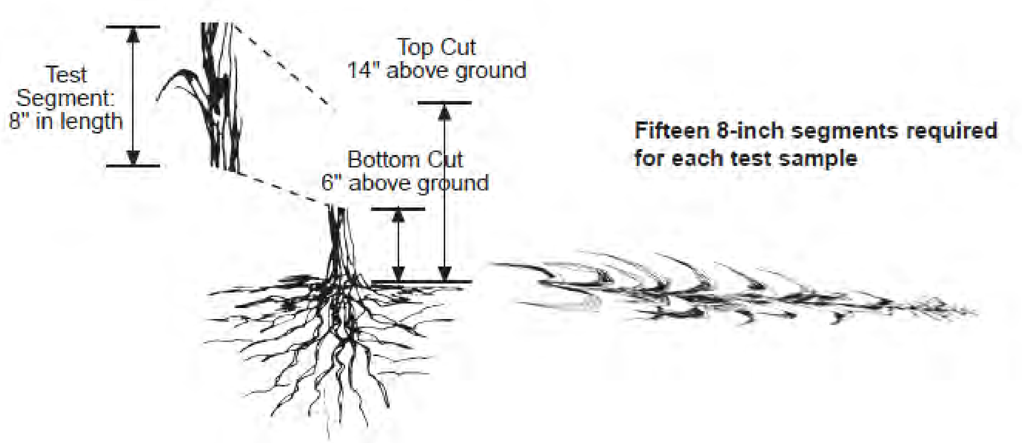
United States Department of Agriculture
Natural Resources Conservation Service

Water Quality Enhancement Activity – KS-WQL04
Stalk or Leaf Tissue Tests for N Application

Kansas Criteria for National Water Quality Enhancement Activity – WQL04

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.”

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). Most soil testing laboratories will do this test.



Interpretation of stalk nitrate concentrations: Stalk nitrate concentrations can be divided into four categories:

1. **Low** (less than 250 ppm N),
2. **Marginal** (250 to 700)
3. **Optimal** (700 to 2000 ppm N), and
4. **Excess** (greater than 2000 ppm N).

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

Kansas criteria for chlorophyll meter (CM) sensing N stress in corn: Corn takes up N rapidly beginning with the V8 growth stage. Since we want to detect and correct any N deficiency in time for adequate yield recovery, N stress sensing can begin at the V10 vegetative growth stage and should be completed before tassel emergence with preference closer to V10. To approach in-season N management in this way, high clearance equipment is needed to apply additional N. Applications should be completed before the silk emergence growth stage. Each CM is provided with a calibration disc to ensure the meter is functioning properly. Always follow the CM use instructions. To collect a CM measurement, place a corn leaf between the sensors and hold the sensors together. Always place the top of the meter on the top side of the leaf. It is important to sample the same leaf on each plant at approximately the same spot on each leaf (halfway down the leaf from the tip to the base and halfway from the leaf edge to the midrib). Before tassel emergence, readings should be taken from the uppermost leaf that is fully collared (leaf collar fully visible around the stalk). If readings are collected at or after tassel emergence, they should be taken from the leaf at the uppermost ear shoot. Readings should be collected from many plants to account for sampling errors and natural color variation across leaves and between plants. The CM memory holds up to 30 sensor measurements. Pressing the CM “Average” button calculates an average of all sensor measurements. After collecting readings from 20 to 30 different plants, scroll back through the data display to review measurements. Numbers significantly higher or lower A CM reading is a unit-less value and by itself does not adequately determine N sufficiency/stress. When CM readings are compared with readings from an adequately N fertilized reference area; however, we can evaluate corn N status relative to the “greenest” corn in the field. It is critical that each field have reference strips (no more than 5 percent of the field total) or areas. By adjusting (normalizing) CM sensor measurements to reflect the adequately fertilized N reference area, the user reduces the effects of other variables such as hybrid differences or moisture stress. Reference strips or areas can be created by applying extra N (approximately 50 to 100 percent more than typically required for the rotation) at pre-plant or early side-dress. Enough reference strips are needed to characterize differing field areas. To normalize the CM readings, take the average CM reading of the corn in the area of interest and divide this number by the average CM reading of the reference strip closest to that area. This normalized value gives you the relative CM (RCM) value.

Use the table below to determine how much, if any, additional N is needed.

Table 1. RCM value and in-season

N application rate.

Table 1. Relative SPAD chlorophyll meter (RCM) value and in-season N application rate.

Relative CM Value†	N Rate to Apply‡
RCM	lb N/acre
< 0.88	100
0.88 - 0.92	80
0.92 - 0.95	60
0.95 - 0.97	30
> 0.97	0

† Readings taken from V10 to VT corn growth stages.

‡ Suggested N rate limited to a maximum of 100 lb N/acre.