Use of FGD Gypsum Soil Amendments for Improved Forage and Corn Production

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Corn/Forages Production and Gypsum

- Sulfur Nutrition
- Soil Chemical Properties
- Soil Physical Properties
Corn Production and Gypsum
Corn (Chemical Properties)

(Fehrenbacher et al., Illinois Res., Spring, 3-4, 1972)
Millet (Surface Acidity and Plant Nutrition)

Corn (Subsoil Acidity)

(Treatments)

Grain Yield (Bu/acre)

<table>
<thead>
<tr>
<th></th>
<th>Lime</th>
<th>Lime + Gypsum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>98</td>
<td>116</td>
</tr>
</tbody>
</table>

Corn (Surface and Subsurface Acidity)

(Smyth and Cravo, Agron. J., 84:843-850, 1992)

Grain Yield (Bu/acre)

Amazon Basin, Brazil

<table>
<thead>
<tr>
<th>Treatments</th>
<th>No Lime</th>
<th>Lime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>17</td>
<td>43</td>
</tr>
<tr>
<td>Gypsum</td>
<td>30</td>
<td>52</td>
</tr>
</tbody>
</table>

(Smyth and Cravo, Agron. J., 84:843-850, 1992)
Corn (Sulfur Nutrition)

### Corn (Subsoil Acidity)


<table>
<thead>
<tr>
<th>Experiment</th>
<th>Control</th>
<th>Gypsum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (16 yrs prior)</td>
<td>6.7</td>
<td>10.1</td>
</tr>
<tr>
<td>2 (15 yrs prior)</td>
<td>6.6</td>
<td>8.5</td>
</tr>
</tbody>
</table>

**Corn (Sulfur Nutrition)**

![Graph showing the relationship between sulfur additions (kg/ha) and grain yield (Mg/ha).](image)

Corn (Sulfur Nutrition)

![Graph showing the relationship between N Rate (kg ha⁻¹) and Average Corn Yield (Mg ha⁻¹). The graph includes two lines: one for S and another for No S. The equations are given as: Y=5.80+0.029x-0.00009x² (R²=0.85) for S and Y=5.19+0.021x-0.00003x² (R²=0.96) for No S.](image)

Wheat (Sulfur Nutrition)

Grain yield was significantly influenced by applied S as CaSO$_4$ in six of 14 site-years.

(Girma et al., *J. Plant Nutr.*, 28:1541–1555 (2005))
Wheat (Plant Nutrition)

Forages Production and Gypsum
Alfalfa (Sulfur Nutrition and Nematode Control)

(Mitchell and Ball, *Alabama Agri. Exp. Station*, Spring, 1972)
Alfalfa (Surface Acidity and Plant Nutrition)

(Yield (g/pot) vs. Mn Tissue Concentrations (ppm))

Tennessee Soil

Uganda Soil

Dashed Lines: Mn Concentrations
Solid Lines: Millet Yields

Forages (Subsoil Acidity)

(Black and Cameron, New Zealand J. Agric. Res. 27:195-200, 1984)

Greenhouse Study

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Tops</th>
<th>Roots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>5.4</td>
<td>3.9</td>
</tr>
<tr>
<td>Lime</td>
<td>6.1</td>
<td>3.7</td>
</tr>
<tr>
<td>Gypsum</td>
<td>5.7</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Yield (g/pot)
Forages (Subsoil Acidity)

Forages (Soil Chemical/Physical Properties)

![Graph showing forage yield in Sodic Soil in India with Gypsum Treatment]

- Forage Yield: Mean of Five Crops (tons/acre)
  - 0 Gypsum Treatment: 12.6 tons/acre
  - 2.3 Gypsum Treatment: 14.5 tons/acre
  - 4.6 Gypsum Treatment: 15.5 tons/acre

(Kumar, *Expl Agric.*, 24:97-103, 1988)
Forages (Sulfur Nutrition)

Corn Silage (Sulfur Nutrition)

(Kless et al., Grass and Forage Science, 44:277-281, 1989)
Forages (Soil Physical Properties)

(Kumar, *Expl Agric.*, 26:185-188, 1990)
Forages (Subsoil Acidity)


Dry Matter Yield (kg/ha)

Treatment

Control | Gypsum | Gypsum plus Drainage

419 | 626 | 1020

Sodic Soil in India
### Forages (Subsoil Acidity)

Soluble Al content in the 45-60 cm soil layer was decreased 43% by treatment regardless of gypsum source.

<table>
<thead>
<tr>
<th>Treatments (Mg/ha)</th>
<th>Control</th>
<th>4.5</th>
<th>9.0</th>
<th>18</th>
<th>4.5</th>
<th>9.0</th>
<th>18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa Yields (kg/ha)</td>
<td>4.9</td>
<td>5.1</td>
<td>5.8</td>
<td>6.1</td>
<td>5.1</td>
<td>5.2</td>
<td>5.7</td>
</tr>
</tbody>
</table>

**Rayne Soil, PA**

Forages (Subsoil Acidity)


Alfalfa Yield (Mg/ha)

Experiment 1
(16 yrs prior)

Control
Gypsum

3.9
6.8

Experiment 2
(15 yrs prior)

5.3
9.1

Forages (Chemical and Physical Properties)

Forages (Subsoil Acidity)

Achievements in management and utilization of southern grasslands

CARL S. HOVELAND

J. Range Manage. 53:17-22 January 2000

Grasslands in the humid southern USA are utilized primarily for grazing on improved pastures, most of which were developed since the 1930s and 1940s. Future areas of emphasis in improvement of these grasslands may include: (a) greater use of grazing-tolerant grasses and legumes; (b) stress-tolerant tall fescue with "friendly" non-toxic endophytes; (c) feed antidotes to the toxins of endophyte-infected tall fescue; (d) use of herbicide-and pest-resistant biotechnology genes in forage plants; (e) use of gypsum to alleviate subsoil acidity and improve rooting depth of aluminum-sensitive forage cultivars; (f) greater use of computers in information access and decision making by livestock producers; (g) greater use of forages for wildlife food; (h) breeding of pasture plants with greater winter productivity; (i) development of a perennial grass biomass energy industry for electrical generation and liquid fuel production.
Forages (Subsoil Acidity)

Yield attributed to calcium carbonate equivalency due to impurity in the gypsum

Forages (Quality)

Forages (Sulfur Nutrition)

Control       V-FGD       P-FGD     Gypsum

Alfalfa Yields (Mg/ha)

A       A       B       B

(A stands for Control, V-FGD, P-FGD, and Gypsum treatments, respectively.)

Forages (Sulfur Nutrition)

Sodic Soil in Coastal Canada

Forage Yield (Mg/ha)

Gypsum Treatment (kg S/ha)

(Zheljazkov et al., *J. Environ. Qual.*, 35:2410–2418 (2006))
Conclusions

- The scientific literature contains numerous examples of corn grain yield and forage yield benefits associated with use of gypsum.
- Benefits for corn and forages seem to be mostly associated with increased sulfur nutrition and reduced subsoil acidity.
- Treating sodic soils with gypsum increases productivity of the soil for crop production.
- Benefits of gypsum use may persist for several years after application to soil.
- Inappropriate use of high rates of gypsum can decrease yield (due to nutrient imbalances).
Thank You