Turfgrass Response to Surface-applied Gypsum

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Turfgrass Nutrition & Soil Fertility
US Southern Piedmont
Physiographic Region #11

13 x 10^6 ha
Highly dissected, 60-400 m elevations
Mesic-Thermic soil temp regime

[Graph showing monthly mean air temperature in Watkinsville, GA]

http://www.blm.gov/wildlife/pifplans.htm
US Southern Piedmont Physiographic Region

Highly dissected, 60-400 m elevations

Mesic-Thermic soil temp regime

Typic Udic soil moisture regime

Watkinsville, GA Mean Weather Data (2003-2006)

Air Temperature (°C)

- Monthly Mean Air Temperature

Watkinsville, GA Mean Weather Data (2003-2006)

- Precip.
- PET
- Deficit
- Surplus Precipitation
- Precipitation

Water (cm month⁻¹)
US Southern Piedmont
Physiographic Region

13 x 10^6 ha

Mesic-Thermic soil temp regime
Typic Udic soil moisture regime

Thus, most upland soils are old, deep, fairly well-structured, highly leached, strongly acidic—

**Ultisols** (with very little OM)
Turfgrass and the SE US

Bermudagrass & Tall Fescue are popular turfgrass selections in the landscape of the US Southern Piedmont (GA, AL, and the Carolinas)
Treatment Options???

• Lime
  – Agricultural grade limestone is an effective ameliorant of soil acidity
  – Commonly incorporated at establishment for production of cotton, soybean, corn, wheat, etc.
  – INCORPORATE is the key word, effective lime treatment of soil acidity requires tillage into the soil profile
How Do Turf Managers Like Incorporating Lime?
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They don’t. Turfgrasses are perennial in nature and establishment is not only uncommon, but dreaded!
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So how can managers ameliorate the effects of surface and subsoil acidity without plowing the lawn?
How about making surface apps of gypsum?
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Many attributes:

– More soluble than agricultural lime
– Doesn’t require tillage
– Doesn’t raise pH of the surface soil
  • This can cause soil structure and turf disease problems
– Provides sulfate (SO$_4$), the plant essential nutrient form of sulfur
Experimental Objective

Determine the suitability of surface-applied gypsum as an ameliorant of acid subsoil-impaired turfgrass systems in the Southern US Piedmont
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Determine the suitability of surface-applied gypsum as an ameliorant of acid subsoil-impaired turfgrass systems in the Southern US Piedmont:

- monitoring Ca and Al soil transport rates
- turfgrass drought resistance ($H_2O$ use)
- turfgrass vegetative growth ($1^o$ & lateral)
- nutrient sufficiency of turfgrass tissue
- resulting turfgrass root proliferation
Experimental Design

Acidic B Horizon Clay

pH$_{w(1:1)}$ 4.9
Exch. Acid 3.9 meq/100g

Mehlich III (M3) exchangeable:

- Phosphorus (P) 2.0 lbs/A
- Potassium (K) 0.04 meq
- Magnesium (Mg) 0.25 meq
- Calcium (Ca) 0.65 meq

Total CEC: 4.84 meq

54-56 cm
Experimental Design

Treatments (5):

• Synthetic Gypsum (Southern Co. FGDG)
• Tech. Grade Gypsum (CaSO\(_4\)•2H\(_2\)O)
• Calcium Chloride (CaCl\(_2\)•2H\(_2\)O)
• Calcitic Lime (100% CCE)
• Control

90 columns: Bermudagrass (‘Princess’ or ‘Sultan’; 30 each), or a turf-type Tall Fescue blend (30)
Half of each instrumented to provide real-time soil moisture data (3 of 6 replications)
Acidic B Horizon Clay

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pHw(1:1)</td>
<td>4.9</td>
</tr>
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Experimental Design

- 11-30cm
- 38-57cm
Experimental Design

The Southern Co. SynGyp is 23.3% Ca by mass (+/- 0.65), and has a calcium carbonate equivalency of 2.7% (+/- 0.14). Trace element and heavy metal analysis show few impurities.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Application Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lime</td>
<td>4,332 (1,735)</td>
</tr>
<tr>
<td>FGD and TG Gypsum</td>
<td>13,796 (3,224)</td>
</tr>
<tr>
<td>CaCl₂</td>
<td>11,825 (3,224)</td>
</tr>
</tbody>
</table>
TF Cultural Methods

Columns mowed every 9±3 d @ 3" height

No signs/symptoms of pest activity observed (tall fescue is good like that)

When >half the TF columns showed stunted growth & leaf firing, all were irrigated with 4" in 1" pulses over 36 hours (every 20-35 d)

Post-estab: 11 lbs N & K$_2$O / acre•month
Berm. Cultural Methods

Columns mowed every 7±2 d @ 1.4” height

Insect pests controlled when necessary

When >half the bermudagrass columns showed stunted growth/dormancy, all were irrigated with 4” in 1” pulses over 36 hours (every 30-50 d)

Post-estab: 32 lbs N & K₂O / acre•month
Data Collection

- Column leachate 4, 7, and 15 MAT
  - pH & EC immed., filtered & acidified for ICP
- Dry & weighed clippings of alt. mows (45 events)
- Acid digested shoot clippings for nutrient analysis (150, 260, 380, and 590 DAT)
- Soil H₂O, greenhouse environment 3X per day
- Percent vegetative cover (20 events; 70-794 DAT)
- Extractable Al, Ca, Mg, K (1 M NH₄Cl) & Sulfur (Mehlich 3), soil pH & EC by soil depth (10 cm)
- RLD, SRL, & architecture by depth (winRhizo)
Leachate chemistry and composition
Solute transport through ~55 cm of red clay, by time after treatment

All Turfgrass Columns

Leachate Electrical Conductivity (dS m\(^{-1}\))

- **Control**
- **Lime**
- **CaCl\(_2\)**
- **Gypsum**

Days After Treatment (DAT)

115 155 195 235 275 315 355 395 435 475 515

Precip. (""

DAT 75
Calcium (Ca) concentration in leachate, by time after TRT

Days After Treatment (DAT)

Leachate Ca (mg L$^{-1}$)

Control
Lime
CaCl2
Gypsums

All Turfgrass Columns
Leaf/shoot biomass production (generally analogous with quality/vigor)
Mean Shoot Biomass Production by Treatment and Turfgrass
Penn State Univ. 2003-2005

Clipping Yield (kg ha⁻¹ d⁻¹)

- Control
- Lime
- CaCl₂
- Gypsums

Turfgrass Varieties:
- Princess
- Sultan
- Tall Fescue
Drought-Stressed Mean Shoot Biomass Production by Treatment and Bermudagrass Cultivar (18 out of 45 CY events)

Clipping Yield (kg ha\(^{-1}\) d\(^{-1}\))

- Control
- Lime
- CaCl\(_2\)
- Synthetic Gypsum
- Tech. Grade Gypsum

Princess

Sultan
Turfgrass water use by soil depth
Tall Fescue H₂O-use by depth over (14) 20-35-d dry down periods

- **Control**: Top 11-30 cm (0.5) Bottom 38-57 cm (0.25)
- **Gypsums**: Top 11-30 cm (0.5) Bottom 38-57 cm (0.35)
- **Lime**: Top 11-30 cm (0.5) Bottom 38-57 cm (0.25)

Mean Daily Soil Water Use (cm)

- Range: 0.2 to 0.8 cm
Lateral growth and density of turfgrass
Turfgrass root growth
Bermudagrass root growth
Tall Fescue 39–62 cm soil depth
Greenhouse Study Summary

- Gypsum trts effectively penetrated 60 cm of clay soil 1 year after a ~7 ton/A application
- Differences between mined & synthetic gyp were minor, do not appear significant
- Benefits to TF were stark: enhanced growth, total & deep water uptake, deep roots, and leaf nutrients; compared to both Lime and Con trts (with no resulting BC deficiencies)
- Benefits to Bermudagrass include: enhanced growth & color response under drought conditions (deeper roots?)
Acknowledgements

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