Minerals in Forages: Plant Considerations

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Macro-minerals:

- Ca – component of cell walls, involved in cell division and elongation, cell membranes and N metabolism
- Mg – component of chlorophyll. Low Mg associated with hypomagnesemia (grass tetany)
- P – energy transfer in plants, component of the nucleus
- K – needed in large quantities in plants
Potassium function in forage legumes

- Enzyme activity
- Carbohydrate production and transport
- Stomatal activity
- Links to increased resistance to disease and lodging
- Balances anionic charges
K in plants:

- Taken up as $\text{K}^+$
- 0.5-8% in plant tissue
- Concentrated in stems and top of plant
- Moves to root by mass flow and diffusion
K management in Wisconsin

1. Soils can be low or deficient, especially if alfalfa is in the rotation, without significant manure applications.

2. Topdress K is often used as insurance.

3. Excessive K in some forages is common.
Comparison of corn nutrient needs with manure nutrient content - Nitrogen strategy

- Corn nutrient need, 160 bu/acre
- Manure nutrient content, 40 tons/acre

Nutrient, lb/acre

Corn nutrient need, 160 bu/acre

Manure nutrient content, 40 tons/acre

N
P$_2$O$_5$
K$_2$O

N
P$_2$O$_5$
K$_2$O

320
Comparison of corn nutrient needs with manure nutrient content - Phosphorus strategy

- Corn nutrient need, 160 bu/acre
- Manure nutrient content, 20 tons/acre

Nutrients:
- N
- P₂O₅
- K₂O

Nutrient levels:
- Nutrient, lb/acre
- Nutrient content, 20 tons/acre
Plot locations used for forage cation research, 1997-2001

- Marshfield – six pH levels 4.8 - 7.3
- Spooner – five pH levels 4.7 - 6.7
- Hancock – six pH levels 4.5 - 7.0
pH – 4.9

Picture taken in May following the seeding year
pH – 6.8
Picture taken in May following the seeding year
Average annual alfalfa dry matter yield by soil pH (1998-2001)
K Treatments

• Four K$_2$O levels – 0, 100, 200, 400 lbs K$_2$O/a/year*

*Applied after first cutting
Alfalfa response to annual K applications at pH 7.0

0 lb K₂O/a  200 lb K₂O/a

3rd cut Marshfield, 2000
Alfalfa response to annual K applications at pH 6.4

400 lb K₂O/a  0 lb K₂O/a

3rd cut Marshfield, 2000
Annual alfalfa yield by $K_2O$ rate (1998-2001)
Effects of pH and K on alfalfa dry matter yield (Hancock, 1998-2001)
Alfalfa tissue K by K$_2$O rate (1998-2001)
Total K removed in alfalfa tissue (1998-2001)
Total K removed in alfalfa tissue (1998-2001)
Final soil test K
(1998-2001)
Wisconsin soil test K trends
1964-1999
Alfalfa Ca level by soil pH
(1998-2001)
Alfalfa tissue Ca by K$_2$O rate (1998-2001)
Effects of pH and K on alfalfa tissue Ca levels (Spooner, 1998-2001)
Alfalfa Mg level by soil pH

Soil pH

%
Alfalfa tissue Mg by K$_2$O rate (1998-2001)
Effects of pH and K on alfalfa tissue Mg levels (Marshfield, 1998-2000)
Alfalfa Tissue P Levels

3rd cut, 1999

% Tissue P

Soil pH

Marshfield
Spooner
Hancock
Average Tissue P Levels
3rd cut alfalfa, 1999

Marshfield | Spooner | Hancock

0 lb/a K2O | 100 lb/a K2O | 200 lb/a K2O | 400 lb/a K2O
Alfalfa tissue K level by height, first cut Marshfield 2002

Soil Test K

Tissue K (%)

97 ppm 150 ppm 430 ppm

0-2 inches 2-4 inches 4-6 inches 6-8 inches 8+ inches
Alfalfa tissue Ca level by height, first cut Marshfield 2002

![Bar chart showing tissue Ca levels by height and K concentration.]

- K = 97 ppm, Ca = 1320 ppm
- K = 235 ppm, Ca = 1380 ppm
- K = 430 ppm, Ca = 1460 ppm
Alfalfa tissue Mg level by height, first cut Marshfield 2002
Alfalfa Tissue P Levels
3rd cut, 2001

0-2 inches
2-4 inches
4-6 inches
6-8 inches
8+ inches

Soil test K, 70 ppm
Soil test K, 370ppm
K composition of perennial forages
(Hoffman, et al. 1994)
Comparison of forage K levels of legumes and legume-grass mixtures

<table>
<thead>
<tr>
<th></th>
<th>Cut 1</th>
<th>Cut 2</th>
<th>Cut 3</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alfalfa</strong></td>
<td>3.82</td>
<td>2.97</td>
<td>2.36</td>
<td>3.05</td>
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<tr>
<td>with ryegrass</td>
<td>3.45</td>
<td>3.80</td>
<td>2.24</td>
<td>3.16</td>
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<tr>
<td><strong>Red Clover</strong></td>
<td>3.50</td>
<td>3.77</td>
<td>2.38</td>
<td>3.22</td>
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<tr>
<td>with ryegrass</td>
<td>4.14</td>
<td>3.26</td>
<td>2.56</td>
<td>3.32</td>
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<tr>
<td><strong>Birdsfoot Trefoil</strong></td>
<td>3.14</td>
<td>3.22</td>
<td>2.42</td>
<td>2.93</td>
</tr>
<tr>
<td>with ryegrass</td>
<td>4.33</td>
<td>2.92</td>
<td>2.86</td>
<td>3.37</td>
</tr>
</tbody>
</table>
## Ten-year average forage mineral content

<table>
<thead>
<tr>
<th></th>
<th>Ca</th>
<th>P</th>
<th>K</th>
<th>Mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legume hay</td>
<td>1.20</td>
<td>0.30</td>
<td>2.71</td>
<td>0.32</td>
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<tr>
<td>Legume silage</td>
<td>1.14</td>
<td>0.32</td>
<td>2.86</td>
<td>0.30</td>
</tr>
<tr>
<td>Legume-grass hay</td>
<td>1.01</td>
<td>0.27</td>
<td>2.25</td>
<td>0.29</td>
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<tr>
<td>Legume-grass silage</td>
<td>1.08</td>
<td>0.33</td>
<td>2.84</td>
<td>0.32</td>
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<tr>
<td>Grass hay</td>
<td>0.71</td>
<td>0.36</td>
<td>1.89</td>
<td>0.27</td>
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<tr>
<td>Grass silage</td>
<td>0.59</td>
<td>0.35</td>
<td>2.92</td>
<td>0.27</td>
</tr>
<tr>
<td>Corn silage</td>
<td>0.28</td>
<td>0.24</td>
<td>1.18</td>
<td>0.21</td>
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<tr>
<td>Small grain silage</td>
<td>0.94</td>
<td>0.29</td>
<td>2.51</td>
<td>0.26</td>
</tr>
</tbody>
</table>

--------- % (DM basis) ---------

UW Soil & Forage Analysis Lab, Marshfield, WI (1992-2001)
Summary

• Soil pH has a significant effect on cation levels found in forage tissue
• Applying K has a significant influence on all tissue cation levels
• As soil K increases, tissue K increases and tissue Ca and Mg tend to decrease.
• Typically, mineral P levels are not greatly affected by the presence of high levels of K.
Summary

- Apply nutrients according to soil test recommendations. High K levels will lead to “luxury consumption” in forages.
- If reducing K is your goal - clip forage lower, and allow the forage to mature a bit more than normal.
- Keep low K forages separated in storage.