Fertilizer Proper Selection and Use

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NITROGEN
NITROGEN

MOST HEAVILY USED NUTRIENT SOURCE

AFFECTS GROWTH RATE AND COLOR

CAN BE EASILY MISUSED
SOIL ANALYSES

NO SOIL ANALYSIS FOR NITROGEN

REASONS

1. NITROGEN HIGHLY MOBILE
2. TOTAL N ANALYSIS NOT INICATIVE OF AVAILABLE N
3. N FERTILIZATION BASED ON TURFGRASS REQUIREMENTS INTENSITY OF MANAGEMENT DESIRED GROWTH RATE/ QUALITY
<table>
<thead>
<tr>
<th>Fate of Nitrogen</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taken up by plant</td>
<td>40-70%</td>
</tr>
<tr>
<td>Lost to volatilization</td>
<td>0-60%</td>
</tr>
<tr>
<td>Lost to leaching</td>
<td>0-50%</td>
</tr>
<tr>
<td>Lost to runoff</td>
<td>0-20%</td>
</tr>
</tbody>
</table>
**TISSUE NITROGEN**

SUFFICIENT LEVELS DEPEND ON TURF SPECIES

<table>
<thead>
<tr>
<th>Grass Type</th>
<th>Nitrogen Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIFWAY BERMUDAGRASS</td>
<td>2.75 TO 3.50%</td>
</tr>
<tr>
<td>BAHIA GRASS</td>
<td>1.50 TO 2.50%</td>
</tr>
<tr>
<td>ST. AUGUSTINEGRASS</td>
<td>2.00 TO 3.00%</td>
</tr>
<tr>
<td>CENTIPEDEGRASS</td>
<td>1.50 TO 2.50%</td>
</tr>
</tbody>
</table>
NITROGEN FERTILIZERS

SOLUBLE
Ammonium Sulfate

• 21% N (NH₄)₂SO₄
• Highly soluble and leachable
• Subject of volatilization
• Very acidifying - 5.35 kg acidity/kg N
• High salt index - 3.25
NITROGEN FERTILIZERS

NITROGEN FERTILIZERS THAT CONTAIN AMMONIACAL FORMS OF NITROGEN PRODUCE ACIDITY

\[ 2\text{NH}_4^+ + 3\text{O}_2 \xrightarrow{\text{Nitrosomonas}} 2\text{NO}_2^- + 4\text{H}^+ \]
EFFECT OF N SOURCE ON SOIL pH

SOIL pH

SS  IBDU  AS

NITROGEN SOURCE

5.6  5.8  4
<table>
<thead>
<tr>
<th>Nitrogen Source</th>
<th>Soil pH</th>
<th>Fe (ppm)</th>
<th>Tissue Mn (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH₄Cl</td>
<td>6.8</td>
<td>155</td>
<td>32</td>
</tr>
<tr>
<td>NH₄NO₃</td>
<td>7.0</td>
<td>160</td>
<td>12</td>
</tr>
<tr>
<td>NaNO₃</td>
<td>7.5</td>
<td>140</td>
<td>10</td>
</tr>
<tr>
<td>(NH₄)₂SO₄</td>
<td>6.0</td>
<td>180</td>
<td>74</td>
</tr>
<tr>
<td>Ca(NO₃)₂</td>
<td>7.2</td>
<td>140</td>
<td>8</td>
</tr>
</tbody>
</table>
ADDITIONAL MEANS OF VOLATILE N LOSS

SURFACE APPLICATION OF NH₄ FERTILIZERS ON CALCAREROUS SOILS

\[(\text{NH}_4)_2\text{SO}_4 + \text{CaCO}_3 \rightarrow \text{NH}_3 + \text{CO}_2 + \text{H}_{2}\text{O} + \text{CaSO}_4\]

THIS MECHANISM OF LOSS CAN BE A PROBLEM WHEN AMMONIUM SOURCE FERTILIZERS ARE APPLIED TO CALCAREROUS SOILS OR RECENTLY LIMED SOILS AND THE MATERIAL IS LEFT ON THE SOIL SURFACE. EASIEST MEANS OF AVOIDING THIS LOSS IS TO APPLY ENOUGH WATER (1/4 -1/2 INCH) TO GET THE N BELOW THE SURFACE.

DO NOT APPLY AMMONIUM SOURCE FERTILIZERS ON A RECENTLY LIMED SOIL WHERE IRRIGATION IS NOT POSSIBLE.
Urea

- 46% N
- Soluble Synthetic Organic
- Nonionic, highly leachable
- Subject to volatilization
- Low acidity - 1.8/kg N
- Low salt index - 1.62
ADDITIONAL MEANS OF VOLATILE N LOSS

UREA HYDROLYSIS

\[ \text{CO(NH}_2\text{)}_2 + \text{H}^+ + \text{HOH} \rightarrow 2\text{NH}_4^+ + \text{HCO}_3^- \]

\[ \text{NH}_3 + \text{CO}_2 + \text{HOH} \]

WHEN UREA IS ADDED TO ACID OR NEUTRAL SOILS
SOLUTION pH INCREASES DURING HYDROLYSIS

AS SOIL SOLUTION pH INCREASES ABOVE 7 BECAUSE
H IS CONSUMED THE NH\textsubscript{4} EQUILIBRIUM SHIFTS TO NH\textsubscript{3}
AND N IS LOST. THIS IS WHY SURFACE APPLICATION
OF UREA IS A PROBLEM BECAUSE OF THE THREAT
OF VOLATILE N LOSS.
VOLATILE LOSS OF NH₃ FOLLOWING SURFACE APPLICATION OF LIME AND NITROGEN TO A BAHIAGRASS SOD ON A LEON F.S. pH 5.8

<table>
<thead>
<tr>
<th>N SOURCE</th>
<th>NO LIME</th>
<th>1 TON 4 M PRIOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS</td>
<td>0.5 %</td>
<td>19.7%</td>
</tr>
<tr>
<td>UREA</td>
<td>29%</td>
<td>36%</td>
</tr>
<tr>
<td>AN</td>
<td>0.3%</td>
<td>3.4%</td>
</tr>
</tbody>
</table>
PERCENT N RECOVERED FROM SURFACE APPLICATION ON FOUR CALCAREOUS SOILS

<table>
<thead>
<tr>
<th>Nitrogen Source</th>
<th>Percent N Recovered (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AN</td>
<td>57</td>
</tr>
<tr>
<td>MAP</td>
<td>58</td>
</tr>
<tr>
<td>AS</td>
<td>46</td>
</tr>
<tr>
<td>DAP</td>
<td>43</td>
</tr>
<tr>
<td>UREA</td>
<td>37</td>
</tr>
</tbody>
</table>
Figure 3. N volatilized as NH₃ during 41 days of dry aeration from 600 mg. of N per pot
FATE OF N FERTILIZATION

LEACHING LOSS OF NITROGEN

INFLUENCE OF N FORM - $\text{NH}_4^+$, $\text{NO}_3^-$, OR UREA

EFFECT OF N FORM ON PERCENTAGE OF N LEACHED

![Graph showing the percentage of N leached at different profile depths for different N forms: AS, KNO$_3$, and UREA.](image)
<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>SALT INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>UREA</td>
<td>1.62</td>
</tr>
<tr>
<td>AMMONIUM NITRATE</td>
<td>2.99</td>
</tr>
<tr>
<td>AMMONIUM SULFATE</td>
<td>3.25</td>
</tr>
<tr>
<td>CALCIUM NITRATE</td>
<td>3.65</td>
</tr>
<tr>
<td>POTASSIUM NITRATE</td>
<td>4.25</td>
</tr>
<tr>
<td>SODIUM NITRATE</td>
<td>6.03</td>
</tr>
</tbody>
</table>

*** BURN POTENTIAL INCREASES WITH INCREASING SALT INDEX
NITRATE- N VS AMMONIUM -N

AMMONIUM –N  TOXIC IF ACCUMULATED
MUST BE DETOXIFIED
BEFORE TRANSLOCATION
REQUIRES CARBOHYDRATE

NITRATE –N  CAN ACCUMULATE WITHOUT
BEING TOXIC

NITRATE-N PROMOTES MORE GROWTH IN COOL
/LOW LIGHT CONDITIONS THAN AMMONIUM-N
NITROGEN FERTILIZERS

CONTROLLED-RELEASE
Nitroform

- Urea formaldehyde
- Insoluble organic
- 38% N ; 65-71% WIN
- Biological N release
  - rate influenced by soil temperature
Nutralene

- Methylene Urea
- 40% N - 36% WIN
- Biological N release
- More rapidly available than UF
- Not as adversely influenced by cool temperatures
Sulfur Coated Urea

- 32-38% N
- Release depends upon
  - thickness of sulfur coating
  - biological
  - soil environment
    - temperature
    - pH
- Cool season response-erratic
- Coating fragile
IBDU

• 31-90% WIN
• N released by hydrolysis
• Relatively unaffected by
  – temperature
  – pH
• Particle size important
• Excellent cool season response
Polyon

- 40% N
- Polyurethane coated urea
- N release influenced by
  - coating thickness
  - diffusion rate
  - soil temperature
- good for both warm and cool season
- Coating is abrasive resistant
CoRon

- 28% N Solution
- Polymethylene ureas and amine modified polymethylene ureas
- N release dependent upon microbial action
N-Sure

- 30% N
- Ring structured
  Triazones may
  contain methylene
diurea
- N release by
  microbial action
- Response very
  similar to CoRon
NITRO 30 (LIQUID)

TOTAL - N  30%
SOLUBILITY  100%

METHYLENE UREA
Figure 5. Percentage of applied N released from selected nitrogen sources over 189 day soil incubation.
<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>% N RELEASED</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBDU</td>
<td>13</td>
</tr>
<tr>
<td>POLYON</td>
<td>14</td>
</tr>
<tr>
<td>NITROFORM</td>
<td>17</td>
</tr>
<tr>
<td>MILORGANITE</td>
<td>22</td>
</tr>
<tr>
<td>SCU</td>
<td>26</td>
</tr>
<tr>
<td>NUTRALENE</td>
<td>34</td>
</tr>
</tbody>
</table>
LEACHING LOSSES OF N FROM CONTROLLED-RELEASE NITROGEN SOURCES

N LEACHED (% APPLIED)

NITROGEN SOURCES

AS  CAS  NUT  SCU  NIT  IBDU

80  62  58  50  28  17
AMMONIUM SULFATE
(12 WEEKS)
Nitrification Inhibitors

- Nitrate is leached easier than ammonium-N
- Fall application for plant uptake in the next growing season (mid-western)
- Some nitrification inhibitors include:
  - Nitrapyrin (N-Serve)
  - Dicyandiamide (DCD)
  - NBPT((N(N-butyl)-triphosphoric triamide)
UFLEXX 46% N
UREA + AGROTAINE
PHOSPHOROUS
PHOSPHORUS ANALYSIS

SOIL ANALYSIS - EXTRACTABLE P

** MANY TURF SOILS HIGH IN P

** NON-LEACHABLE IN MOST SOILS – BUT LEACHES IN SAND SOILS

** EXTRACTANT MAY DISSOLVE P NOT AVAILABLE TO PLANT

** CORRELATED WITH GROWTH
PHOSPHORUS ANALYSIS

TISSUE ANALYSIS - TOTAL P

BERMUDAGRASS TISSUE LEVELS:

< 0.2 %  LOW
0.2 - 0.5 %  SUFFICIENT
> 0.5 %  HIGH
Monoammonium phosphate

MAP

- 11% N, 48% P$_2$O$_5$ or
- 21% P  $\text{NH}_4\text{H}_2\text{PO}_4$
- Very soluble
- Subject to leaching and volatilization
- Acid reaction (pH 3.47)
- Low salt index (0.49)
- Green’s grade available
Diammonium phosphate

DAP

- **18% N, 46% P$_2$O$_5$** or
- 20% P (NH$_4$)$_2$HPO$_4$
- Very soluble
- Subject to volatilization on high pH soils
- Subject to leaching
- Initial basic rx (pH 7.98) then acidifying
- Low salt index (0.64)
POTASSIUM
SOIL POTASSIUM

* K leaches rapidly in sand soils

* Response to K fertilization most likely where clippings are removed

* Adequate K fertilization promotes strong root growth and tolerance to stress and disease

* Soil K threshold appears low

* No excess K uptake by bermudagrass
POTASSIUM ANALYSIS

TISSUE ANALYSIS - TOTAL TISSUE K

BERMUDAGRASS TISSUE LEVELS

<1.0 %  LOW
1.0 - 1.5 %  SUFFICIENT
>1.5%  HIGH
EFFECT OF K APPLICATION ON BERMUDAGRASS TISSUE K CONCENTRATION

Figure 2.
EFFECT OF K APPLICATION RATE ON BERMUDAGRASS VISUAL QUALITY

Figure 3.
EFFECT OF K APPLICATION RATE ON BERMUDAGRASS MEAN ROOT GROWTH

Figure 4.
EFFECT OF pH ON K LEACHING

![Graph showing the effect of pH on K leaching.](image-url)
Potassium Chloride
Muriate of Potash

- KCl (60% K₂O or 50% K)
- Completely soluble
- High salt index (2.29)
Potassium Sulfate

- $\text{K}_2\text{SO}_4$ (50% K$_2$O or 41% K; 17% S)
- Good source of K and S
- Leaches less rapidly than KCl in coated soils
Potassium-Magnesium Sulfate

- \( \text{K}_2\text{SO}_4 \cdot \text{MgSO}_4 \)
- 22% \( \text{K}_2\text{O} \) or 18% \( \text{K} \);
  11% \( \text{Mg} \); 22% \( \text{S} \)
- Good for soils low in \( \text{K} \) and \( \text{Mg} \)
- Moderate salt index (1.97)
Potassium Nitrate

- 13% N, 44% K₂O or 37% K
- Moderately soluble with good handling characteristics
- High salt index (4.25)
- Thought to promote establishment and rooting
EXTRACTABLE CALCIUM

* EXTRACTABLE Ca - DIFFICULT TO INTERPRET
  RARELY DEFICIENT
  USUALLY HIGH IN TURF SOILS

* Ca ONLY DEFICIENT UNDER LOW pH AND HIGH AL

* EXT. SOIL Mg STATUS MORE IMPORTANT

* APPLICATION OF Mg AND K REDUCES EXT. Ca

* MANY SOURCES - LIME,
  PHOSPHATE FERTILIZERS
  IRRIGATION WATER
EXTRACTABLE MAGNESIUM

* Mg LEACHES READILY IN ACID SAND SOILS

* MEHLICH I EXTRACTABLE LEVELS OF < 20 PPM - DEFICIENT FOR TURFGRASSES

* POTASSIUM FERTILIZATION REDUCES MG UPTAKE

* TURFGRASSES DO NOT REQUIRE A SPECIFIC Ca/Mg RATIO FOR OPTIMUM GROWTH - THE CRITICAL LEVEL OF EXT. Mg IS MUCH MORE IMPORTANT
MAGNESIUM ANALYSIS

TISSUE ANALYSIS - TOTAL Mg

- HAVE OBSERVED A RESPONSE TO APPLIED Mg WHEN SOIL Mg DROPPED BELOW 20 PPM AND TISSUE < 0.15% Mg
MICRONUTRIENTS
EFFECT OF SOIL pH ON MICRONUTRIENTS

SOLUBILITY OF Fe, Mn, Cu, Zn, and B decreases with increasing pH

SOLUBILITY OF Mo increases with increasing pH
1. N FERTILIZATION BASED ON TURFGRASS SPECIES, CULTIVAR AND LEVEL OF MANAGEMENT

2. TO MINIMIZE ENVIRONMENTAL IMPACT USE A MIXTURE OF SOLUBLE AND SLOW-RELEASE N SOURCES.

3. SLOW-RELEASE N SOURCES RELEASE N SLOWLY OVER TIME AND MAY PRODUCE A MORE UNIFORM GROWTH WITH LESS MOWING IMPORTANT

4. DUE TO SLOW RELEASE NATURE MUST APPLY ENOUGH TO EFFECT A RESPONSE
PHOSPHORUS FERTILIZATION

1. APPLY P ONLY WHEN NEEDED BASED ON A SOIL TEST.

2. APPLY NO MORE THAN 0.5 lbs PHOSPHATE/m sq/yr

3. DRAMATIC RESPONSES IN VISUAL QUALITY AND GROWTH ARE RARE.

4. ROOTING RESPONSE MORE LIKELY IN ESTABLISHING TURFGRASS

5. OLDER TURFGRASS AREAS GENERALLY TEST HIGH IN P AND ARE NOT RESPONSIVE TO P APPLICATION
POTASSIUM FERTILIZATION OF TURF

FOR UNSTRESSED BERMUDA GRASS A N:K FERTILIZATION RATIO OF 1.5 TO 1.0 IS SUFFICIENT TO MAINTAIN HEALTHY TURF.

RESEARCH HAS SHOWN THAT ADDITIONAL K FERTILIZATION DID NOT RESULT IN ADDITIONAL K IN THE TISSUE OR TOP OR ROOT GROWTH.
LET’S GO BOATING