NITROGEN PLACEMENT IN NO-TILL CORN[1]

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ABSTRACT

Placement of nitrogen (N) fertilizers on no-till corn was evaluated in various single and multiple N rate experiments at the Belleville and Carbondale Research Centers of Southern Illinois University from 1983 to 1993. In 15 experiments in which granular urea placement was compared, ear leaf N and grain yield were essentially the same whether urea was broadcast or concentrated in surface bands near corn rows. Only a 2 bu/ac average yield advantage was observed for banding versus broadcasting urea in those studies. For UAN benefits to yield from subsurface placement were clearly evident. In early experiments (1983-1986) in which the Nutri-Blast high pressure injection system for UAN was used, corn yield increases of 9 bu/ac were obtained for injection over broadcast placement of UAN. In later experiments (1987-1993) when the point injection concept was used, greater yields were yet attained due to deeper placement afforded by the system. In those experiments grain yields from point injection were 18 bu/ac greater than obtained from broadcast placement of UAN. Injection of UAN 6 inches from corn rows compared to mid-row (15 inches) placement also was shown in selected experiments to increase yields about 4 bu/ac and decrease average grain moisture at harvest by about 0.5 percent. Generally, dribble placement of UAN gave yields increases of 3 to 5 bu/ac greater than those obtained from broadcasting.

INTRODUCTION

Nitrogen management in no-till corn offers special challenges. The mulch layer in a no-till system serves to shield the soil from the erosional effects of raindrops but also creates an unique environment in the soil just below the residues. Microbial activity associated with decomposition of the residues is high in the soil zone just below the residues. N applied in this zone can readily become immobilized by the soil microorganisms if the residues have a high carbon to nitrogen ratio, such as the residues

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from a preceding corn crop. Likewise, the greater soil wetness below the mulch can result in favorable conditions for denitrification and leaching, if appreciable amounts of the applied N has converted to nitrate (NO_3) or was applied as NO_3. Under prolonged soil wetness losses by denitrification and leaching can be severe.

Urea and urea-containing N fertilizers, such as urea-ammonium nitrate (UAN) solutions, can suffer greater losses than other N sources if placed on the soil surface in contact with the residues. Urea and the urea contained in UAN readily undergoes enzymatic hydrolysis to form ammonia and carbon dioxide as end products. If the ammonia is not absorbed by the soil, it will volatilize and be lost to the atmosphere. Slow conversion of urea to form ammonia, such as occurs in cool soils or with the use of a urease inhibitor, reduces the magnitude of ammonia lost from the soil. Likewise, placement of urea and UAN below the soil surface has been found to reduce the potential for ammonia volatilization loss.

The objective of this report is to summarize the effects of different placement methods of N fertilizers on no-till corn N utilization and crop yield over an 11-year period from 1983 to 1993. Placement methods include broadcast and surface banding of urea and broadcast, dribble, and injection placement of UAN. In selected experiments, the effect injection placement distance for corn rows was evaluated in terms of corn development, N utilization, and yield.

MATERIALS AND METHODS

Studies in this report were conducted at the Southern Illinois University Belleville Research Center and Carbondale Agronomy Research Center from 1983 to 1993 on soils that are typical for the southern Illinois region and adjoining states. Soils at both locations belong mainly to the Udalfs and Aqualfs suborder, have a relatively low organic matter content (1-2 percent), and possess subsurface horizons that are argillic in nature which restricts both water movement and root penetration. Important soil series at Belleville include the Alford, Iva, and Weir and at Carbondale the Hosmer, Stoy, and Weir series dominate.

Broadcast and surface band placement comparisons of granular urea were included in a total of 15 experiments at both locations from 1983 to 1991. UAN placement (broadcast, dribble, and injection) was evaluated in a total of 22 experiments at the two locations from 1983 to 1993. In 8 of those experiments the Nutri-Blast (high pressure) injector was used and in the other 14 experiments a point injector (adapted from Benjamin, et al., 1988) similar in concept to the spoke-wheel injector was used. Nutri-Blast achieved a soil penetration below the surface residues of about 1-2 inches whereas point injection was 4-5 inches below the

soil surface. Broadcast placement was achieved by uniform distribution of the fertilizers (urea or UAN) between corn rows whereas surface banding of the urea and UAN was about 6 inches to the side of corn rows. Flat fan and dribble nozzles were used for the UAN. Placement of the injected UAN likewise was approximately 6 inches to the side of corn rows.

Nitrogen rates varied among experiments and years but ranged from 80 to 160 lb N per acre in all studies. The timing of N application was within 2 to 3 weeks following emergence. No irrigation was provided and the responses were evaluated across a wide range of seasonal conditions -- from drought to excessive wetness. In all experiments corn was planted into residues of a previous corn crop. Ear leaf samples for N composition were taken at the mid-silking stage and grain yields were corrected to a standard 15.5 percent moisture content.

RESULTS AND DISCUSSION

Placement of Urea

Concentrating granular urea in bands on the soil surface of no-till corn compared to uniform distribution by broadcasting had negligible effects on ear leaf N composition and yields (Figure 1). Averaged over 15 experiments at 2 locations, banding urea resulted in a 0.02 percent ear leaf N increase and 2 bu/ac grain yield increase compared to broadcasting. In most all experiments these differences were statistically nonsignificant. Improved yields from band placement of urea were not observed under the conditions of these experiments but have been reported by other researchers.

Placement of UAN

Injection of UAN was clearly superior to broadcasting UAN and in most cases better than dribble placement when no-till corn yield and leaf N composition were evaluated over 11 years and in 22 different comparisons (Figures 2 and 3). In the early studies (Figures 2) UAN was injected with the Nutri-Blast (high pressure) system. Frequently, with Nutri-Blast, only partial soil incorporation of UAN was achieved and much spattering occurred if the soils were compact and/or dry. In reality, Nutri-Blast served to be much like dribble placement. In the 8 experiments that included Nutri-Blast, ear leaf N compositions was increased 0.08 and 0.27 percent, respectively, by dribbling and injection compared to broadcast placement. Grain yields were 6 and 9 bu/ac greater with dribble and Nutri-Blast injection compared to broadcast application.

Adoption of the point injection system led to improved N utilization relative to broadcast and dribble placement (Figure 3). Grain yields were increased 3 bu/ac for dribble placement and 18 bu/ac for point injection placement compared to broadcasting.

Point injection deposited the UAN deeply into the soil and only minute amounts were observed at the soil surface. Upon hydrolysis of the urea component of UAN, greater soil absorption of ammonia likely occurred leading to enhanced crop N utilization and yield. Additionally, N immobilization was likely much less with the injected UAN compared to surface broadcasting or dribbling the liquid N fertilizer.

Proximity of UAN Placement to Corn Rows

The summarized results of 8 experiments conducted to evaluate the effect of distance of UAN placement from corn rows are given in Figure 4. In general, near-row injection of UAN was superior to mid-row placement. Average yield increases of 4 bu/ac were observed as well as a reduced grain moisture (0.5 percent) content at harvest when near-row placement was made compared to mid-row placement. The near proximity to rows of the applied N likely permitted early N utilization by the roots of the growing corn and led to advanced development and earlier maturity. Also once the N was taken up by the crop, soil loss would no longer be a contributing factor to reduced N use efficiency.

SUMMARY AND CONCLUSIONS

Research over an 11-year period in southern Illinois has shown that nitrogen placement was of considerable importance in N management for no-till corn. It was the authors' experience that broadcast and dribble placement of urea gave approximately equal yield results. However, application of UAN that was injected resulted in yields that were much greater than those obtained from surface broadcast or dribble placed UAN. To obtain the most benefit from injected UAN, placement 3 to 4 inches below the soil surface and complete slit closure of the applicator equipment are recommended.

LITERATURE CITED

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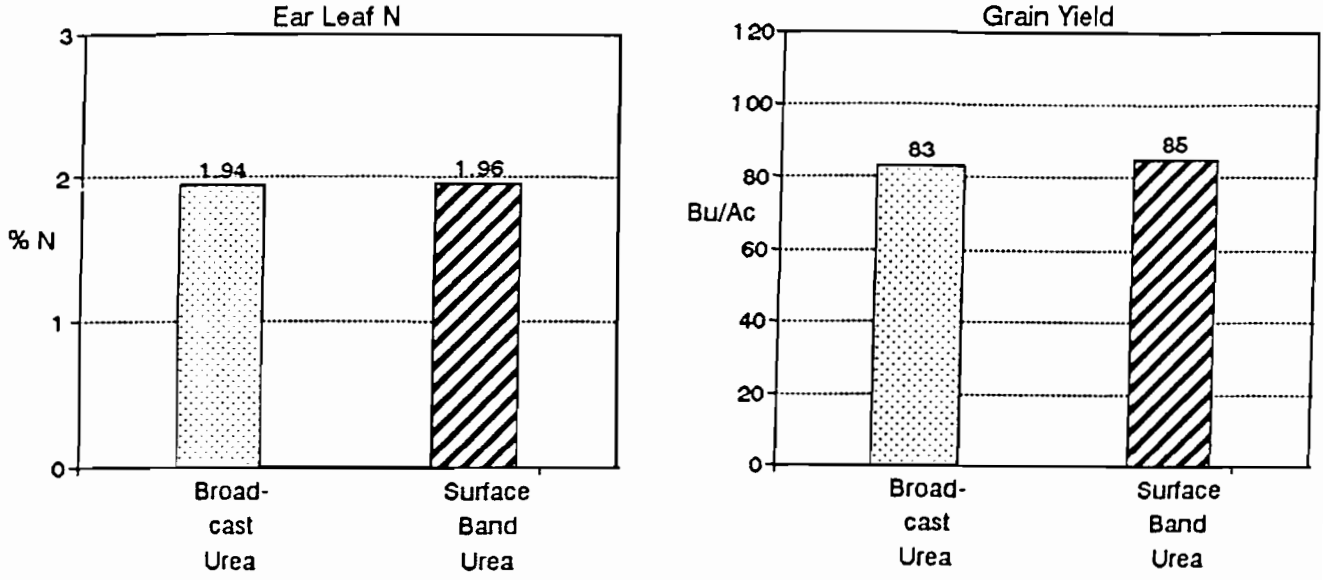

Figure 1. Corn ear leaf N composition and grain yield as affected by broadcast and surface band placement of urea on no-till corn. Average of 15 experiments conducted at Belleville and Carbondale, IL, 1983-1991.

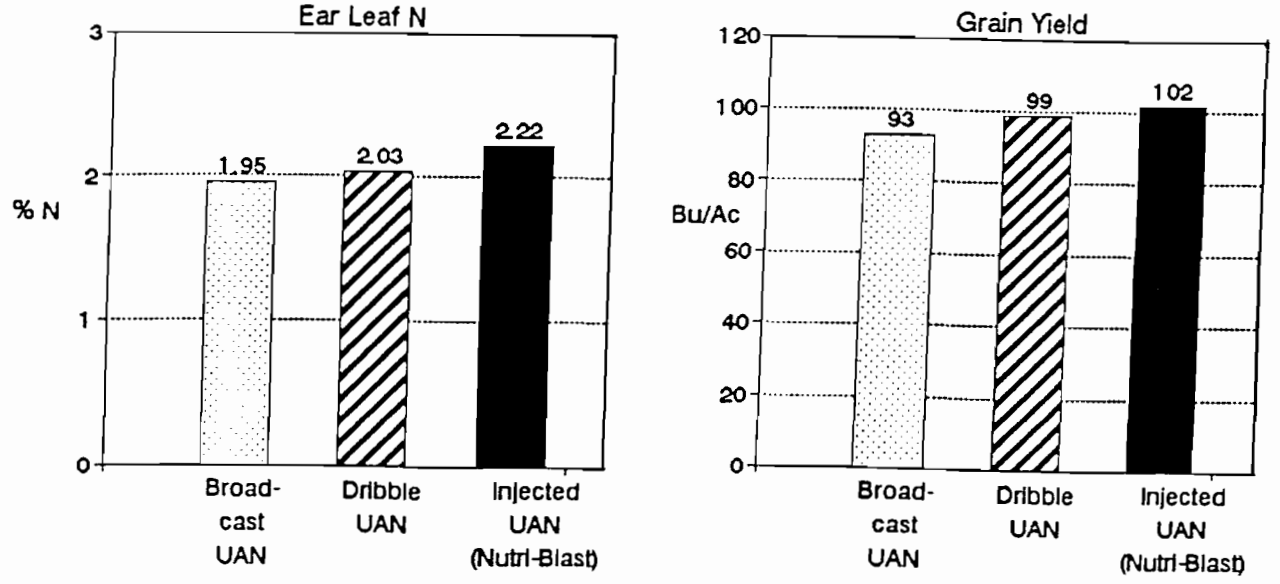

Figure 2. Corn ear leaf N composition and grain yield as affected by broadcast, dribble, and Nutri-Blast injection of UAN on no-till corn. Average of 8 experiments at Belleville and Carbondale, IL, 1983-1986.

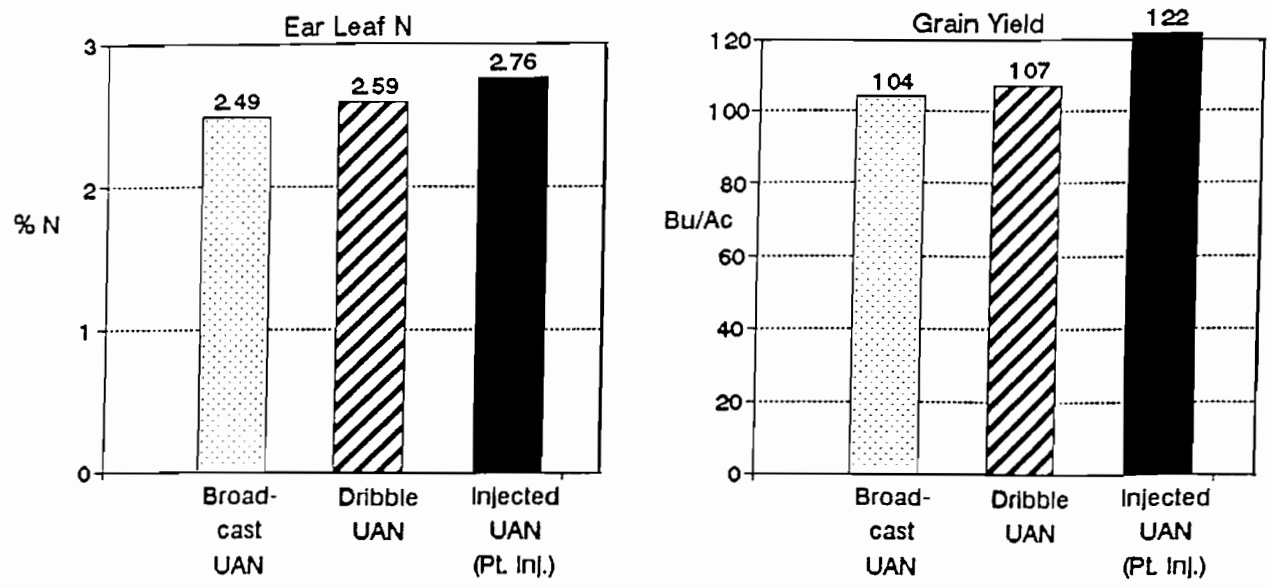

Figure 3. Corn ear leaf N composition and grain yield as affected by broadcast, dribble, and point injection placement of UAN on no-till corn. Average of 14 experiments at Belleville and Carbondale, IL, 1987-1993.

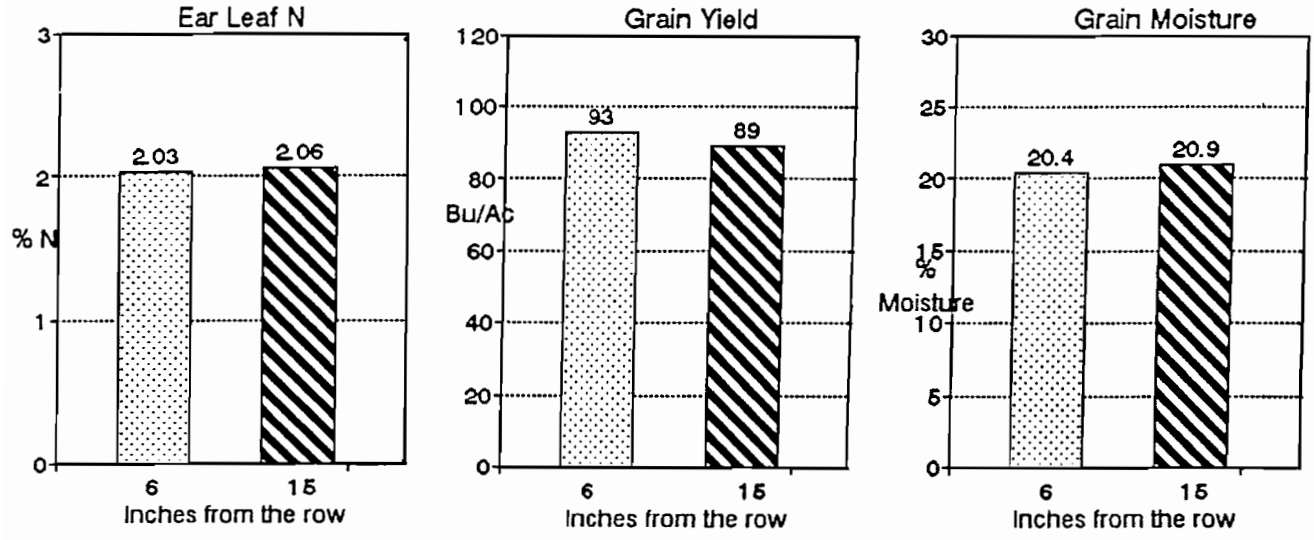

Figure 4. Effect of distance of injected UAN (near-row vs mid-row) placement from corn rows on ear leaf N composition, grain yield, and grain moisture content. Average of 8 experiments at Belleville and Carbondale, IL, 1983-1986. Injection utilized the Nutri-Blast system.

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