NITROGEN MANAGEMENT USING REDUCED RATES OF POLYMER COATED UREA IN CORN

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Introduction:
Poorly drained soils are common in Missouri. Farmers with poor drainage have additional options for N management using polymer coated urea (Merchán Paniagua et al., 2005; Schwab et al., 2005). Polymer coated urea has been shown to reduce N_2O flux in plots with poor drainage (Merchán Paniagua et al., 2005). Performance of polymer coated urea has been equivalent to anhydrous ammonia in Northern Missouri (Motavalli et al., 2005) and less consistent in Central Missouri (Medeiros et al., 2005). Preliminary research in 2005 at Novelty has indicated that polymer coated urea rates may be reduced up to 30% while maintaining corn grain yields similar to a 150 lb/a rate regardless of application timing. This may be a cost-effective management option for farmers to offset the cost of the polymer coating.

Availability of ammonium nitrate and anhydrous may be limited in the future. The slow-release properties of polymer coated urea have appealing characteristics for corn producers in watersheds with the potential of surface water runoff or soils with high leaching potential (Rosen and McNearney, 2005). Placement of polymer coated urea has demonstrated improved utility and yield of potato in Wisconsin (Rosen and McNearney, 2005) and corn in Minnesota (Randall, unpublished) compared to other N sources. Finally, incentive payments through the Conservation Security Program were available to producers in Missouri utilizing coated urea technology. This could impact over 1.8 million acres in qualified watersheds (NRCS, 2005). Recently, N prices have increased dramatically while corn prices have been variable. A polymer coating may increase cost of N up to $0.11/lb; therefore, reduced rates of polymer coated urea need to be evaluated to balance the additional cost of the coating while maintaining the yield potential of corn. In addition, no published research has evaluated the release of the polymer coated urea for corn in field experiments on poorly drained soils. No research has evaluated degradation as affected by residue, tillage, or placement in the soil. No published research has reported the effects of reduced rates of polymer coated urea and determined the interaction with application timing as a cost-effective method to reduce N application rates.

The objectives of this study were to: 1) evaluate yield response of no-till corn with reduced rates of polymer coated urea compared with non-coated urea at different application timings, 2) determine the interaction between application timing and N source on ammonium-N and nitrate N in the soil profile, and 3) assess the impact of application timing and placement on polymer coated urea degradation.

Materials and Methods:
A field trial with four replications was established at the Greenley Research Center in plots 10 by 40 ft to evaluate crop response to polymer coated urea (ESN) compared to non-coated urea at 0, 50, 100, and 150 lbs N/acre. ‘Asgrow RX752’ was no-till planted on April 28, 2006 at 30,000 seeds/acre. A fall application of 23-60-100 and 27-70-200 was applied as recommended by the University of Missouri soil test lab in 2005 and 2006, respectively. Nitrogen application timings included: 1) fall (November 4, 2005 and November 7, 2006), 2) early preplant (April 5, 2006

and March 16, 2007), 3) preemergence (broadcast applied on April 28, 2006 and April 23, 2007), and 4) broadcast sidedress (1-2 ft corn on June 5, 2006 and June 29, 2007) treatments. An untreated and standard anhydrous treatment at 150 lbs N/acre was included as a control. The field trial was monitored for ammonium-N and nitrate-N at three timings throughout the season (first rainfall after the sidedress timing, prior to silking, and black layer) and throughout the profile at three incremental depths (0-6, 7-12, 13-18 inches). The untreated control and 150 lb N/a rates of polymer coated urea, urea alone, and anhydrous treatments were monitored for N concentrations.

An additional field study utilized buried bags to evaluated degradation of the polymer-coated urea to determine N release throughout the growing season. This method has been utilized in wheat research on poorly drained soils (Schwab et al., 2005) and potato research on sandy soils (Rosen and McNearney, 2005), but N release has not been evaluated on poorly-drained soils for corn planted in different residues common in Missouri. This study included a factorial arrangement of 3 residues (no-till wheat stubble with red clover, no-till soybean residue, and reduced till soybean residue), 3 application depths (surface applied, 2 inch depth, and 4 inch depth), 3 application timings (March, April, and May), and 5 removal timings (April, May, June, July, and black layer). An additional air exposed control was included in the design. Each treatment was replicated three times. A nylon window screen packet was constructed for each treatment. Each screen packet held approximately 10 grams of polymer coated urea. Packets were weighed prior to placement in the field. The packets were then recovered from each treatment, washed with ice water, dried and weighed. Release of urea was calculated as (1-(removal date weight/weight at application))*100. All data were subjected to an analysis of variance and means separated using Fisher's Protected LSD (P=0.05).

Results in 2006:

Grain yields were above average at Novelty in 2006. No-till corn yield with polymer coated urea at 150 lb/a was similar to anhydrous at 150 lb/a at all four application timings while yields with anhydrous were 24 to 59 bu/acre greater than urea at the fall, early preplant, and side-dress timings (Figure 1). Rainfall following application of the pre-emergence N treatment probably contributed to grain yields that were similar among the N sources at this timing in this research. Reduced rates of polymer coated urea appear justified at later application timings when compared with urea alone. Polymer coated urea rates that were reduced by 30% had yields similar to the 150 lb/a rate at the pre-emergence and side-dress timings in 2006, and were similar to anhydrous at 150 lb/acre.

Release of nitrogen from polymer coated urea granules was greatest for deep placement followed by the 1-2 inch depth placement in no-till wheat/clover residue (Figure 2). Moisture content may be greater in this cropping system which probably contributed to increased release of urea. Surface applied polymer coated urea release was ranked no-till soybean stubble > no-till wheat/clover residue = conventional tillage.

November applied polymer coated urea released 20-30% of the fertilizer by mid-April, 2006 (Figure 3). Fertilizer release was similar for nearly all of the 1-2 and 4 inch deep placements for all of the recovery dates except November applied polymer coated urea. Surface applied polymer coated urea was slower for March applied fertilizer from mid-May to mid-July, April applied fertilizer from mid-June to mid-July, and May applied fertilizer at the mid-July recovery dates. Air exposed packets were included as control treatments to determine the effect of sunlight, rainfall, and other conditions on the integrity of the polymer coating. Sunlight was probably a major factor affecting the coating and may help in the degradation of the polymer coating. In the absence of direct soil contact, release of fertilizer from the polymer coating was generally less than surface applied treatments.

Summary and Conclusions:

Reduced rates of polymer coated urea may be justified at pre-emergence and side-dress application timings. Tillage system and fertilizer placement affects the release of polymer coated urea. This may be related to the moisture content in the soil of these systems. Variable crop response from polymer coated urea during dry years may be related to slower fertilizer release especially when polymer coated urea was applied in no-till conditions. Polymer coated urea fertilizer release reached 70-90% by black layer while in the absence of direct contact with moist soil, fertilizer release was 50-60%. In general, yields with polymer coated urea were greater than or equal to non-coated urea in 2006.

References:

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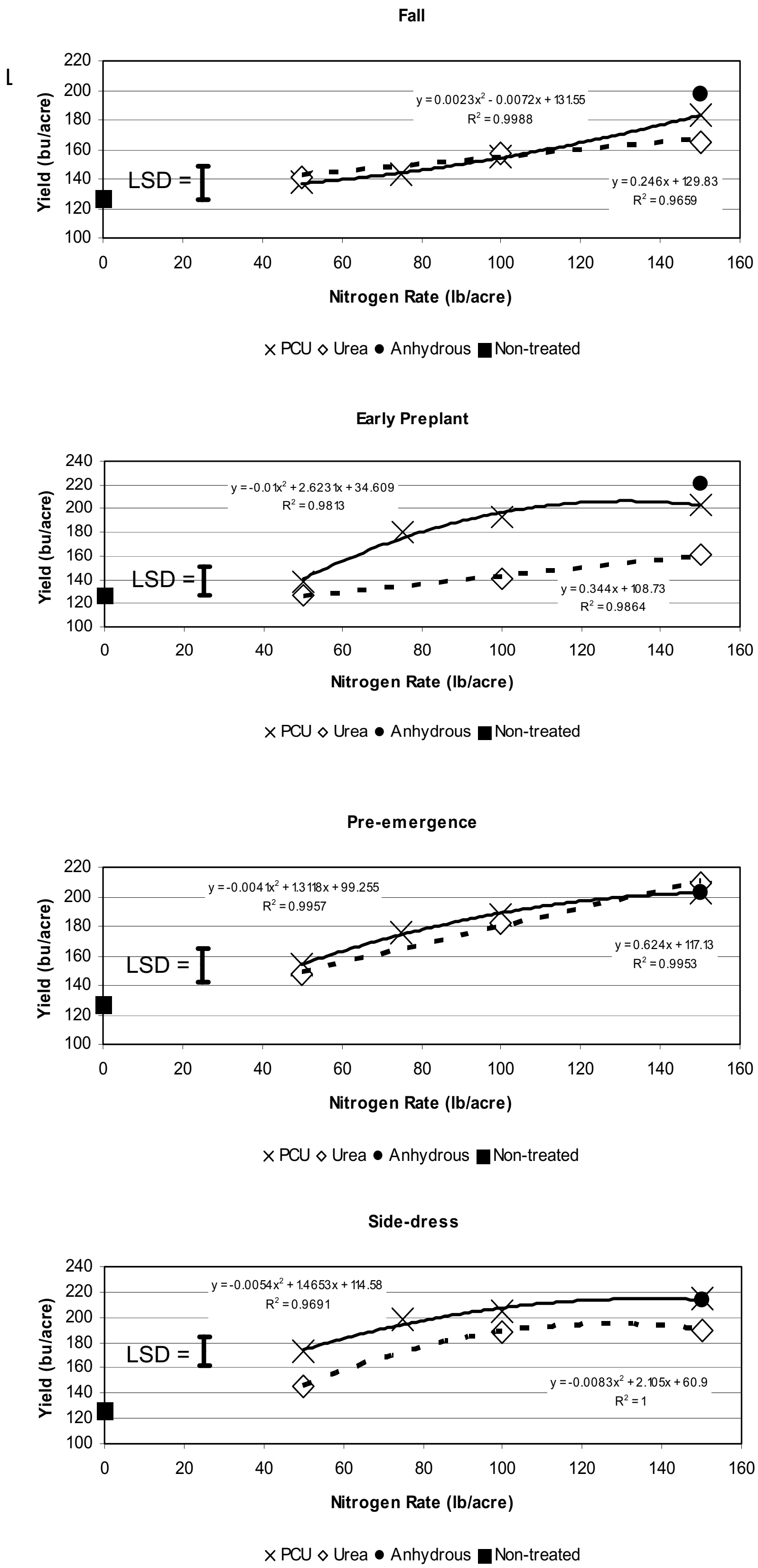

Figure 1. Yield response of no-till corn to reduced rates of polymer coated urea compared with non-coated urea at fall, early preplant, pre-emergence, and side-dress application timings.

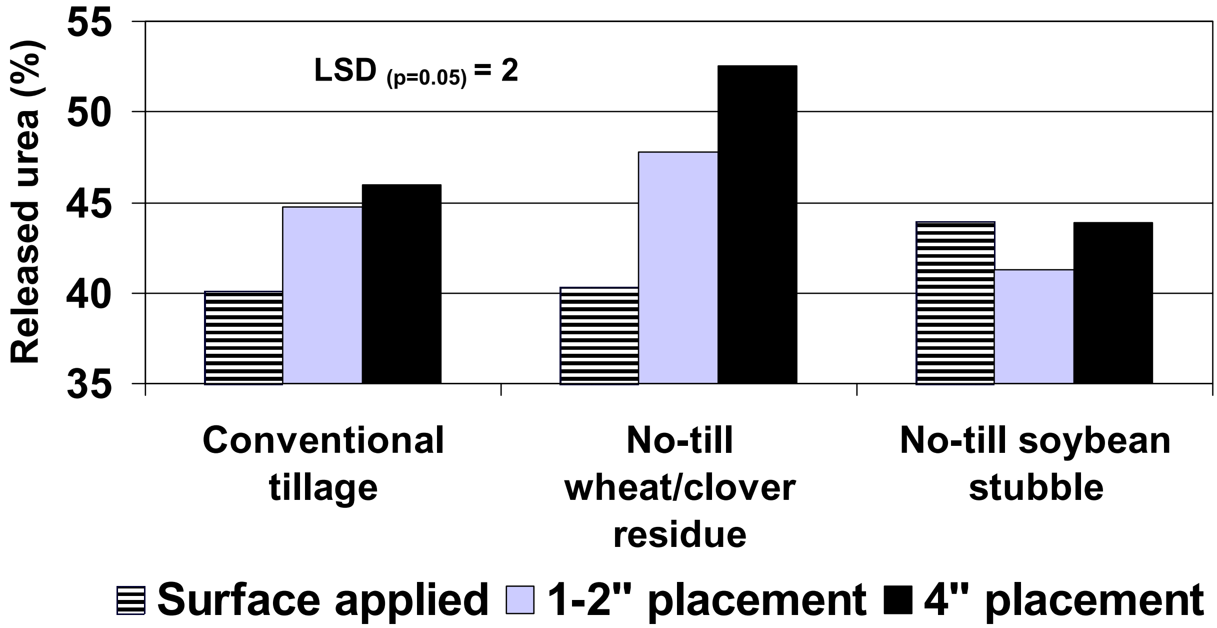

Figure 2. Effect of tillage and placement on release of fertilizer from polymer coated urea. Data were averaged over application and removal timings.

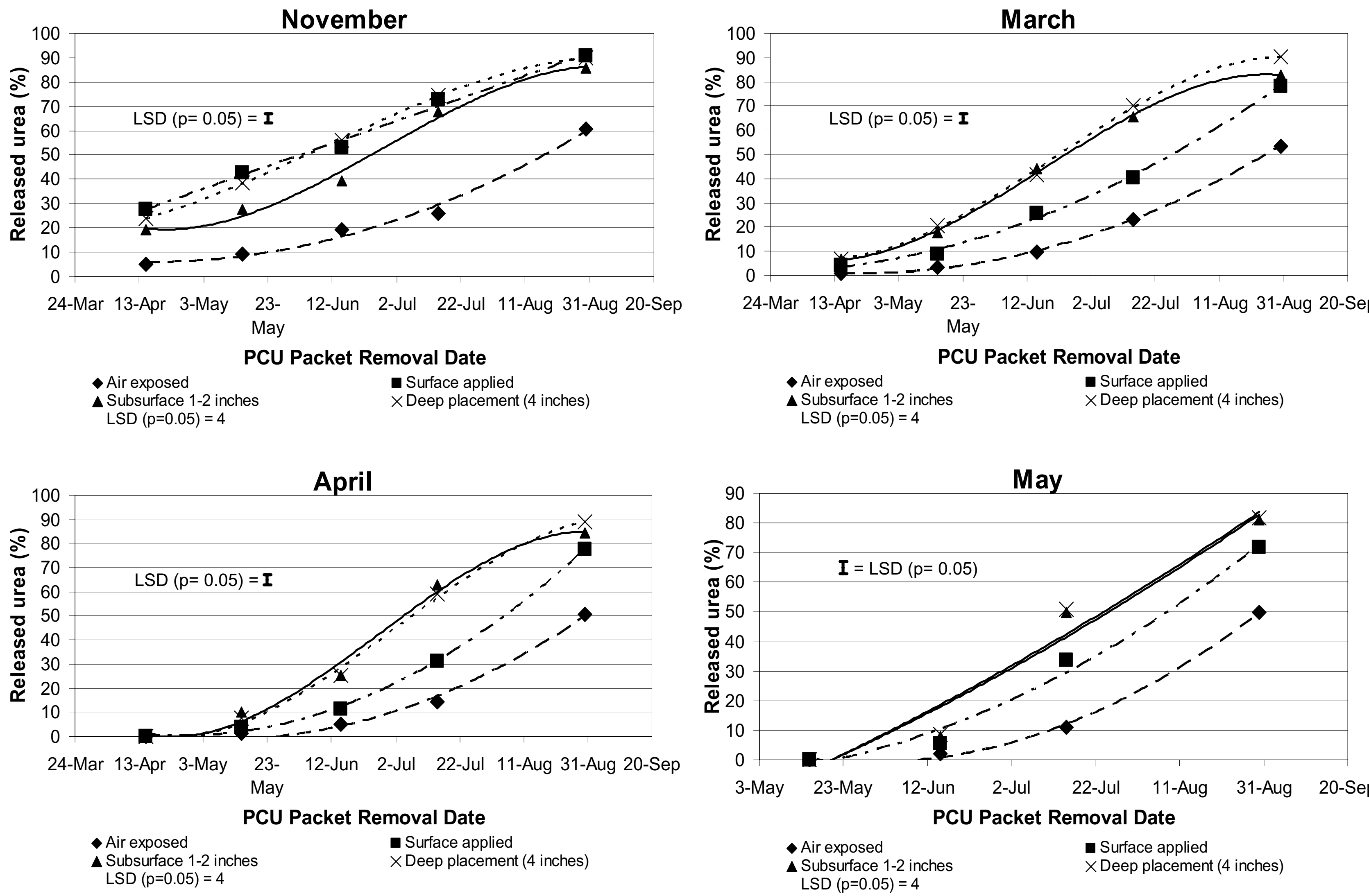

Figure 3. Polymer coated urea released from November 15, March 15, April 15, and May 15 application timings. PCU packets were removed on April 1, May 1, June 1, July 1, and August 31. Released urea values were calculated as (1-(removal date weight/weight at application))*100.