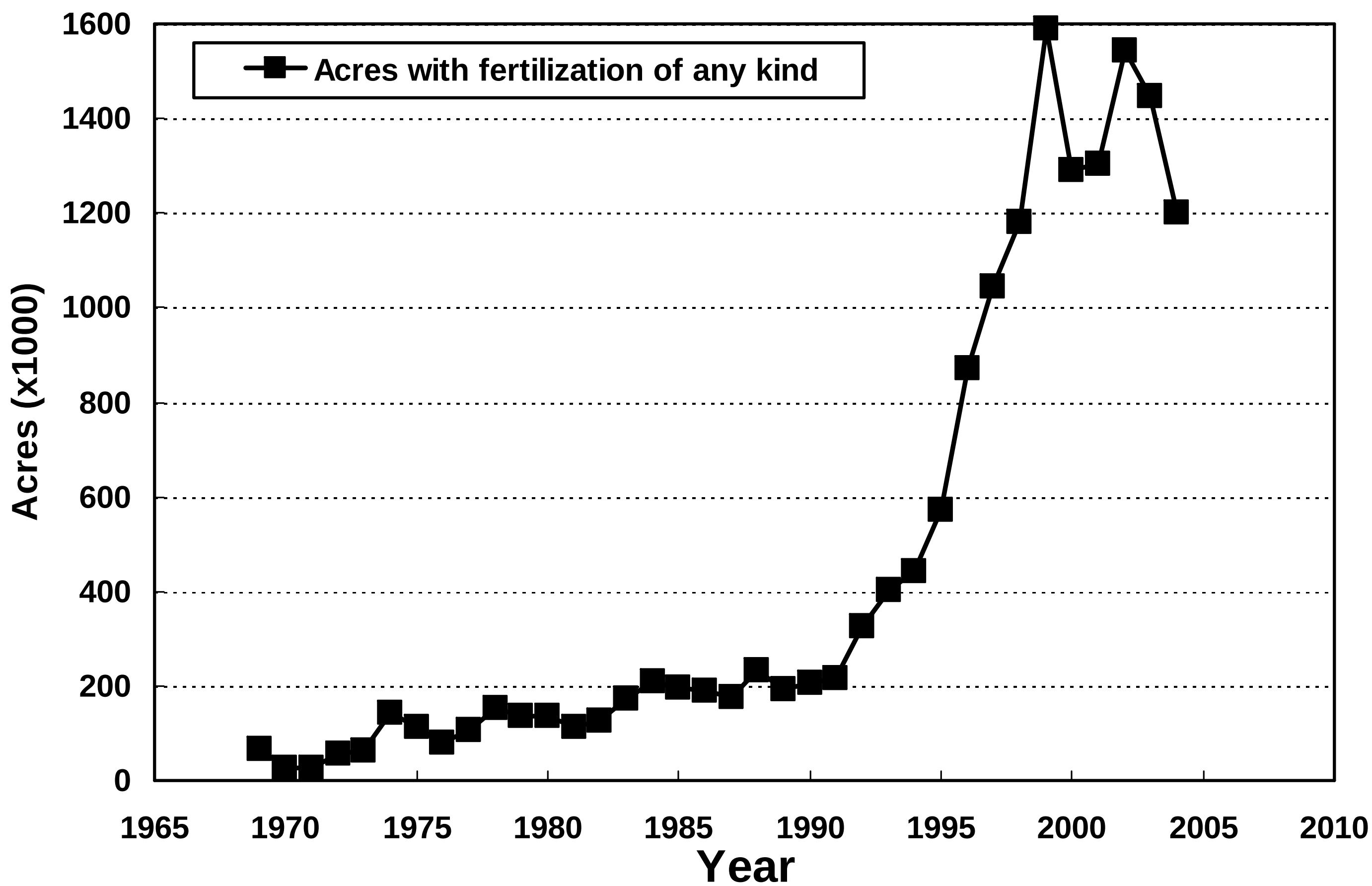
Nitrogen Volatility Control for Forestry

Robert Campbell, Garnett Whitehurst, Tim Albaugh, Eric Sucre, Zakiya Leggett

Robert Campbell, Eric Sucre, and Zakiya Leggett; Weyerhaeuser NR Company; Garnett Whitehurst, Brooks Whitehurst, Associates, Inc.; and Tim Albaugh, Forest Nutrition Cooperative.

Forest Fertilization History
Southeastern U.S.
Albaugh, et.al., 2007



FOREST NUTRITION COOPERATIVE

North Carolina State University • Virginia Polytechnic Institute and State University • Universidad de Concepción

Shaping the Future of Plantation Forestry

We create innovative solutions to enhance forest productivity
and value through sustainable management of site resources

- Industry/University research and education cooperative since 1970.
- Universities:

North Carolina State, Jose Stape, director,

Lee Allen, professor emeritus.

Virginia Tech, Tom Fox, director.

University of Concepcion, Rafael Rubilar, director.

Forest Nutrition Cooperative

- **<u>LANDOWNER MEMBERS</u>**
- American Forest Management
- Arauco-Bioforest
- The Campbell Group
- Claritas
- Deforsa
- Dougherty & Dougherty Forestry
- FOMEX
- Forest Capital Partners
- Forest Investment Associates
- Forestal Mininco
- Forestal Rio Biabo
- Hancock Timber Resource Group
- Jordan Lumber
- Masisa
- Milliken Forestry
- Molpus Timber Management
- Plum Creek Timber Company
- Potlatch Forest Holdings
- Rayonier
- Refocosta
- RMK Timberland Group
- Resource Management Service
- Smurfit Carton de Columbia
- Smurfit Carton de Venezuela
- Sonoco Products
- Superior Pine Products
- Westervelt Company
- Weyerhaeuser Company

Forest Nutrition Cooperative

- **SUSTAINING MEMBERS**
- BASF
- NV Division of Forest Resources
- Southeastern Community College
- Virginia Department of Forestry

- **CORRESPONDING MEMBERS**
- Agrotain
- ArborGen
- Bayer Crop Science
- CellFor
- DuPont Crop Protection
- Forestry & Land Resource Consultants
- Gavilon
- ImageTree
- International Plant Nutrition Institute
- Payne's Flying Service
- Syngenta
- Thrash Aviation

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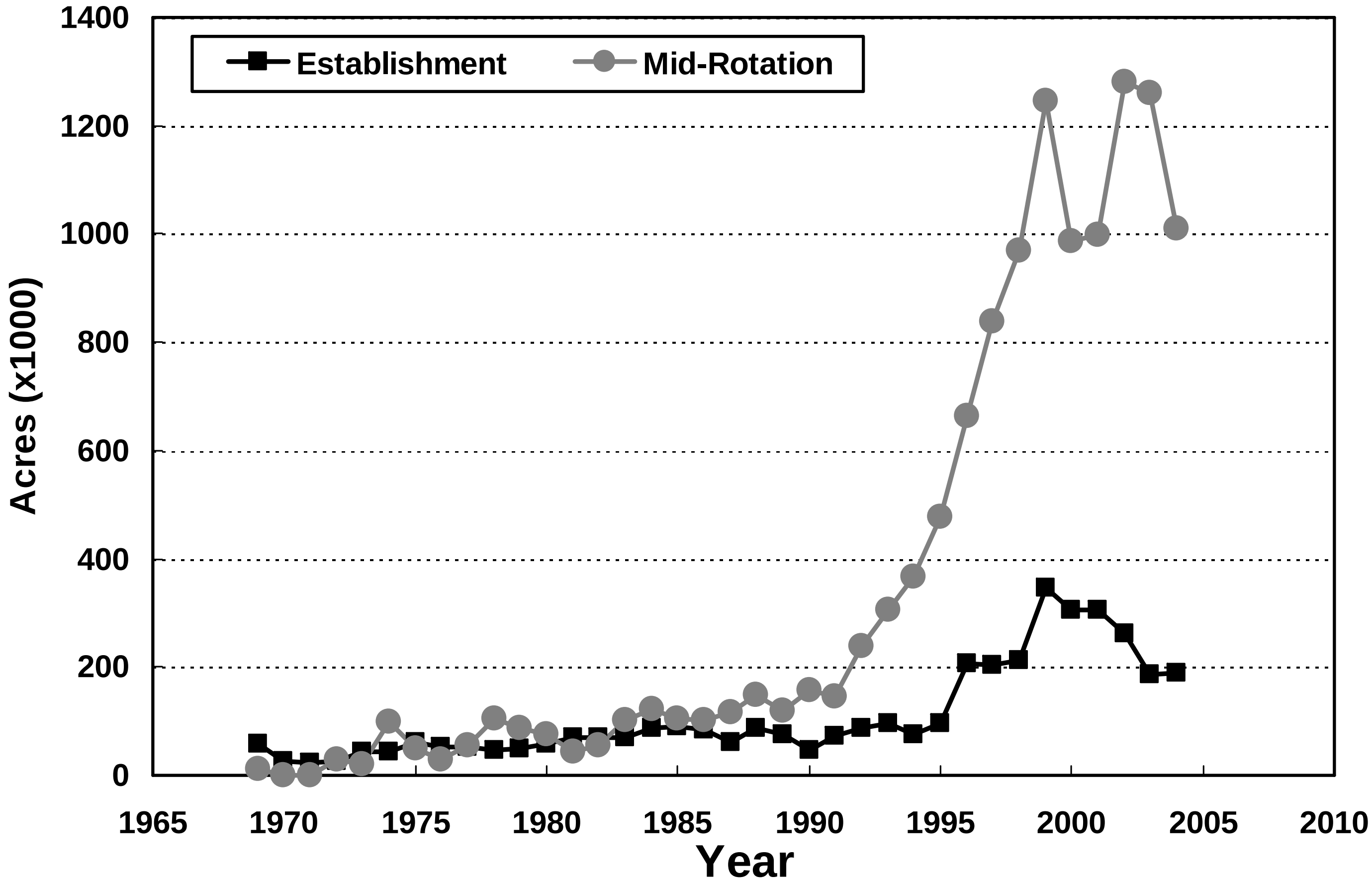

Forest Fertilization History Southeastern U.S.

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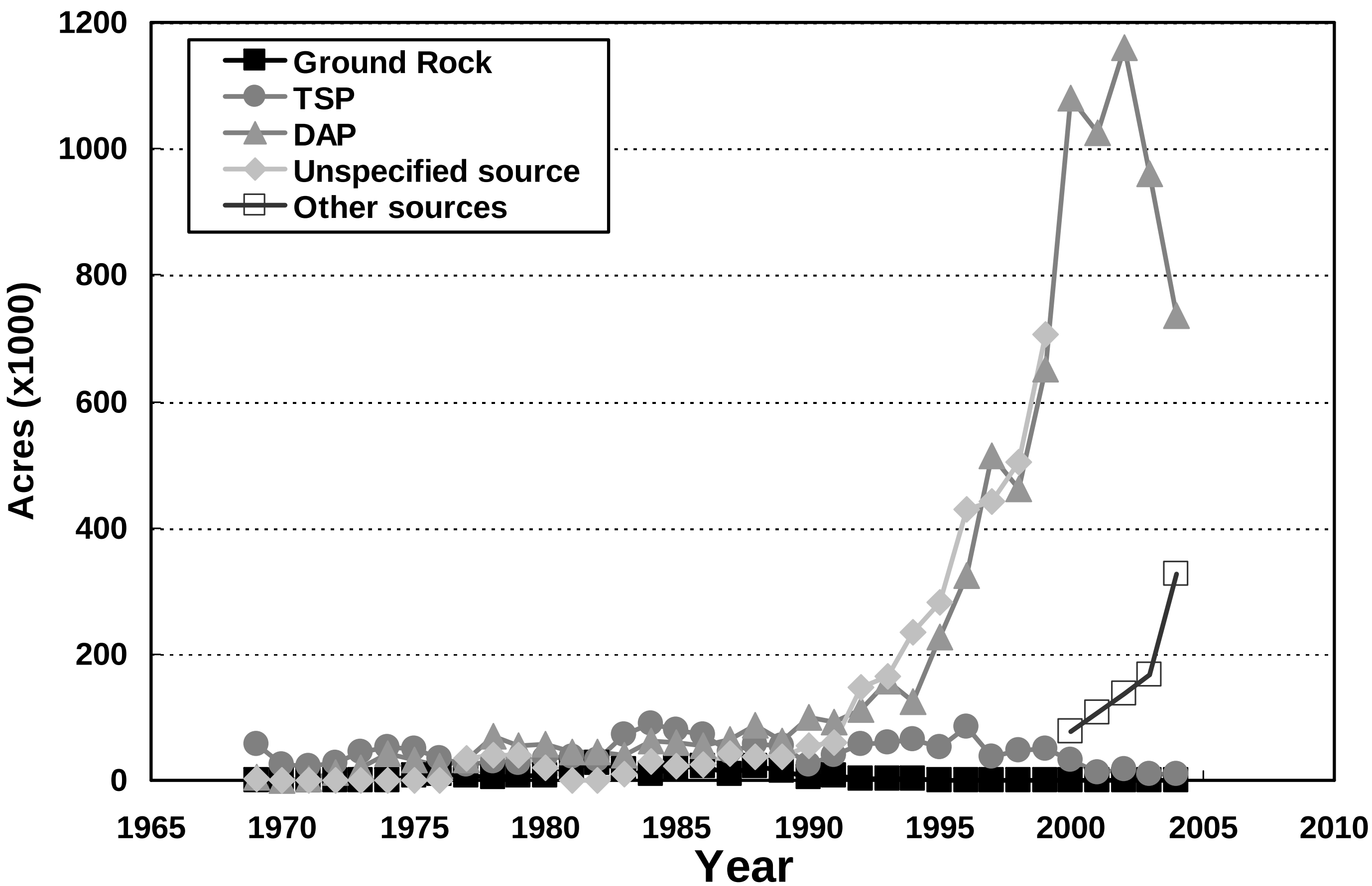

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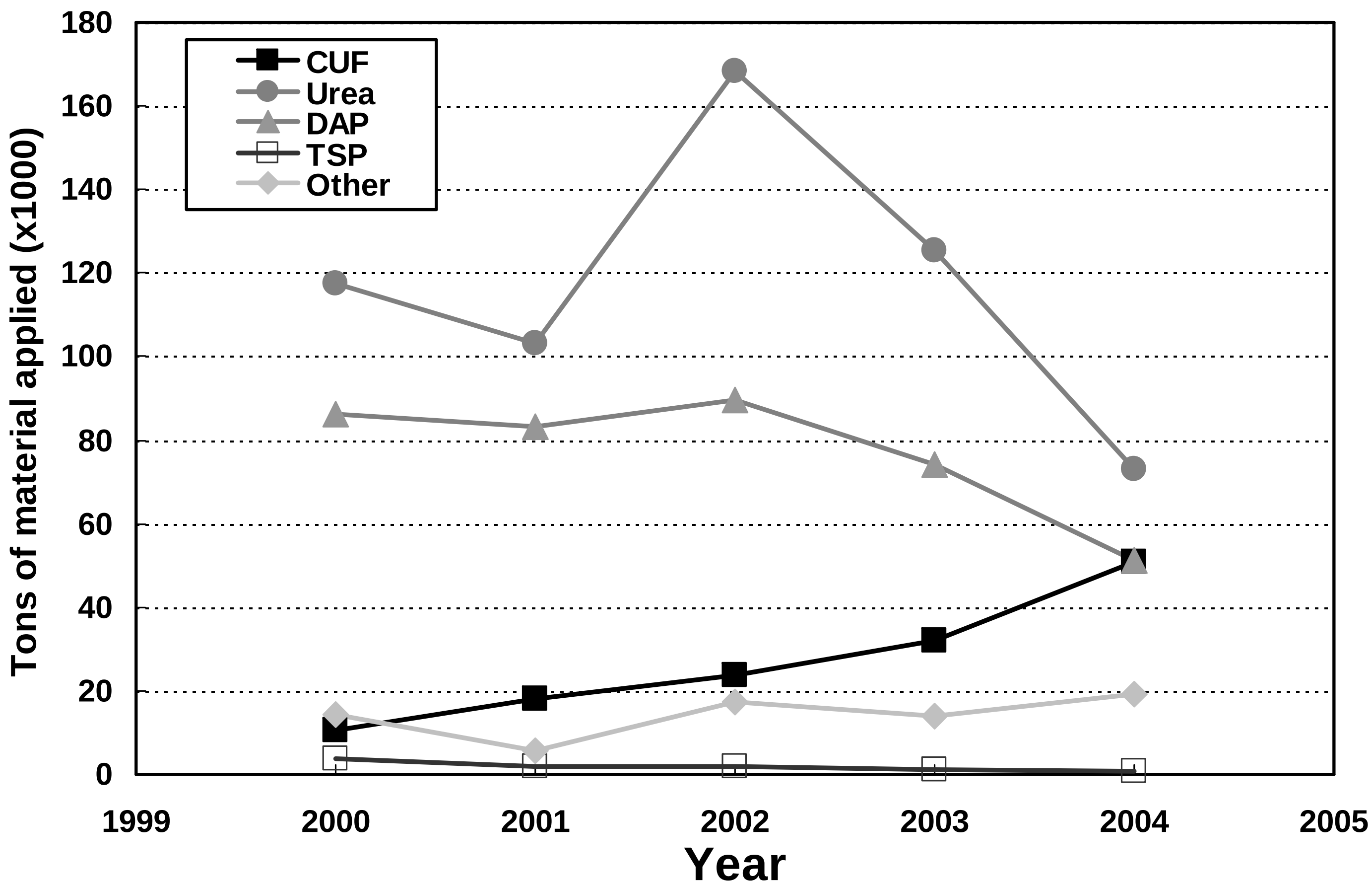
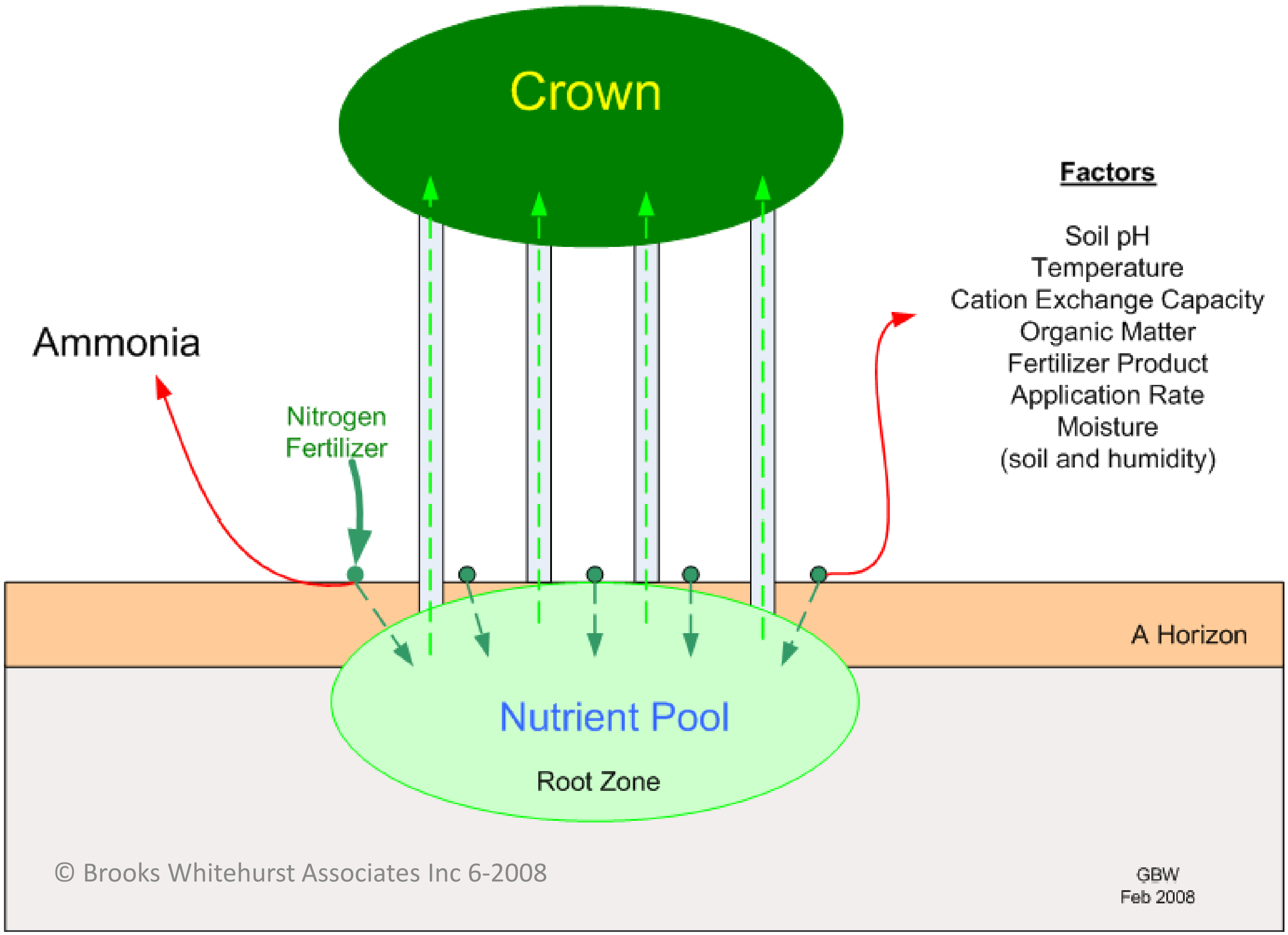


Forest Nutrition Cooperative

- More information: http://www.forestnutrition.org
- *Historical Patterns of Forest Fertilization in the Southeastern United States from 1969 to 2004, 2007,* Timothy J. Albaugh, H. L. Allen, and Thomas R. Fox, South. J. Appl. For. 31(3)129-137.
- From 1969-2004, 16 million acres fertilized.
- Acres fertilized doubled every 2 years from 1991 to 1999 after Region Wide 13 results became available.
- Peak of 1.59 million acres fertilized in 1999.
- Fluctuation of annual acres fertilized related to fertilizer cost and product values.

Economic Growth Responses

Volatility of Nitrogen

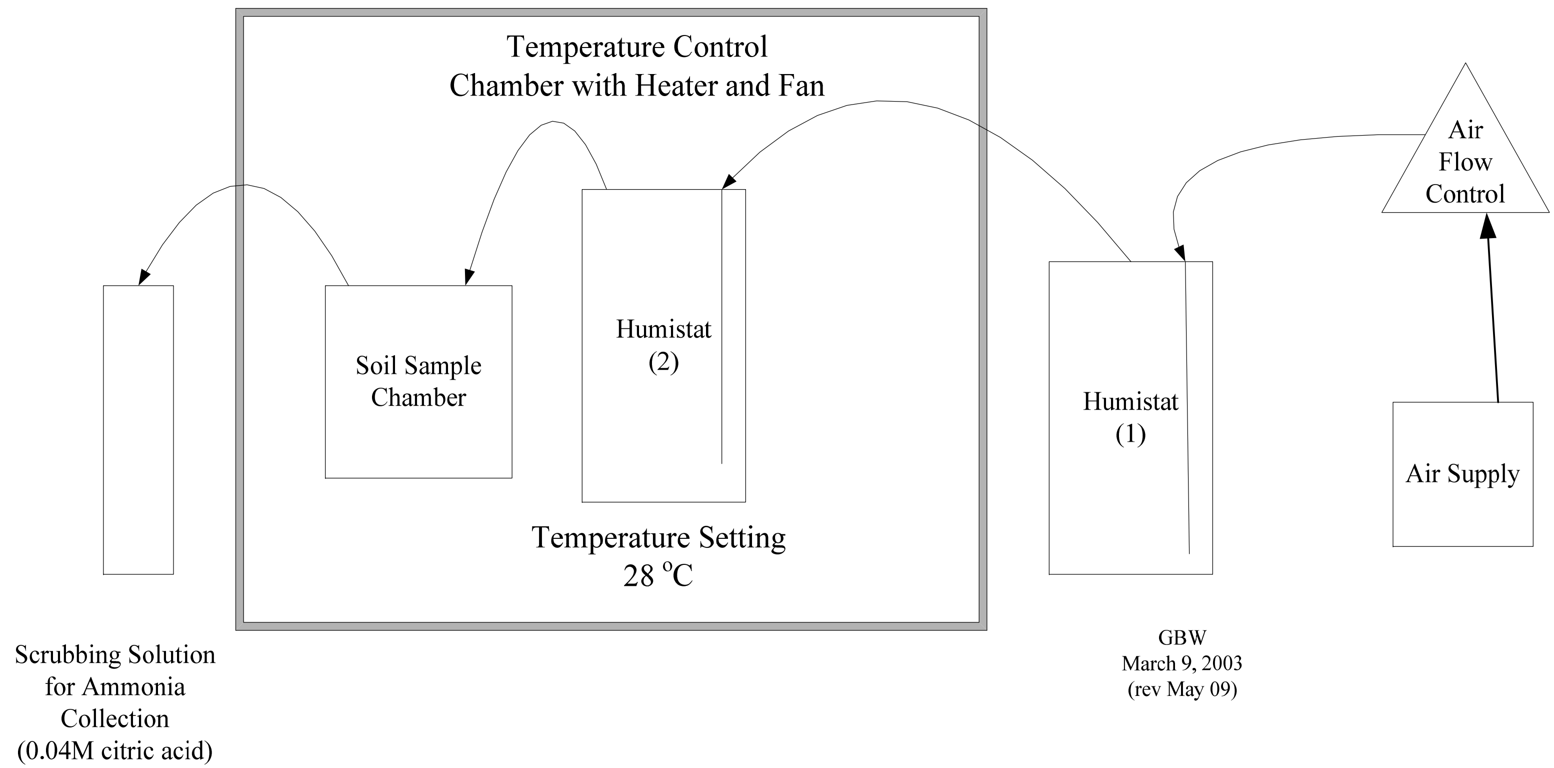


Volatility Testing

- Collect ammonia released after a fertilizer sample is placed on soil
  - Control soil moisture (15% - 18%)
  - Control temperature (28 °C or 82 °F)
  - Control humidity of air above soil
    - Moisture saturated air
  - Soil pH is not directly controlled but is the pH of whatever soil is being tested

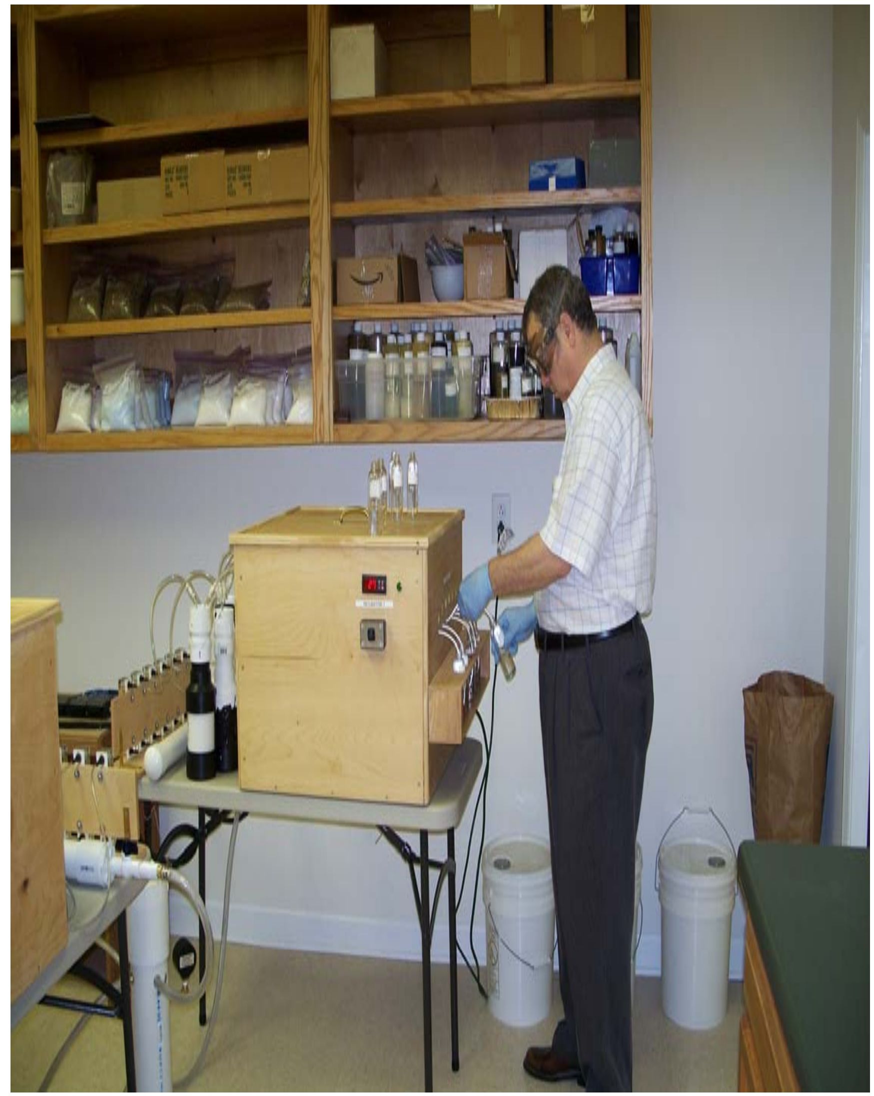
Flow Diagram for Volatility Measurements

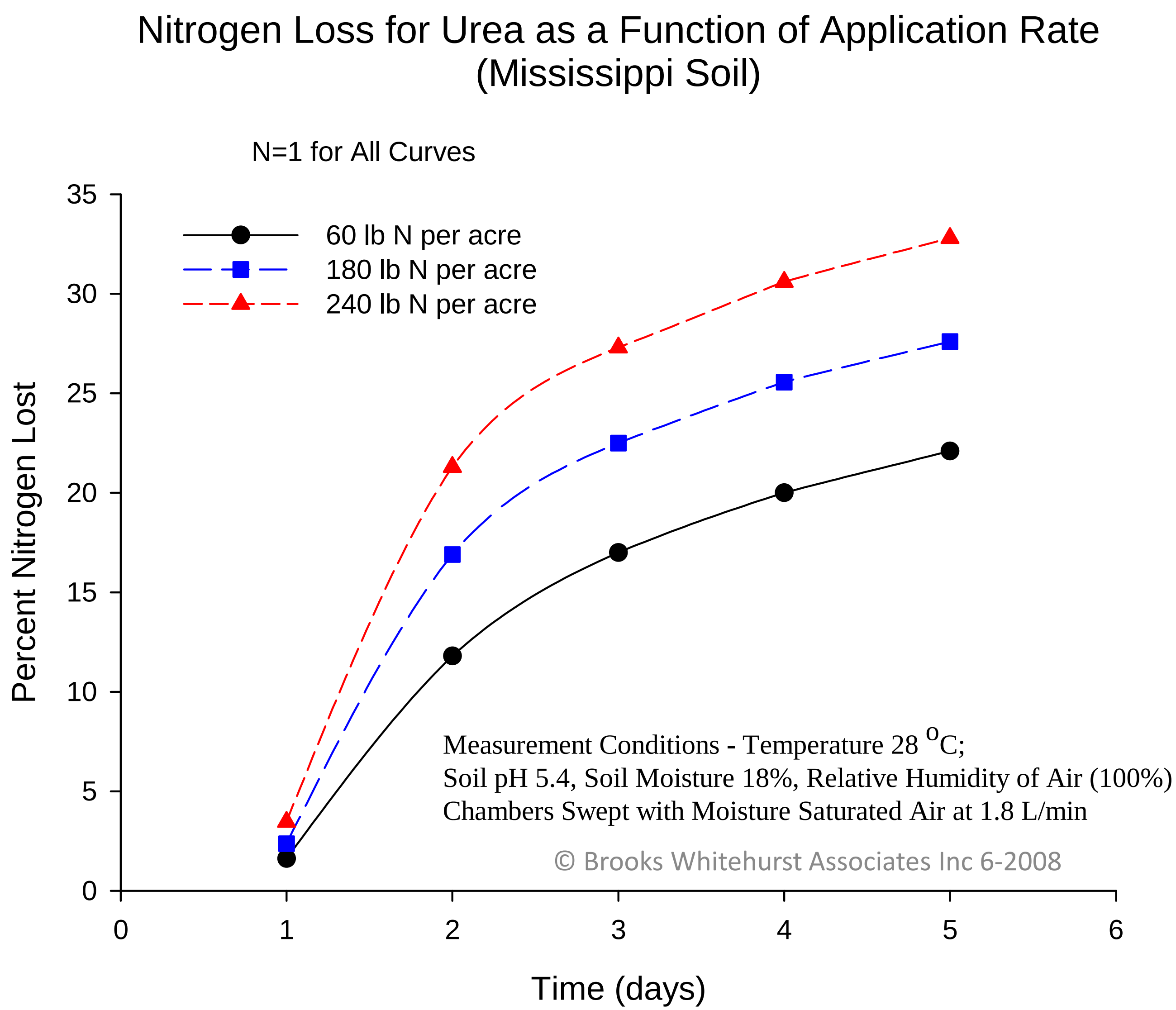
For High Humidity Conditions Distilled Water is Used in Humistats 1 and 2



Analytical Procedure

- Study is started by placing a sample of fertilizer on the hydrated soil
- Air is passed through soil chamber and collected in an acid solution
- The ammonia scrubbing solution is replaced at timed intervals
  - 12 to 24 hours
  - Test length varies from 2 days to 14 days
- *Ammonia content of the scrubbing solution is measured using an ion selective electrode for ammonia*




Nitrogen Loss for Urea as a Function of Application Rate
(Mississippi Soil)
N=1 for All Curves
60 lb N per acre
180 lb N per acre
240 lb N per acre
Percent Nitrogen Lost
0
5
10
15
20
25
30
35
0
1
2
3
4
5
6
Time (days)
Measurement Conditions - Temperature 28 °C;
Soil pH 5.4, Soil Moisture 18%, Relative Humidity of Air (100%)
Chambers Swept with Moisture Saturated Air at 1.8 L/min
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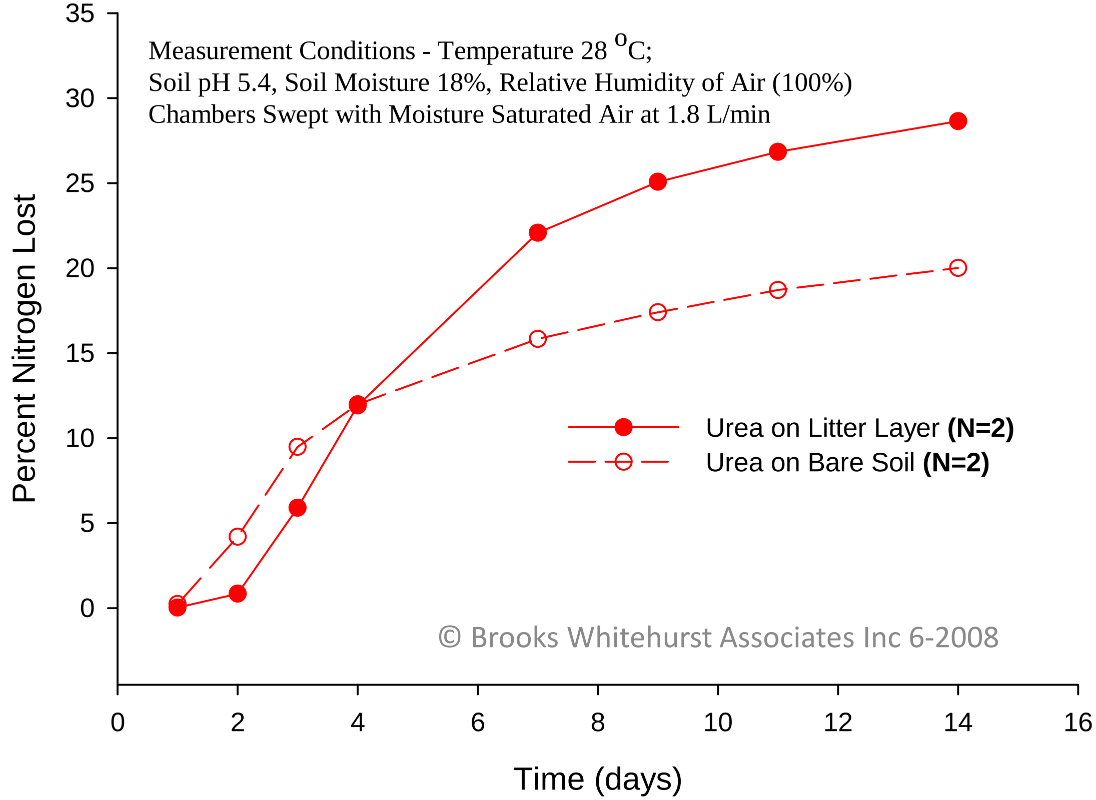
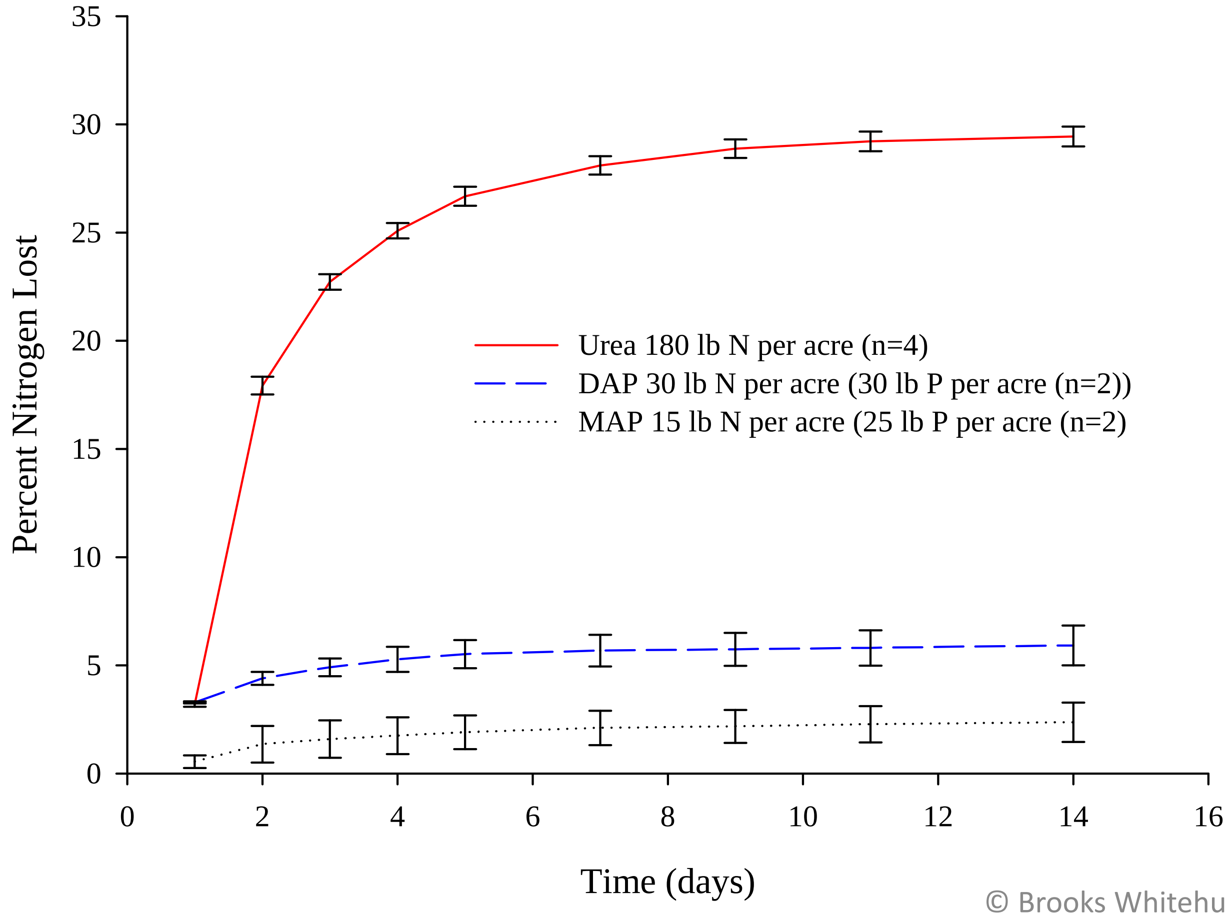
Nitrogen Loss for Urea
on a Simulated Litter Layer Above a Forest Soil
(Columbus Mississippi)

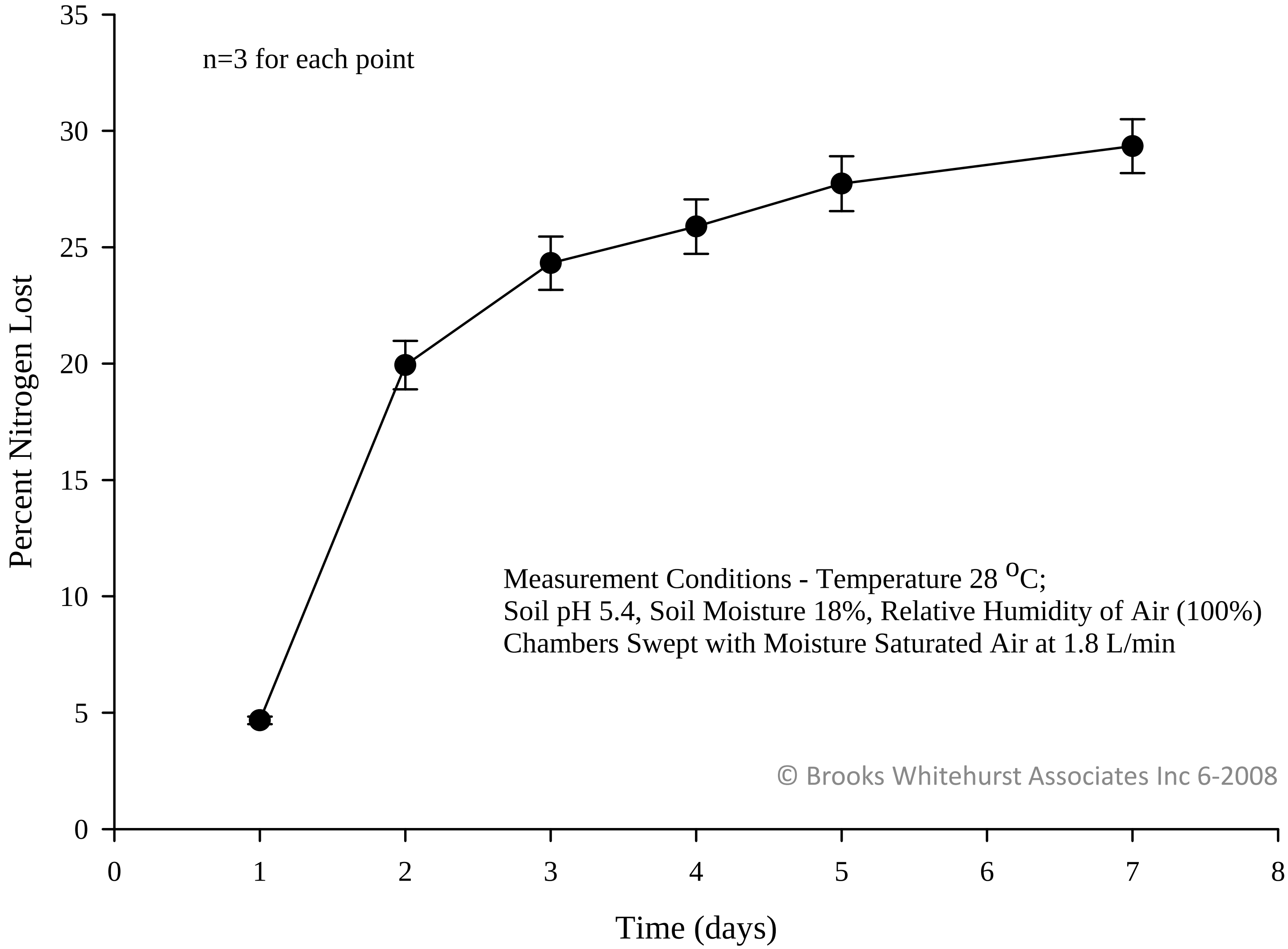


Cumulative Nitrogen Loss for DAP, MAP and Urea on a Mississippi Soil

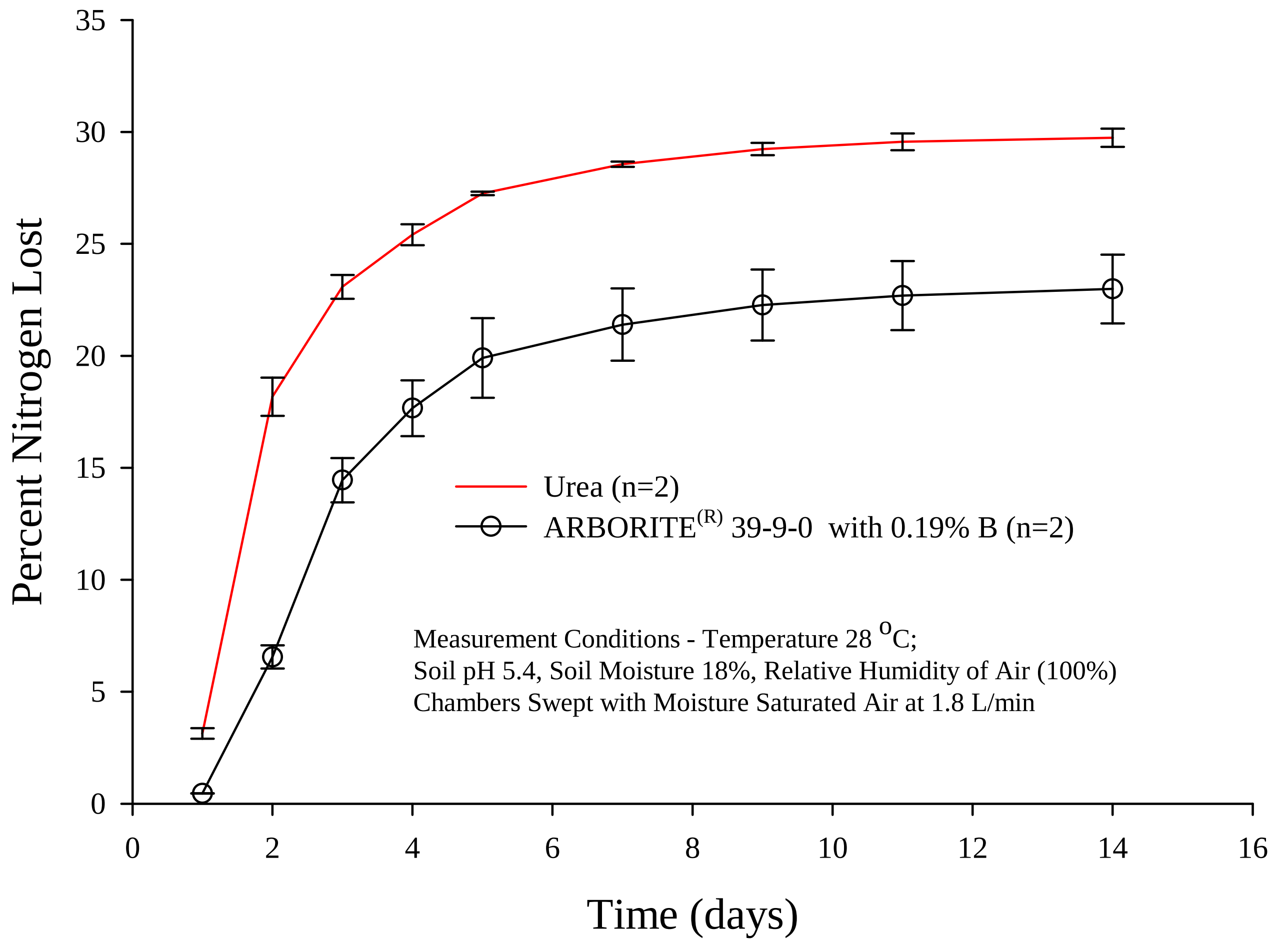


Measurement Conditions - Temperature 28 ^{o}C;
Soil pH 5.4, Soil Moisture 18%, Relative Humidity of Air (100%)
Chambers Swept with Moisture Saturated Air at 1.8 L/min

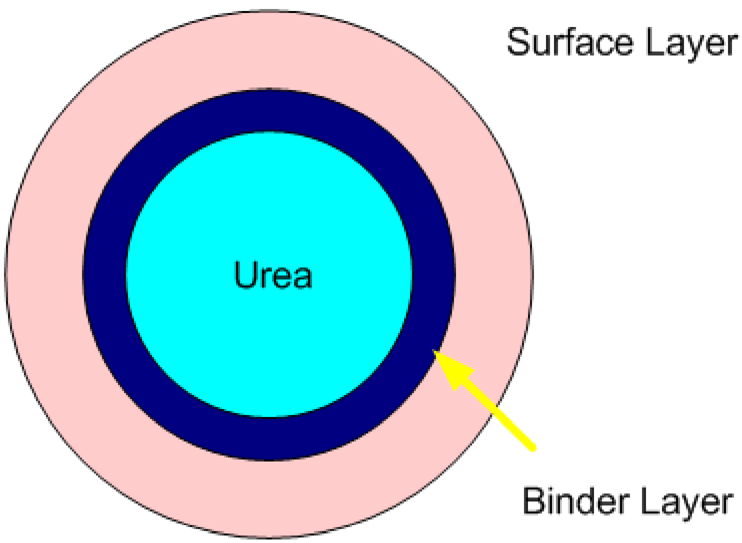
Cumulative Nitrogen Loss on a Mississippi Soil for A Blend of Urea and DAP
for a Fertilization Rate of 200 lb N per acre and 25 lb P per Acre



Cumulative Nitrogen Loss for Urea and ARBORITE(R) 39-9-0 on a Mississippi Soil when Applied at a Rate of 180 lb N per acre

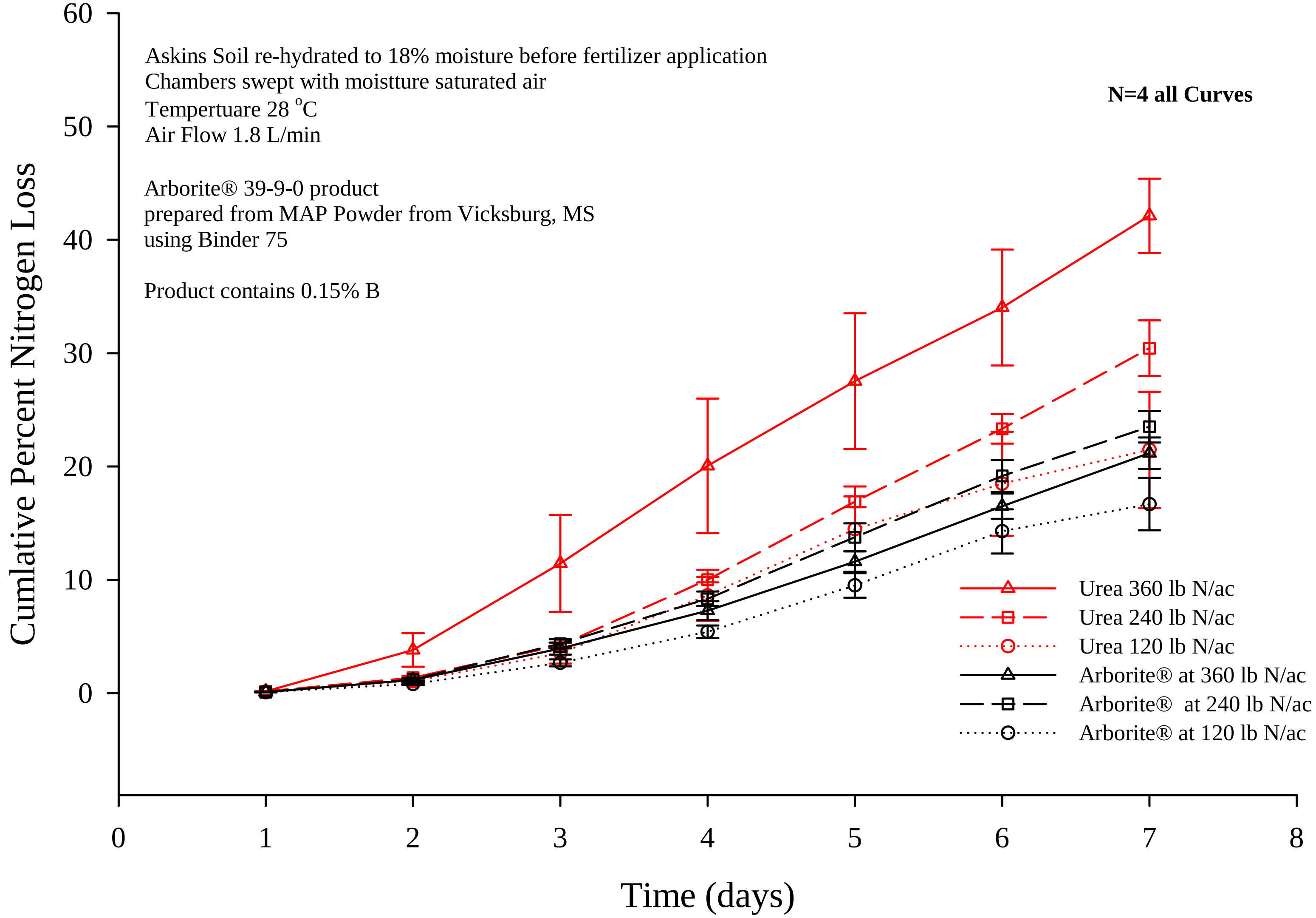


ARBORITE®
Phosphate Coated Urea

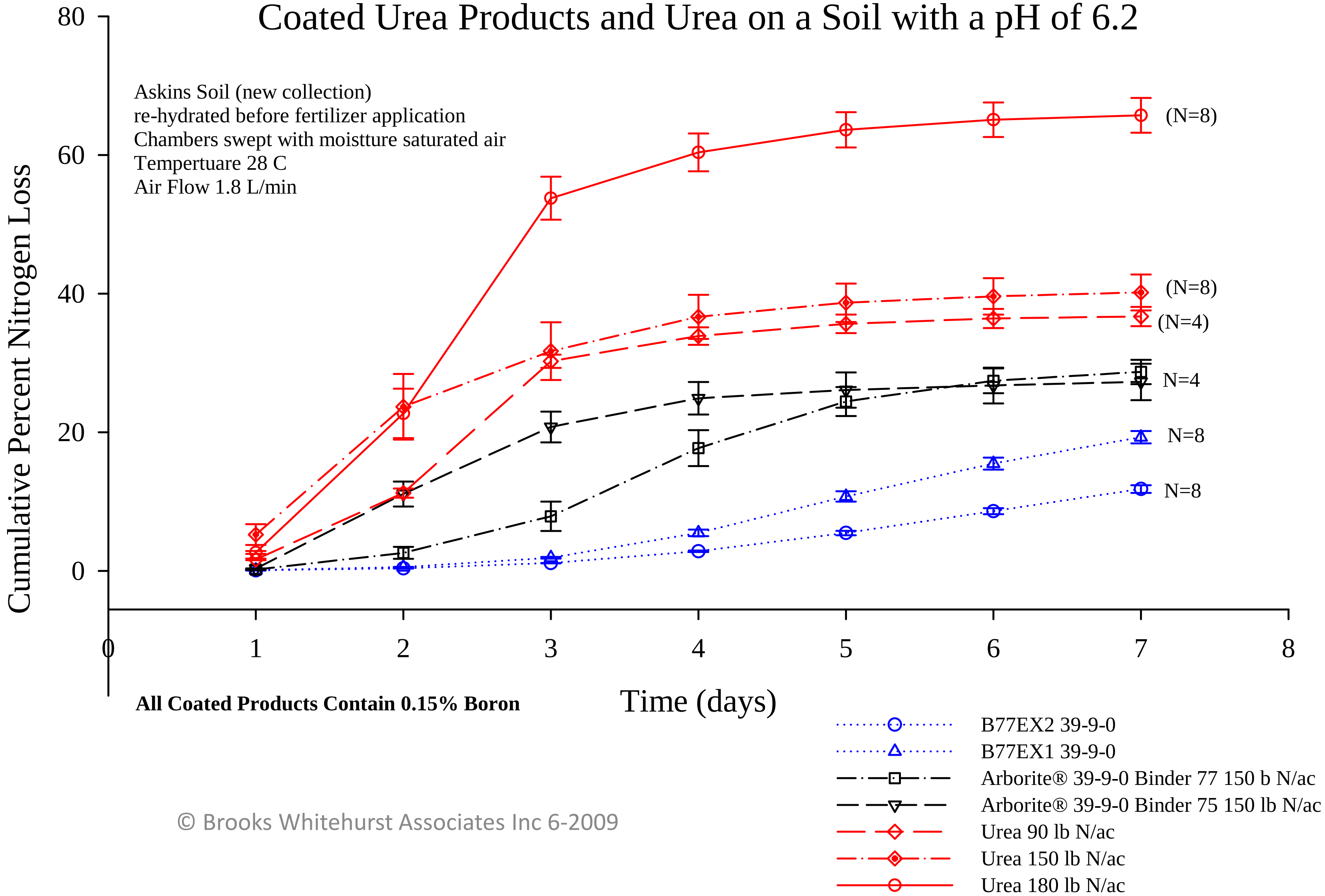


- Central particle is granular urea
- Binder is an aqueous mixture of a boron compound and copper sulfate which acts to partially inhibit urease
- External layer is a phosphate source such as MAP

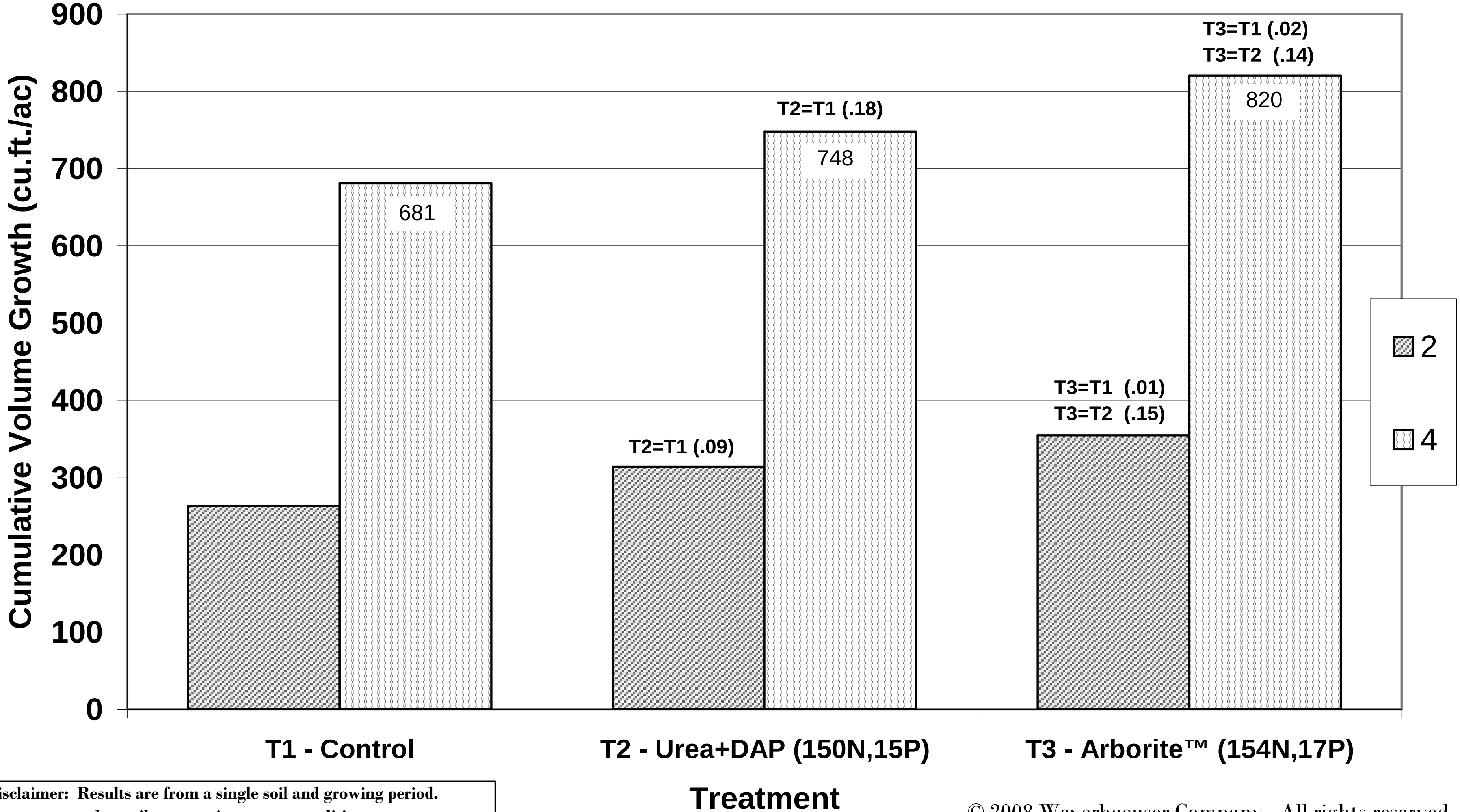
Nitrogen Loss for Urea and Arborite® 39-9-0 on a Soil with a pH of 6.4 as a Function of Nitrogen Application Rate



Cumulative Nitrogen Loss for Various Phosphate Coated Urea Products and Urea on a Soil with a pH of 6.2



Volume Growth 2 and 4 Years After Treatment at Weyerhaeuser's Scooba, MS Test
No treatment (control) vs Urea+DAP vs Arborite™ [Coated Urea Fertililizer]
P>|t| for H_0:Ti=Tj are shown above each bar for within year comparisons



Disclaimer: Results are from a single soil and growing period. Response on other soils or growing season conditions may vary.

Summary

- Forest Nutrition Cooperative and internal Weyerhaeuser Company research since 1970 have established the value of fertilization in plantation forestry.
- A peak of 1.59 million acres was reached in 1999 with 16 million acres fertilized between 1969 and 2004.
- Tons of Arborite® coated urea fertilizer applied have increased since 2000 while urea/DAP tons have fluctuated with price levels.
- Urea nitrogen volatility loss in plantations was identified as a significant cost of fertilization in the early 1990's.
- Weyerhaeuser Company, Brooks Whitehurst Associates and EnCee Chemical Sales developed Arborite® coated urea fertilizer as a forestry product with N, P, and B and volatility control.
- Our laboratory analytical procedure for volatility measurement produces consistent, repeatable results under dynamic, controlled conditions.

Summary

- Percent Nitrogen loss increases with N rate.
- Percent N loss increases with forest floor compared to bare ground.
- Percent N loss from urea and DAP can be 30% in seven days.
- Arborite® can lower percent N loss by a third from 30% to 20% under the same conditions..
- Higher pH (6.2) soils can have increased N loss, up to 60%.
- Experimental Arborite® formulations can reduce losses by 60% under these conditions.
- The Scooba, MS trial provides an example of volume growth benefit from the volatility control, single granule, and boron effects of Arborite®.
- Application of this coating technology to agricultural crops is currently being tested.
- The delivery of a volatility controlled urea with additional nutrients in a single granule has biological and economic benefits.