Absorbent Technology

2006 Fertilizer Outlook & Technology Conference

Tampa, FL – November 3

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Spectrum Brands, Inc.

St. Louis, MO USA

On behalf of NFT Industries, LLC

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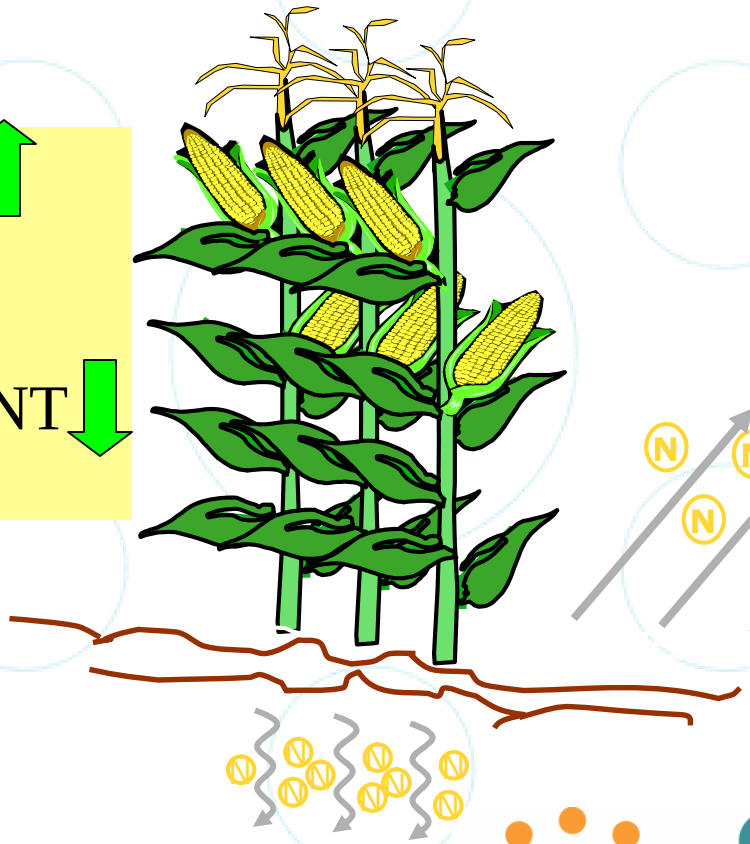
2006 Fertilizer Outlook & Technology Conference

- EFFICIENCY ↑
- YIELD ↑
- ENVIRONMENT ↓



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Absorbed Fertilizer – Nurea®

- Research started in January 2000 at ACT
- Developed absorption w/blockers technology
- Granular nutrient delivery system
  - Target: Extended release fertilizer for homeowner market
  - Optimize nutrient availability
  - Efficient release of nutrients
  - Minimize loss to the environment
  - Economically viable for Agricultural

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NUREA® HISTORY

Concept

Paradigm shift in the way we look at extended release, or enhanced-efficiency fertilizers

- Identify absorbent materials w/ greatest capacity for absorption.
- Identify materials to delay the release of the absorbed nutrients.
- Identify nitrogen source.

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NUREA® TECHNOLOGY

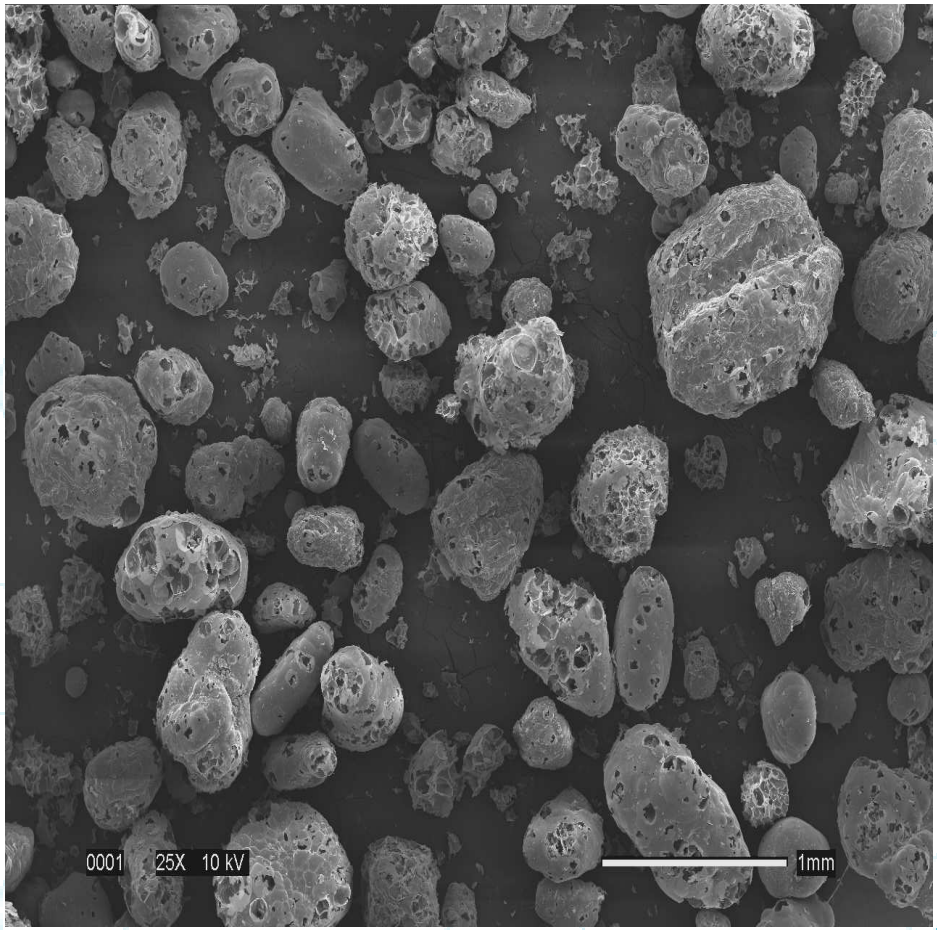
Determine absorbent material

Perlite

Capacity to absorb 20x its own weight

Natural volcanic glass

(hydrated obsidian) – Distinctive concentric cracks and a relatively high water content.



SEM Raw Perlite

Wayne Robarge, NC State 2001

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NUREA® TECHNOLOGY

Identify mechanism to delay release

- Assessed synthetic and natural hydrogels
- Evaluated natural starches:
  - Wheat, Potato, Corn, Rice.

Determine nitrogen source

- Must be in a fluid state
- Molten urea provided best opportunity for success

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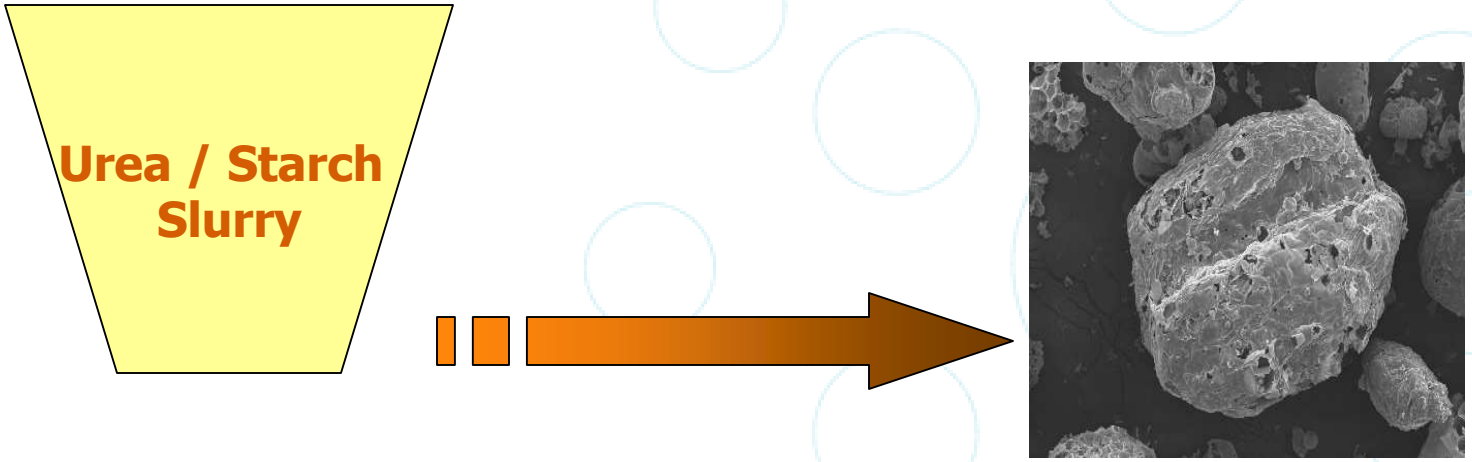
NUREA® TECHNOLOGY

Determine Absorption Process

Develop process to get urea-starch matrix into perlite



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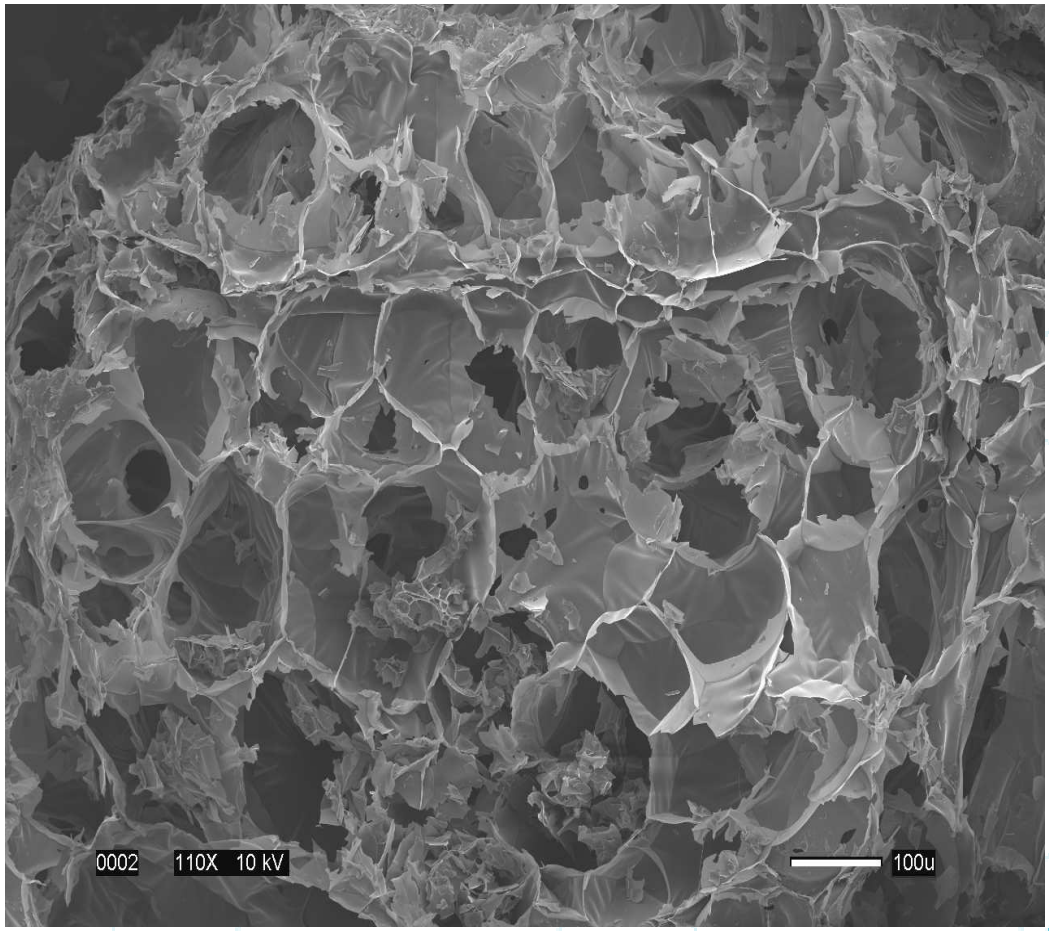
NUREA® TECHNOLOGY

Exfoliated Perlite

- Developed steam process to remove outer shell exposing inner fissures.
- Steam collapses when the perlite is brought in contact with urea solution forming a vacuum.



SEM Exfoliated Perlite

Wayne Robarge, NC State 2001

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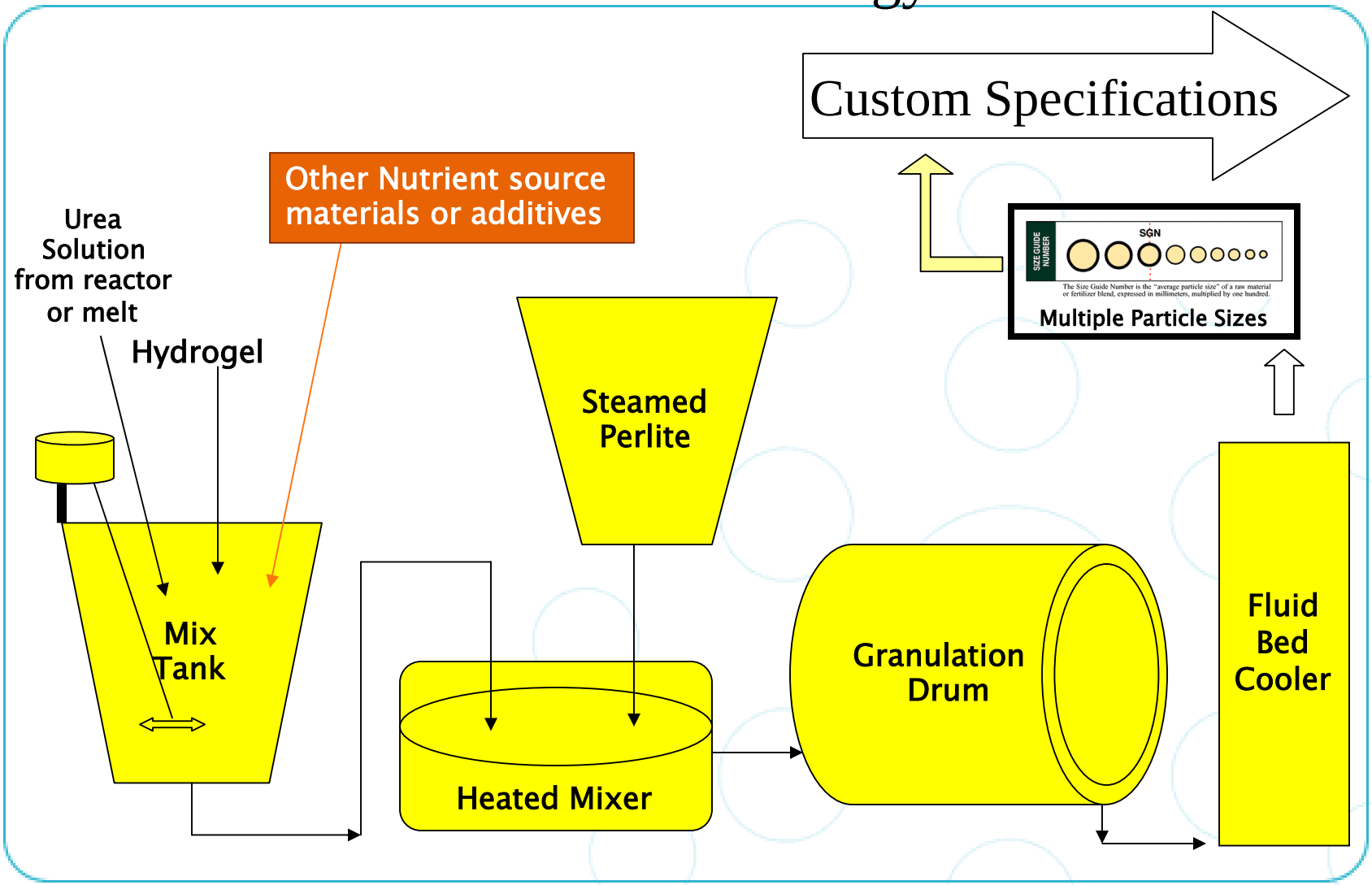
Flexible Technology

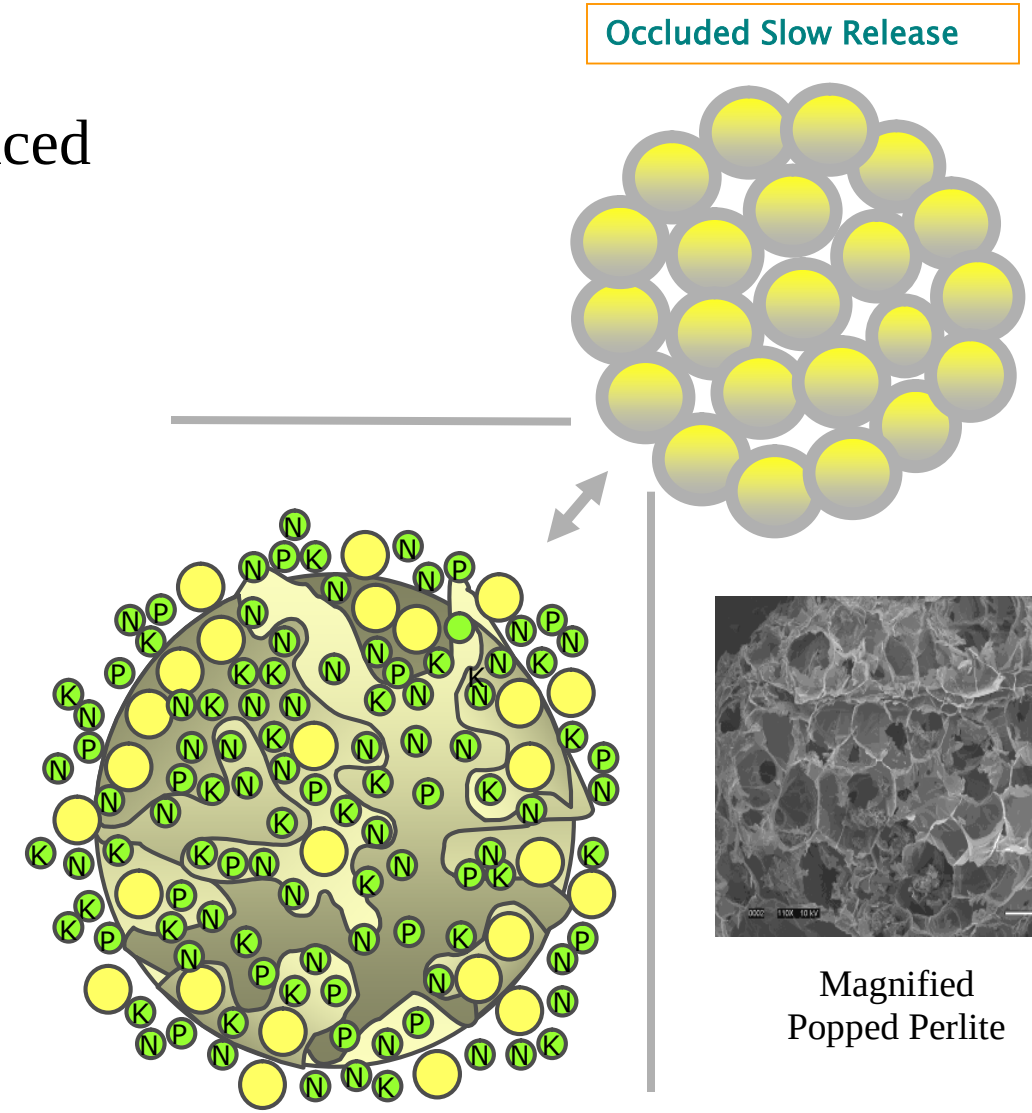


- Nutrient matrix is introduced into popped Perlite
  - Absorbed in Cavities
- Micro Particles of Perlite Agglomerated into One
  1. Outer Area = Quick Release
  2. Inner Area = Extended Release

U = Urea + Nitamin™ Matrix

CS = Natural Polymer

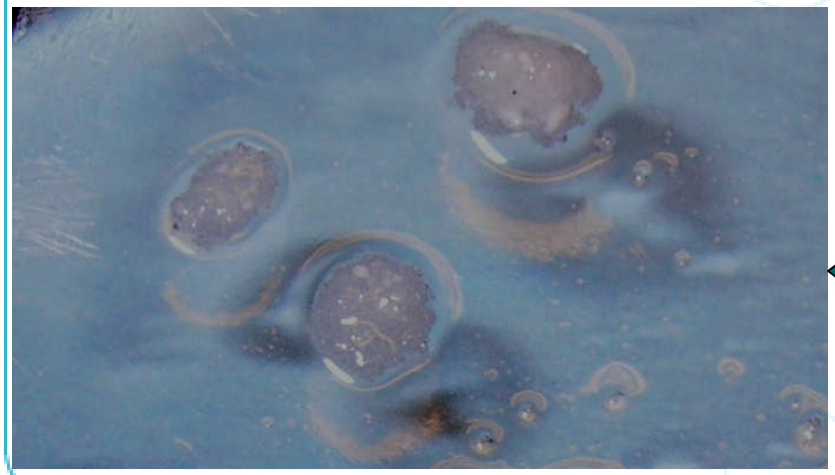
= Perlite



Magnified
Popped Perlite

NUREA®

As Manufactured



Formation of Gel
when
exposed to water

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Absorption Determination - IFDC

- **Quantify how well pores are filled in Nurea process**
  - **Accomplished by calculating POROSITY**
  - **Calculate porosity before and after absorption process**

Porosity: A measurement of the pore space within a granule

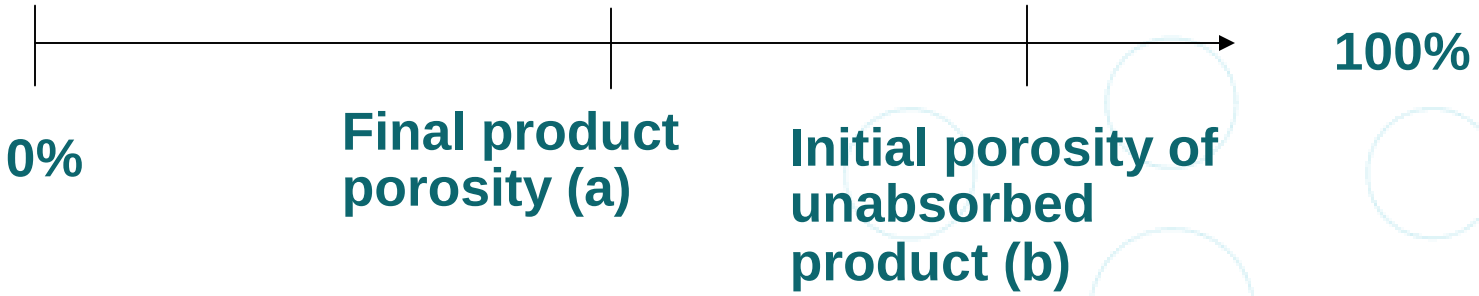
Apparent Density only accounts for space inside the granule

True Density – sample ground < 300 microns to collapse any voids, so porosity is equal to 0%.

$$\text{Porosity, \%} = (T_d - A_d / T_d) \text{ X } 100$$

Where T_d = true density, g/cm^3, and A_d = apparent density, g/cm^3

Absorption Determination - IFDC



Porosity Scale: % of pore volume filled = (b–a / b) X 100

Using the percent of each component in formula (by analysis), the amount of N in the pore volume can be determined.

The % absorbed N / Total N of product = % N absorbed

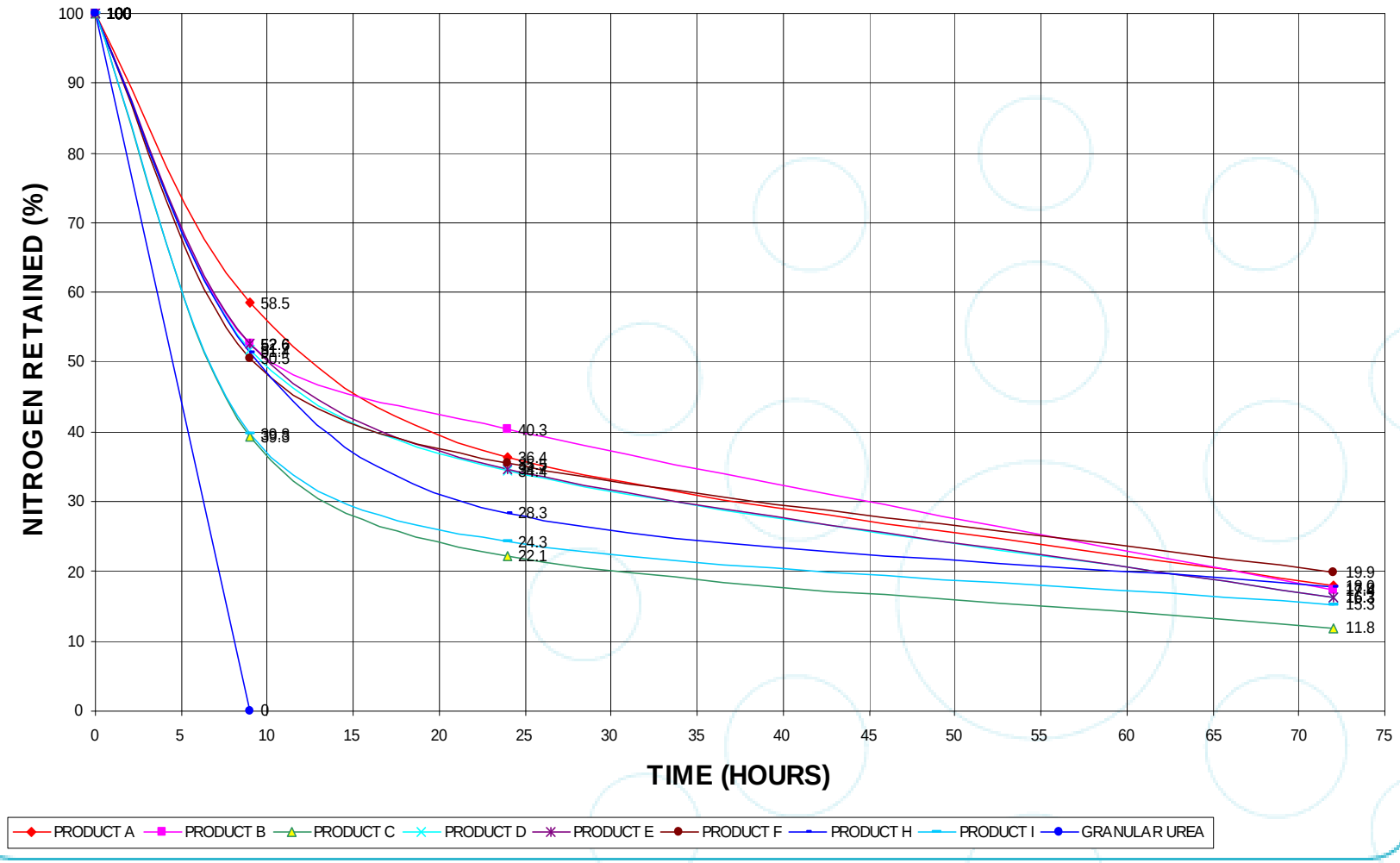
Pilot plant range = 30 % ➡ 50 % absorbed N

Research & Development

Soil Incubation

- 300 g potting soil (40% moisture)
- 5 g Nurea (2.8-3.35 mm) in wire mesh
- Add 150 g potting soil
- Mist with 4 g DI water
- Measure N remaining after 9, 24, 36 hours

ACT Soil Incubation Test Release Curves



Research & Development

Florida: N – 500 Method

- **3 g sample in chromatography column**
- **250 ml of DI water**
- **Circulate water through sample for 2 hours using proportioning pump**
- **Analyze extract for N**

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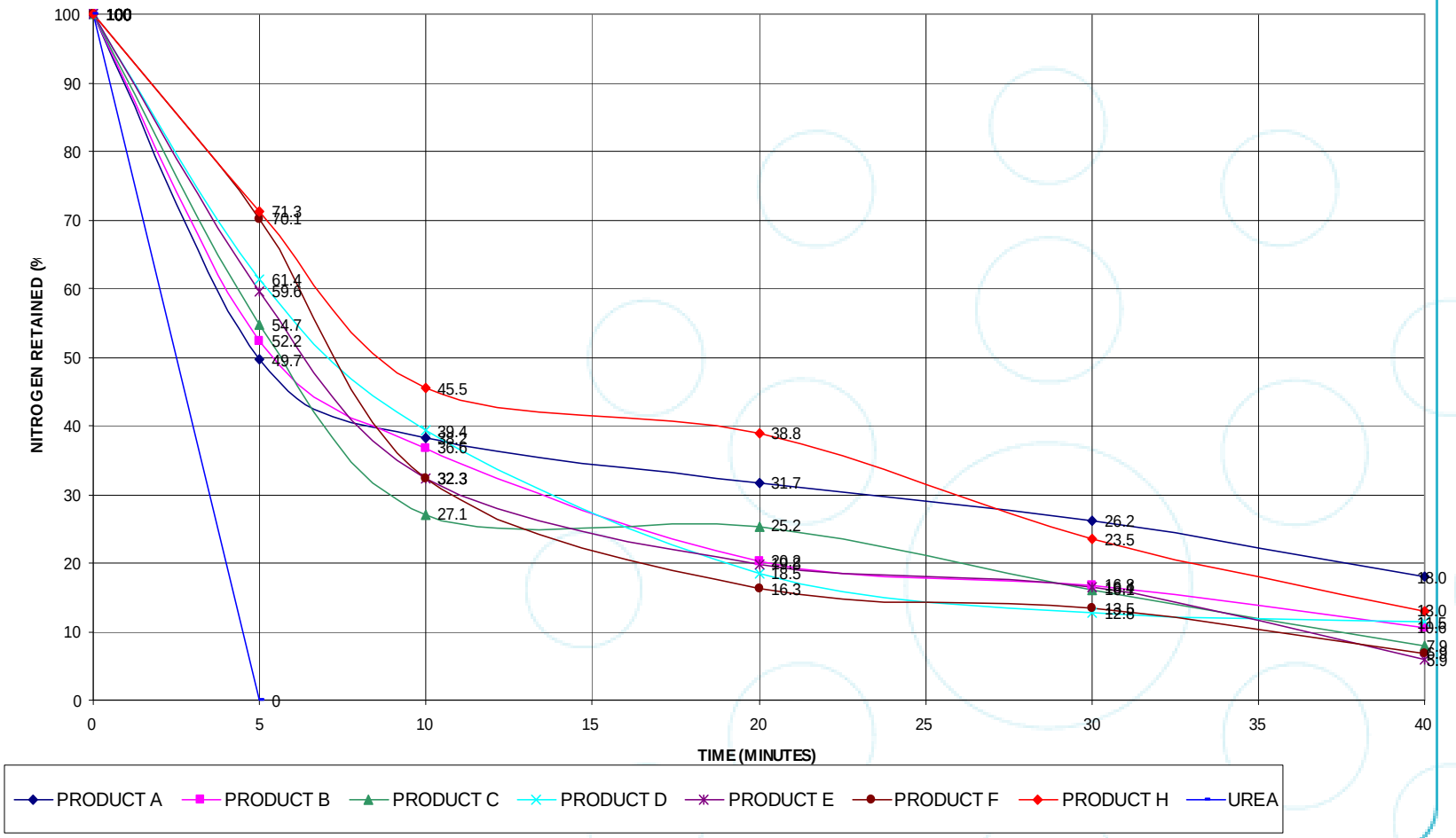
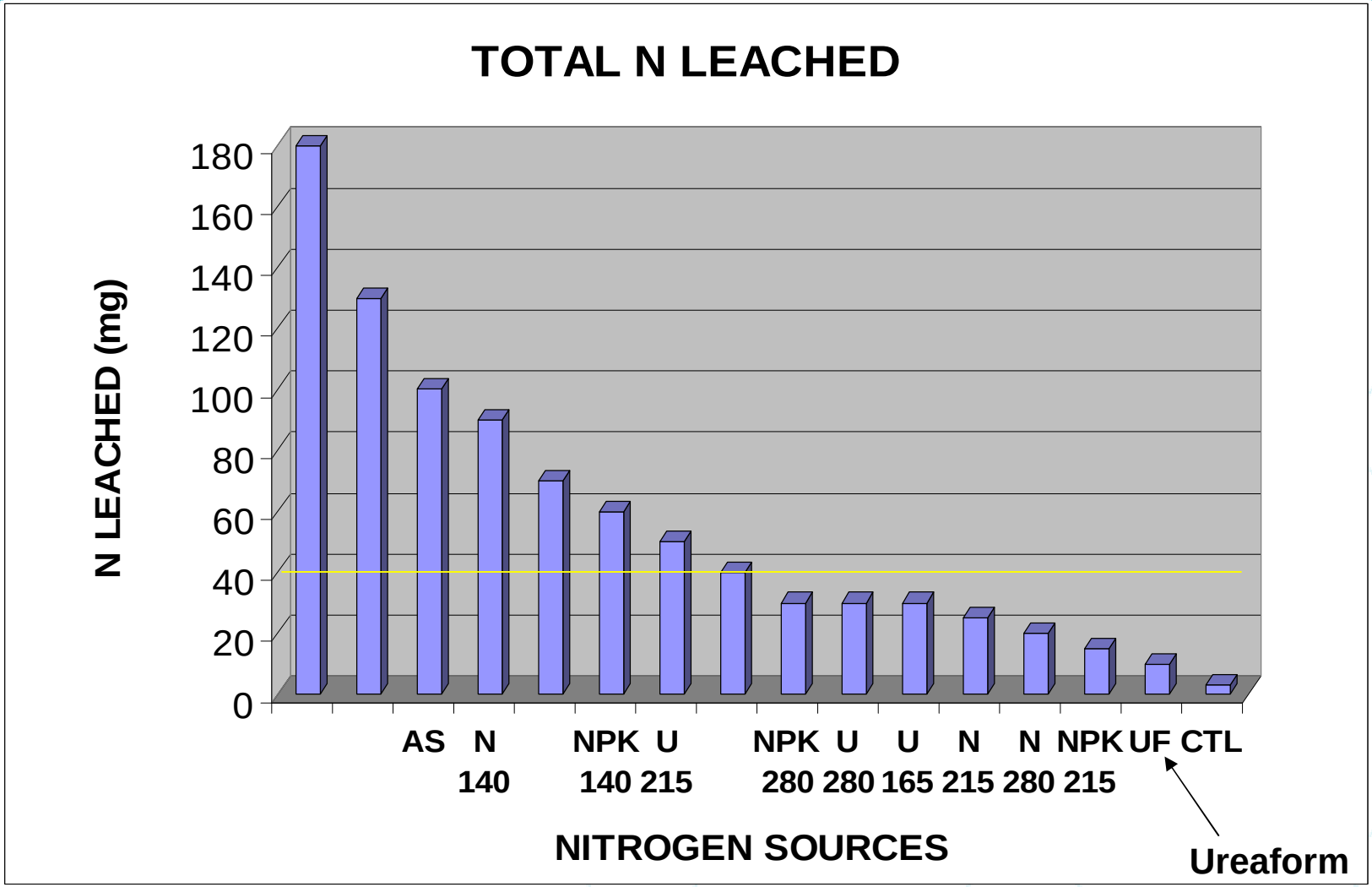
METHOD N-500 COLUMN TEST RELEASE CURVES



Environmental Fate – Sartain 2004



Greenhouse temperature at 90 – 92 °F.

Zero P found in leachate; K followed N sources.

N = Nurea NPK = Nurea NPK

NUREA™ research on Turf I

2001 University of Arkansas (Dr. James A. Robbins), Little Rock, AR
"Fertilizer Rate Study – Nurea Trials for Turf Grass"
2001 University of Arkansas (Dr. James A. Robbins), Little Rock, AR
"Fertilizer Burn Study – Nurea Trials for Turf Grass"
2001 Auburn University (Dr. Elizabeth Guertal), Auburn, AL
"Nurea Burn Study"
2001 Auburn University (Dr. Elizabeth Guertal), Auburn, AL
"Nurea Turfgrass Color Rating Study"
2001 University of Wisconsin-Madison (Dr. Wayne R. Kussow), Madison, WI
"Performance of Experimental Nitrogen Sources [Nurea] on Kentucky Bluegrass"
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"Performance of Experimental Nitrogen Sources [Nurea] on Kentucky Bluegrass"
2001 Michigan State University (Dr. Kevin W. Frank), Lansing, MI
"Nurea Trials – Color and Quality"
2001University of Arkansas (Dr. Douglas Karcher), Fayetteville, AR
"Nurea Fertility Trials"
2001North Carolina State University (Dr. Charles Peacock), NC
"Nurea Fertility Trials"

NUREA® research on Turf II

2003 The University of Wisconsin (Dr. Wayne R. Kussow), Madison, WI

"Tolerance Testing – Assessment of Safety at 2.0 to 6.0 lbs. N/1,000 sq. ft. on Kentucky Bluegrass/Ryegrass"

2003 The Pennsylvania State University (Dr. Max Schlossberg), University Park, PA "Nitrogen Source and Rate Evaluation on Bentgrass Fairway"

2003 The University of Georgia (Dr. Clint Waltz), Griffin, GA "Tolerance Testing – Assessment of Safety at 2.0 to 6.0 lbs. N/1,000 sq. ft. on Tall Fescue"

2003 Auburn University (Dr. Elizabeth A. Guertal), Auburn, AL "Field Lysimeter and Leaching of Nurea N source"

2003 Michigan State University (Dr. Kevin Frank), East Lansing, MI "Nitrogen Source and Rate Evaluation on Kentucky Bluegrass/Ryegrass Turf"

2003 Texas A&M University (Dr. James A. McAfee), Dallas, TX "Nitrogen Source and Rate Evaluation on Bermudagrass Turf"

2003 TrueGreen ChemLawn (Dr. Mark Prinster), Douglasville, GA "Nitrogen Source and Rate Evaluation on Tall Fescue and Bermuda Turf"

2003 University of Florida (Dr. John Cisar), Ft. Lauderdale, FL "Nitrogen Source and Rate Evaluation on St. Augustine Turf"

2003 University of Florida (Dr. Jerry B. Sartain), Gainesville, FL "Growth Response Study"

2003 North Carolina State University (Dr. Charles Peacock & Wayne Robarge), Raleigh, NC "Field Volatilization/Leaching Studies"

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AAPFCO Definitions

Absorbent Technology

T – 56 Absorbent – A material having the capacity to take into its mass a second substance.

T – 57 Hydrogel – A colloidal gel in which water is the dispersion medium.

T – 58 Absorbed Fertilizer – A fertilizer that has been taken into an absorbent material.

AAPFCO

Rule 3 b: …(3) occluded slow release, where fertilizers or fertilizer materials are mixed with waxes, resins,or other inert materials and formed into particles…

Search for other ways to enhance release rate…

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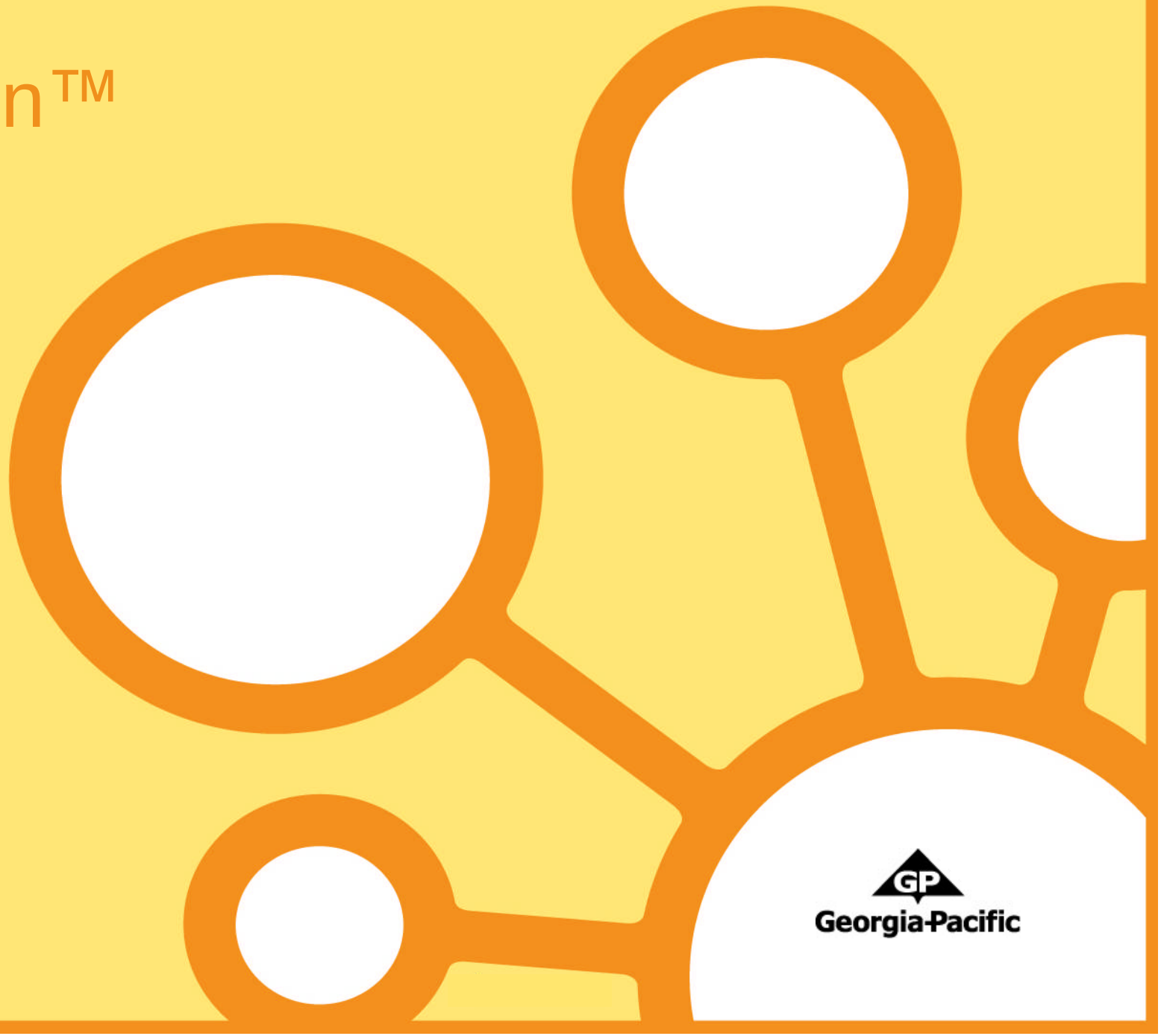
nurea

Nitamin™



nitamin™

GP
Georgia-Pacific

What is Nitamin™ 30L?

- Patented urea-based polymer
- Product Form – Liquid
  - 30% N water-soluble liquid
    - 30-40 % free urea
    - 25-30 % mono substituted ureas
    - 5-10 % di/tri substituted ureas
    - 20-30 % cyclic material

AAPFCO N-33 Triazone, N-35 Urea-Triazone Solution

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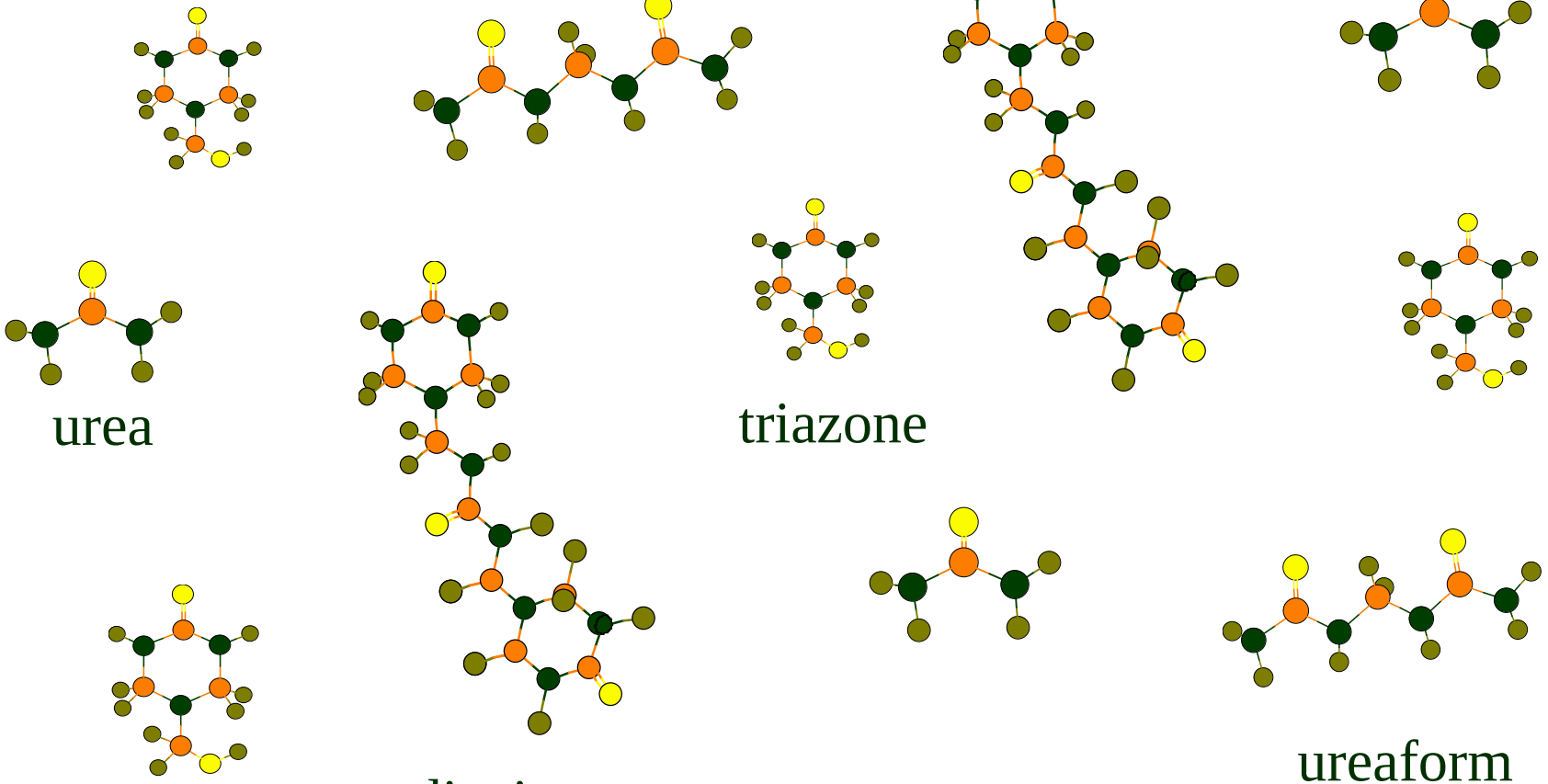
Nitamin 30L Structural Composition



The Nitamin Advantage

- Advantages are soil and climate dependent
  - Consistent with other enhanced-efficiency fertilizers
  - Fewer applications required
  - Lower N application rates
  - Stays in root zone
  - Reduced N leaching
  - Improved Nitrogen Use Efficiency (NUE)

Expectations for Nitamin™

- Trial results confirm efficacy
  - Yield improvements for some crops at reduced N rate
  - Nitrogen rates reduced by 25-30% and maintain yields
  - Single application at planting sufficient for some crops
  - Nurea-Nitamin Granular – Bulk Density 44-46 lb/Ft^3
    - Storage & handling characteristics similar to urea

Georgia-Pacific

Nitamin 30L and Nitamin Granular 2005 US Trials

Blue = Replicated research trials Red = Grower trial

Nitamin Granular - Tomatoes

Photos taken after 2 harvests.

3rd harvest taken from plots treated with Nitamin Granular.

Grower Standard

200 lb N - AN Drip over 12 wk

Nitamin Granular 30%

175 lb N - Preplant

Dr. Doug Sanders, NC State University, Asheville, NC 2005

Bell Peppers – 50 DAP

Nitamin 30L vs. Grower Standard

From right to left: 250 lbs N from Nitamin 30L, middle row 175 lb. N from Nitamin 30L, left row is 200 lb. N grower standard. No discernable growth differences.

Missing plants due to fertilizer burn in N/N 30% 250 lb. N treatment. Injury did not occur uniformly in all plots.

N/N 30% granular treatments from right to left – 250 lb. N, 175 lb. N and 125 lb. N.
All three treatments looked similar.

Dr. Doug Sanders, NC State University, Fletcher, NC 2005

Leaching Study at Auburn University

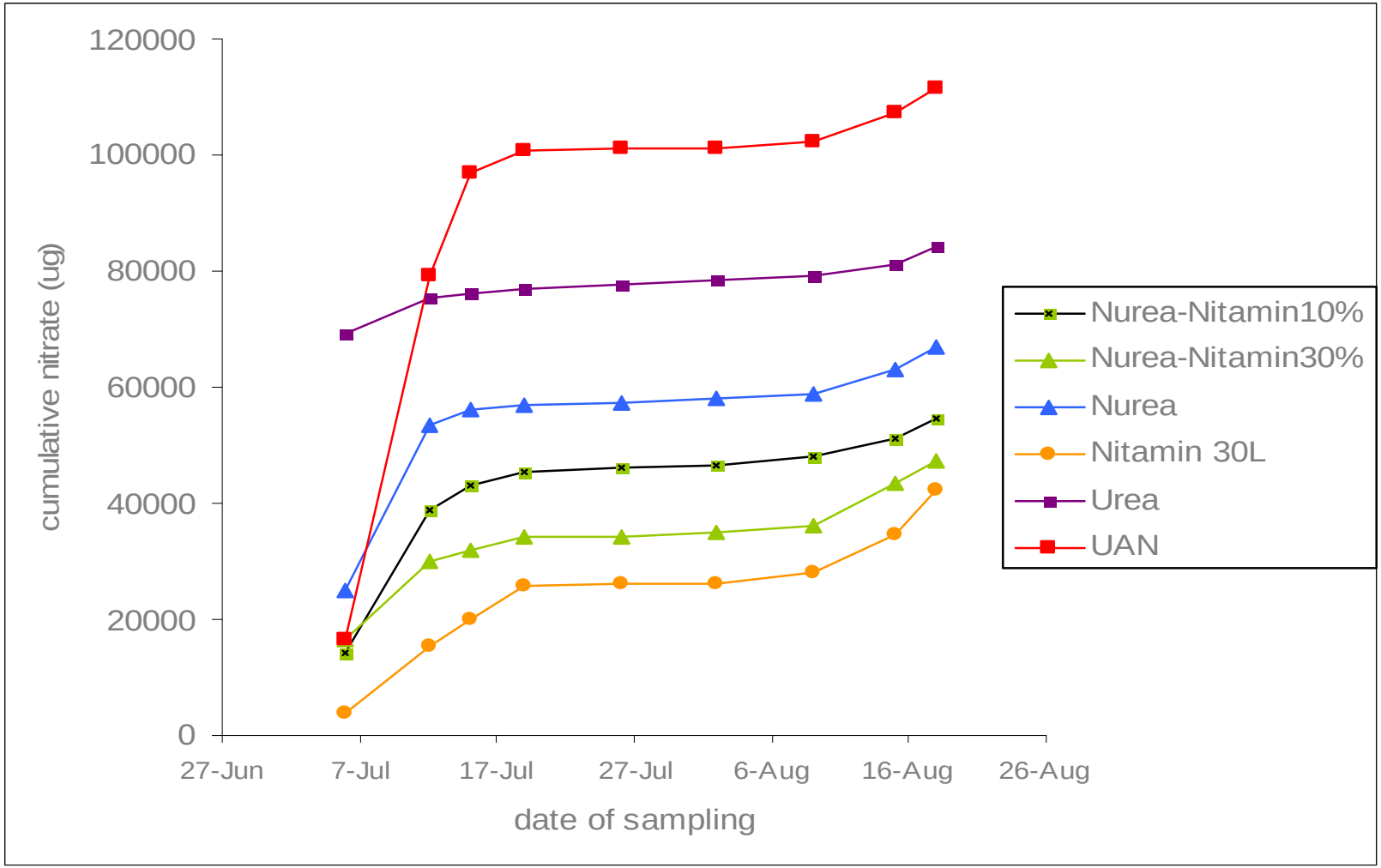
- Lysimeters drained to individual 5 gallon receivers
- Leachate collected at least once a week.

- Lysimeter Construction: Nalgene lined, 70 gal. container
- Filled with Marvyn loamy sand soil
- Tifway bermudagrass planted in and around them.

N rate of 3 lbs. N / M – All treatments

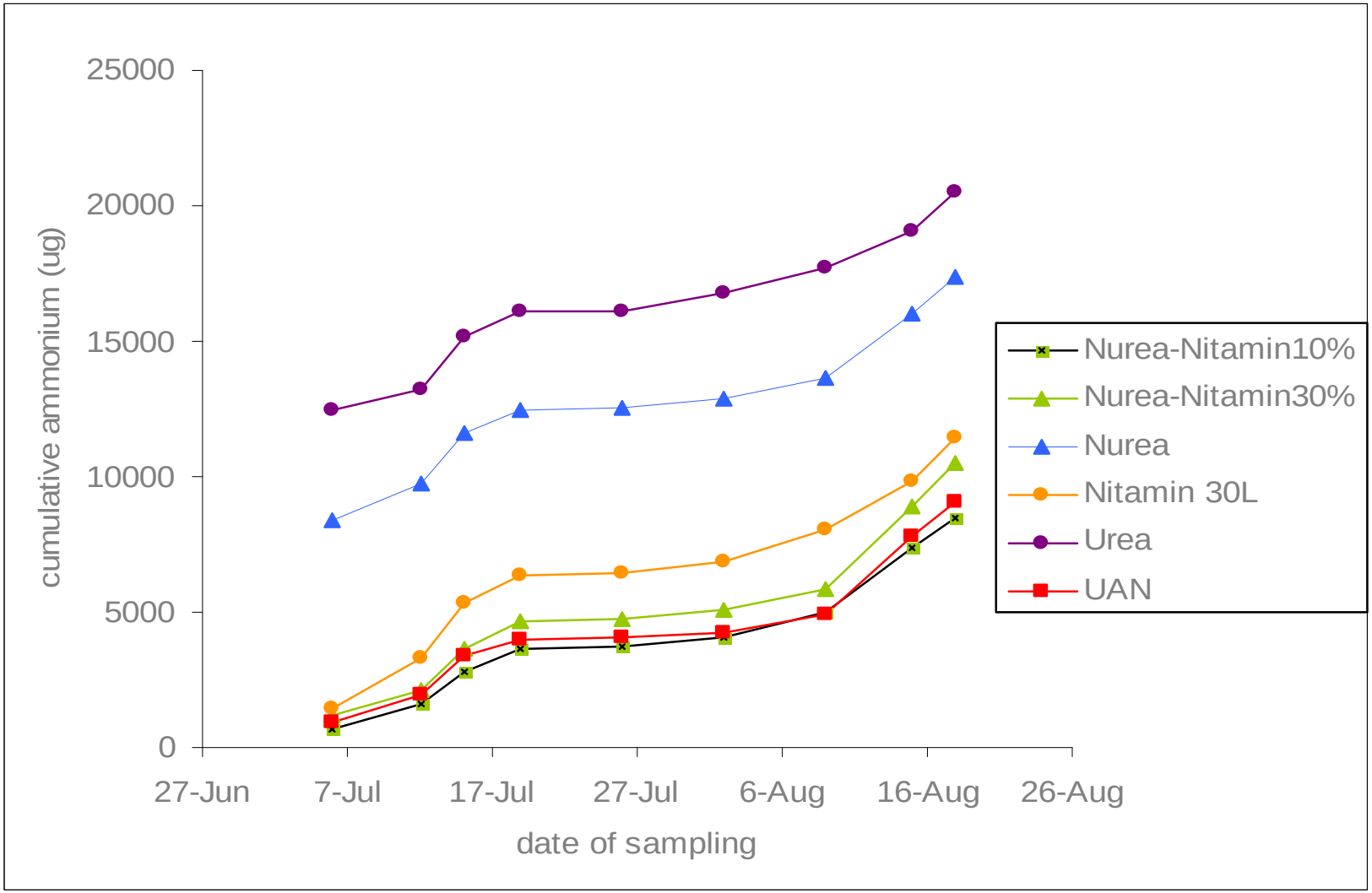
Dr. Elizabeth Guertal, 2005

Cumulative Nitrate Leached



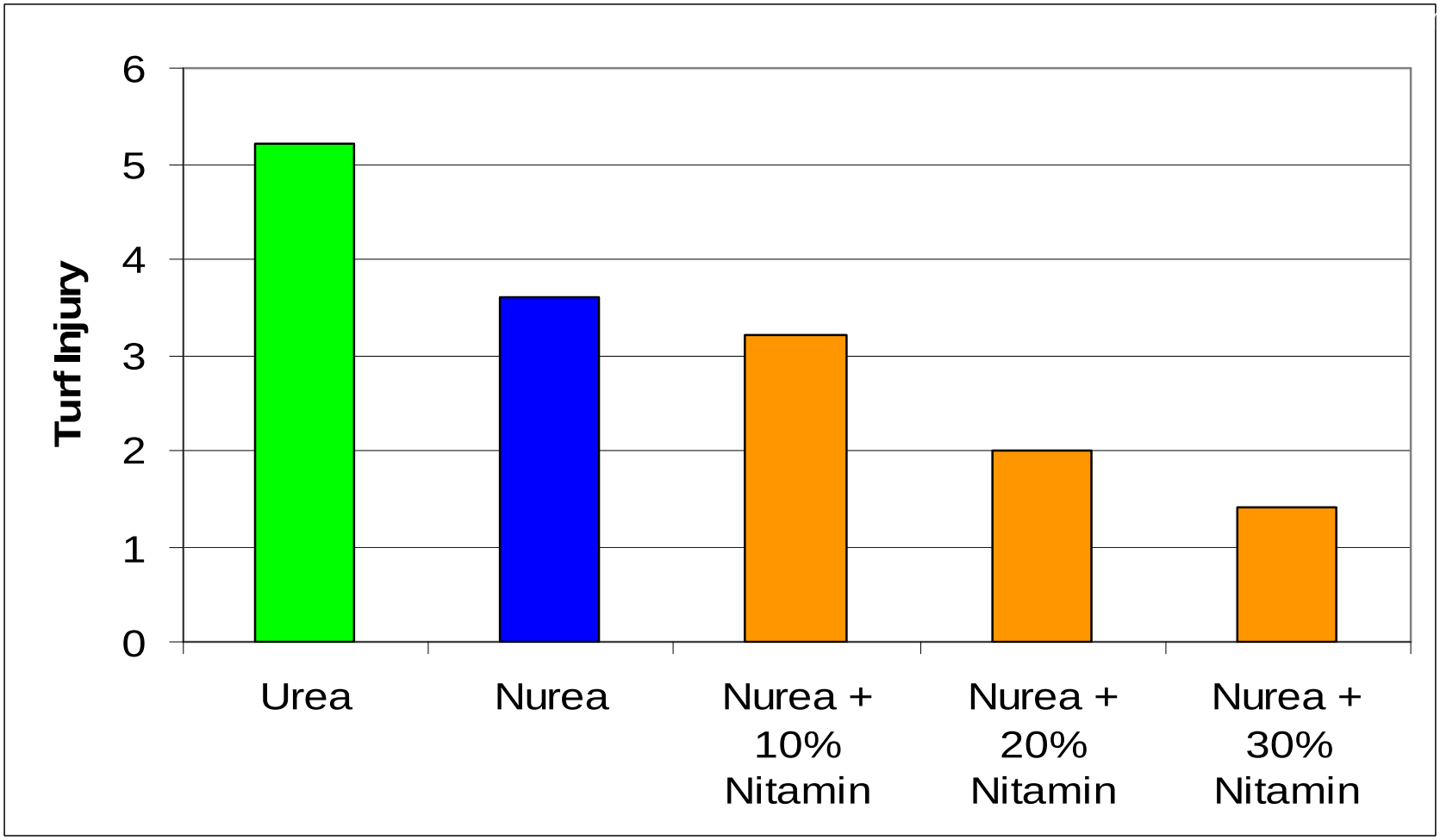
7 – Week Trial

Cumulative Ammonium Leached



7 – Week Trial

Fertilizer Tolerance of Kentucky Bluegrass
6 lb N/M Rated 2 DAT



Ratings (0-9): w/ 0 = no injury; 1 = slight tip burn; 5 = tip and whole leaf burn; 9 = all blades dead

Path Consulting, Rydal, Georgia, 2005

Enhanced-Efficiency Fertilizers

- Reduced Nitrogen loss to the environment
- Equivalent and/or improved yields with less N applied
- Ability to apply full Nitrogen loading in one application
- Economically viable for use in row crop Agriculture

Agriculture

Pro T & O

Specialty

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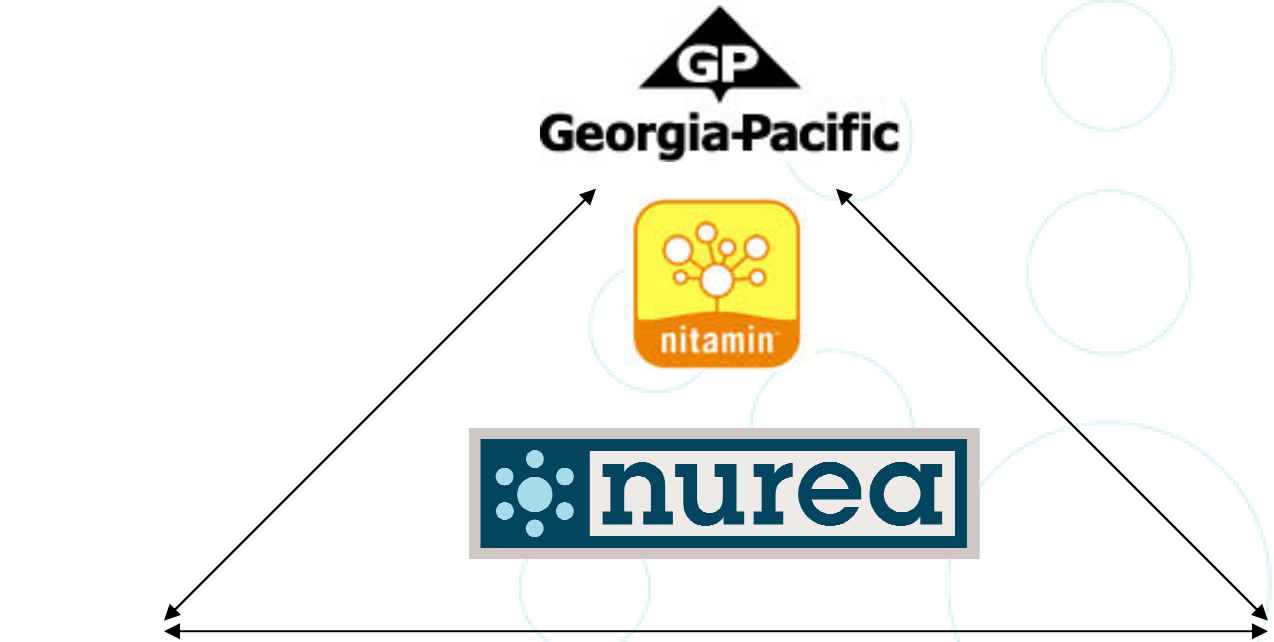
GP Georgia-Pacific

Thank You for your attention



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