

Cornstalk testing to evaluate nitrogen management

Recent studies have shown that the nitrogen (N) status of a corn crop can be assessed by measuring nitrate concentrations in the lower portion of cornstalks at the end of the growing season. This finding led to the development of a new tissue test that can be used to evaluate N management practices used in any field in any year. The test is called the “end-of-season cornstalk test”. This pamphlet describes the test and how it should be used.

Basis for the test

Corn plants suffering from inadequate N availability remove N from the lower cornstalks and leaves during the grain-filling period. Corn plants that have more N than needed to attain maximum yields, however, accumulate nitrate in their lower stalks at the end of the season.

The end-of-season cornstalk test was calibrated by establishing relationships between yields and stalk nitrate concentrations in trials having N fertilizer applied at rates ranging from 0 to 300 lb. N/acre. The studies were conducted at many sites over several years to include a wide range of soil, management, and weather conditions.

The calibration studies showed that small increases in rates of fertilization tended to produce either of two kinds of response (see Figure 1). The first is an increase in yield with little or no increase in stalk nitrate concentration. The second is an increase in stalk nitrate concentration with little or no increase in yield. The first type of response indicates that supplies of available N were limiting plant growth at the end

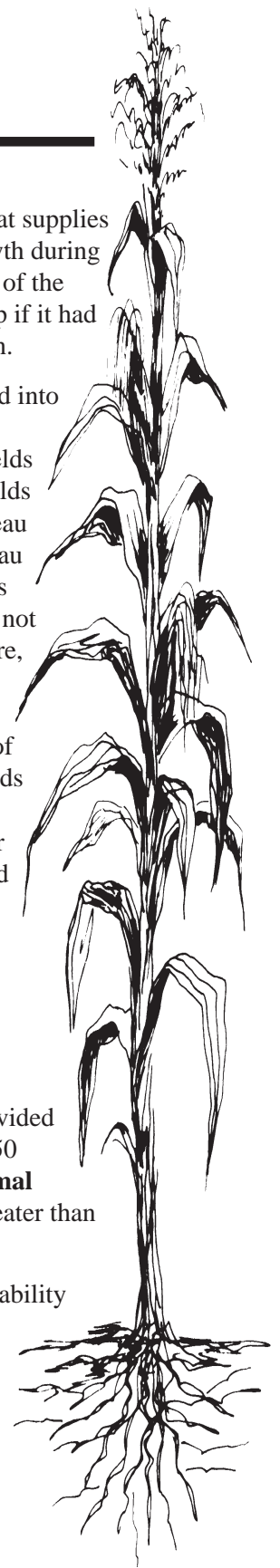
of the season; the second indicates that supplies of available N were not limiting growth during this period. In essence, therefore, use of the test enables a producer to ask the crop if it had adequate N late in the growing season.

The results of all trials were combined into a common relationship between stalk nitrate concentrations and relative yields (see Figure 2). Relative yields are yields expressed as a percentage of the plateau yield observed within each site. Plateau yields are the mean yields for all plots within the range where fertilizers did not significantly increase yields. Therefore, the highest yield that should be expected at high rates of N fertilization is 100 percent, and deficiencies of nitrogen are indicated by relative yields significantly less than 100 percent. Some relative yields slightly above or below 100 percent should be expected because measured yields tend to differ slightly among plots having ample N.

Interpretation of stalk nitrate concentrations

Stalk nitrate concentrations can be divided into four categories; **low** (less than 250 ppm N), **marginal** (250 to 700 ppm N), **optimal** (700 to 2000 ppm N), and **excess** (greater than 2000 ppm N).

The **low** category indicates high probability that greater availability of N would



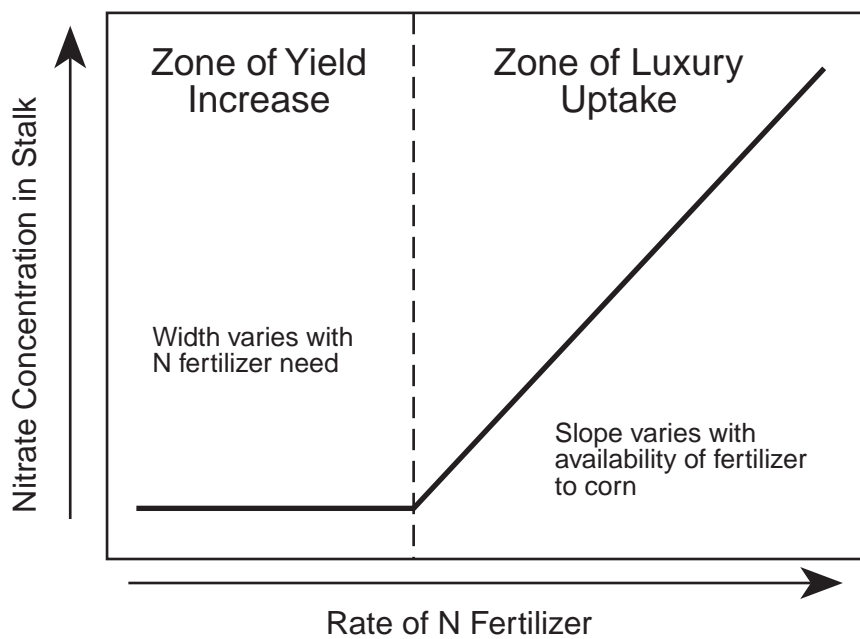


Figure 1. Relationship between rates of fertilization and stalk nitrate concentrations.

have resulted in higher yields. It should be noted that concentrations in this range give little indication of the magnitude of yield increase that might be expected from more available N. Visual signs of N deficiency usually are clear when nitrate concentrations are in this range.

The **marginal** category indicates that N availability was very close to the minimal amounts needed. Although producers should not be concerned when samples test in this range, this range is too close to economic penalties to be the target for good N management under most conditions.

The **optimal** category indicates high probability that N availability was within the range needed to maximize profits for the producer. The higher end of this range is more appropriate when fertilizer N is relatively cheap and grain prices are relatively high (compared with prices in Iowa during the past decade). The lower end of the range is most appropriate when fertilizer N is relatively expensive and grain prices are relatively low. Visual signs of N deficiency often are observed in this range.

The **excess** category indicates high probability that N availability was greater than if fertilizer N had been applied at rates that maximize profits for producers.

The concentration of nitrate in the stalk at the end of the season reflects all factors that influenced N availability and N needs during the growing season.

Because many of the factors influence N availability after fertilizers are applied, it is unrealistic to expect any producer to attain **optimal** concentrations in all fields in all years. Indeed, experience has shown that the **optimal** range is difficult to consistently attain with existing management practices.

When interpreting the results of the test, consideration must be given to weather conditions that occurred during the growing season. Rates of fertilization that are most profitable over many years should be expected to result in **low** concentrations in some years and in **excess**

concentrations in other years.

Lower-than-desired concentrations should be expected in years having unusually large amounts of in-season rainfall that results in unusually large losses of N and (or) high yield potential. Higher-than-desired concentrations should be expected in years when unusually low rainfall limits N losses and (or) yield potential.

It is possible that deficiencies of N early in the growing season sometimes limit yield potential in ways that are not directly indicated by the stalk test. Additions of more fertilizer than needed after such damage has occurred will result in concentrations of stalk nitrate that correctly indicate that higher rates of fertilization would not have increased yields. This problem is avoided if enough N is applied before planting or if the late-spring soil test routinely is used to ensure that such deficiencies are unlikely.

After appropriate consideration is given for weather conditions, fertilization rates should be increased for areas that usually test in the **low** range and decreased on areas that usually test in the **excess** range. The test does not directly indicate how much N rates should be increased or decreased, but continued use of the test for several years enables producers to make adjustments toward optimal rates. Concentrations in the **excess** range indicate that use of the late-spring soil test to guide N fertilization will probably increase profits for the producer.

Why the test is needed

Recent surveys using the late-spring soil test and the end-of-season cornstalk test indicate that a high percentage of Iowa cornfields receive substantially more fertilizer N than is economically optimal. This means that many corn producers can increase their profits by identifying these fields and reducing rates of N fertilization accordingly.

The underlying reason for over-fertilization is that corn plants show no visual symptoms that enable producers to recognize when above-optimal rates of N have been applied. This means that producers can apply too much N year after year and never suspect a problem with their nitrogen management. The end-of-season cornstalk test makes it possible for producers to avoid this pitfall.

Many producers associate a dark green plant with optimal rates of fertilization, and they fertilize to maintain dark green plants late in the growing season. This practice needs to be questioned, however, because corn leaves tend to lose their deep green color late in the season at economically optimal rates of fertilization. The end-of-season cornstalk test, therefore, helps producers distinguish between fertilizing to maximize greenness and fertilizing to maximize profits.

Tissue tests commonly used to evaluate the N status of corn in the past have little ability to detect excessive applications of N. These include analysis for N in the leaf at silking and in the grain at harvest. Recent studies show that both of these tests often

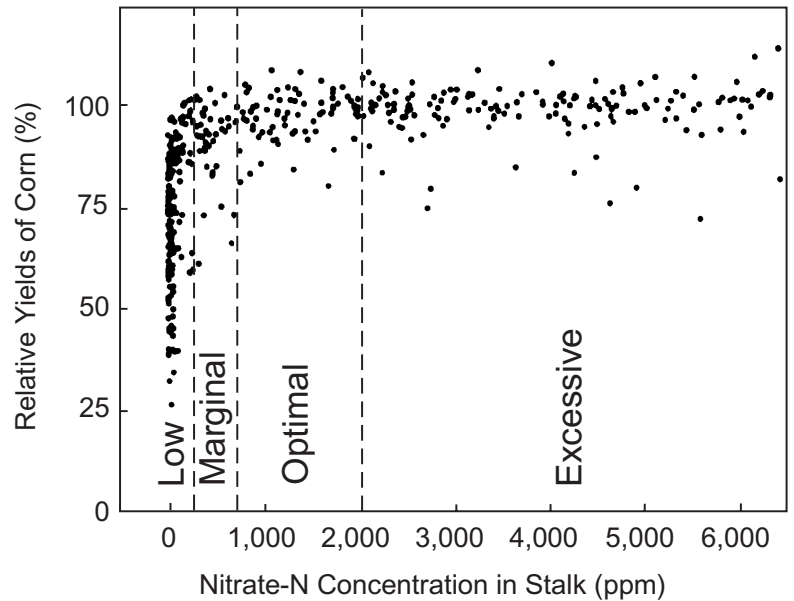


Figure 2. Relationship between stalk nitrate concentrations and relative yields.

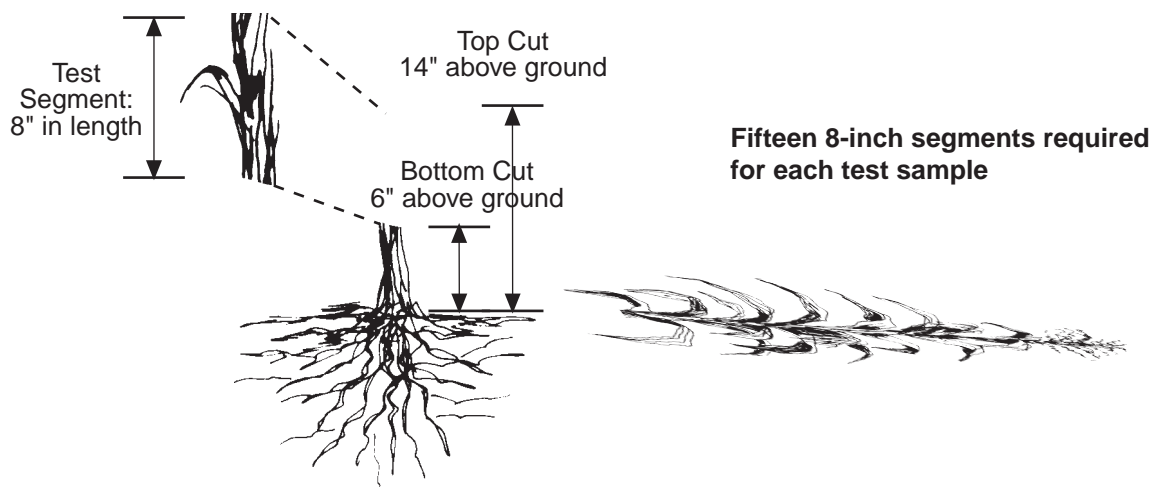
incorrectly indicate N deficiencies in situations where marked excesses of N are present.

How the test is done

The time for sampling is between one and three weeks after black layers have formed on about 80 percent of the kernels of most ears.

The portion of each plant sampled is the 8-inch segment of stalk found between 6 and 14 inches above the soil. Leaf sheaths should be removed from the segments. Stalks severely damaged by disease or insects should not be used.

Fifteen 8-inch segments should be collected to form a single sample to be sent for analysis. Areas differing



in soil types or management histories should be sampled separately. Collecting one composite sample from each of several small areas (less than an acre) that seem to be representative of larger areas within a field is an effective strategy.

Samples should be sent to a laboratory for analysis as soon as possible after collection. Samples should be placed in paper (not plastic) bags to enable some drying and minimize growth of mold. The time normally required to mail samples to a laboratory is not a problem. Samples should be refrigerated (but not frozen) if stored for more than a day before mailing.

Laboratories will dry the samples as soon as they are received. The samples should be ground and analyzed for nitrate concentrations. Concentrations are expressed as PPM (parts nitrate-N per million parts of dry stover) in this fact sheet. Most soil testing laboratories, including the Iowa State University Soil Testing Laboratory, will do this test.

Who should use the test

All corn producers should consider using the test on a few fields each year. Those who learn that their fields usually test in the optimal range need not make larger

investments in time or money. Those who learn that they usually apply too much N to some or all of their fields will find it profitable to adjust rates of application. Thoughtful use of the test for a few years should help producers optimize rates for their fields.

All producers who grow corn on manured soils should use the stalk test. Recent studies indicate that most producers greatly underestimate the amount of N supplied by animal manures and apply unneeded fertilizer.

All producers who grow corn after alfalfa should use the stalk test. Recent studies indicate that most producers greatly underestimate the amount of N supplied by alfalfa and apply unneeded fertilizer.

Producers comparing alternative management practices should use the test. Possible comparisons include fertilizer materials, methods of application, times of application, or systems used to select rates. The stalk test could be used to compare recommendations based on the late-spring soil test with recommendations derived by other means.



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