500); K₂O (0, 100, 300)

- **Design:** Factorial in RCBD. Plot area = 400 ft², 5 ft b/n plots and 10 ft b/n replications.
Trials at Maricopa Ag Center (MAC)

- Fertilizers applied, November 2017
- Eight cuttings in 2018 and six in 2019
- Hay Yield adjusted to 12% moisture
- Soil samples at 6 inches depth collected
- Soil P & K determined
- A subsample of 48 shoots each plot
- Plant P & K concentration determined
Tube Trials
Texture: Sandy loam (72% sand)

K (ppm): 250
Na (ppm): 210
Olsen-p (ppm): 7.8
Nitrate-N (ppm): 3.9
pH: 9.0
P fertilization VS hay yield at MAC Trial 2018

<table>
<thead>
<tr>
<th>P₂O₅ (MAP) †</th>
<th>January</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lbs. acre⁻¹</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 (0)</td>
<td>1.24B ††</td>
<td>1.62B</td>
<td>1.94B</td>
<td>2.36B</td>
<td>2.69A</td>
<td>1.63B</td>
<td>2.15A</td>
<td>2.19B</td>
<td>15.82B</td>
</tr>
<tr>
<td>100 (192)</td>
<td>1.31B</td>
<td>1.85A</td>
<td>2.08A</td>
<td>2.49A</td>
<td>2.97A</td>
<td>1.93A</td>
<td>2.24A</td>
<td>2.33A</td>
<td>17.20A</td>
</tr>
<tr>
<td>125 (240)</td>
<td>1.46A</td>
<td>1.88A</td>
<td>2.10A</td>
<td>2.50A</td>
<td>2.88A</td>
<td>1.76AB</td>
<td>2.33A</td>
<td>2.31A</td>
<td>17.22A</td>
</tr>
</tbody>
</table>

**P Fertilizer Increased Yield**
- The benefit of phosphorus fertilizer was realized in all cuttings. No difference was detected between the rates of 100 (192) and 125 (240) lbs. acre⁻¹, after the first January cuttings.

† Sources of fertilizer: MAP-monoammonium phosphate (11-52-0).
†† Within a column, values followed by the same letters are not significantly different at 0.05 level of probability.
P Fertilization VS Hay Yield at MAC Trial 2019

P Fertilizer Increased Yield

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<tr>
<th>P₂O₅ (MAP)†</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lbs. acre⁻¹</td>
<td>Hay Yield, tons ha⁻¹</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 (0)</td>
<td>1.51††</td>
<td>2.22A</td>
<td>2.18A</td>
<td>1.85A</td>
<td>1.67B</td>
<td>1.54A</td>
<td>10.98B</td>
</tr>
<tr>
<td>100 (192)</td>
<td>1.74A</td>
<td>2.32A</td>
<td>2.30A</td>
<td>1.89A</td>
<td>1.88A</td>
<td>1.61A</td>
<td>11.74A</td>
</tr>
<tr>
<td>125 (240)</td>
<td>1.83A</td>
<td>2.36A</td>
<td>2.32A</td>
<td>1.89A</td>
<td>1.85A</td>
<td>1.64A</td>
<td>11.88A</td>
</tr>
</tbody>
</table>

† Sources of fertilizer: MAP-monoammonium phosphate (11-52-0).
†† Within a column, values followed by the same letters are not significantly different at 0.05 level of probability.
Separate Impacts of P & K Fertilization on Yield at MAC Trials 2018 & 2019

Graph 1: P₂O₅ (lb./acre)
- 2018
- 2019

Graph 2: KCL (lb./acre)
- 2018
- 2019
Combined Impacts of P & K Fertilization on Yield at MAC Trials 2018 & 2019
# Synergetic Effects of P & K on Average Yield at MAC Trials

<table>
<thead>
<tr>
<th>P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt; (lb. acre&lt;sup&gt;-1&lt;/sup&gt;)</th>
<th>K&lt;sub&gt;2&lt;/sub&gt;O (lb. acre&lt;sup&gt;-1&lt;/sup&gt;)</th>
<th>Yield (tons ac&lt;sup&gt;-1&lt;/sup&gt;)</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>12.86</td>
<td>--</td>
</tr>
<tr>
<td>0</td>
<td>100</td>
<td>13.66</td>
<td>0.80, tons ac&lt;sup&gt;-1&lt;/sup&gt;</td>
</tr>
<tr>
<td>125</td>
<td>0</td>
<td>14.20</td>
<td>1.34, tons ac&lt;sup&gt;-1&lt;/sup&gt;</td>
</tr>
<tr>
<td>125</td>
<td>100</td>
<td>14.90</td>
<td>2.04, tons ac&lt;sup&gt;-1&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Average (P + K)</strong></td>
<td></td>
<td><strong>13.94</strong></td>
<td><strong>1.08, tons ac&lt;sup&gt;-1&lt;/sup&gt;</strong></td>
</tr>
<tr>
<td><strong>Difference ((PK - ave (P+K))</strong></td>
<td></td>
<td><strong>0.96</strong></td>
<td><strong>6.44%</strong></td>
</tr>
</tbody>
</table>

Yield Advantage of Interaction (PK) over Individual components

- Together (PK) over P alone: 0.7 (4.70 %) - Synergetic effect of PK Interaction
- Together (PK) over K alone: 1.24 (8.32 %)
Combined Impacts of P & K on Yield (5 cuts) Tube Trial 2019

Blends of Fertilizers (P2O5/K2O)

Feb  March  April  May  June  Total  %D
Separate Impacts of P & K Fertilization on Yield at Tube Trial 2019

**P2O5 (lb./acre)**

- 0.00: 8.42%
- 100: 11.03%
- 125: 29.01%

**K2O (lb./acre)**

- 0.00: 9.85%
- 100: 8.96%
- 300: 6.55%
### Synergetic Effects of P & K on Average Yield at Tube Trial 2019

<table>
<thead>
<tr>
<th>P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt; (lb. acre&lt;sup&gt;-1&lt;/sup&gt;)</th>
<th>K&lt;sub&gt;2&lt;/sub&gt;O (lb. acre&lt;sup&gt;-1&lt;/sup&gt;)</th>
<th>Yield (tons acre&lt;sup&gt;-1&lt;/sup&gt;)</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>7.60</td>
<td>--</td>
</tr>
<tr>
<td>0</td>
<td>100</td>
<td>8.16</td>
<td>0.56, tons ac&lt;sup&gt;-1&lt;/sup&gt;</td>
</tr>
<tr>
<td>125</td>
<td>0</td>
<td>11.01</td>
<td>3.41, tons ac&lt;sup&gt;-1&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>125</strong>&lt;sup&gt;→&lt;/sup&gt;</td>
<td><strong>100</strong>&lt;sup&gt;→&lt;/sup&gt;</td>
<td><strong>13.05</strong>&lt;sup&gt;→&lt;/sup&gt;</td>
<td><strong>5.45, tons ac&lt;sup&gt;-1&lt;/sup&gt;</strong></td>
</tr>
<tr>
<td><strong>Average (P + K)</strong></td>
<td></td>
<td><strong>9.59</strong></td>
<td><strong>1.99, tons ac&lt;sup&gt;-1&lt;/sup&gt;</strong></td>
</tr>
<tr>
<td><strong>Difference {PK-ave(P+K)}</strong></td>
<td></td>
<td><strong>3.46</strong></td>
<td><strong>26.51%</strong></td>
</tr>
</tbody>
</table>

**Yield Advantage of Interaction (PK) over Individual components**

| Together (PK) over P alone | 2.04 (15.63 %) | **Synergetic effect of PK Interaction** |
| Together (PK) over K alone | 4.89 (37.47 %) |  |
Impacts of P & K Fertilization on Yield at Tube Trial 2020
### Balanced P and K Fertilizers Improved Alfalfa Yield and Yield Components at Tube Trial 2020

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>100</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Yield (t/ha)</strong></td>
<td>1.7</td>
<td>2.6</td>
<td>2.73</td>
</tr>
<tr>
<td><strong>Shoots/m²</strong></td>
<td>35.3</td>
<td>42</td>
<td>47</td>
</tr>
<tr>
<td><strong>Shoots/plant</strong></td>
<td>7.67</td>
<td>8.87</td>
<td>10.1</td>
</tr>
<tr>
<td><strong>Height (in)</strong></td>
<td>24.7</td>
<td>26.7</td>
<td>29</td>
</tr>
<tr>
<td><strong>Mass/shoot (gm)</strong></td>
<td>0.4</td>
<td>0.467</td>
<td>0.467</td>
</tr>
</tbody>
</table>

![Graph showing the effect of P and K fertilizers on alfalfa yield and components]
P Fertilizer Effect on Soil and Plant-P (Tube-2019)

- Olsen-P
- Plant Concentration (PO4-P)
Conclusions

• P has significant, while K has slight effect on yield individually,
• P & K interaction has synergetic effects on yield,
• Highest fertilizer application did not result in significantly increased yield,
• Balanced PK produced the highest productivity,
• With increasing fertilizer costs, a conservative approach to identifying fertilizer application rates may be more profitable.
• Additional research and detail economic analysis required.
Alfalfa Aphid Complex

- The pea aphid, *Acyrthosiphon pisum*

- The blue alfalfa aphid, *Acyrthosiphon kondoi*
Alfalfa Aphid Complex

• The spotted alfalfa aphid, *Therioaphis maculata*

• The cowpea aphid, *Aphis craccivora*
Isaria sp & Zoophthora sp.
Entomopathogenic Fungus
Effects of formulations of *Isaria fumosorosea* (If) & *Beauveria bassiana* (Bb) on blue alfalfa aphid (BAA)

Setup for **direct** (spray) application method

Setup for **indirect** inoculum application method
Mortality % of BAA exposed to different doses of (If) & (Bb) application methods after 5 days
Aphid Populations/Stem vs Yield (ton/A) for 2017 Study

![Graph showing aphid populations and yield per treatment.](image-url)
Aphid Populations/Stem vs Yield (ton/A) for 2018 Study
Biologically Reliant IPM Continuum

Biologically-based strategies

Prevention

Reduced risk insecticides

Thresholds

Scouting

Chemically Reliant

Crop Pest(s)

Collops spp.

Geocoris spp.

Orius tristicolor

Drapetis sp.

Lacewings

Spiders

Crop