BENEFITS OF GYPSUM IN FORAGE PRODUCTION

Malcolm E. Sumner
Regents’ Professor of Environmental Soil Science Emeritus
University of Georgia

1875

Introduction

• Many soils in the Southeast have
  • Acid subsoils
    • Occur naturally
    • Acidification by ammonical fertilizers
  • Toxic Al³⁺ increases as pH drops
  • Subsoil tillage or natural hardpans
  • Acidity and hardpans limit root growth

Al³⁺ Increases with Decreasing Soil pH

Al in Solution Reduces Fescue Root Growth

• Al³⁺ retards root growth

Nitrogen Fertilizers Cause Soil Acidity

3600 lb N/ac over 4 years on bermudagrass

Hay Removal and N Acidify Soil

• Both N and loss of bases increase soil acidity

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Depth</th>
<th>pH</th>
<th>Basic cations (cmol/kg)</th>
<th>Al</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0-4</td>
<td>6.2</td>
<td>13.4</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>4-8</td>
<td>6.2</td>
<td>6.1</td>
<td>0.1</td>
</tr>
<tr>
<td>6500 lb N/ac hay removed</td>
<td>0-4</td>
<td>4.6</td>
<td>2.1</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>4-8</td>
<td>4.6</td>
<td>1.3</td>
<td>0.8</td>
</tr>
<tr>
<td>6500 lb N/ac hay spread</td>
<td>0-4</td>
<td>4.7</td>
<td>3.8</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>4-8</td>
<td>4.7</td>
<td>2.4</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Dr. Malcolm E. Sumner
Regents’ Professor of Environmental Soil Science Emeritus
2014 Southeast Hay Convention
Benefits Of Gypsum In Forage Production

Dr. Malcolm E. Sumner
Regents’ Professor of Environmental Soil Science Emeritus

Lime Does Not Move Down Soil Profile

<table>
<thead>
<tr>
<th>Location</th>
<th>Lime rate</th>
<th>Time after liming</th>
<th>Movement</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virginia</td>
<td>3.6</td>
<td>9</td>
<td>0</td>
<td>Rechciel et al. (1991)</td>
</tr>
<tr>
<td>Australia</td>
<td>2</td>
<td>10</td>
<td>8</td>
<td>Cumming (1991)</td>
</tr>
<tr>
<td>Connecticut</td>
<td>6</td>
<td>20</td>
<td>18</td>
<td>Brown et al. (1956)</td>
</tr>
<tr>
<td>Australia</td>
<td>4.5</td>
<td>40</td>
<td>18</td>
<td>Ridley et al. (1990)</td>
</tr>
<tr>
<td>South Africa</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>Farina (1993)</td>
</tr>
</tbody>
</table>

- Surface applied lime ineffective in overcoming subsoil acidity
- Lime (CaCO₃) solubility: 0.047 g/L
- Gypsum (CaSO₄·2H₂O) is the answer: 2.2 g/L
- Gypsum 46 times more soluble than lime

What is Required for Good Root Growth into Subsoils?

- Adequate supply of soluble Ca²⁺ at root tip
- Low levels of soluble Al³⁺ at point of root elongation
- Absence of hardpans

Gypsum Reduces Subsoil Acidity

- Gypsum is much more soluble than lime
- Readily moves down soil profile
- Reacts with iron oxide surfaces to produce alkalinity in subsoil
- Root growth improves with
  - Soluble Ca²⁺ at root tip
  - Reduced Al³⁺

“Self-liming Effect”

\[
\begin{align*}
[Fe,Al](OH)₂ + CaSO₄ & \rightarrow [Fe,Al]OHSO₄ + \frac{1}{2}Ca^{2+} + \frac{1}{2}Ca(OH)₂ \\
2Al³⁺ + 3Ca(OH)₂ & \rightarrow 2Al(OH)₃ + 3Ca^{2+}
\end{align*}
\]

Gypsum Improves Pasture Production

- Alfalfa
- Hay grasses (Bermuda, Fescue)
- Application rate: 4.4 T/ac once
- Results presented from experiments and comparisons in farmers’ fields

Gypsum Increases Alfalfa Production

- Yields
  - Long-term experiment (Athens, GA)
  - Gypsum effect lasts many years

Effect of Gypsum on Soil Properties

- 16 years after application

The University of Georgia
Dr. Malcolm E. Sumner
Regents’ Professor of Environmental Soil Science Emeritus

Gypsum Increases Alfalfa Root Growth (5 Years after application)

Gypsum Increases Alfalfa Root Growth in Farmers’ Fields (10 site years)

Gypsum Increases Bermuda/Fescue Yields in Farmers’ Fields (Mean of 20 site years)

Gypsum Increases Bermuda/Fescue Root Growth in Farmers’ Fields (Mean of 20 site years)
Gypsum Increases Root Growth

Gypsum Increases Water Extraction in Bermuda/Fescue Pastures

Gypsum Softens Hardpans & Promotes Alfalfa Root Growth

Determination of Gypsum Requirement

Conclusions

- Gypsum
  - Is now cheap
  - More soluble than lime
  - Readily moves down soil profile
  - Supplies Ca\(^{2+}\) needed for root elongation
  - Reduces toxic Al\(^{3+}\) which impairs root elongation
  - Reduces hardness of subsoil hardpans

Dr. Malcolm E. Sumner
Regents’ Professor of Environmental Soil Science Emeritus

Thank you for your attention!