P and K Placement for Alfalfa

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Potential use of fertilizer for forage production

“Despite the proven importance of forage crops . . . , growers seldom devote as much attention to the cultivation, fertilization, and conservation of their fodder crops as they do to their more readily marketable cash crops. . . . ”

1974, J.D. Beaton, Cominco, Ltd.
Alfalfa root morphology

- **Dryland**
  - Deeper penetration
  - Fewer but longer laterals
  - More secondary branches

- **Irrigated**
  - Shallower
  - More but shorter laterals
  - Less secondary branches

Weaver, 1926 (Nebraska)
Alfalfa root morphology

- **Dryland**
  - Root system is more profusely branched
  - Branches reached same depth as tap root
  - Shallower root system

- **Irrigated**
  - Fewer branches
  - Greater rooting depth
  - Tap root is the dominant structure

Weaver, 1926 (Nebraska)
Alfalfa root morphology

- **Dryland**
  - Greater number of branches in upper 1 ft. of soil
  - Maximum depth of 5 ft.
  - Roots oriented downward

- **Irrigated**
  - Fewer branches in upper 1 ft. of soil
  - Maximum depth of over 6 ft.
  - Greater lateral extent of root system

Weaver, 1926 (Nebraska)

(End of first year)
Alfalfa root morphology

- **Dryland:**
  - Depth of over 9 ft.
  - Roots oriented downward
  - Little lateral extension

- **Irrigated**
  - Depth of nearly 10 ft.
  - Greater lateral extent

Weaver, 1926 (Nebraska)

(July 10, second year)
Factors restricting root growth reduce nutrient uptake

- Disease damage
- Root pruning
- Soil Compaction
- Insect damage
- Temperature
- Nutrient deficiencies
- Excess salt or sodium
- Poor drainage
- Low oxygen
- Acidity
Relative Nutrient Mobility

P

K
Banded P increases alfalfa yields

Disc band applied by coulter-type disc drill 2-in deep x 6 in apart.
Yields averaged over 5 years. Mahli et al, Alberta, 1992-1996
Response to P placement in Alberta

- Stand damage was minimized by disc coulter.
- Advantage of banding was greatest at low rates.
- Advantage of banding averaged 840 lbs/ac over five years and four P rates.
- Banding had higher energy cost, but averaged $22 to $26/ac more profit than broadcast.
Banded P improves dryland alfalfa

Goos et al., N. Dakota, 1982-83
Deep band applied by thin-profile knife, 4-in deep x 12 in apart.
Total of two cuttings; average of two sites.
Response to P placement in N. Dakota

- Stand disturbance had no effect on yield at two of three sites.
- Stand disturbance reduced yield in an older thinner stand at a third site.
- Stand disturbance effect observed only in first cutting following application.
P application methods influence established alfalfa

<table>
<thead>
<tr>
<th>P method</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check (no P)</td>
<td>1.93</td>
<td></td>
</tr>
<tr>
<td>Disk drill (no P)</td>
<td>2.00</td>
<td>1.97</td>
</tr>
<tr>
<td>Disk drill</td>
<td>2.19</td>
<td>2.15</td>
</tr>
<tr>
<td>Surface band</td>
<td>2.23</td>
<td>2.16</td>
</tr>
<tr>
<td>Topdress</td>
<td>2.17</td>
<td>2.14</td>
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</tbody>
</table>

Average yield per harvest (12% moisture)

P applied in one application of 300 lbs P$_2$O$_5$/ac.
Average of 3 sites over 3 years. Number of harvests dependent on available moisture.
Response to P placement in Montana

- Effect of stand disturbance inconsistent across sites – some yield reductions, some increases.
- Addition of P more than compensated for damage caused to stand by banding.
- Yield and response to P limited by lack of available water for hay production.
- Surface band was as effective as subsurface
Banded P increases alfalfa yields.

Total P$_2$O$_5$ applied=600 lbs
From Mullen et al., Oklahoma State Univ., 2000.
P & K Placement in Manitoba

Average annual alfalfa yield (tons/ac)

- Band
  - Clay loam: 2.0
  - Sandy loam: 5.1
- Broadcast
  - Clay loam: 4.9
  - Sandy loam: 2.0

P rates are 18, 34, & 71 lbs P$_2$O$_5$/ac; K rates are 45 & 89 lbs K$_2$O/ac.
Response to P & K Placement in Manitoba

- Small overall K response ~ 0.1 tons/ac
- Significant K response at higher P rates
- K inhibited grass population
- Subsurface banding was not superior to broadcasting.
Response to K Placement in Wisconsin

Average of two soil types, total 5 site years
K rate is 210 lbs/ac
Univ. of Wisconsin, 1983
Response to K Placement in Wisconsin

Average of two soil types, total 5 site years
K rate is 210 lbs/ac
Univ. of Wisconsin, 1983
**Response to K Placement in Wisconsin**

- Alfalfa yield and K uptake was greatest for surface and shallow placements
- K uptake from surface and shallow placements increased with time indicating increasing root density
## Banding increases fescue yield

<table>
<thead>
<tr>
<th>N</th>
<th>P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt;</th>
<th>Placement</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>40</td>
<td>Broadcast</td>
<td>1.2</td>
</tr>
<tr>
<td>120</td>
<td>40</td>
<td>Dribble band</td>
<td>1.6</td>
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</tbody>
</table>

Lamond et al., Kansas.  
Fertilizer is 10-34-0 + 28-0-0
### N-P-K placement influences tall fescue yield

<table>
<thead>
<tr>
<th>Placement</th>
<th>Yield (tons/acre)</th>
<th>3-year average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broadcast</td>
<td>1.7</td>
<td></td>
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<tr>
<td>Knifed</td>
<td>2.3</td>
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</table>

Kansas, 1980-1982
Fertilizer is 100 lbs N/ac, 40 lbs P$_2$O$_5$/ac, and 40 lbs K$_2$O/ac applied as 10-34-0, 28-0-0, and 0-0-10
Broadcasting

- Lowest cost
- Rapid
- Suitable for applying high rates for building low soil tests.
- Response dependent on adequate moisture for shallow root growth.
- Surface broadcasting may strand nutrients in low rainfall, dryland conditions.
Banding

- Less convenient, greater energy cost
- P response can compensate for root pruning
- Usually produces greater yields, profit
- Apply when stand is dormant
- Use implements that minimize stand damage
- Effect of stand loss greater in thinner stands
- Effect of stand damage decreases with time
Summary

- Soil moisture, root growth, and stand age influence the choice of nutrient application methods.
- Banding P – surface or subsurface – can be more efficient in perennial crops, as has been shown for row crops.
- Banding K does not seem to offer an advantage over broadcasting.