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Understanding the End-of-Season Test for Cornstalk Nitrate

Alfred M. Blackmer
Iowa State University

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The end-of-season test for cornstalk nitrate is a relatively new tool for evaluating nitrogen (N) management during corn production. The test was first introduced about a decade ago, and information describing the test and how it should be used is provided in PM 1584 (attached). The basic procedures for using the test have not changed, but considerable information has been generated since the test was developed. There is need to summarize this new information in a way that answers questions that have emerged.

**Basic principles on which the test is based**

The end-of-season test for cornstalk nitrate is based on evidence that measured concentrations of nitrate indicate the sufficiency of N during the grain-filling period. Sufficiency refers to supply of N relative to the needs of plants for growth.

This test is unique among N tissue tests for corn because it works within the range of "luxury uptake" rather than the range of "poverty adjustment". Important differences between the ranges are discussed by Blackmer (1997c,d). Luxury uptake occurs when plants have adequate N; nitrate concentrations increase without significant increases in yields. Tests based on poverty adjustment are reliable only in situations where severe deficiencies of N cause yield losses that are unacceptable to modern corn producers.

Optimal concentrations of stalk nitrate were identified in experiments where 10 rates of N were applied and both grain yields and stalk nitrate concentrations were measured. Stalk nitrate concentrations are considered to be optimal at N-sufficiency levels that maximize profits for producers who must pay for N applied as commercial fertilizer. The optimal concentration should be considered a range rather than an exact value because the costs of increasing rates of N are offset by small increases in yields within a range of fertilization rates.

Concentrations of nitrate are interpreted in terms of likelihood that greater profits would have been obtained by adding more or less N at the site studied. It must be recognized, however, that a given test value is influenced by weather, time of N application, placement, and many factors other than rate of N application.

Uncertainty in interpretation must be expected because measurements always include some errors. Also, an exact match in supply and demand for N can result in essentially maximum yields and no nitrate in the stalks. This situation indicates that there was no
margin of safety, however, and is analogous to having a racecar run out of gas as it crosses the finish line.

**Important problems solved by the test**

Yields at the most profitable rates are very close to the maximum that can be obtained by adding fertilizer N. Differences in yield due to rate of fertilization, therefore, usually are too small to measure with any degree of confidence when rates are near optimal. Stalk nitrate concentrations, however, usually show clear effects of N rate within this range.

Nitrogen deficiencies of economic importance can occur without symptoms that are easily detectable. Corn plants show no visual symptoms when supplies of N exceed optimal. Normal examination of cornfields, therefore, cannot be used to evaluate N-sufficiency level within the range of practical interest.

**Reliability of the test**

Large datasets collected during the past decade clearly indicate that the end-of-season test for cornstalk nitrate gives very reliable assessments of N-sufficiency within the range of practical interest to modern corn producers. Interpretations of the test results given in current guidelines are appropriate for evaluation of current N management practices.

The reliability of the test is limited primarily by the skill of the user. Inadequate distinction between N-sufficiency levels and yield levels often is a problem. Lack of preparation for the high degree of variability (spatial and temporal) in N-sufficiency levels often found within and among fields probably is the greatest problem. This variability has been essentially ignored in N recommendations in the past.

**New knowledge acquired by using the test**

The end-of-season test for cornstalk nitrate has provided large amounts of information that is consistent with measurements of soil nitrate in late spring and grain yields at the end of the season. These findings are generally summarized in the following four points.

1. There is great opportunity for improving N management during corn production in Iowa. Crop producers, input suppliers, and the general public have much to gain by making these improvements.

2. Widespread acceptance of recommendations based on yield goals and credits is the major barrier to improving N management in Iowa. Basic assumptions of this test are questionable (Blackmer, 1997a,b). These recommendations do not consider some of the most important factors affecting N fertilizer needs, so acceptance of these recommendations makes it difficult to recognize important factors affecting N fertilizer needs.
3. The stalk test gives groups of producers the power to evaluate the reliability of recommendations (or regulations). When true, producers can prove that they are using management practices superior to those recommended or required.

4. Widespread and systematic use of the stalk test can provide the information needed to develop a new generation of N recommendations. An example of this use of the test is presented at this conference in a separate workshop entitled “Early season losses of fertilizer N from Iowa cornfields”.

**Future use of the test**

Studies over the past decade clearly indicate that the end-of-season test for cornstalk nitrate has most value when systematically used across many fields, farms, and years. The basic approach is that many producers work together by each collecting a few samples from each of a few fields each year. Aggregate analyses of the test results, information about conditions and practices where each sample was taken, and weather conditions show which practices tend to work best under various conditions. Individual producers can objectively compare the quality of their N management to the averages of other producers within the region.

**REFERENCES**

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