Nitrogen dynamics of standard and enhanced urea in corn

James H. Houx III and Felix B. Fritschi

INTRODUCTION:

Concerns about illegal uses of anhydrous ammonia and ammonium nitrate may make urea a more suitable N fertilizer choice in the future. Urea is more concentrated than most N sources and thus may be more economical to apply. However, urea is subject to volatilization losses that in extreme circumstances can be as much as 50% (Harrison and Webb, 2001). To combat N losses from urea, manufacturers have developed additives and specialty N fertilizer products designed to inhibit N losses and prolong the N release period. These characteristics may reduce leaching and nitrate runoff, and may reduce emissions of N-containing greenhouse gases. Further, they may offer producers some flexibility in their N management decisions.

OBJECTIVE:

The overall objective of this project is to evaluate different Urea-N management products on the fate of fertilizer N and corn yields.

Specifically, we will:

1) Evaluate corn yield response to fertilization with standard urea and enhanced N-urea (Agrotain, Nutrisphere, and ESN).
2) Examine timing and quantity of corn fertilizer N uptake, fertilizer N use efficiency, and recovery in the soil base for these product classes using ^{15}N tracer techniques.

2010 ACCOMPLISHMENTS AND UPDATE:

- This year (2010) was the second year of a 3-year project evaluating urea-N management products on corn yield and nitrogen uptake, nitrogen use efficiency, and recovery of soil nitrogen following corn harvest.
- The following treatments were randomly applied to 30’ x 80’ plots and replicated four times at the Bradford Research and Extension Center. Four, square-meter microplots were embedded in each plot receiving treatments 2, 3, and 4 in which ^{15}N-enriched urea at 2% atom excess was supplanted for standard urea. This year, we added another urea product, SuperU from Agrotain LLC, to the study.

  Main Treatments*: (6 treatments to evaluate product effect on yield)*

  1) Zero fertilizer N
  2) Urea (^{15}N microplot)
  3) Agrotain treated Urea (^{15}N microplot)

4) PCU (Polymer coated Urea—Duration 75) (^{15}N microplot)
5) Nutrisphere treated Urea
6) ESN urea
7) 28% UAN (as a growers standard)
8) SuperU urea

- International Fertilizer Development Corporation (IFDC) in Mussel Shoals, AL manufactured the ^{15}N urea and we received the material in April 2009. The pellet size was consistent with bagged urea purchased from MFA.
- Pioneer hybrid 33M16 (corn) was no-till planted into good soil conditions on May 24, 2010 and established a uniform population of approximately 32,000 plants/acre.
- The N treatments were broadcast surface-applied (except injected UAN) at a rate equivalent to 150 lbs N/acre the day of planting.
- Soil and plant tissue samples were taken periodically in the main plots and ^{15}N microplots during the growing season and following harvest—these samples are being processed and analyzed with the 2009 samples and we expect analysis to be completed in early 2011.
- Once soil and tissue samples have been analyzed, full-season fertilizer use efficiency, amount of plant N derived from fertilizer, amount of fertilizer N removed from the field with the grain, and ^{15}N remaining in the soil will be determined to construct a fertilizer N balance.

2009 and 2010 PRELIMINARY RESULTS:

- Yields of all treatments, except UAN, were significantly less in 2010 than in 2009 (Fig. 1).
- The highest yielding treatment in 2009 (PCU) was the second highest yielding treatment in 2010. UAN yields were similar in 2009 to PCU but greater in 2010 than PCU.
- In 2010, like in 2009, there were no differences in yield between Agrotain-treated urea, untreated urea, and Nutrisphere-treated urea. Yields from these products were less than that from ESN, UAN, and PCU.

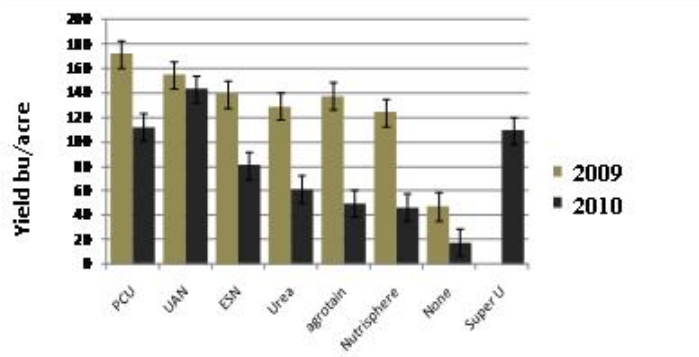

Figure 1. 2009 and 2010 corn yield from plots receiving different urea-N management products.

- SuperU, which was evaluated for the first time in 2010, resulted in yields that were similar to PCU and greater than all other treatments, except UAN.
- Yield differences corresponded to differences in kernel weight in 2009 (Fig. 2) with PCU applications resulting in the highest kernel weight of 36.3 grams/100 kernels and the zero N fertilizer resulting in the lowest kernel weight of 27.1 grams/100 kernels. In 2010, yield differences did not correspond to kernel weight, but the highest kernel weights did

correspond to the highest yielding treatments, UAN and PCU (29.2 and 28.5 grams/100 kernels, respectively).

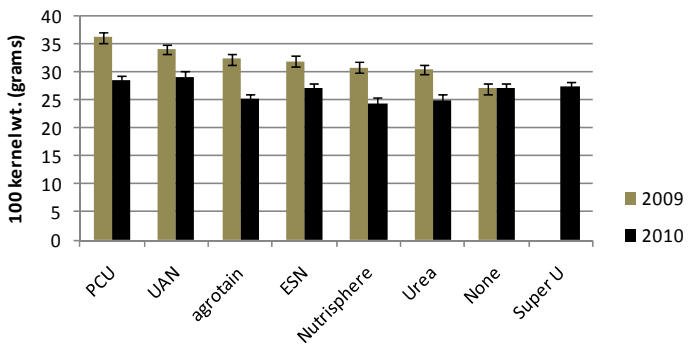

Figure 2. 2009 and 2010 kernel weights for corn receiving different urea management products.

- In 2009, there were no statistically significant differences in kernel weight between Agrotain- treated urea, ESN, Nutrisphere-treated urea, and untreated urea. These treatmtents resulted in 100 kernel weights of 32.4, 31.9, 30.8, and 30.5 grams, respectively. In 2010, there were no differences in kernel weight between Agrotain-treated urea, untreated urea, and Nutrisphere-treated urea (25.3, 25.1, and 24.5 grams/100 kernels, respectively), but these products resulted in lower kernel weights than no urea or ESN (27.1 and 27.2 grams/100 kernels, respectively) which were similar to each other.
- In 2009, rainfall events soon after application likely incorporated much of the surface applied urea. In 2010, urea applied at planting remained at the soil surface for 8 days before rainfall could incorporate the fertilizer on June 2. This may partly explain the poor yields in 2010 from the urea and urea products.

OBJECTIVES FOR YEAR 3 (2011):

The third field season of this 3-year experiment will be repeated in 2011 using a similar planting and experimental layout as in 2009 and 2010. Following are the planting and experimental layout for 2011.

Cultural Practices: This study will be conducted as the third season of a 3-yr field study at the Bradford Research and Extension Center in Columbia, MO. The experiment was initiated in spring 2009. Fertilization of P and K will be conducted according to soil test results and N fertilization will be uniform across all main treatments as surface-applied urea at planting. N will be applied at rates equivalent to 150 lbs N/acre. This rate should allow for differences in N release, uptake, and loss to affect yield. Higher N rates may not allow us to delineate treatment differences due to N source. Microplots will be embedded in the larger plots and standard urea will be substituted with ^{15}N- enriched urea.

Design: Each treatment will be replicated four times in a randomized complete block design. Each main treatment will be applied to 30’x 80’ plots to allow for destructive plant sampling throughout the study. From these plots, tissue N analysis, final yield, and soil N samples will be taken. Within the 30’x80’ plot of treatments 2, 3, and 4 outlined above, a microplot will be delineated for fertilizer tracing. Microplots are standard research units and are necessary due to costs of ^{15}N-enriched fertilizer. We propose to apply ^{15}N-enriched urea (1.0 atom% excess) to 4-

m^2 microplots within the main treatment plots. Thus, we will be able to determine corn fertilizer uptake efficiency, residual soil fertilizer N, and N loss.

Measurements: Corn yield will be determined for every treatment in 30'x80'plots. Crop growth and development will be measured 5 times over the course of each growing season and plant samples will be collected at selected time points for determination of tissue N levels. Plants will be sampled in all treatments in the main plots (not labeled with ^{15}N) as well as the microplots where applicable. Samples collected at harvest will allow us to determine full season fertilizer use efficiency, amount of plant N derived from fertilizer, and amount of fertilizer N removed from the field with the grain. Soil samples will be taken to determine ^{15}N remaining in the soil, and construct a fertilizer N balance.

PROPOSED BUDGET FOR YEAR 3 (2011)

Category	**Year 3**
Personnel	
Research Associate (40%)	$14,710
Benefits	$4,859
Analytical cost (soil and plant N and ^{15}N analysis)	$3,000
^{15}N fertilizer purchase, formulation, and field supplies	$4,500
Travel	$1,000
Total	**$28,069**