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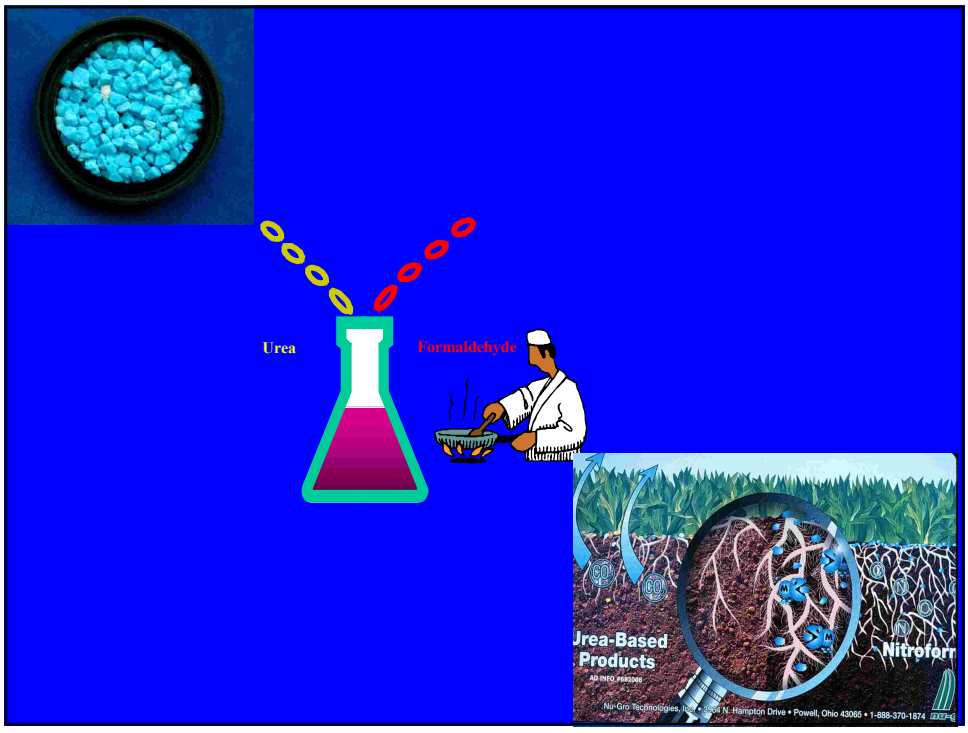
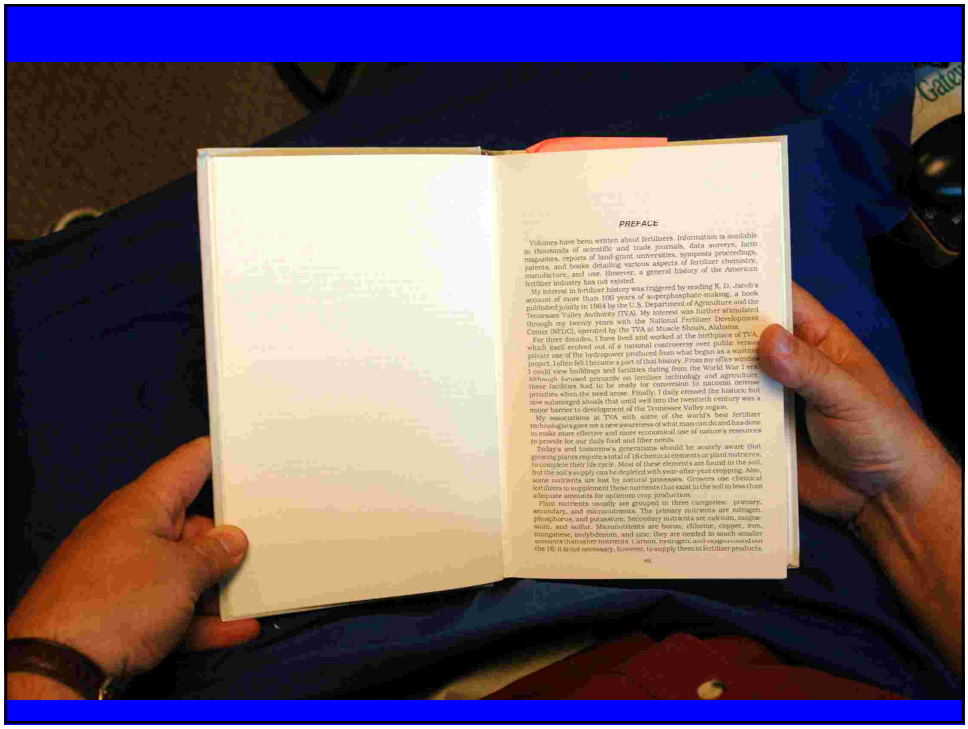
DIVISION OF AGRICULTURE
Cooperative Extension Service

Slow-release Fertilizers ?

THANKS





Fertilizer History

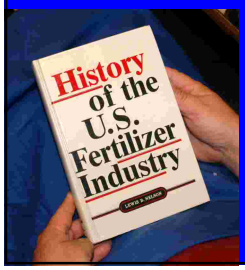
B.C. - Greeks, Romans; 'organic farming'; lack of plant science/chemistry

11th/12th centuries: European agric.; animal manures/ waste products

1600-1700's: alchemists; 'potash', bones, AS (1795 commercial prod'n), urea (1773), nitrate of soda

Early/mid 1800's: superPO4 (acidified bones), guano (for N), first field exp's w/ chemical fertilizers

1862: U.S. Morrill Act



Fertilizer History

- 1924 (European patent); 1955 commercial prod'n U.S.

  UF
- early 1960's - crotonylidene diurea
- late 1960's - IBDU

- 1961 (TVA); early 70's commercial U.S. prod'n

  - SCU

Coated SR - examples

- 1967 - Osmocote®

- 1985 - Nutricote®

  (Meister ® , Prokote ® , Escote ®)
- 1990 - PolyOn®

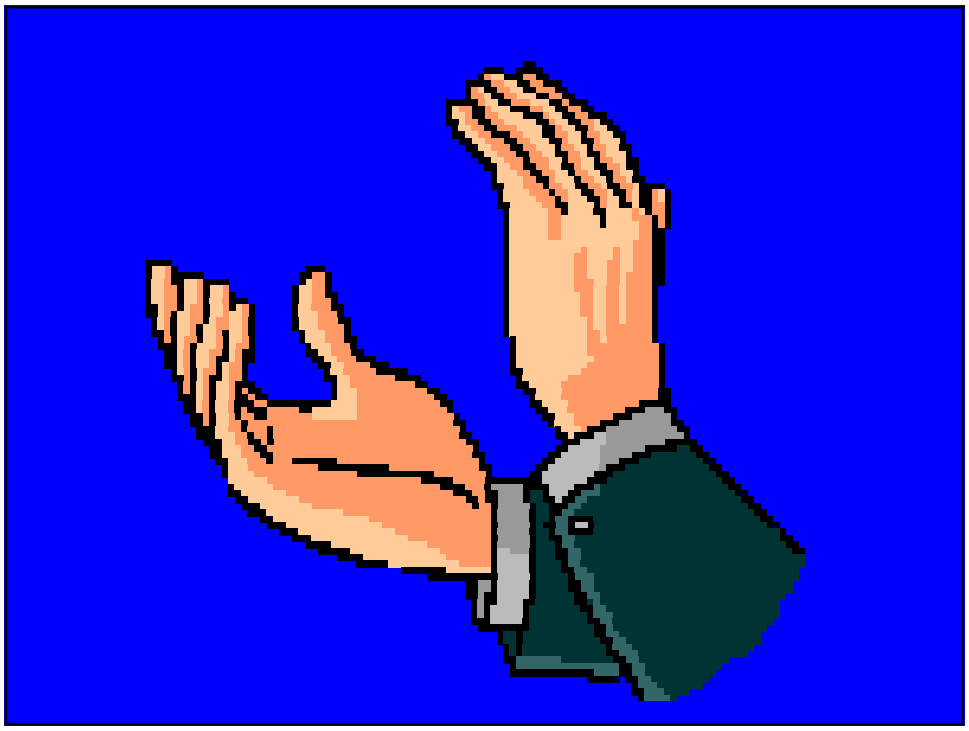
- 1990 - Multicote®

- 90's - VCote®/ TR2®

  ESN®/ Duration®

POINT

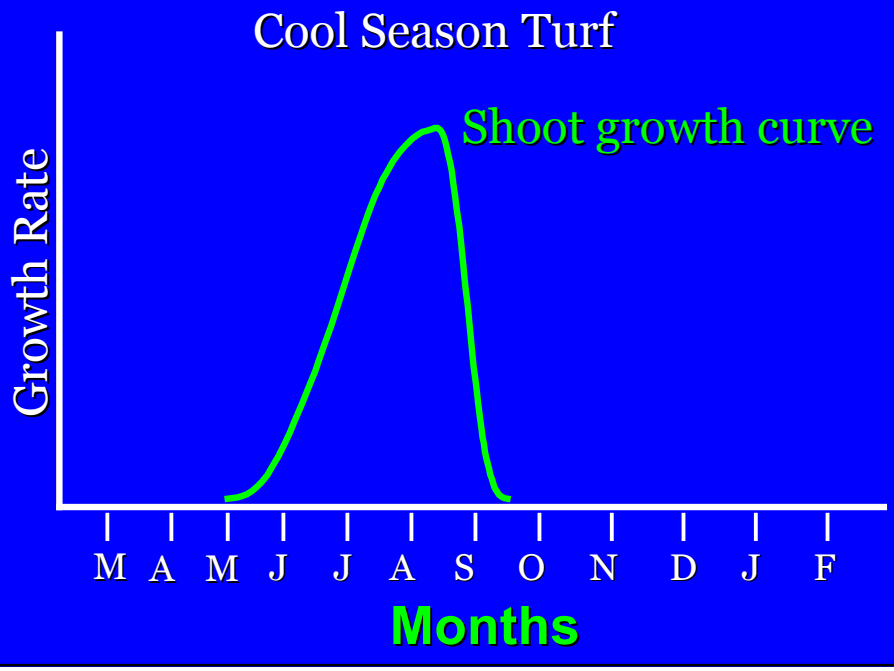
In the past 40 years the fertilizer industry has made significant strides in achieving their goal.

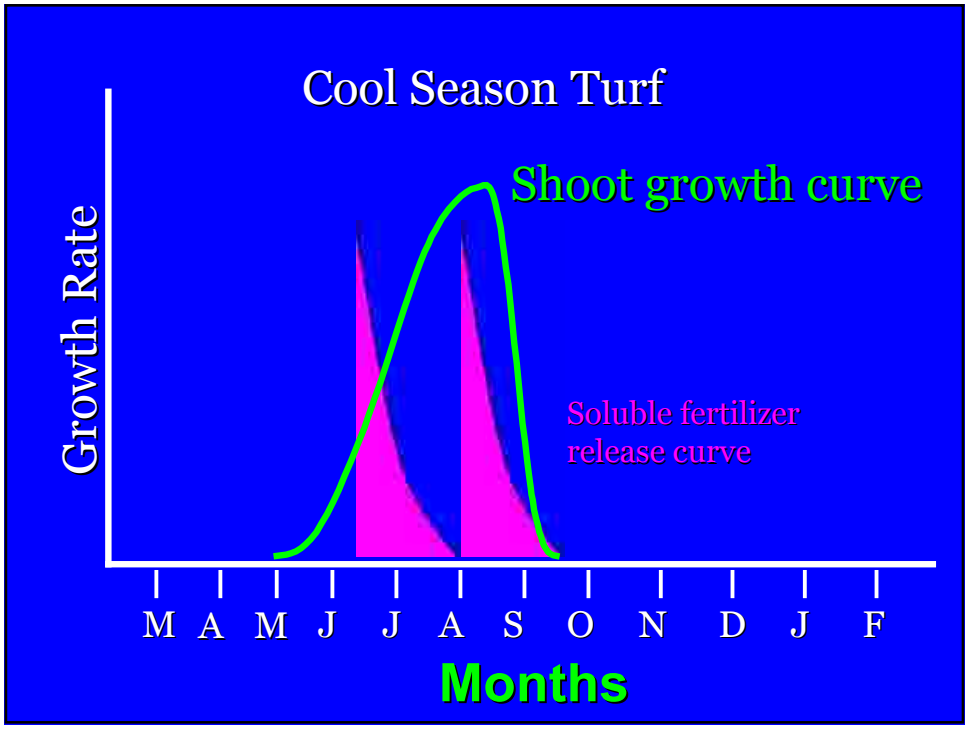


What is Our Ultimate Goal ???

To provide optimum levels of nutrients that match a plants needs.

Match the kinetics of nutrient release with the kinetics of plant growth.



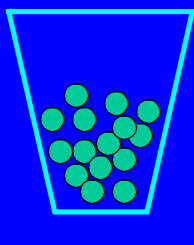

Cool Season Turf
Growth Rate
Shoot growth curve
Soluble fertilizer
release curve
M A M J J A S O N D J F
Months


Fertilizers as Tools

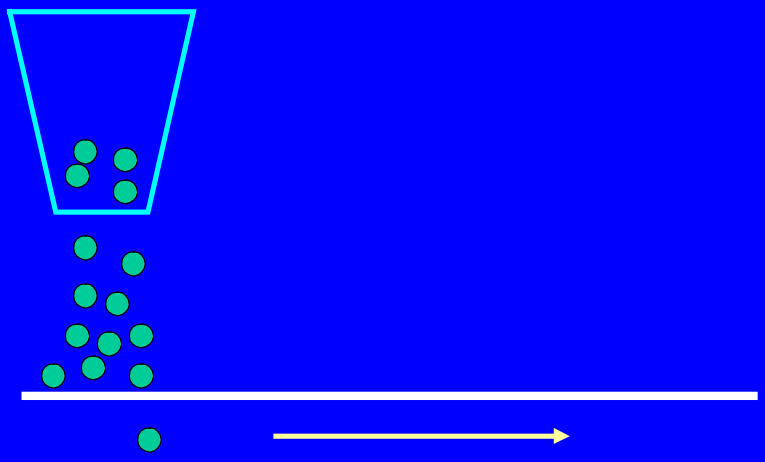
Soluble Sources

and

Slow-release Sources

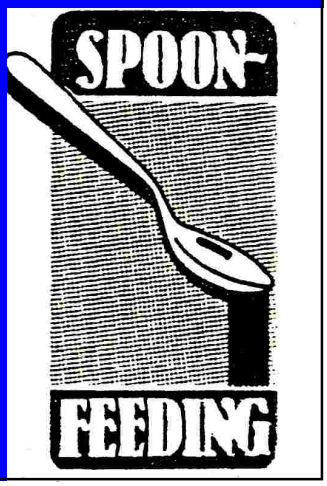


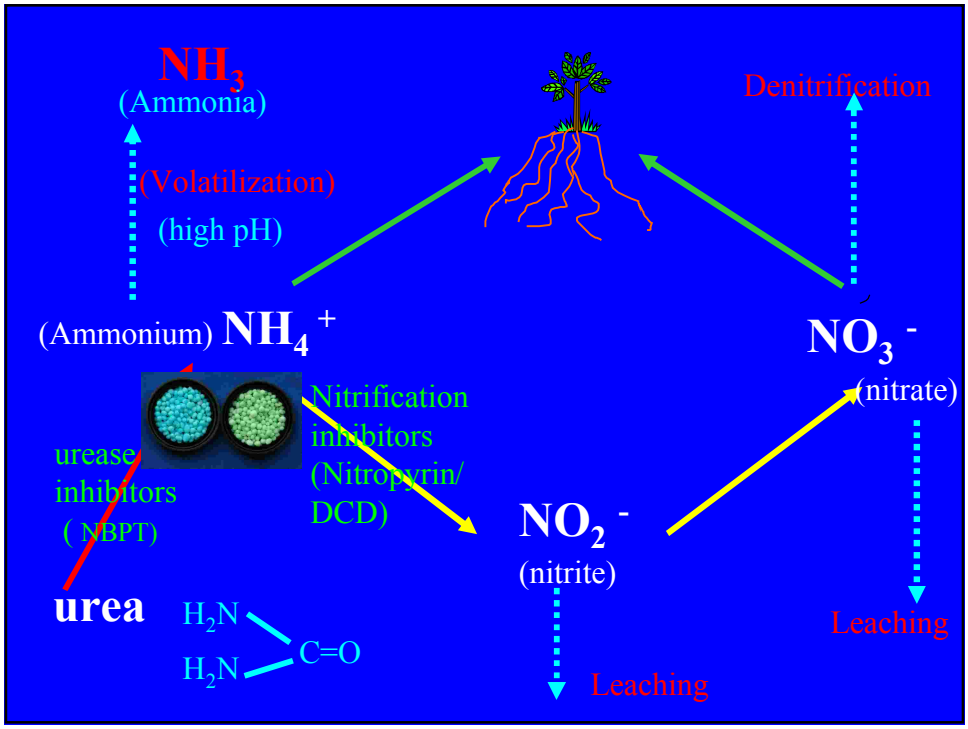
Soluble nutrient source



Soluble nutrients

How do we ‘control’ nutrient delivery with soluble nutrient sources?



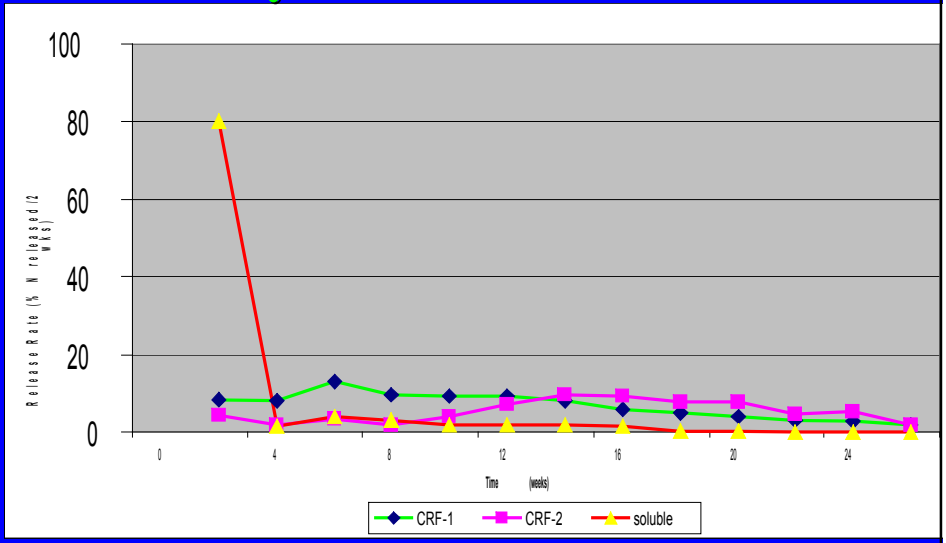

NH_3
(Ammonia)
(Volatilization)
(high pH)
Denitrification
(Ammonium) NH_4^+
NO_3^-
(nitrate)
Nitrification inhibitors (Nitropyrin/ DCD)
urease inhibitors (NBPT)
urea
H_2N
H_2N
C=O
NO_2^-
(nitrite)
Leaching
Leaching


ROSS Gro-STAKES™ Fertilizer
Slow-release/controlled-release
Sources as Fertilizer 'Tools'

Why use SR over soluble?

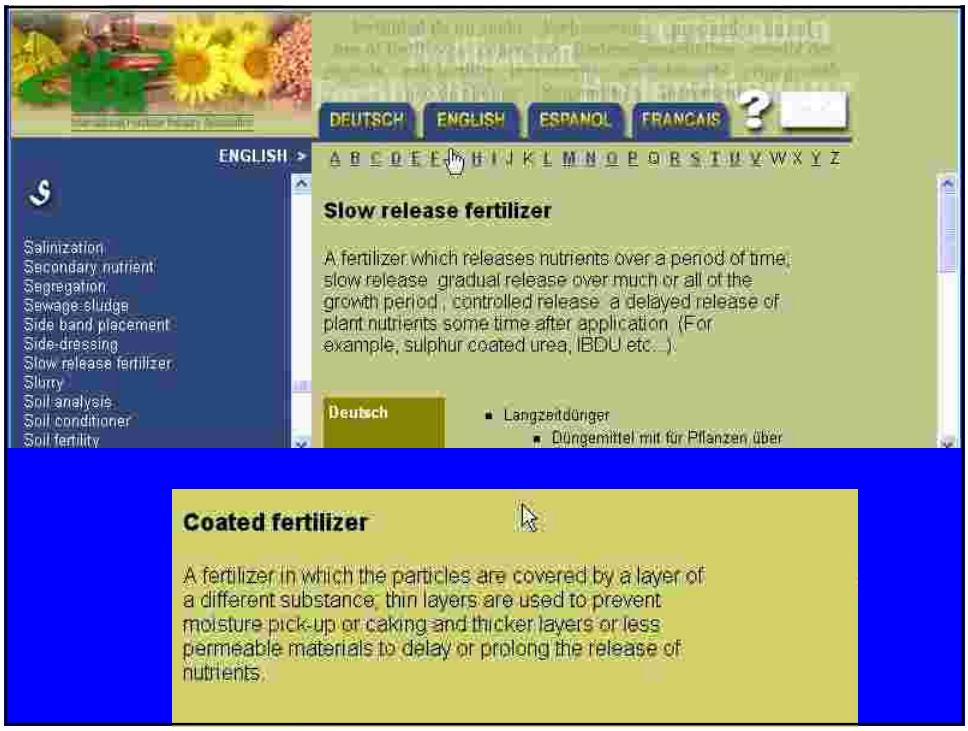
- Reduced nitrogen loss (leaching, volatilization)
- Reduced application frequency
- More uniform growth response
- Reduced burn potential

Why use SR over soluble?



Forest Nursery Notes, Winter 2003

How do we define SR/CR????



AAPFCO Official Publication #58 (2005)

Slow or controlled release fertilizer: A fertilizer containing a plant nutrient in a form which delays its availability for plant uptake and use after application, or which extends its availability to the plant significantly longer than a reference "rapidly available nutrient fertilizer" such as ammonium nitrate or urea, ammonium phosphate, or potassium chloride.

Such delay of initial availability or extended time of continued availability may occur by a variety of mechanisms. These include controlled water solubility of the material (by semipermeable coatings, occlusion, or by inherent water insolubility of polymers, natural nitrogenous organics, protein materials, or other chemical forms), by slow hydrolysis of water soluble low molecular weight compounds, or by other unknown means. (Official 1985)

AAPFCO Defined Slow-release Plant Nutrients

Water Insoluble: e.g. natural organics, urea-formaldehyde products, IBDU™, ureaform materials, oxamide, etc.

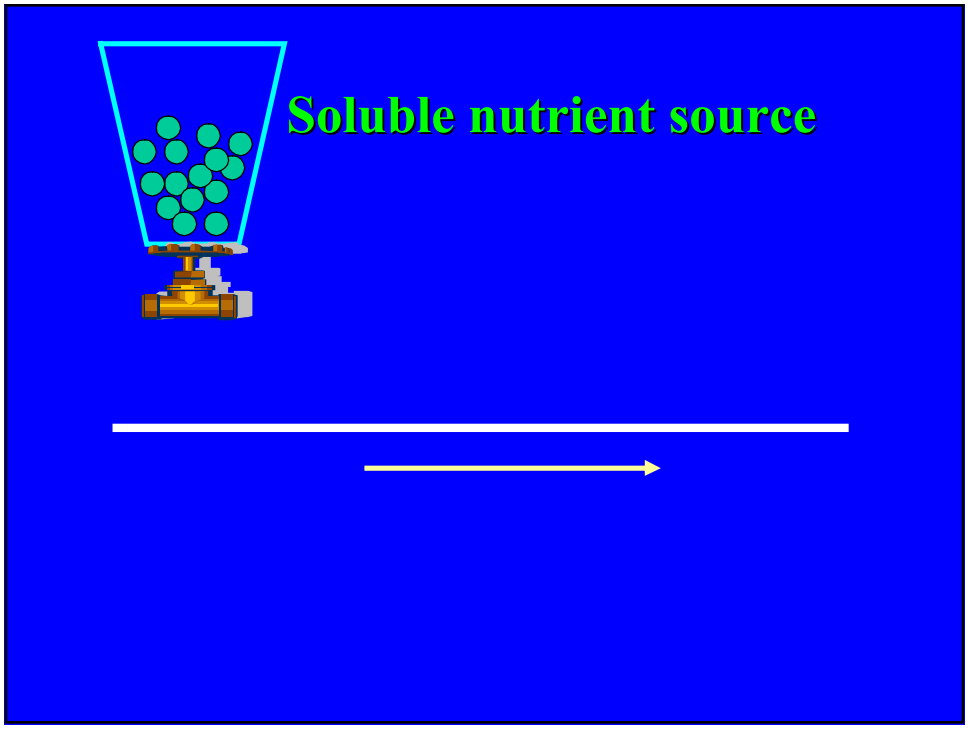
Coated SR: e.g. SCU, PCU

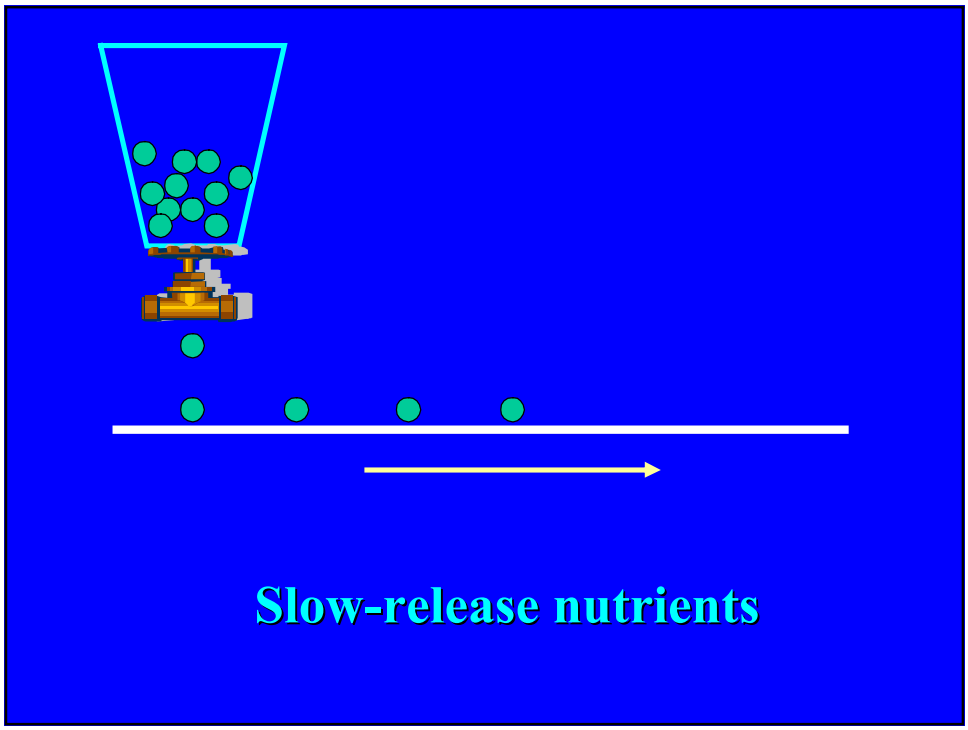
Occluded SR: fertilizers mixed with waxes, resins, or other inert materials e.g. Jobes Plant Spikes

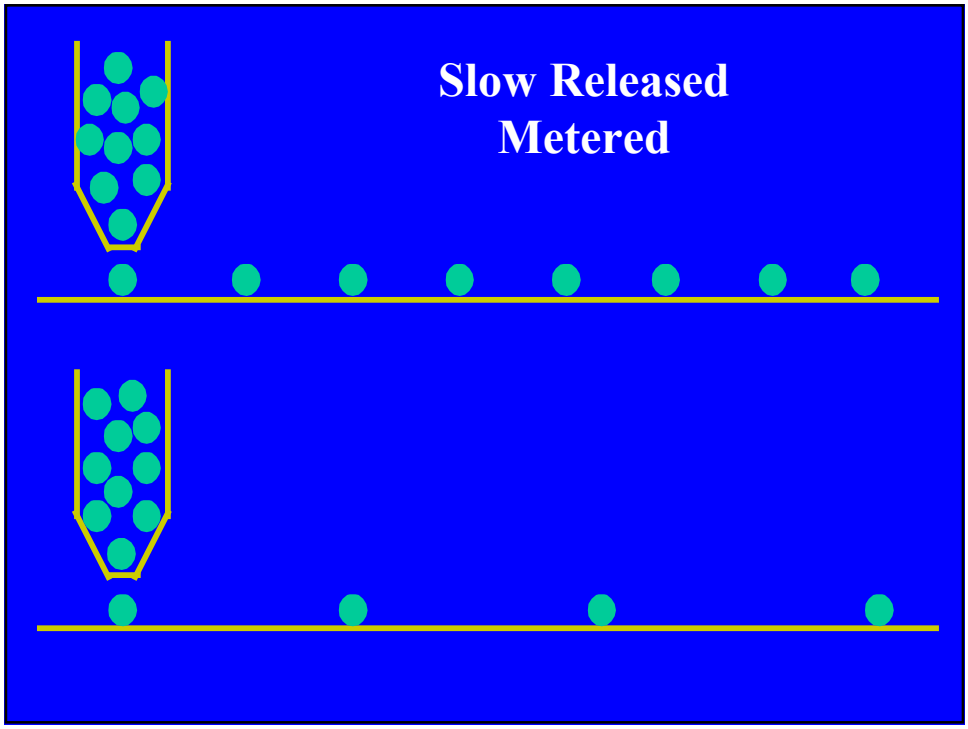
Slowly Available Water Soluble: e.g. MDU, DMTU, DCD, urea-triazone solution, etc.

In a nutshell:

Research activity concerning the slow release of nutrients has focused on altering the chemical or physical characteristics of the fertilizer material.


Soluble nutrient source


Slow-release nutrients



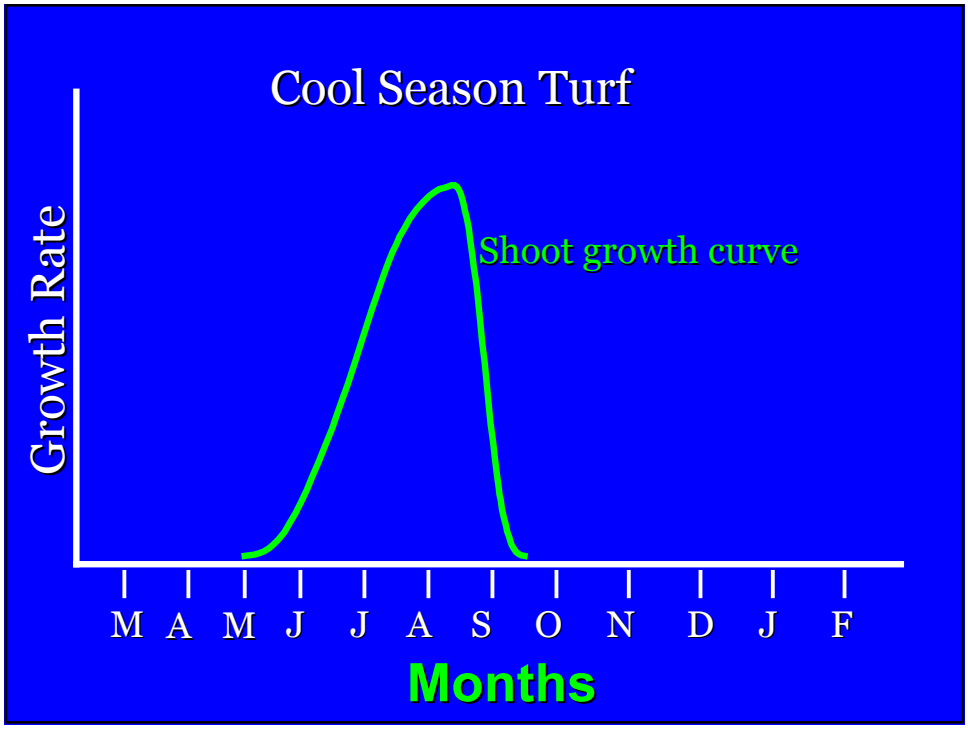
Challenges to Achieving this Goal

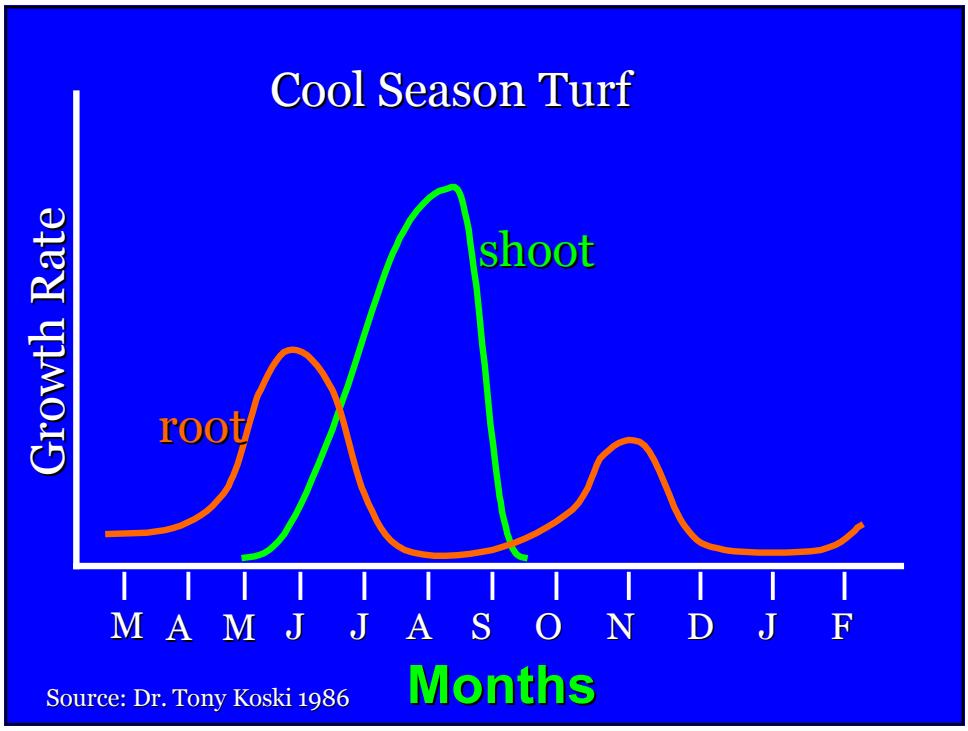
1. Many different types of plants.

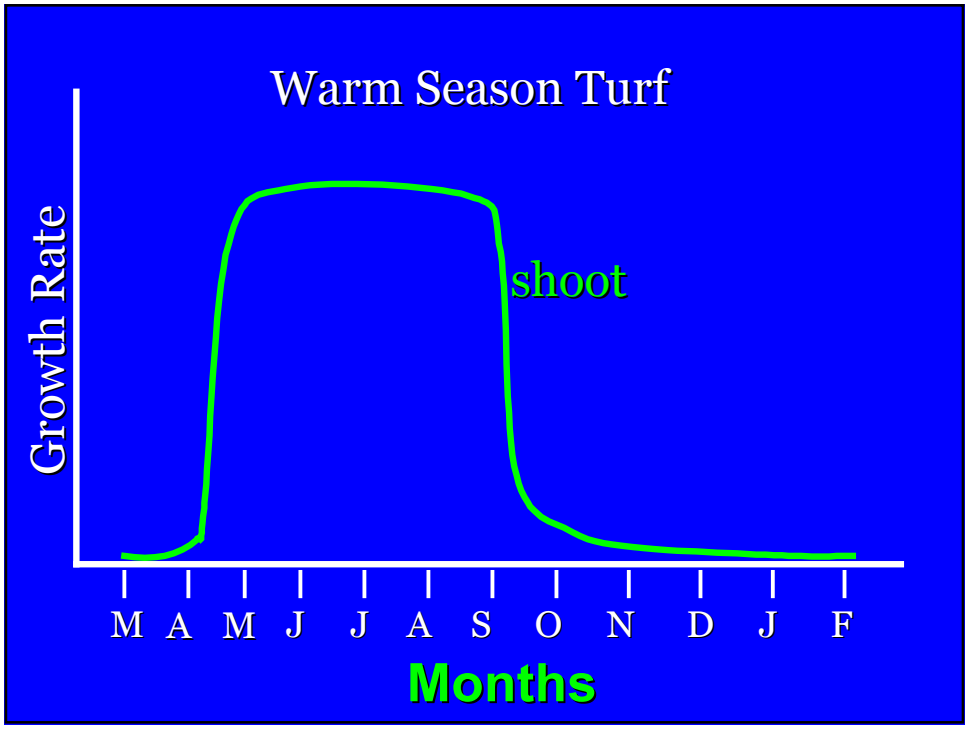
woody plants (exponential, increasing nutrient demand)

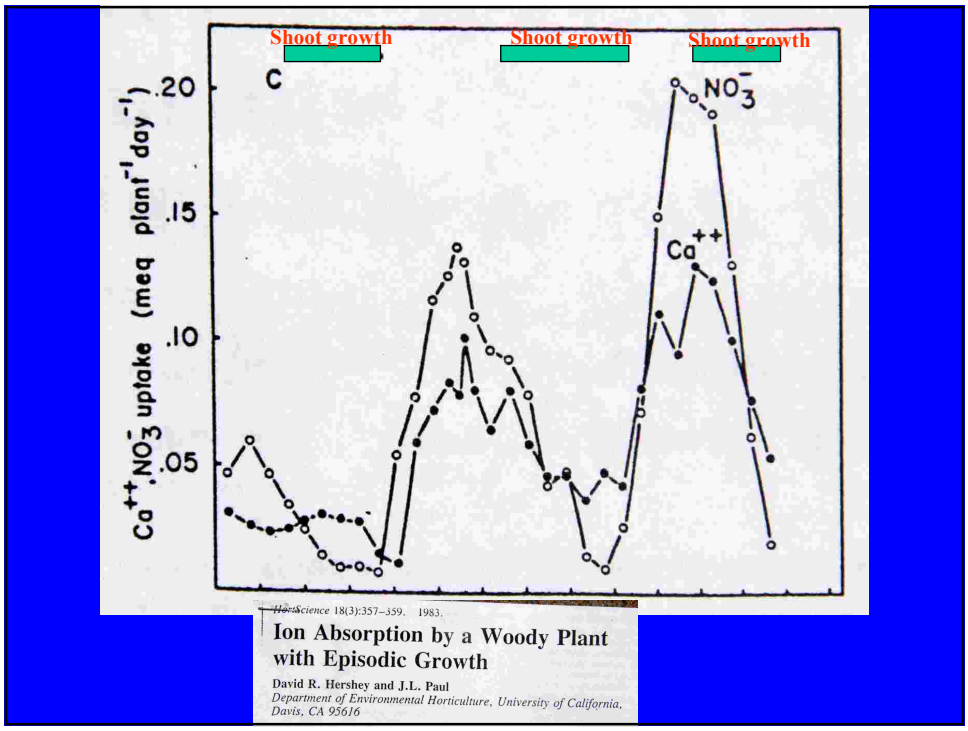
versus

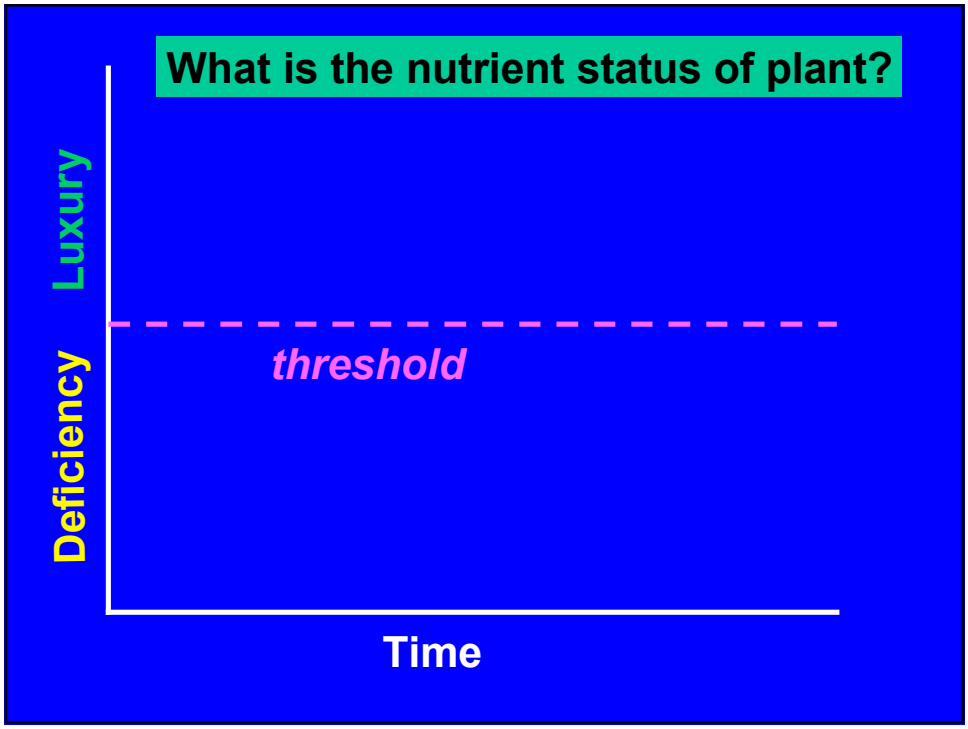
turf and annuals (Gaussian, bell-shaped demand)

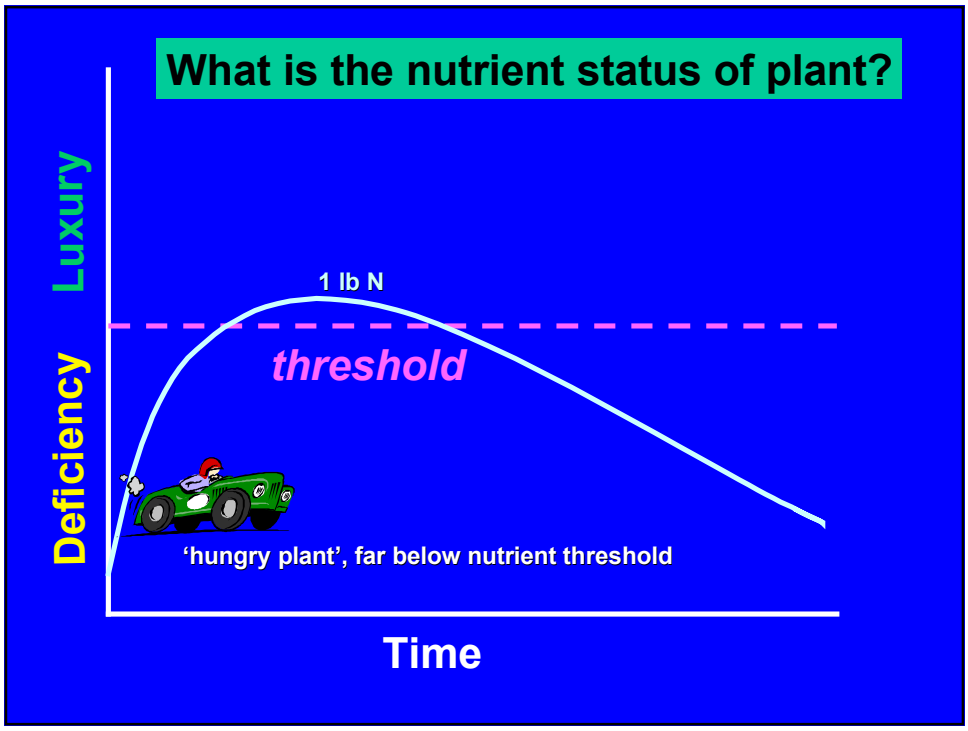

Cool Season Turf
Growth Rate
Shoot growth curve
M A M J J A S O N D J F
Months

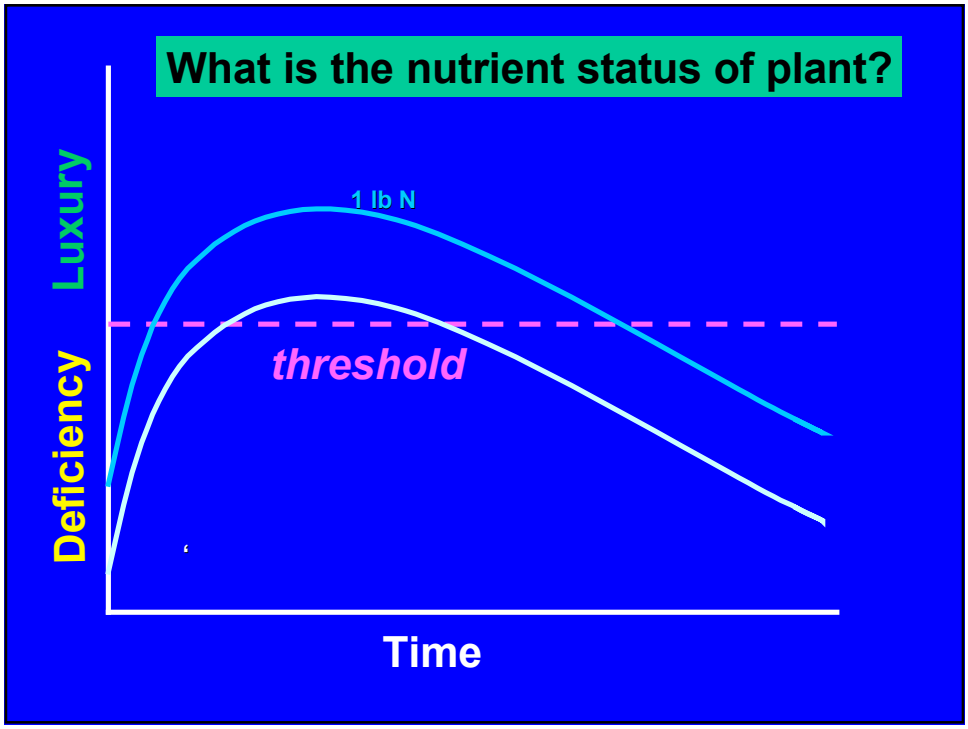

Cool Season Turf
Growth Rate
shoot
root
M A M J J A S O N D J F
Months
Source: Dr. Tony Koski 1986


Warm Season Turf
Growth Rate
shoot
M A M J J A S O N D J F
Months


Shoot growth
Shoot growth
Shoot growth
C
NO_3^-
Ca^{++}
Ca^{++}.NO_3^- uptake (meq plant^{-1}day^{-1})
.20
.15
.10
.05
HortScience 18(3):357–359. 1983.
Ion Absorption by a Woody Plant with Episodic Growth
David R. Hershey and J.L. Paul
Department of Environmental Horticulture, University of California, Davis, CA 95616


What is the nutrient status of plant?
Luxury
Deficiency
threshold
Time


What is the nutrient status of plant?
Luxury
Deficiency
1 lb N
threshold
'hungry plant', far below nutrient threshold
Time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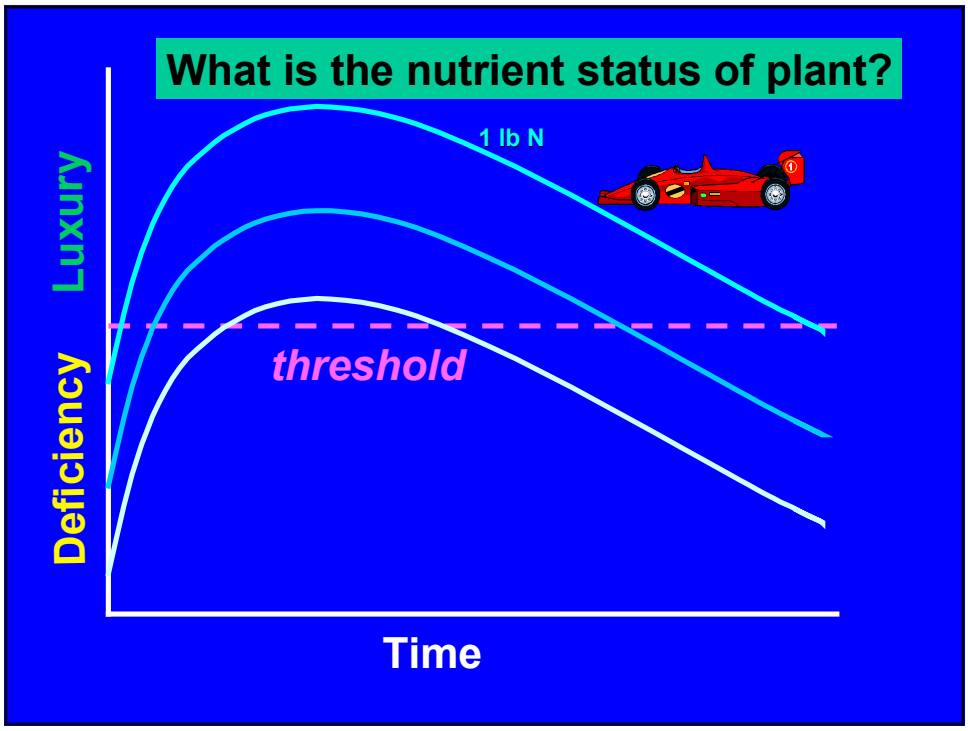
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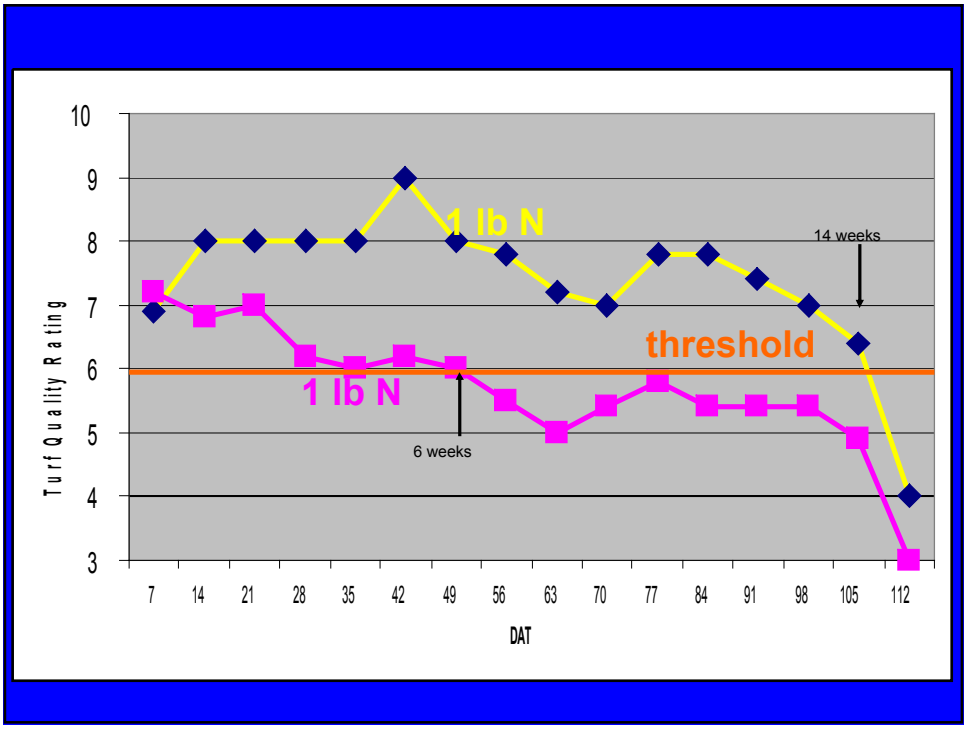
Luxury
Deficiency
1 lb N
threshold
Time

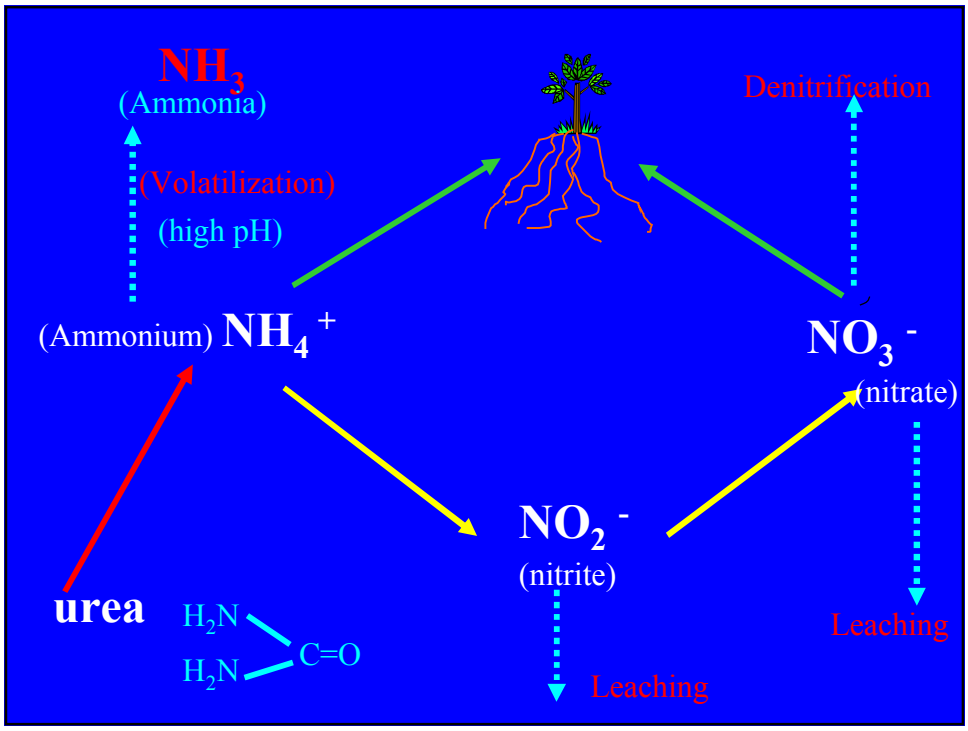


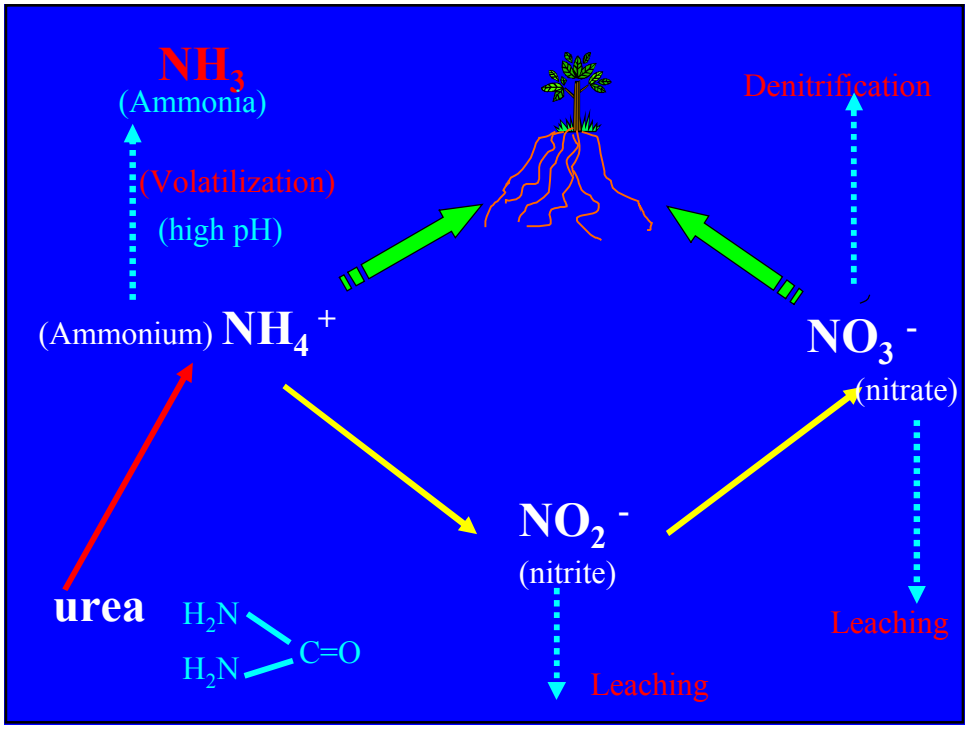
Challenges to Achieving this Goal

2. Impact of environment on release of nutrients, retention in growing media/soil, and losses from system.

Fertilizer Use Efficiency (FUE)
Or
Fertilizer/nutrient Recovery Efficiency (NRE)

The total nutrient absorbed by the plant as a % of total nutrients supplied by that fertilizer for a given time interval. Weinbaum et al. 1978. JASHS 103: 516-519

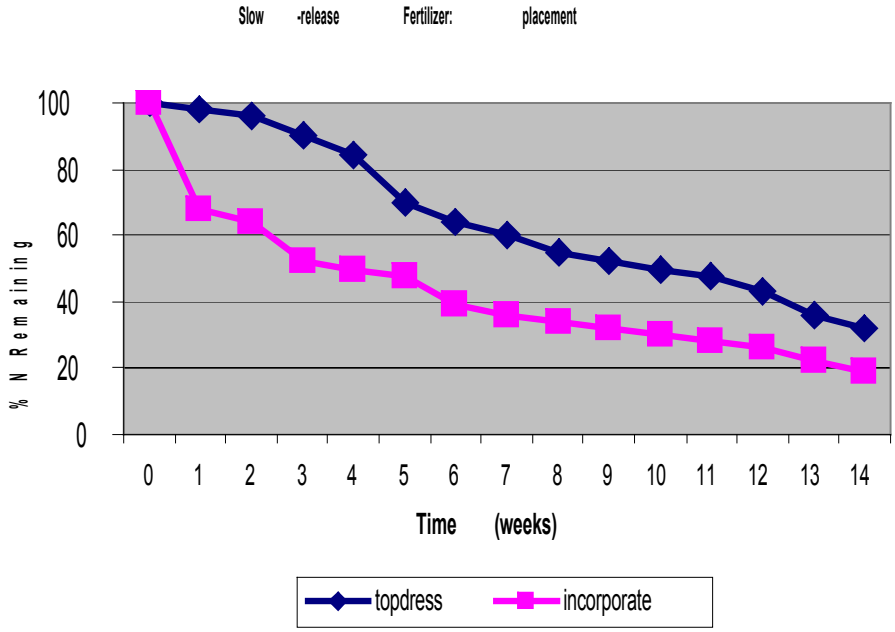




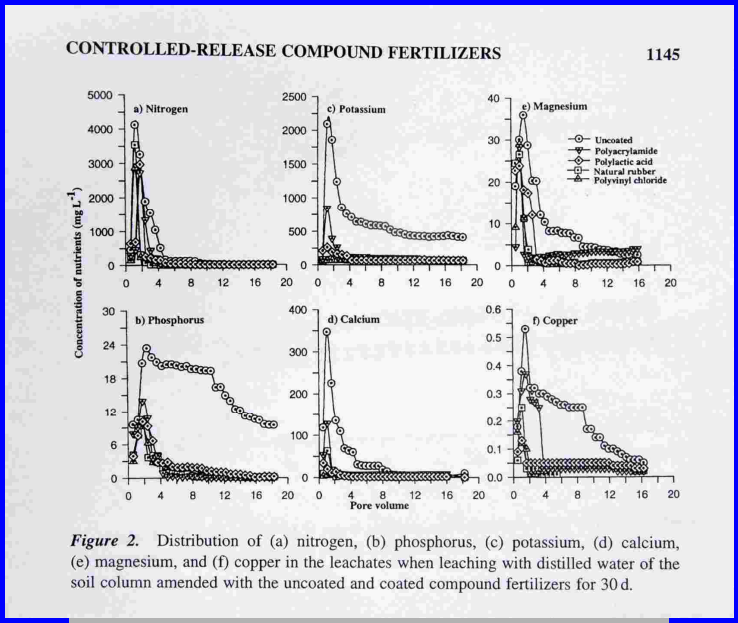
Challenges to Achieving this Goal

3. Nuances of the technologies

Placement of SR



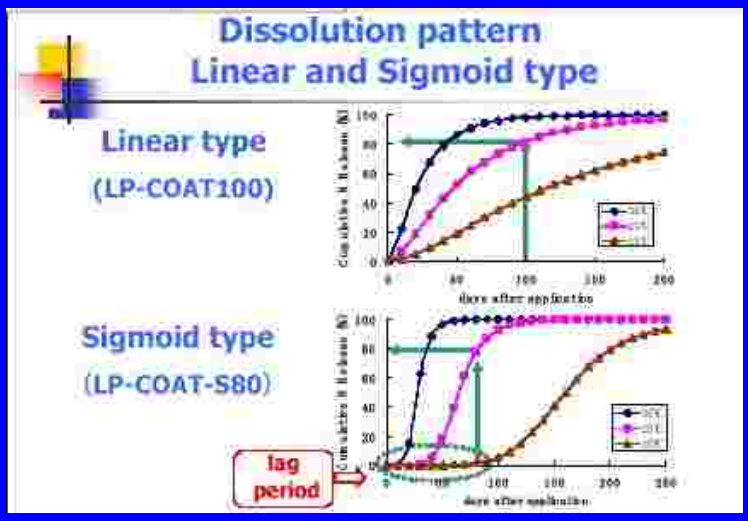
Nutrient Release Patterns



CONTROLLED-RELEASE COMPOUND FERTILIZERS 1145

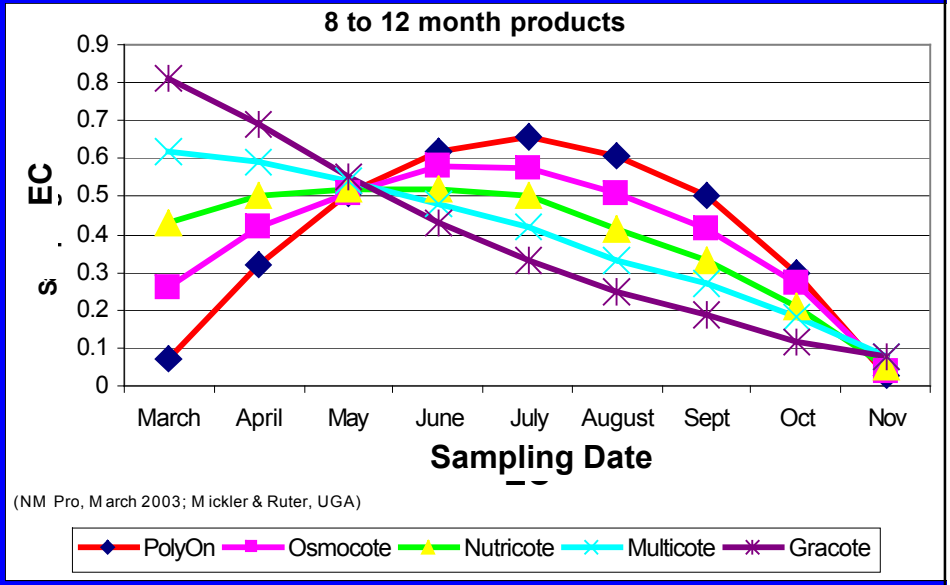
Figure 2. Distribution of (a) nitrogen, (b) phosphorus, (c) potassium, (d) calcium, (e) magnesium, and (f) copper in the leachates when leaching with distilled water of the soil column amended with the uncoated and coated compound fertilizers for 30 d.

Hanafi, M.M. et al. 2002. Comm. Soil Sci. Plant Anal



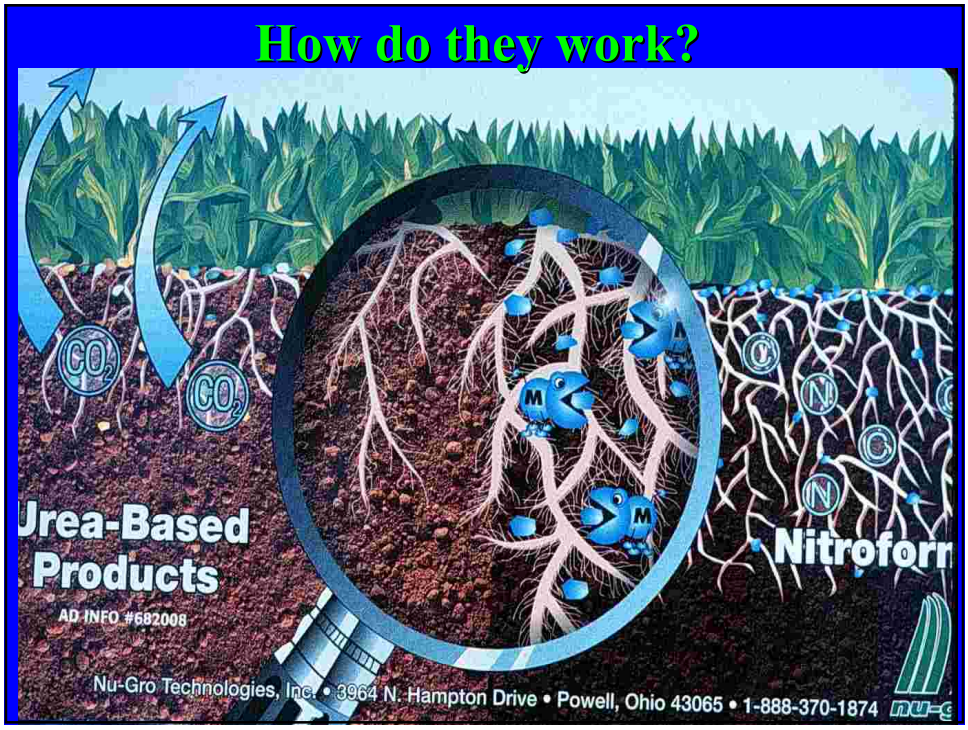
Use of the slow- and controlled Release Fertilizers in Rice Production in Japan. Ja Zen-noh, S. Kubo, and T. Matsuo. 2004.

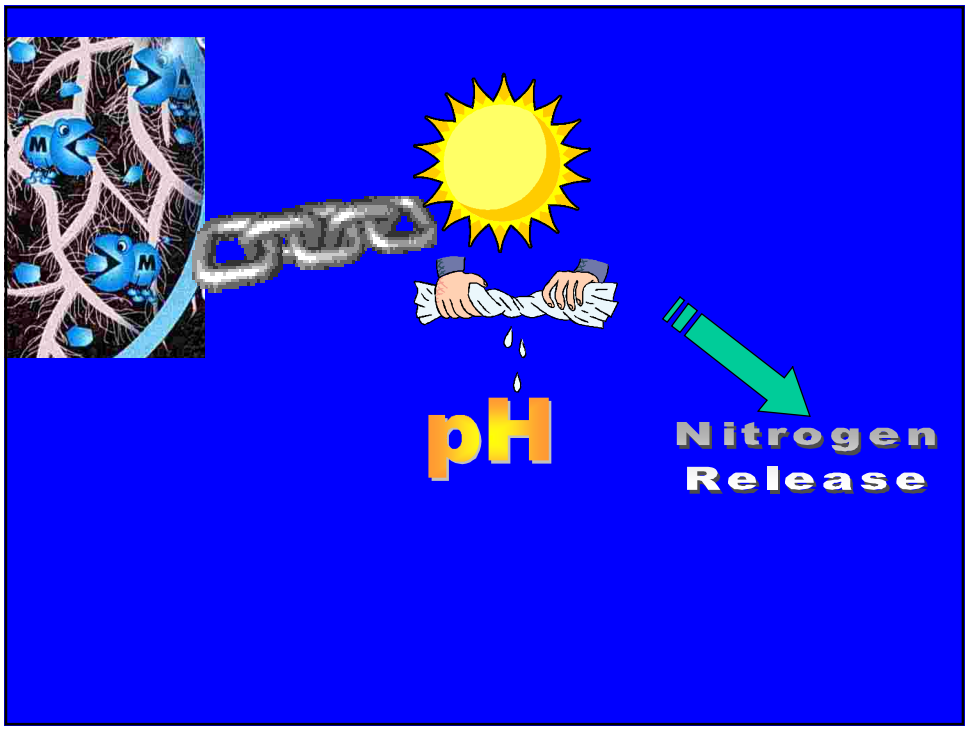
http://www.fertilizer.org/ifa/publicat/PDF/2004_regional_auckland_kubo_slides.pdf

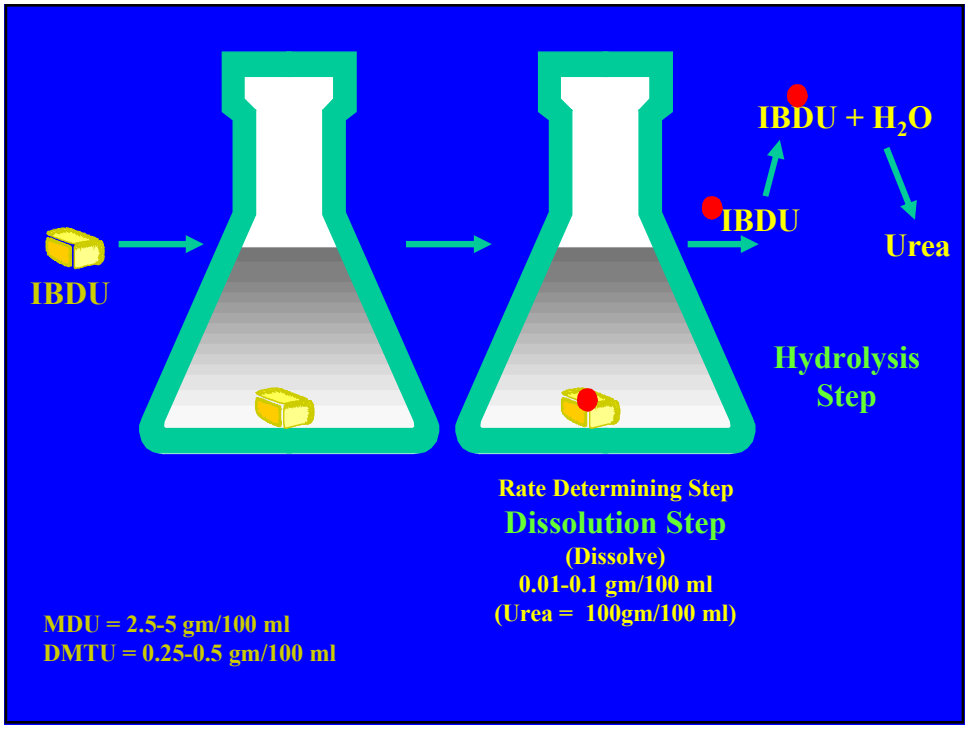


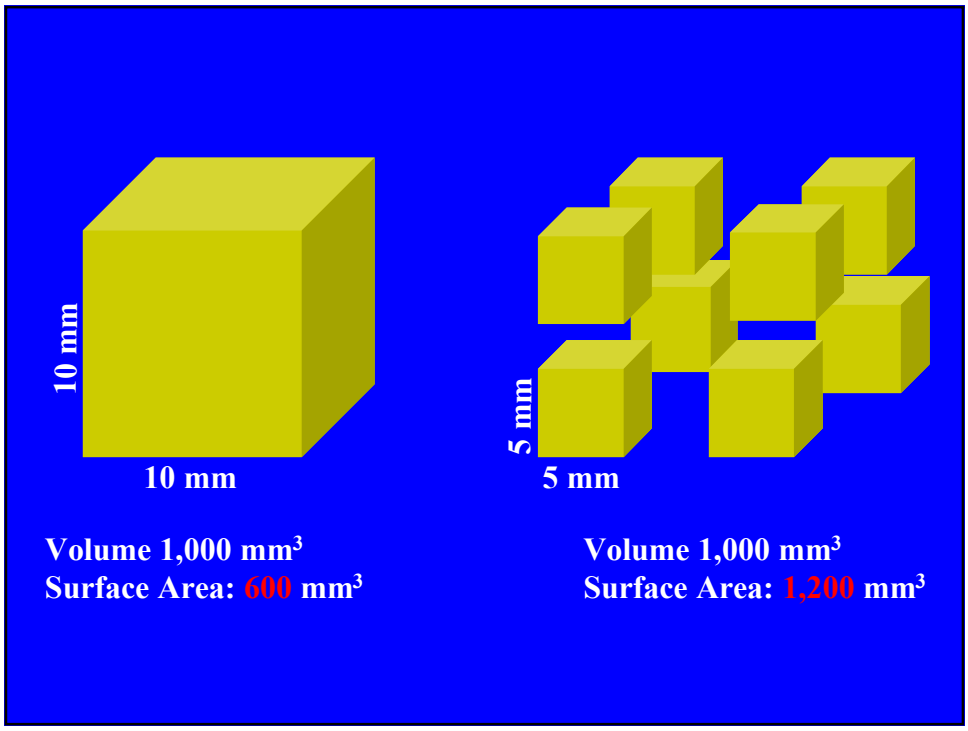
Fertilizers as Tools

How is the nutrient released?

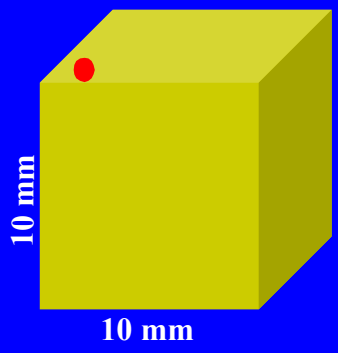

How do they work?
Urea-Based Products
AD INFO #682008
Nitroform
Nu-Gro Technologies, Inc. • 3964 N. Hampton Drive • Powell, Ohio 43065 • 1-888-370-1874

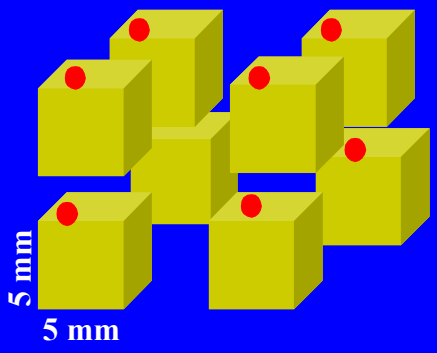

pH
Nitrogen Release


IBDU
IBDU + H_2O
IBDU
Urea
Hydrolysis Step
Rate Determining Step
Dissolution Step
(Dissolve)
0.01-0.1 gm/100 ml
(Urea = 100gm/100 ml)
MDU = 2.5-5 gm/100 ml
DMTU = 0.25-0.5 gm/100 ml


10 mm
10 mm
Volume 1,000 mm^3
Surface Area: 600 mm^3
5 mm
5 mm
Volume 1,000 mm^3
Surface Area: 1,200 mm^3

Since nitrogen release rate depends on particle size,



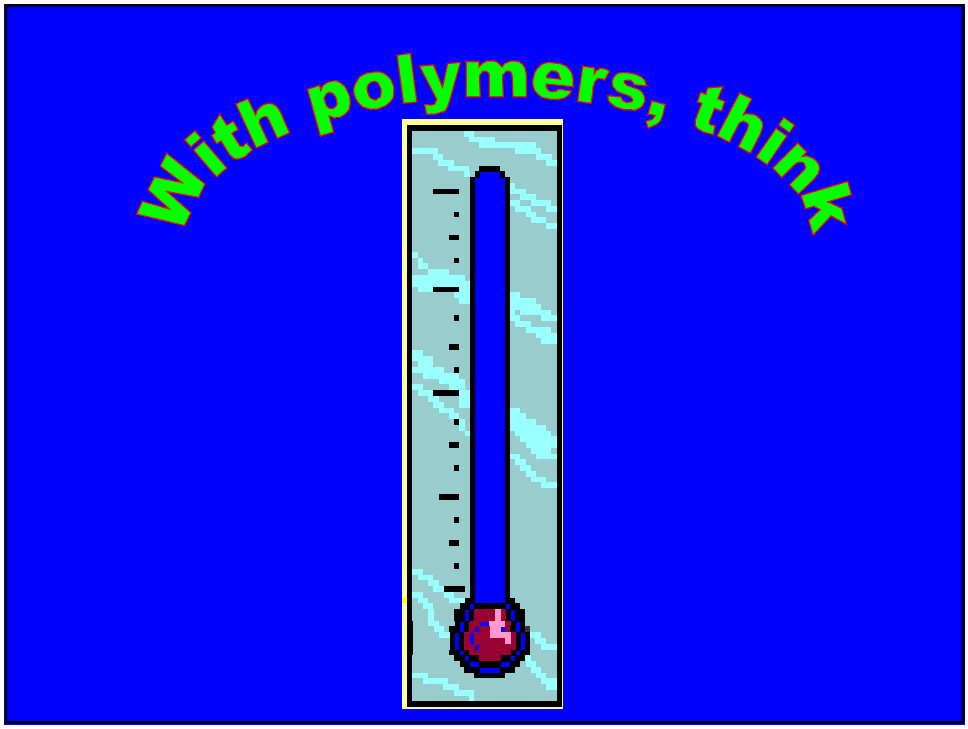


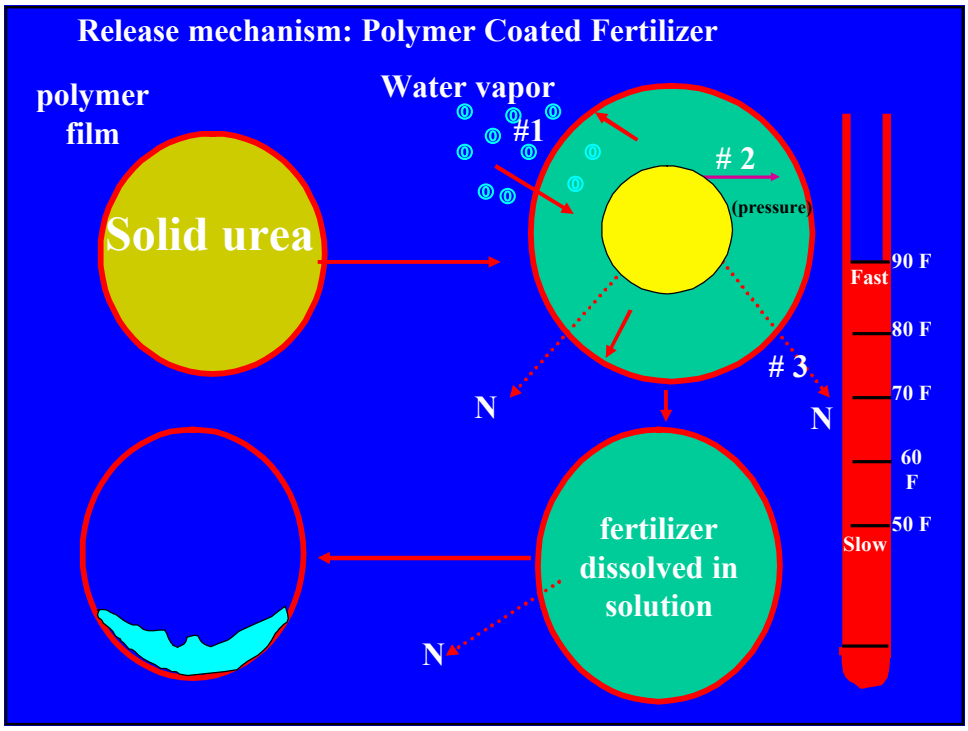
Volume 1,000 mm^3
Surface Area: 600 mm^3

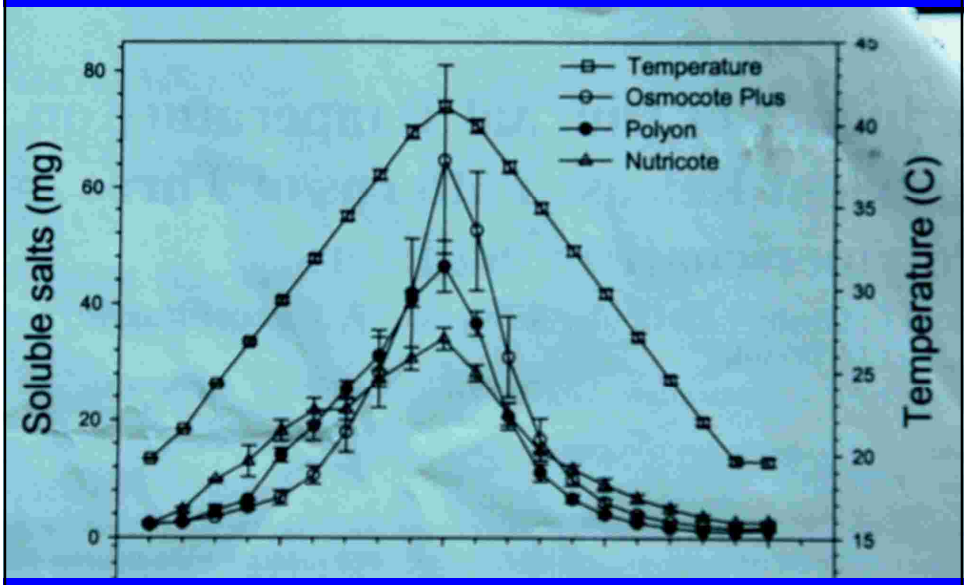
Volume 1,000 mm^3
Surface Area: 1,200 mm^3

longevity is related to particle size!!!!!

Different sizes for different longevities.


With polymers, think


Release mechanism: Polymer Coated Fertilizer
polymer film
Water vapor
#1
Solid urea
2
(pressure)
3
N
N
N
fertilizer dissolved in solution
90 F
Fast
80 F
70 F
60 F
50 F
Slow

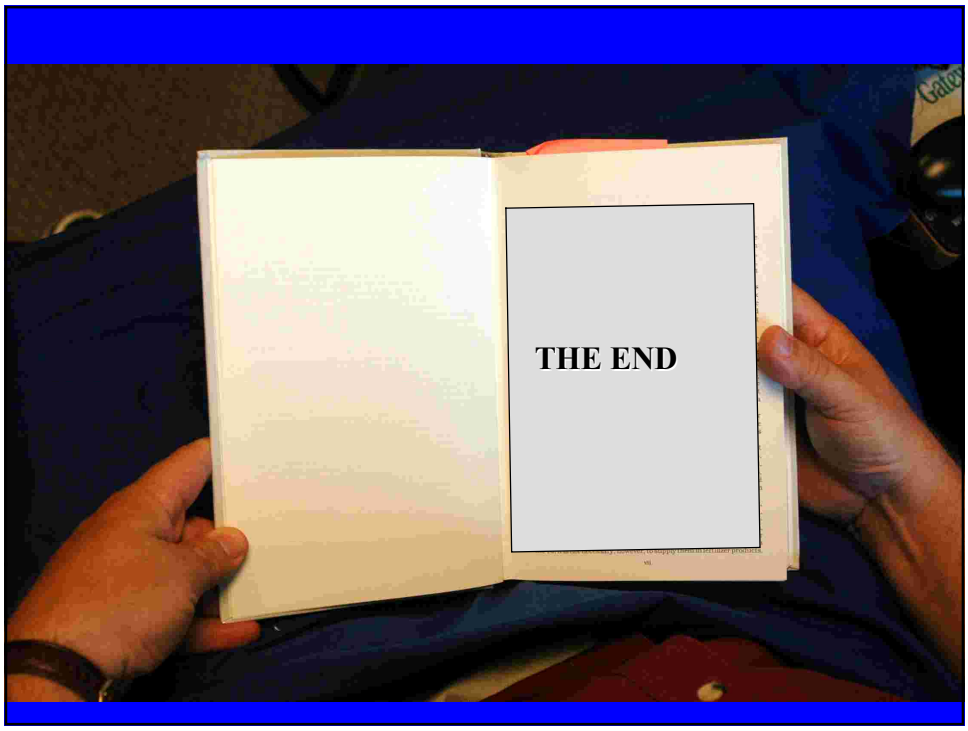


Husby et al. 2003. Influence of Diurnal Temp. on Nutrient Release Patterns of Three Polymer-coated Fertilizers. HortSce 38:387-389.

Factors that affect nitrogen release from CR/SR nitrogen sources

	Temperature	Soil microbes	Moisture	pH	Particle Size
Natural organics	High/very high	Very high	High	Slight	Moderate
Long chain UF's	High/very high	High/very high	Slight	Slight	None
Short chain UF's	Moderate/high	Moderate	Moderate	Slight	Slight
IBDU	Slight/moderate	Slight	High	Slight/moderate	Very high
SCU	Moderate	Slight	Moderate	None	Moderate
PCU	High	None	Slight	None	High

(G. Harada. 1995. Turf Tales Magazine)


THE END