New Crop Nutrition Technologies Nitrogen case

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Orlando, December 5, 2012

Outline

- Remarks
- Plant nutrients and emerging technologies
- Nitrogen case
- Future needs

Introduction

- Industrial Agriculture
- The last 100 years
  - Best accomplishments:
    - Genetic selection
    - Technology advances
    - Use of fertilizer
    - Exponential increase of yield in most crops

Soil-Plant relationship?

- Plant response to yield and productivity
  - Genetic component
  - Environmental Component
    - Water
    - Nutrients
- We have managed to keep them separate in the last 100 years.

Opportunities?

The ideal system

- Efficient crop system
  - Minimize loses
  - Maximize utilization of resources and energy
- Management
  - Plant and crop level
  - Soil level
  - Technology level

The ideal system

- Technology Level
  - Fertilizer Technology
  - Application Technology
  - Monitoring Technology
  - Emerging technologies

- "Our 21st century hybrids and varieties use 19th century fertilizer technology" as a solid general statement

Potential Advantages of Controlling Nutrient Supply

- Better Crops and Yields
- Environmental Aspects, Nitrogen case

  Input vs. Output ~ Balance

  – Reduction of surplus on soil-plant-water system

  – Critical Areas with HUGE surplus

    - Mississippi Delta
    - Yellow River China
    - Chesapeake Area

Potential Advantages of Controlling Nutrient Supply

- Economic Aspects.
  - Potential for Reducing Nutrient Losses.
  - Cost of Fertilizer Application.
- Physiological Aspects.
  - Reduction of Stress and Specific Toxicities.
  - Increase Availability of Nutrients.
  - Supply of Preferred nutrient Form by Plants.
  - Enhancing “Synergistic” Effects (nutrients).

Potential Advantages of Controlling Nutrient Supply

- Increasing crop efficiency on fertilizer use
- Reducing Environmental Impact of Fertilizers
- Matching Supply with Plant Demand and Maintaining plant Availability.
- However, even today we think nutrients as:
  - Units of nutrients per area!
  - An approach that is still in the 19^{th} century

Possible valid solutions

- Solutions for N case (ONE DIMENTION)
  - The plant breeders:
    - To obtain a hybrid that can have a high NUE
  - The soil physicist:
    - To monitor water loses related N loses
  - The soil fertility specialist:
    - To develop a soil N test
  - The environmentalist:
    - To reduce 35% nitrogen application
  - The fertilizer Industry:
    - To develop higher NUE fertilizers

POSSIBLE SOLUTIONS

- Solution (TWO DIMENTIONS)
  - The plant breeders:
    - To obtain a hybrid that can have a high NUE
  - The soil physicist
    - To monitor and reduce water loses related N loses
  - The soil fertility specialist
    - To split the nitrogen application
  - The environmentalist
    - Reduce 35% nitrogen application
  - The fertilizer Industry
    - To produce a higher NUE fertilizer

Fertilizer and Nutrient Technology

- What is out there?
  - Need To stabilize nutrients (particularly N)
  - Fertilizer technology and development is old and without relevant innovations (slowly changing).
    - » Urea (1890's)
    - » Last commercial fertilizer technology was introduced in the 1970's with DAP

Fertilizer and Nutrient Technology

- Is anything new?
  - Enhanced release fertilizers, effects?
    - Organic Nitrogen Low solubility compounds
      - Urea Formaldehyde (UF)
    - Fertilizers with Physical Barrier
      - Coated with organic polymers
      - Coated with sulfur
    - Inorganic Low-solubility compounds
      - $MgNH_4PO_4$
      - Phosphorus stabilized technology (ex.Stearic P)
  - Stabilizers of the Nitrogen cycle: Inhibitors

Why is of interest Nitrogen Fertilizer Technology?

- To improve Nitrogen Use Efficiency - NUE
- Given that nitrate is so readily leachable, the use of technologies that can reduce the pool of nitrate, but still make N available in adequate quantities and at the right timing for crop growth could improve NUE

Time Release Fertilizers

ESN SmartNitrogen
Controlled Release Fertilizer
A smarter source of nitrogen. A smarter way to grow corn.

Duration 45
Controlled-Release Fertilizer

Coated urea prills, not chemically reacted (polyurethane and other coatings)

nitamin

GREENFEED™

N-Sure®

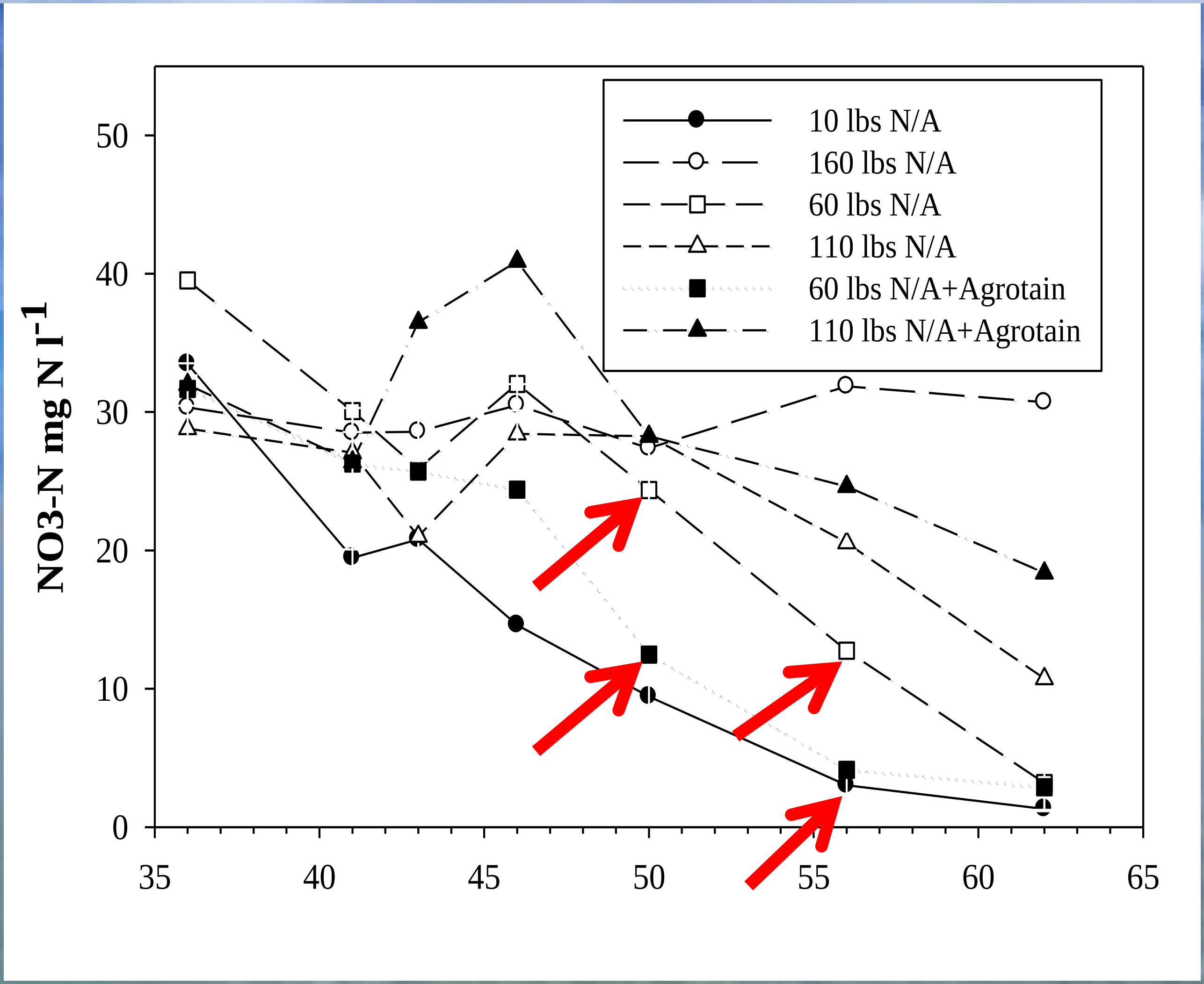
Chains or rings of urea molecules with polymers (Methyl Urea, Triazone, etc.)

Time Release Fertilizer

- **The diffusion of urea-nitrogen out of the prill is controlled by the thickness of the coating and environmental conditions (temperature)**
- **The coating meters the released N rather than allowing the release of a large quantity that would build up a N pool**

Urea **Polyurethane coated Urea**

2010 Nitrification Inhibitor Impact on Nitrate in Leachate



Richard Smith UC Cooperative Extension, Monterey County CA

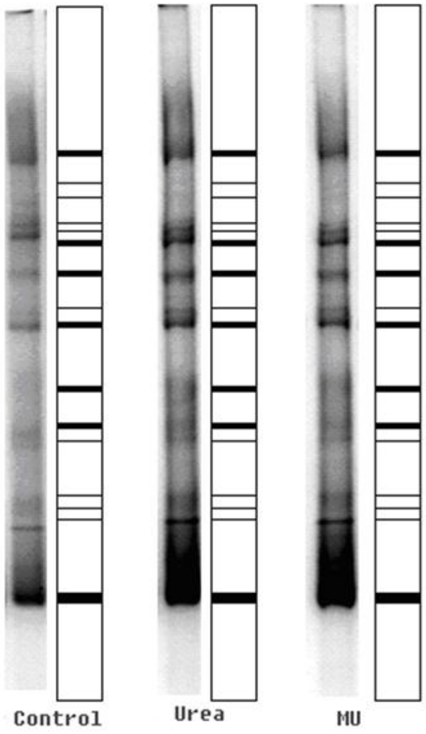


Figure 5. PCR DGGE banding pattern of soil samples from 15 days. This bad pattern was obtained utilizing the density trace from BioRad Density One Software. The Gel was electrophoresed in the 100-L DGGE tank

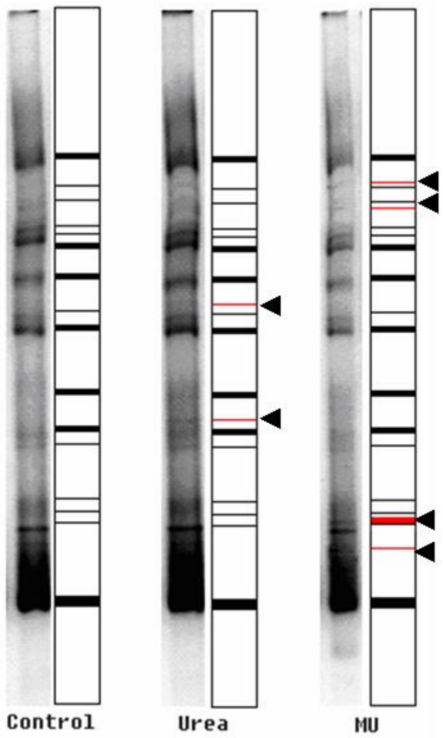
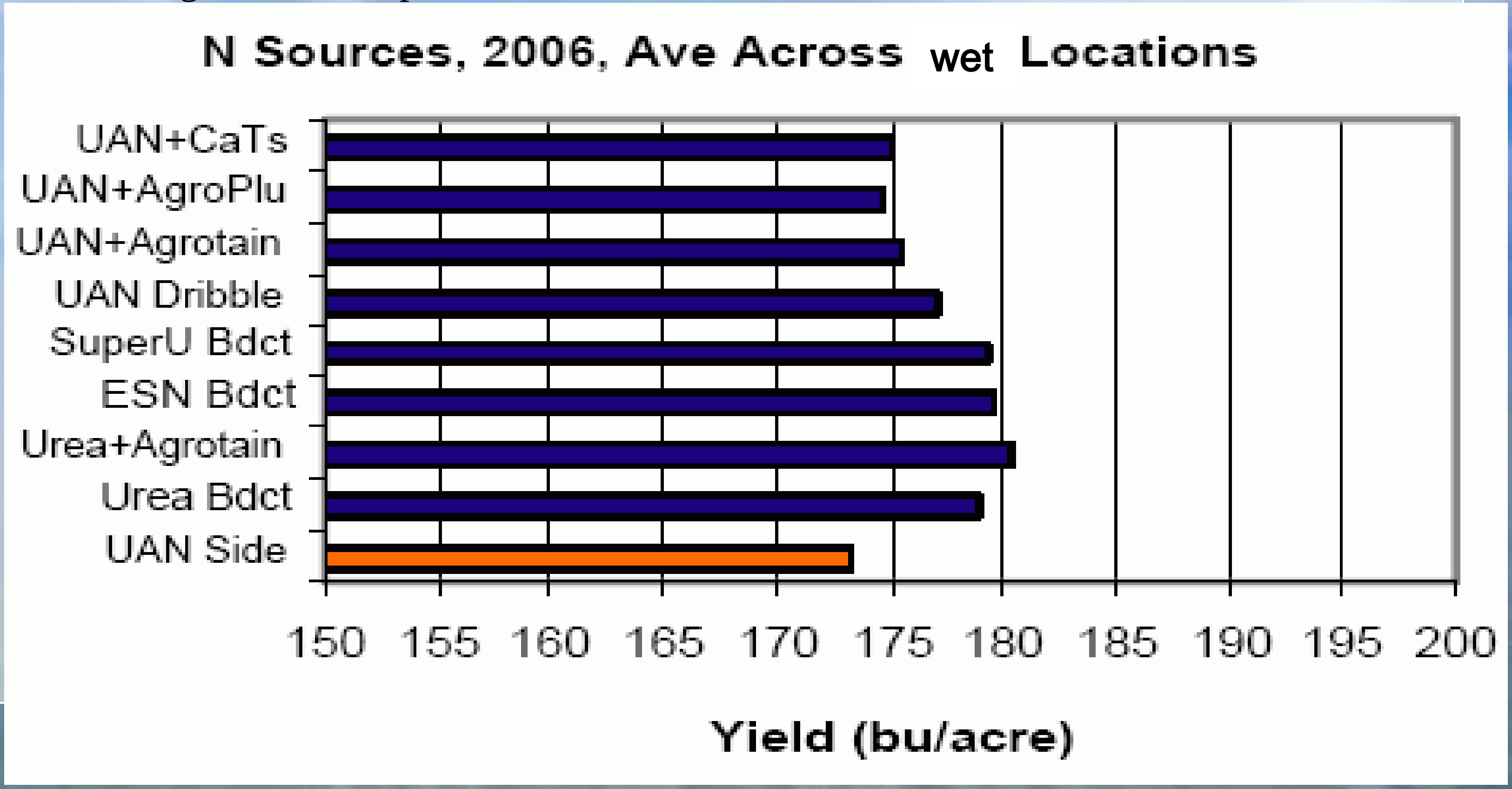


Figure 6. PCR DGGE banding pattern of soil samples from 42 days. This band pattern was obtained utilizing the density trace from BioRad Density One Software. The Gel was electrophoresed in the 100-L DGGE tank.

◀ black arrow indicates an additional band

When studying nutrient plant response… is water important?

- Ebelhard, Hernandez, Fernandez, Paul, and Hart. 2007. Evaluation of Nitrogen Fertilizer Technologies for Corn production



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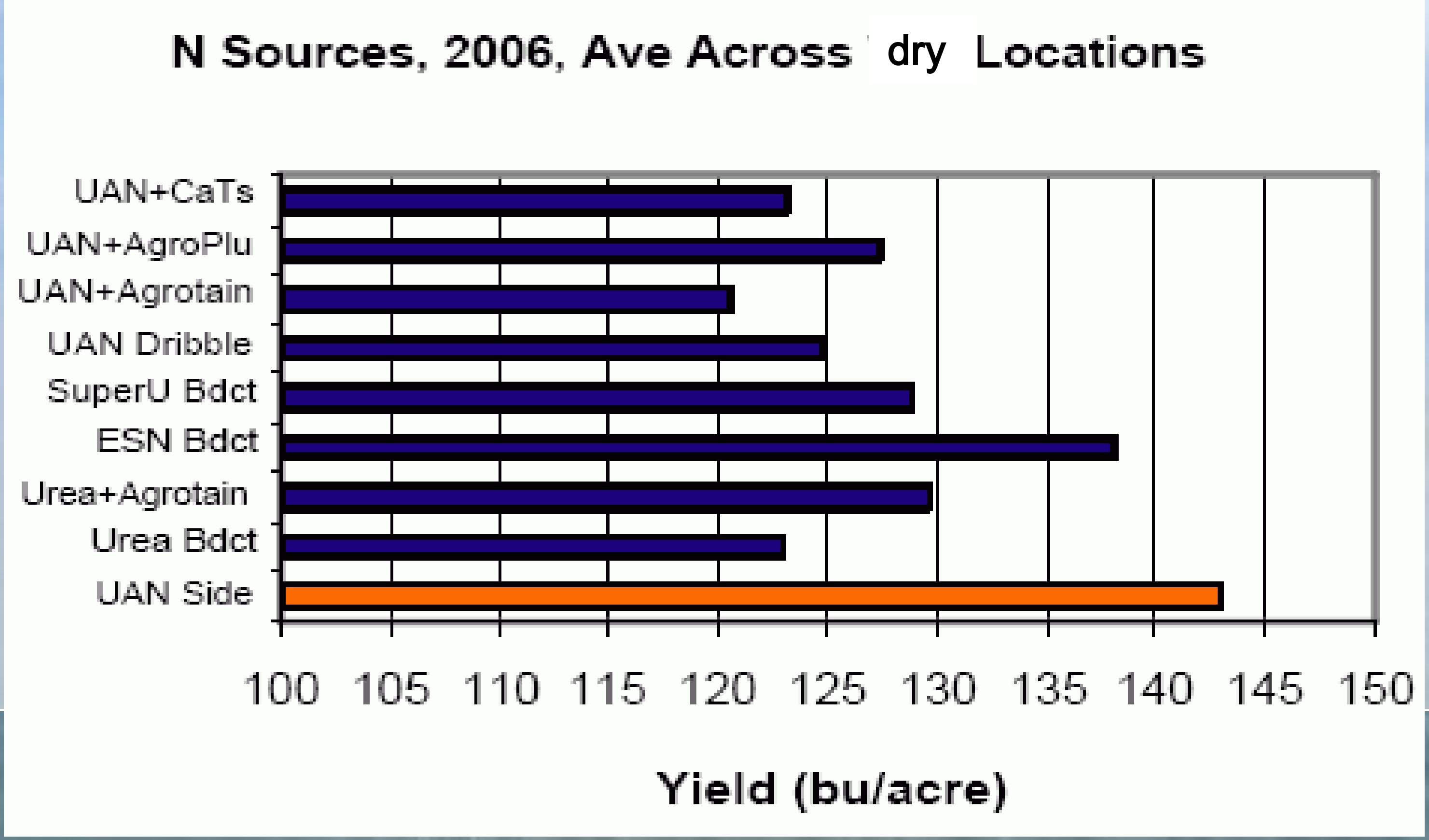

Ebelhard, Hernandez, Paul, Hart, Fernandez. 2009. Effect of N source and N rate in non tilled corn yield 2008

N Source	Belleville	DSAC	Average
	Corn Grain Yields (bu/acre)		
UAN Side Injected	126 ab	182 a	154
Urea Broadcast	91 e	151 d	121
Urea+Agrotain	122 bc	169 b	145
ESN Broadcast	139 a	166 bc	153
SuperU Broadcast	109 cd	163 bc	136
UAN Broadcast	111 bcd	160 bcd	136
UAN+Agrotain	121 bc	160 bcd	141
UAN+AgrotainPlus	118 bcd	159 bcd	139
UAN+CaTs	104 de	157 bc	131
UAN+AgrotainDF	124 bc	165 bc	145
Average	116.5	163.4	
$LSD_{0.05}$ N Source	15.0	10.2	
Statistics:			
N Source (NS)	***	***	
N Rate (NR)	***	***	
NS x NR	NS	NS	
N Rate	Corn Grain Yields (bu/acre)		
0	54	137	96
60	88	158	123
120	120	170	146
180	152	176	164
240	168	176	172
Check (% of Max.)	32%	78%	
Statistics:			
NR linear	***	***	
NR quadratic	***	***	

, **, and * refer to significance at the 10, 5 and 1% levels, respectively. NS = nonsignificant.*

Future Needs & new N fertilizer technologies

- To accept that we need them to increase productivity
- To increase the understanding of mechanisms controlling release rate, its pattern and the environment.
  - Example: Temperature, moisture, soil-plant microorganisms, soil chemistry, soil type, crop physiology, etc.

Future Needs

- Economical Significance of Reducing Fertilizer Pollution by increasing nutrient use efficiency by integrate approach (soil-plant-technology)
- Improved Quantification of the Physiological, Agronomic, and Economic Advantages of Using Plant, Soil, Fertilizer, management approaches.

Future Needs

- Use of Mechanistic-Mathematical Models for predicting release and uptake of nutrients under lab and field conditions and relate it to plant productivity.
- Integrating soil, water, crop, fertilizer & new available tecnologies knowledge to increase the bottom line.

Provocative statements

- Are we willing to accept new technologies in crop nutrition at a faster pace than other industries?
- Are we willing to brake the tradition to quantify crop nutrients only as UNITS of NUTRIENT per area?
- Is any opportunity to believe that not all the nutrients are equal per unit in the soil?

Provocative statements

- Are we the last Ag Industry to believe in innovation in Ag production (plant nutrients)?
- What about other new emerging technologies in crop nutrition such as
  - Beneficial Nutrients (example Titanium)
  - Biostimulants


Questions?