Making Urea Work in No-till

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Objectives & Relevance:

- The objective of this project is to evaluate several strategies to reduce the risk of ammonia volatilization loss from urea applied to no-till corn and wheat.
  - Yield and economic outcomes from these strategies will be compared with broadcast urea and with other N sources.
  - Strategies to be evaluated include:
    - Urea treated with Agrotain volatilization inhibitor
    - Polymer-coated urea
    - Knife-injected urea

- This project is relevant to Missouri agriculture because:
  - No-till and reduced-tillage production systems are widely used in Missouri.
  - In no-till systems, there is a high risk of N loss from broadcast urea. Research has shown substantial yield loss when broadcast urea is compared with other N sources.
  - Ammonium nitrate has been a low-risk granular N source for use in no-till, but its availability has been declining while availability of urea has been increasing. In the long term it does not appear that continuing use of ammonium nitrate will be a viable alternative for no-till corn producers.
  - Thus, there is a need to find ways to make urea a viable, reliable, economical, and low-risk N source for no-till corn and wheat production.

Procedures:

- Trials will be located on Bradford Farm near Columbia.
- Treatments will be nitrogen sources and placement
  - All treatments will be applied at rates of140 lb N/ac for corn, 80 lb N/ac for wheat.
  - Broadcast treatments
    - Urea
    - Urea with Agrotain volatilization inhibitor
    - Polymer-coated urea
    - Ammonium nitrate
    - 30% urea-ammonium nitrate solution
  - Knife-injected treatments (corn only)
    - Urea
    - Anhydrous ammonia
    - 30% urea-ammonium nitrate solution
- Each treatment will be replicated eight times.
- Nitrogen stress will be measured mid-season with a chlorophyll meter. When yield is lower due to N loss, the same plots should show stress in these measurements.
- Yield measurements will be made for all treatments.
- Estimates of economic return will be made for all treatments.
- Yield and economic return will be statistically analyzed to evaluate possible differences between treatments.

Current status and importance of urea use in no-till grain production:

- No-till and reduced till systems for grain production have become much more widely used in the past thirty years.
  - These systems have been highly successful in:
    - Reducing soil erosion and topsoil loss
    - Reducing phosphorus movement to surface water
    - Reducing labor, fuel, and equipment requirements

- In no-till systems, there is a high risk of N loss from broadcast urea.
  - When urea is surface applied, an average of 25% and maximum of 50% of the applied N is lost via ammonia volatilization.
  - Past University of Missouri research has shown that corn and wheat yields with broadcast urea are, on average, 15 and 5 bushels/acre lower, respectively, than with broadcast ammonium nitrate (from 30 corn experiments, 7 wheat experiments).
  - In tilled systems, we recommend tillage to incorporate urea to prevent ammonia volatilization losses of N from the urea. This option is not practical in no-till systems and may not be practical in some reduced-till systems.

- The University of Missouri has recommended ammonium nitrate in preference to urea for broadcast application to no-till systems; however, current market forces are reducing availability of ammonium nitrate while increasing availability of urea.
  - New urea production plants are being built, while no new ammonium nitrate production plants are being built.
  - Old ammonium nitrate plants are being shut down.
  - These trends have to do with production and transport costs and with liability.
  - Missouri retailers who have been selling ammonium nitrate are switching to urea.
  - Old anhydrous ammonia plants are being shut down in the U.S. due to high natural gas prices. This is increasing our reliance on imported nitrogen fertilizers.
  - Urea is the main imported N fertilizer.
    - Much of the nitrogen production in the rest of world is urea.
    - Urea is easy to import, not much infrastructure is required.

- Thus, there is a pressing need to come up with ways to make urea work as a nitrogen source for no-till systems. Promising ideas include:
  - Treating urea with the urease inhibitor Agrotain before broadcasting. This product was developed in the 1980s and stood out far above the other inhibitors being tested at the time. It slows down the breakdown of urea and delays volatilization losses, increasing the odds that a substantial rainfall will move the urea into the soil.
  - Polymer coating of urea. Agrium has recently started producing a polymer-coated urea that is inexpensive enough to use for field crops. This product releases urea slowly and appears to be effective in reducing the amount of N lost to ammonia volatilization.
  - Knife injection of urea. Ammonia gas will still form, but will be trapped in the soil and not lost to the atmosphere. Cost analysis is a major need for this alternative.

Timetable:

Feb-March 2004	Equipment and materials preparation
March 2004	Apply N treatments to wheat
April 2004	Apply N treatments for corn, plant
May 2004	Chlorophyll meter measurements on wheat plants to sense any N deficiencies
June-July 2004	Harvest wheat
July 2004	Chlorophyll meter measurements on corn plants
September 2004	Harvest corn
Oct-Dec 2004	Analyze results, write report
2005, 2006	Same as 2004

Strategy for application/transfer of knowledge:

Transfer of knowledge will be mainly via written and verbal educational programs, including press releases, newsletter articles, radio interviews, conferences, and transfer via the university's network of regional Extension Specialists. For any treatments that are particularly successful, a focused educational campaign will be mounted to educate fertilizer users and retailers about the advantages relative to broadcasting urea.

Budget:

- Although we have much of the equipment that will be needed to make the fertilizer applications for this project, some modifications of this equipment will be necessary in order to correctly apply the treatments. Parts needed include shanks/coulters/knives, regulator, vertical dam manifold, shutoff, valves, electric clutch, and other smaller parts. Larry Mueller, my research specialist, has excellent skills in equipment design and fabrication.
- Larry is also very good at conducting plot research and will have the main responsibility for planting, applying N treatments, taking chlorophyll meter measurements, and harvesting. I estimate that it will take 35% of his time to conduct these experiments.
- Supplies including fertilizer, fuel, seed, herbicides, and computer supplies will also be needed to carry out this project.

Budget year 1:

Equipment modification	
parts	$5,000
labor	3,000
Research specialist 35%	11,200
Benefits @27.5% of salary	3,025
Supplies	1,000
Total year 1	**$23,225**

Budget year 2, 3:

Research specialist 35%	11,200
Benefits @27.5% of salary	3,025
Supplies	1,000
Total year 2,3	**$15,225**
3-year total	**$53,675**

Peter Clifton Scharf

Education

Degree	*Date*	*Institution*	*Major*
Ph.D.	May 1993	Virginia Polytechnic Inst. and State University	Crop & Soil Environmental Sciences
M.S.	July 1988	Virginia Polytechnic Inst. and State University	Agronomy
B.S.	August 1982	University of Wisconsin	Biochemistry, Genetics

Professional Experience

2002 to present *Associate Professor* in the Agronomy Department of the University of Missouri. Responsible for applied research and extension in the area of nutrient management.

1995 to 2002 *Assistant Professor* in the Agronomy Department of the University of Missouri.

Areas of Interest

- field-specific, soil-specific, and variable-rate fertilizer recommendations
- minimizing environmental impacts of agricultural practices
- optimizing crop management

Skills

- ability to communicate effectively, to cooperate with others, and to manage projects and people
- outstanding laboratory, field, project design, and data analysis skills
- excellent natural science background

Sample Research Publications

Scharf, Peter C. and William J. Wiebold. 2003. Soybean yield responds minimally to nitrogen applications in Missouri. Online. Crop Management doi:10.1094/CM_2003_1117_01_RS.

Scharf, Peter C., John P. Schmidt, Newell R. Kitchen, Kenneth A. Sudduth, S. Young Hong, John A. Lory, and J. Glenn Davis. 2002. Remote sensing for N management. J. Soil Water Cons. 57:518-524.

Scharf, Peter C., William J. Wiebold, and John A. Lory. 2002. Corn yield response to nitrogen fertilizer timing and deficiency level. Agron. J. 94:435-441.

Scharf, Peter C. 2001. Soil and plant tests to predict optimum N rates for corn. J. Plant Nutr. 24:805-826.

Sample Extension Publications

Scharf, Peter. 2003. Nitrogen prices are up again: How should that affect management decisions? Integrated Pest and Crop Management 13:25-26.

Scharf, Peter, Kevin Bradley, Shawn Conley, and Bill Wiebold. 2003. Risk of atrazine carryover damage to wheat and soybean. Integrated Pest and Crop Management 13:140.

Scharf, Peter and John Lory. 2003. Calibrating corn color from aerial photographs to predict sidedress nitrogen need. Crop Decisions Jan/Feb 2003 p. 26-28.