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Early Season Losses of Nitrogen from Iowa Cornfields

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Most corn producers apply fertilizer nitrogen (N) several weeks or months before corn plants emerge from the soil. N is applied early to obtain price discounts, to complete some field operations early, to avoid practical problems associated with fertilization after crops have emerged, and to ensure that wet weather in May and June does not make fertilization impossible. These reasons seem valid if it is assumed that the early applications of N do not promote significant losses of N before the crop grows.

The fertilizer industry has promoted the idea that early applications of N do not result in substantial losses of fertilizer N. Government groups have re-enforced this message through fertilizer recommendations that do not identify time-of-application as an important factor affecting N fertilizer needs. Recommendations that fertilizer N should not be applied before soils cool to 50°F in the fall have reinforced the idea that time-of-application is not important if N is applied between early November and early June.

Research during the past decade has provided compelling evidence that time of application has great effects on losses of fertilizer N before plants grow. This evidence was obtained in several types of studies, but information from precision farming trials and surveys of cornfields deserve special attention.

**Surveys of N-sufficiency levels in cornfields**

The late-spring test for soil nitrate (Blackmer et al., 1997) and the end-of-season test for cornstalk nitrate (Blackmer and Mallarino, 1994) are new tools for measuring the sufficiency (supply relative to needs) of N for corn growth. The stalk test clearly gives after-the-fact measurements that integrate all factors occurring within the growing season. When used in fields where all fertilizer N is applied before corn emergence, the soil test evaluates management practices for ability to supply optimal amounts of N when plants begin rapid growth in June. This use of the soil test integrates all processes occurring between N application and sampling of the field.

The tests were recently used over a 12-year period to survey the outcomes of N management in Iowa cornfields (Blackmer and Balkcom, 2001). More than 3,200 samples were collected and the results were analyzed in relation to weather and information provided by the cooperating corn producers. The results showed that annual means for soil and stalk nitrate concentrations were highly correlated to annual means for rainfall during March through May. The means revealed marked excesses of N on relatively dry years and yield-limiting deficiencies of N on relatively wet years. Concentrations of nitrate found in cornfields were inversely correlated with concentrations of nitrate found in rivers. The results provide compelling evidence that
early season losses of N is a major factor affecting rates of fertilization needed to supply adequate N for corn growth.

The survey demonstrates a novel way to evaluate and improve N management. The methods involved have been described as Level 4 management by Blackmer (1997). Basically, soil and cornstalk samples and relevant information were collected across many different fields in production agriculture. The results were used to identify current practices that work best and to develop even better management practices. This approach empowers groups of corn producers to evaluate the reliability of recommendations and regulations developed by groups responding to environmental concerns. This empowerment is very important because outdated guidelines seem to be the major factor slowing the improvement of N management today.

**Precision farming trials**

On-farm studies involving the integrated use of soil nitrate testing, cornstalk nitrate testing, remote sensing, and yield monitoring have provided compelling evidence that losses of fall-applied N are more important than has been generally recognized. Three major types of trials have been conducted.

One type of trial involves replicated comparisons of yields attained when similar rates of N were applied in the fall and spring (Blackmer and Ellsworth, 2000; Blackmer and Kyveryga, 2001). Such studies clearly demonstrate marked benefits for delaying N applications. This type of study, however, is too expensive to conduct across many sites and years.

A second type of trial involves application of extra N in replicated strips on fields where producers fall-applied anhydrous ammonia in accordance with their normal practices. Large yield losses often are observed. Such studies are an effective way to estimate losses of yield associated with fall applications of N, but they do not directly relate the yield losses to losses of the fall-applied N.

A third type of trial estimates the rates of fertilizer N needed when all N is applied after crops have emerged (White and Blackmer, 1999; Van De Woestyne and Blackmer, 2002a,b). These studies indicate that optimal rates of N application are much lower than generally believed if N application is delayed to minimize losses of N during spring rainfall.

**Conclusions**

Research data collected over the past decade clearly indicate that modern corn producers, the fertilizer industry, and the public cannot afford to continue using N recommendations that ignore time of application as an important factor affecting optimal rates of N fertilization for corn in Iowa. Recent advances in knowledge and technology offer
powerful new ways to continuously evaluate and improve N management practices. It is time to recognize that a recommendation to use these new tools should replace recommendations that do not acknowledge the importance of time of N application.

REFERENCES


