NITROGEN FERTILIZATION OF CORN GROWN IN KENTUCKY

G.J. Schwab and L.W. Murdock
University of Kentucky, Lexington and Princeton, KY

Introduction

Approximately 225 million pounds of nitrogen are applied to corn annually in Kentucky. Because of the dramatic rise in the price of N, farmers are reevaluating their fertilizer applications. Traditionally, research at the University of Kentucky has centered on determining the appropriate N rate for soil drainage classes and split applications to improve overall N use efficiency. Recently, new technological advancements have become available that might further reduce N requirements for corn. Research studies were initiated in Lexington and Princeton, Kentucky to evaluate two of theses technologies: polymer coated urea and the GreenSeeker sensor.

Current fertilizer recommendations used by the University of Kentucky call for reducing total N application by 35 lbs/a when nitrogen is applied to corn approximately 1 month after planting on soils that are somewhat poorly or poorly drained. By delaying N applications for approximately one month, the potential for N loss via denitrification and leaching is dramatically reduced. Although farmers realize they can potentially save money by applying N later and reducing the rate, many are not doing this because they don't have the time (because of planting soybeans) or equipment needed for side-dress applications. Polymer coated urea (PCU) offers a potential remedy for this problem. Ideally, PCU could be applied a week or two in advance of corn planting and, because of it's controlled release, would not be subject to as much loss as non-coated urea. One objective of this study was to compare pre-plant PCU to pre-plant ammonium nitrate, and to the current best management practice of split N applications.

Approximately, 50 % of Kentucky corn farmers are currently supplying some or all N fertilizer as a side-dressed application (V4-V8 growth stage). Soil sampling has been one approach to improving NUE for corn. Many states have begun recommending either the amino sugar test (Mulvaney et al., 2001) prior to planting, to identify fields not likely to respond to N fertilization, or the PSNT test (Magdoff et al., 1984: Blackmer et al., 1989) at V6, to account for early season mineralization. Both of these methods require additional annual soil sampling with adjustments to the N fertilizer recommendation being made on a whole field basis, and in KY they have not proven very useful. A secondary problem is that the N requirement (soil N supply) for corn is not uniform throughout a field and annual soil testing on a spatial scale is not feasible. An active sensor has been developed by NTech Industries Inc. (Ukiah, Ca) to help address the problem of spatial variability of N supply. The sensor computes a normalized difference vegetative index (NDVI) using red and infrared wavelengths. A second objective of this study was to evaluate the potential of using a NDVI sensor (red) to predict N requirement just prior to side-dress applications.

Research Approach

The study was conducted at two sites in 2003 and 2004 on soils within different drainage classes. One site located near Lexington, KY is classified as a Maury silt loam and is considered well drained. The other site near Princeton, KY is classified as a Pembroke silt loam and is considered moderately well drained. In 2004 a third site was added near Princeton on a Zanesville silt loam, a fragipan soil that is considered poorly drained. The objective was to compare application timing of polymer coated urea (PCU product name is ESN manufactured by Agrium Inc.) and ammonium nitrate (AN) for corn production. The study was arranged in a split plot design with preplant N applications of 0, 50, 100, 150, and 200 lbs N as NH_4NO_3 as the whole plots. Subplots consisted of 0, 50, 100, 150, and 200 lbs N as PCU applied preplant and 0, 50, 100, 150, and 200 lbs N as NH_4NO_3 applied approximately 4 weeks after planting. The maximum total application rate was capped at 200 lbs N/a which resulted in a total of 19 treatments. There were four replications at each location. Ammonium nitrate was selected as the comparison fertilizer so that N loss via volatilization would not be a factor for these treatments. Corn was no-till planted in a timely fashion at all locations and commercial hybrids with a high yield potential were grown. Hybrid information, planting date, and fertilizer application date Table 1. Data collected included dry matter and N uptake at V6 (for the preplant applications only), red normalized difference vegetative index (NDVI) at approximately V4 and V6, and grain yield at maturity. NDVI was collected at a distance of 30 inches from the canopy using an active sensor manufactured by NTech Industries, Inc.

Results and Discussion

Early season temperature and precipitation (from planting to V6) in both years was cooler and wetter than normal (Fig. 1), but growing conditions overall were very good and yield potential for all sites was very high.

The measured plant responses to fertilizer source and application timing for 2003 are given in Table 2. There was not a significant source by rate interaction for any of the parameters measured. Although not significant, there was a trend for both dry matter and N uptake at the V6 growth stage to be higher for the PCU treatment as compared to the AN treatment. At the Pembroke site, N uptake at V6 was significantly ($p<0.10$) higher for PCU than AN. For this year of the study, both locations received heavy rain events shortly after planting. Nitrate in the AN treatments might have been temporarily leached beyond the rooting depth causing lower V6 dry matter and N uptake. As the plant roots developed, this nitrate-N probably became available for uptake. As expected, dry matter and N uptake increased ($p<0.10$) as N rate increased at both locations.

The NDVI measurements reported in this paper are from the plots that received all of the N fertilizer at planting. As observed in other crops, absolute NDVI did not correlate well with final yield. For wheat, Raun (et al., 2002) has proposed calculating an in-season estimate of grain yield (INSEY) by dividing NDVI by the number of days with GDD>0. We calculated INSEY for each treatment and compared it to the final corn yield. When the data for the four locations was graphed there were distinct curves for each location (Fig 2.). Separate curves might be a result of different early season growing conditions and the amount number of days required to reach the V6 growth stage. In an attempt to correct for early season growing conditions, we calculated a relative NDVI for each plot by dividing the plot NDVI by the NDVI of the highest plot at each location. Relative yield as a function of relative NDVI was then plotted (Fig. 2). Using this method there appeared to be a relationship between relative NDVI and relative yield (r^2=0.55) which was independent of location. A method of estimating yield potential and N requirement that is independent of locations is essential before this technology will be useful in production agriculture. Additional research will be conducted to validate this relationship.

For grain yield, there was not a significant source by rate interaction at any location (Fig. 3). There was however a significant timing effect at the Zanesville site with side-dress applications producing higher yields than either of the pre-plant treatments. There was a trend for slightly higher yield for PCU at the low lower fertilizer rates at the sites that were less than well drained. Variability, caused by water standing in some plots, was extremely high for the Zanesville site in 2004.

Conclusions

For the NDVI data yield estimate methods used in the Great Plains do not appear to work well with Kentucky growing conditions. The INSEY measurement was not stable across sites or years. A better method for predicting yield might be to determine the relative NDVI.

PCU applied prior to planting produced yields equivalent to pre-plant application of ammonium nitrate. This demonstrates that nitrogen from the PCU was not lost via volatilization, and the release of N from the PCU was quick enough to obtain maximum production. PCU at one location increased early season N uptake suggesting that PCU reduced early season leaching potential. At one of the four locations, yields of pre-plant treatments were less than side-dress treatments and PCU had a slight trend (not significant) for higher yield compared to pre-plant AN. This research will be repeated in 2005 at the three locations to test PCU's performance in a third year.

References

Blackmer, A.M., D. Pottker, M.E. Cerrato, and J.Webb. 1989. Correlations between soil nitrate concentrations in late spring and corn fields in Iowa. J. Prod. Agric. 2:103-109.

Magdoff, F., D.Ross, and J. Amadon. 1984. A soil test for nitrogen availability to corn. Soil Sci. Soc. Am. J. 48:1301-1304.

Mulvaney, R.L. and Khan. 2001. Diffusion methods to determine different forms of nitrogen in soil hydrolysates. Soil Sci. Soc. Am. J. 65:1284-1292.

Raun, W.R., J.B. Solie, G.V. Johnson, M.L. Stone, R.W. Mullen, K.W. Freeman, W.E. Thomason, and E.V. Lukina 2002 Improving Nitrogen Use Efficiency in Cereal Grain Production with Optical Sensing and Variable Rate Application. Agron. J. 94:815-820.

Table 1. Hybrid, planting date and side-dress date for each location.

Location	Hybrid	Date Planted	Date Side-dressed
Maury 2003	Pioneer 31R88	May 1	May 28
Maury 2004	Southern States 842	May 6	June 10
Pembroke 2003	Cropland 818RR-BT	April 14	May 17
Pembroke 2004	Golden Harvest H9122-RR	April 8	May 20
Zanesville 2004	Golden Harvest H9122-RR	May 13	June 1

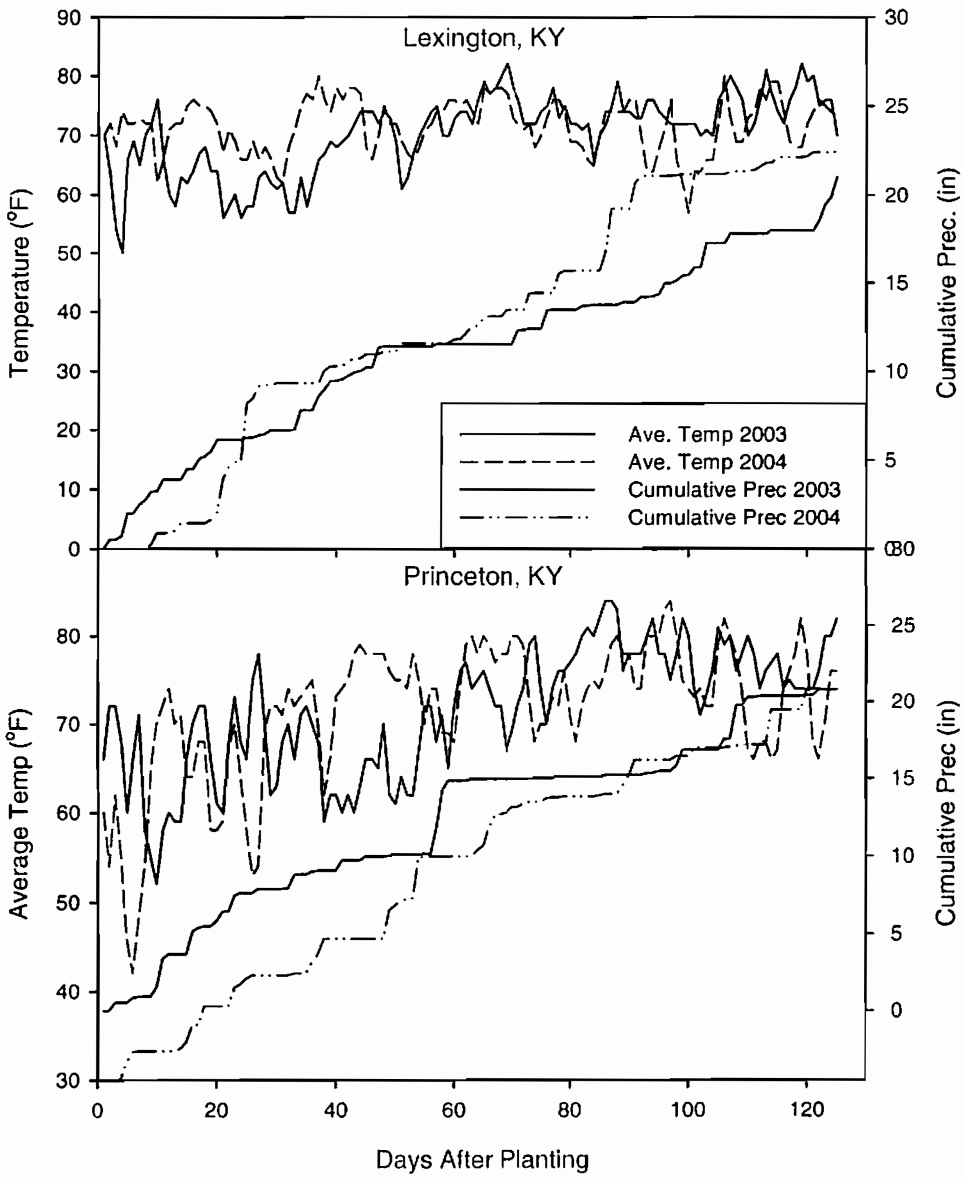

Figure 1. Average air temperature and cumulative precipitation for the Lexington site for 2003 and 2004. The 2004 Zanesville site was planted on day 35 at Princeton, KY.

Table 2. Dry matter and N uptake at V6 for the Maury and Pembroke sites in 2003.

	Maury 2003		Pembroke 2003	
	V6 Dry Matter	V6 N Uptake	V6 Dry Matter	V6 N Uptake
	----------	---------- lbs/a	----------	----------
Source				
Amm. Nitrate	453	14.45	363	12.22
PCU	463	15.59	391	13.92
LSD $_{(0.10)}$	NS	NS	NS	1.55
Rate				
0	332	8.08	230	6.19
50	468	13.08	322	10.02
100	419	13.39	372	12.57
150	443	15.42	404	14.38
200	501	18.18	412	15.32
LSD $_{(0.10)}$	62	2.16	53	1.93

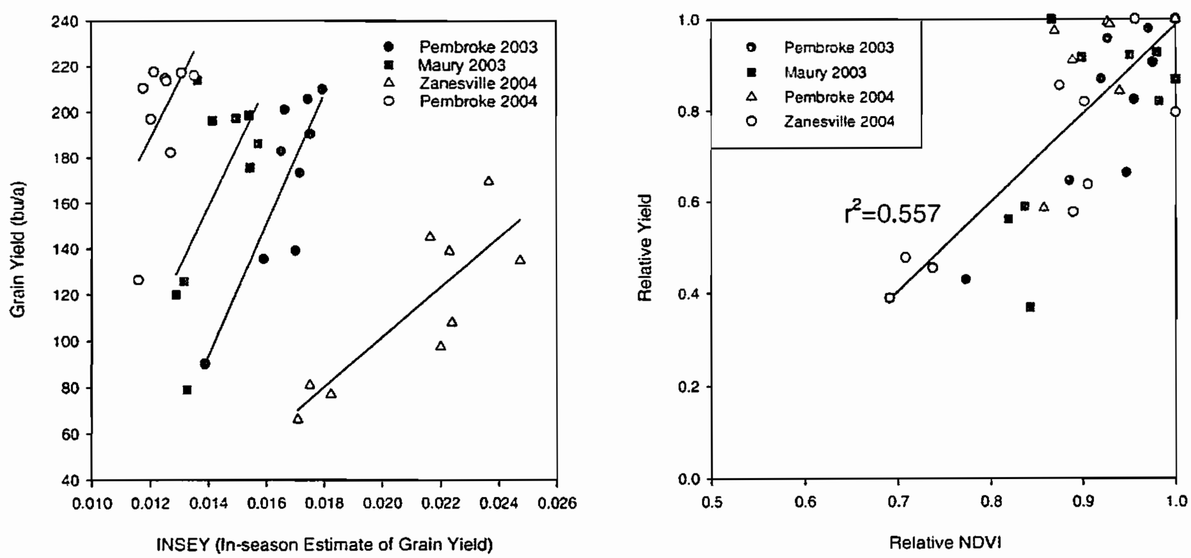

Figure 2. Relationship between in-season estimate of grain yield (INSEY method proposed by Raun) and grain yield and relative NDVI verses relative yield for all locations.

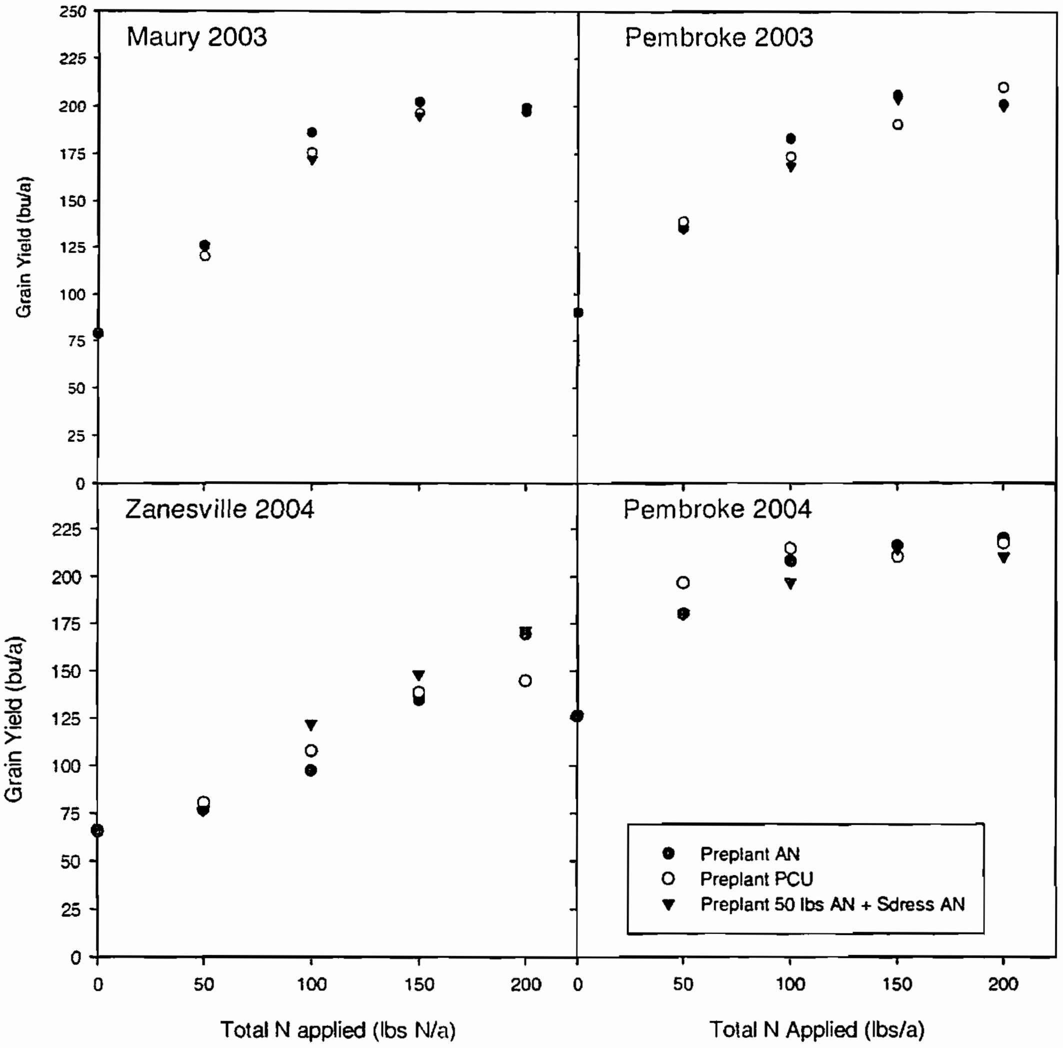

Figure 3. Corn yield for pre-plant ammonium nitrate (AN), pre-plant polymer coated urea (PCU), and 50 lbs N/a as AN at planting with the remainder as AN at V6 for three KY soils in 2003 and 2004.

PROCEEDINGS OF THE

THIRTY-FOURTH NORTH CENTRAL EXTENSION-INDUSTRY SOIL FERTILITY CONFERENCE

Volume 20

November 17-18, 2004
Holiday Inn Airport
Des Moines, IA

Program Chair:
Bob Hoeft
University of Illinois
Urbana, IL 61801
(217) 333-9480

Published by:
Potash & Phosphate Institute
772 – 22nd Avenue South
Brookings, SD 57006
(605) 692-6280
Web page: www.ppi-ppic.org