A FOUR-STATE STUDY TO DEVELOP A LEAF-BLADE NITROGEN TEST FOR COTTON IN THE MID-SOUTH

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Abstract

Soil and tissue tests help determine the N status of soils and plants. Because of a lack of accurate soil or plant tests, there are no leaf or soil tests recommended by the Extension Service in Louisiana for determining the N status of cotton soils or plants. This project helps determine the leaf N concentrations of the uppermost, fully mature, leaf blade associated with N deficiency in cotton for Louisiana and Mid-South cotton. Nitrogen-rate fertilizer field experiments were conducted at 12 research station and farm sites in Louisiana, Arkansas, Mississippi, and Alabama in 1997. Data from some of the sites were used to determine the critical value for leaf-blade N. Preliminary results indicated the leaf-blade total N % associated with N deficiency in cotton were at concentrations less than the values listed below: at 1st pin-head square 4.6% N; at early-bloom 4.0% N; at mid-bloom (defined as 3 weeks after early bloom) 3.8% N; and at cut-out 3.3% N. Critical values at pin-head square and cut-out are not accurate but demonstrate the drop in critical values as the season progresses. The accuracy was poor at mid-bloom because mid-bloom was near cut-out at some sites in ‘97. Critical values for the 1997 season were about 0.2% less N than those optimized from the 1996 data.

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Introduction

Louisiana Cooperative Extension Service recommends N fertilizer applications near-planting and at side-dress and, in most years, no additional N is required (Funderburg and Burch, 1991). For those infrequent years when additional N is required, it is difficult to determine N need since soil or tissue tests are not available from the LSU Agricultural Center. Soil and petiole-nitrate tests have been unreliable for dryland conditions in Louisiana (Phillips et al., 1987; Breitenbeck 1990; Breitenbeck et al., 1994).

In two review articles on tissue testing, Arkansas scientist, Wayne Sabbe and his coauthors, called for the calibration of a leaf-tissue test for N in cotton (Sabbe and Mackenzie, 1973; Sabbe and Zelinski, 1990). This project addresses that need and tests the leaf-blade N method in four states, 12 sites, 9 site-cooperators, conventional and no-tillage conditions, and various cotton varieties. Unlike some experiments where variation is minimized, this variation is welcome as it exposes the tests to numerous conditions similar to growers’ samples sent to a tissue-testing laboratory. Calibration results often are accurate for a site but fail if other sites and years are compared. The 1996 results were promising regardless of site selected, but results here indicate that maintaining accurate diagnoses across years is difficult (Bell et al., 1997). The objectives of this research are to (i) determine the accuracy of the leaf-blade N test for determining the N status of cotton and (ii) evaluate factors that may affect the accuracy of the tissue test including leaf position, season, and growth stage. A long-term objective is to replace or assist the petiole-nitrate test for assessing the N status of cotton.

Materials and Methods

Sampling Method

Leaves were sampled from the uppermost part of the plant and from leaves that were fully mature. The petiole (stem) was removed and the mid-rib in the leaf remained with the leaf sample. The sampled leaf is at the 3rd or 4th node from the topmost node that contains a leaf about the size of a half-dollar coin. This node corresponds to that used in petiole-nitrate monitoring (Maples et al., 1977). Samples were dried at 80°C overnight and ground to pass a 40 mesh screen. Samples were taken at 1st or 2nd pin-head square (about 500 degree day units after planting), early bloom (820 degree-days after planting or about 1 bloom per 2 feet of 38" row), mid-bloom (3 weeks after early bloom), and cut-out (blooms have progressed up the plant and are at the fifth node from the top. Nodes were counted from where leaves were at least the size of a half-dollar coin). Results are presented from the St. Joseph, Winnsboro, Newellton, Columbia, Bossier City, Starkville, Prattville, and Brewton sites.

N Fertilization Application Rates: Application rates varied with site but all sites included zero, optimum, and excessive rates.

Observations: Cotton was observed for unusual conditions such as stunted plant height, water stress, insect stress, and excessive temperatures.

Analyses: Leaves were analyzed for N using a Leco FP-428 analyzer and total N concentration determined (Kjeldahl-equivalent).

Results and Discussion

Effect of Leaf Position on Leaf-N Concentration

There is some confusion what constitutes the *youngest, but fully mature leaf*. This first experiment was conducted to determine the amount of error made if the wrong leaves were sampled. The youngest fully mature leaf typically is the 3rd or 4th node from the top node that contains a leaf the size of a half-dollar. Leaves at early-bloom stage were sampled from the 0, 60 and 150 N-Lb/A treatments at the Bossier City site (E.Millhollon) at nodes 1, 3, 5, 8, and the bottom leaves. Leaf N concentrations were most different from the group of samples taken from the 1st, 3rd and 5th nodes VS the 5th, 8th, or bottom nodes at any N fertilization rate. Among the first 3 nodes sampled, there was little difference in leaf N concentrations among the nodes at the zero N rate. However, at the 60 lb/A rate, there were significant differences in leaf N concentrations at the 1st, 3rd, and 5th nodes ($P<0.05$). This did not follow the general trend of leaf N decreasing from upper to lower leaves as the 3rd-node leaf had lower leaf N than the 5th -node leaf (3.5 vs 3.7% N for leaves at the 3rd and 5th nodes, respectively). At low N rates, leaf N reach a minimum and it is likely more difficult to change leaf N due to node position or other conditions. At borderline-N levels, environmental conditions and temporal changes can affect leaf N significantly. We will include sampling instructions for growers to sample leaves at the 3rd or 4th node in addition to the instructions common for most crops–sample the *youngest, but fully developed leaf*.

Effect of Sampling at Various Growth Stages on the Sensitivity of the Leaf-Blade N Test

Sampling at early bloom was most accurate in predicting lint yield. Diagnoses were inaccurate when made at first pin-head square or cut-out. Cut-out is too late to remedy a N deficiency in cotton and was included to show the decreasing trend in critical values with maturity. First pin-head square was hoped to be an accurate sampling time, but instead shows the effects of site conditions more readily than the amount of N applied that year. Significant differences in leaf N occurred across sites. In 1996, both Alabama sites had significantly lower leaf N than other sites. Some sites had dismal results at mid-bloom with the St. Joseph, LA site having leaf N less than the critical value from *all* N-fertilization rates. The definition for mid-bloom used here failed–3 weeks after early bloom was near cut-out at the St. Joe site in 1997. Fertilization is most easily done and response most likely near early bloom. Fruitful future research may include examining other sampling times between 1st pin-head square and early-bloom.

Accuracy of the Leaf-Blade N Test for Diagnosing N Deficiencies or Sufficiencies

Preliminary results: The accuracy of the leaf-blade N test was determined using the Cate-Nelson method where the critical concentration is selected that minimizes misdiagnoses. Critical values determined for 1997 were at 1st pin-head square 4.6% N; at early-bloom 4.0% N; at mid-bloom (3 weeks after early bloom) 3.8% N; and at cut-out 3.3% N. These critical values were about 0.2% N less than those optimized for the 1996 data. Preliminary critical values for both years were at early bloom leaf N 4.1% and at mid-bloom 3.9%.

Comparison of Our Results with Others

Our critical values were higher than those by Sabbe et al. (1972) or Jones et al. (1991) who record mid-bloom critical values around 3.0% versus our 3.9%. Jones et al. (1991) listed a critical value of 3.5% at early bloom while we suggested 4.1% (or greater as one approaches pin-head square). An earlier Jones reference (1974 as reported in Reuter, 1986) cited an early-bloom critical value of 3.75% which is closer to our 4.1% value. We cannot recommended critical values for 1st pin-head square or cut-out.

Explanations for our higher values include: (i) earlier values represent a period when adequate N fertilization could mean more insect damage and less N was applied; and (ii) Sabbe et al. (1972) used survey results and could have more easily introduced errors than through the use of field experiments as we have done.

For more info and figures used in Beltwide presentation see:
http://www.agctr.lsu.edu/wwwac/dept/agronomy/plantlab/belt98.html.

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