New Crop Nutrition Technologies
Nitrogen case

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Arysta LifeScience
Orlando, December 5, 2012
• 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\textsuperscript{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 DIMENSIONS)
  • 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
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
    - MgNH₄PO₄
    - 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

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

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.
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 band pattern was obtained utilizing the density trace from BioRad Density One Software. The Gel was electrophoresed in the 100-LDGGE 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-LDGGE tank.

*black arrow indicates an additional band*
When studying nutrient plant response... is water important?

When studying nutrient plant response... is water important?


<table>
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<th>N Source</th>
<th>Belleville</th>
<th>DSAC</th>
<th>Average</th>
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<tr>
<td>UAN Side Injected</td>
<td>126 ab</td>
<td>182 a</td>
<td>154</td>
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<tr>
<td>Urea Broadcast</td>
<td>91 e</td>
<td>151 d</td>
<td>121</td>
</tr>
<tr>
<td>Urea + Agrotain</td>
<td>122 bc</td>
<td>169 b</td>
<td>145</td>
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<tr>
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<tr>
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<tr>
<td>UAN Broadcast</td>
<td>111 bed</td>
<td>160 bcd</td>
<td>136</td>
</tr>
<tr>
<td>UAN + Agrotain</td>
<td>121 bc</td>
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<td>141</td>
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<tr>
<td>UAN + AgrotainPlus</td>
<td>118 bed</td>
<td>159 bcd</td>
<td>139</td>
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<td>UAN + CaTs</td>
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<td>UAN + AgrotainDF</td>
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<td>LSD (In N Source)</td>
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**Statistics:**
- N Source (NS): ***
- N Rate (NR): ***
- NS x NR: NS

<table>
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<th>Belleville</th>
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<td>172</td>
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<tr>
<td>Check (% of Max.)</td>
<td>52%</td>
<td>78%</td>
<td></td>
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**Statistics:**
- NR linear: ***
- NR quadratic: ***
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?