EVALUATION OF NEW NITROGEN FERTILIZER TECHNOLOGIES FOR CORN

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ABSTRACT

Farmers today are faced with escalating fertilizer prices, especially for nitrogen. Gains in nitrogen use efficiency (NUE) can help offset these prices. Nine different N sources were surface broadcast at four to five locations annually across the state of Illinois over a three year period. These sources included 1) urea, 2) liquid urea-ammonium nitrate (UAN), 3) urea + agrotain®, 4) UAN + agrotain, 5) UAN + agrotainplus® (agrotain plus a nitrification inhibitor), 6) UAN + 10% v/v CaTs® (calcium thiosulfate), 7) SuperU® (urea with agrotain and a nitrification inhibitor), 8) ESN® (polymer-coated urea), and 9) UAN sidedress injected. All of the above treatments were applied at planting, except for the sidedress UAN injected treatment. Treatments included each of the N sources above either incorporated or left on the surface under conventional tillage (CT), or left on the surface under no-tillage (NT) systems. Nitrogen rates of 67, 134, 201 and 268 kg N per hectare were associated with each N source. The yield responses associated with N sources could be broken into wet locations (those with >35 cm rainfall over the 15 week period after fertilizer application), moderate (25-35 cm), and dry locations (<25 cm). Nitrogen source effects were highly significant at the wet locations. The dry fertilizer products tended to do better than the liquid products. With CT, the lower residue levels at the surface appeared to reduce N losses from volatilization and denitrification. With NT, there was a fair amount of N loss from surface applied urea or UAN, indicating volatilization losses, which was reduced significantly by the application of agrotain or superU. Sidedress injection of UAN or application of ESN also significantly reduced N losses and increased yields. It appears that many of the N sources in this study may provide significant improvements in N use efficiency, especially during wet years. These differences appear to more important with NT than CT, but more research is needed.

JUSTIFICATION

Farmers today are faced with escalating fertilizer prices, especially for nitrogen. In addition, new state and federal regulations are reducing the availability of some products such as anhydrous ammonia and ammonium nitrate. It appears that urea is going to the primary replacement for these products. But urea requires a higher level of management to prevent N losses and inefficient N use.

The current nitrogen recommendation numbers for corn in Illinois ranges from 14 to 21 kg N Mg^{-1} based on yield goal, previous crop, manure credits and other incidentals. But corn has a nitrogen use efficiency (NUE) of less than 50% on average. Fertilizer N losses can occur from leaching, volatilization, denitrification, and immobilization. Several new N technologies have recently appeared on the market in Illinois to reduce N loss potentials. Many of these products are being evaluated in this study.

The objectives of this study were to 1) evaluate the effects of new nitrogen fertilizer technologies on corn yields under no-tillage and conventional tillage systems for corn after corn, and 2) determine the N use efficiencies for these new nitrogen fertilizer technologies.

Disclaimer: Mention of product names is for informational purposes only and does not imply endorsement of products by the University of Illinois

MATERIALS AND METHODS

Nine different N sources were utilized at four-five locations annually across the state of Illinois from 2006-2008. These sources included 1) liquid urea-ammonium nitrate (UAN) sidedress injected, 2) urea surface broadcast, 3) UAN surface broadcast, 4) urea + agrotain® (Agrotain International) surface broadcast, 5) UAN + agrotain surface broadcast, 6) UAN + agrotainplus® (agrotain plus a nitrification inhibitor, Agrotain Intl.) surface broadcast, 7) UAN + 10% v/v CaTs® (calcium thiosulfate, Tessenderlo Kerley) surface broadcast, 8) SuperU® (urea with agrotain and a nitrification inhibitor, Agrotain Intl.) surface broadcast, and 9) ESN® (a polymer coated urea, Agrium US, Inc.) surface broadcast. All of the above treatments were applied at planting, except for the sidedress UAN injected treatment. Treatments also included each of the N sources above either incorporated into the soil with a final tillage pass (disk or field cultivator) or left on the surface. There were four nitrogen rates associated with each of the above N source/ placement treatments, plus a check plot which received no fertilizer N. The nitrogen rates used were 67, 134, 201 and 268 kg N ha^{-1}.

The locations are identified in Figure 1. The Dixon Springs (DSAC) and Belleville (St. Clair) sites included both conventional tillage (CT) and no-tillage (NT) systems, but fertilizer sources were only surface applied with the NT system. With NT, all of the UAN treatments were dribble applied in narrow bands on 30" spacings.

Quadratic equations were utilized to fit curves across N rates. These curves were used to calculate economic optimum N rates (EONR) based on average prices of individual N sources and corn grain values during the period of study. Yields at EONR were determined and N use efficiencies (NUE) were calculated as kg N per Mg corn yields at the EONR.

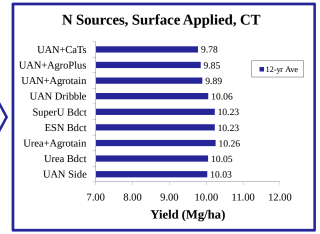
Results and Discussion

N sources significant in 10 out of 14 site-years.

Increased yields with ESN, Urea+Agrotain, and SuperU

Products with UAN base had lower yields that Urea based products, perhaps related to nitrate portion of UAN being more susceptible to leaching loss.

Sidedress was less effective because of not being able to time the application optimally some of the site-years.



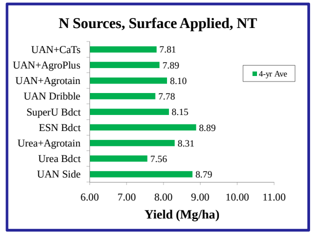
Means do not include Urbana and DeKalb from 2007.

Incorporation significant only 3 of 14 site-years.

N source by incorporation interaction significant only 4 of 14 site-years.

Incorporated N source effects on yields were very similar to surface applied treatments.

N rate effects significant 14 of 14 site-years but there were no significant N source x N rate interactions.



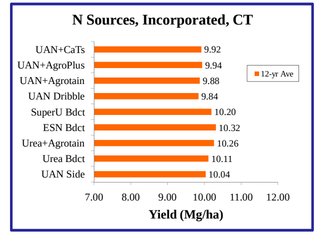
Means do not include Belleville from 2007 because of missing treatments..

N sources and N rates highly significant in 5 of 5 site-years, but no interactions. *Note: NT fields not same as CT fields so direct comparisons should be avoided.*

Most effective N sources were ESN and UAN sidedress injected.

Products containing Agrotain also produced higher grain yields than urea and UAN.

Appears that N losses more prevalent with NT than CT systems.

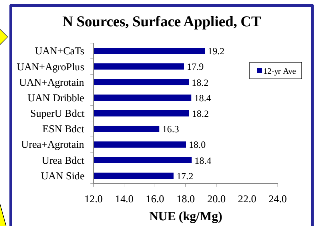


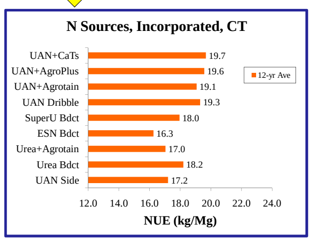
Means do not include Urbana and DeKalb from 2007.

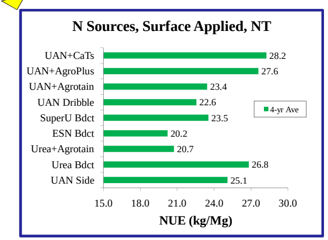
ESN tended to have the best NUE across placement and tillage systems in that they required the least amount of fertilizer N per Mg of corn yield.

NUE was higher for NT than CT, as expected, since N products were surface applied with greater potential for volatilization losses, especially in the presence of high residue levels. This higher residue would also lead to higher soil moisture retention and increased potential for denitrification.

With CT, incorporation of N sources did not appreciably improve NUE over surface applications. It appears with CT that the lower residue levels at the surface reduces N losses from volatilization and denitrification compared to NT.







Improved performance of incorporated ESN and SuperU in “wet” years (>35 cm rainfall during 15-week period after N sources applied), especially with ESN, which appears to effectively reduce losses of N, most likely from denitrification.

Lower yields in “wet” years versus “dry” years is also an indication of significant N losses in “wet” years.

Decreased performance of ESN when surface applied during “dry” years (<25 cm rainfall). This is most likely due to inadequate moisture availability to allow the full release of N from the ESN.