A LEAF-BLADE NITROGEN TEST FOR COTTON IN THE MID-SOUTH

P.F. Bell, G. Breitenbeck, D. Boquet,
E. Millhollon, M. Holman, S Moore
Louisiana State University Agricultural Center:
Agronomy Department, Northeast Res. Sta., Red River Res. Sta., and Dean Lee
Res. Sta.; Baton Rouge, Winnsboro, St. Joseph, Bossier City, and
Alexandria LA
J. Varco
Dept. Plant Soil Sciences; Mississippi State University
Starkville, MS
C. Mitchell
Department of Agronomy and Soils
Auburn University
Auburn University, AL
W. Ebelhar, Mississippi Agricultural and Forestry Experiment
Station Delta Research and Extension Center
Stoneville, MS
W. Baker, J.S. McConnell, and W. Robinson
Soil Testing and Research Laboratory; Arkansas Agricultural
Experiment Station; University of Arkansas
Marianna, AR

Abstract

Soil and tissue tests are important in determining the N status of soils and plants. Unfortunately, there are no leaf or soil tests recommended by the Extension Service in Louisiana for determining the N status of cotton soils or plants. A project was developed to determine the leaf N concentrations of the uppermost, fully mature, leaf blade best 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 1996. Some of the results were used to determine the critical value for leaf-blade N. 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 5.2% N; at early-bloom 4.4% N; at mid-bloom (3 weeks after early bloom) 3.3% N; and at cut-out 3.3% N. These critical values were developed with incomplete data and will be modified depending on the outcome of the complete data set of 1996 and forthcoming 1997 results.

Introduction

Louisiana Cooperative Extension Service recommends N fertilizer applications near-planting and at side-dress. Additional applications should not be necessary in most years (Funderburg and Burch, 1991). Determining when these additional, but infrequent applications, should be applied is difficult since no soil or tissue tests are available from the LSU Agricultural Center. Research has indicated that under Louisiana conditions soil and petiole-nitrate tests have been unreliable for dryland conditions (Phillips et al., 1987; Breitenbeck 1990; Breitenbeck et al., 1994).

University of Arkansas agronomist Wayne Sabbe described the need for the calibration of a leaf-tissue test for N in cotton in two review articles in monographs on soil testing and plant analyses (Sabbe and Mackenzie, 1973; Sabbe and Zelinski, 1990). This project addresses that need and tests the leaf-blade N test in four states, at 12 sites, using 9 site-cooperators, in conventional and no-tillage conditions, and using various cotton varieties. Unlike some experiments where variation is minimized, this variation is welcome as it exposes the tests to numerous conditions similar to samples sent to an analyst in a tissue-testing laboratory. 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, growth stage, and nutrient interactions. 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 but the mid-rib in the leaf was not removed from the leaf. Samples were dried at 80°C overnight and ground with 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 were at the fifth node from the top. Nodes were counted from where leaves were at least the size of a quarter).

N fertilization application rates: Application rates varied with site but included zero, and 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).

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Results and Discussion

Effect of Leaf position on the sensitivity of the leaf-blade N test: Nitrogen is a mobile element within a plant and can move from older to younger leaves if N deficiency occurs. Therefore, older leaves may show N deficiency before younger leaves and may be a more sensitive leaf part than younger leaves for tissue testing. Normal tissue testing--and which we use--samples the younger leaves. Figure 1 reports the leaf N concentrations of younger versus older leaves as a function of the N fertilizer application rate (Northeast Research Station; Merritt Holman). The difference in leaf N concentrations at low N fertilizer application rates versus higher N application rates were greater for the younger than the older leaves. The standard sampling protocol was more sensitive than sampling older leaves.

Effect of sampling at various growth stages on the sensitivity of the leaf-blade N test: Figure 2 shows the leaf N concentrations of cotton at Mississippi State University's Ramsey site (Jac Varco) across N fertilizer application rates and at different sampling times. Results indicate (I) that the critical leaf-N associated with N deficiency decreases as the plant ages; (ii) this change was not gradual as the length of periods between growth stages were about equal, but differences in leaf concentrations between growth stages were not; (iii) the greatest sensitivity was at cut-out (difference in leaf-blade N at lowest to highest N application rate). The sampling at cut-out, however, is not useful for correcting any in-season N deficiency.

Accuracy of the leaf-blade N test for diagnosing N deficiencies or sufficiencies: *Preliminary results* The accuracy of the leaf-blade N test is given in figures 3-6. Each figure lists an optimum critical leaf N concentration below which plants would be diagnosed N deficient, and above which plants would be diagnosed N sufficient. Averages of each treatment at all sites where yield data is available are presented. Not all sites are presented in each figure. Critical leaf values were selected to maximize the accuracy and are only preliminary. The average values from each treatment at each site are presented where data is available. Not all sites are presented in every figure. At the pin-head square sampling stage, 62% of the diagnoses were accurate, at early bloom 73%, at mid-bloom 63%, and at cut-out 81%. These critical values will likely change as we receive all of 1996 samples and after the 1997 results are evaluated.

Comparison of our results with others: Our critical values are higher than those by Sabbe et al. (1972) or Jones et al. (1991) who record mid-bloom critical values around 3.0% versus our 3.5%. Jones et al. (1991) lists a critical value of 3.5% at pin-head square while we have listed 5.2%. No values are listed by others for cut-out. Our values are strictly from calibration and correlation field trials and may not represent a physiological deficiency of N. They represent a similar outcome, however, and in this they may be more accurate than that critical values representing real N deficit. In addition, others' critical values are older values and may represent earlier days when adequate N fertilization could mean more insect damage. The earlier values of Sabbe et al. (1972) were not correlation and calibration studies like ours, but were surveys. The Jones et al. (1991) value may have come from Sabbe's work. Our results are only one years and, also, the accuracy of our diagnoses is the worst at pin-head square when our results differ the greatest from others.

Disclaimer

Coauthors did not have the opportunity to review this manuscript and this paper is primarily the work of Paul Bell.

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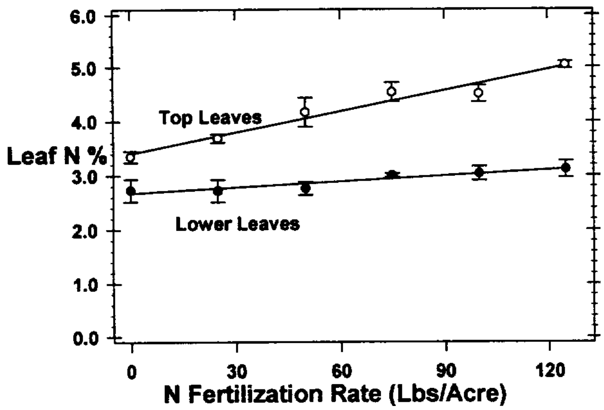

Figure 1. Top leaves more sensitive to N deficiency than lower leaves at early-bloom growth stage (Northeast Research Station site)

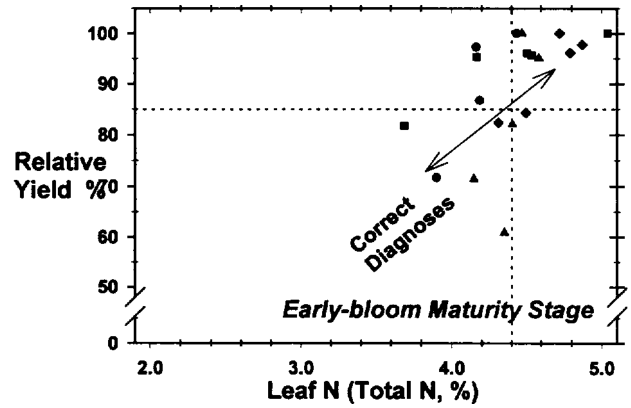

Figure 4. Accuracy of the leaf-blade N test at early bloom maturity stage.

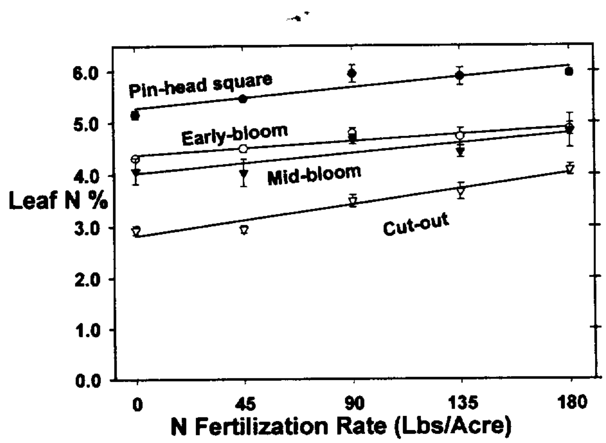

Figure 2. Ability of leaf N to assess N status in cotton: Effect of sampling period (Mississippi State University Ramsey site).

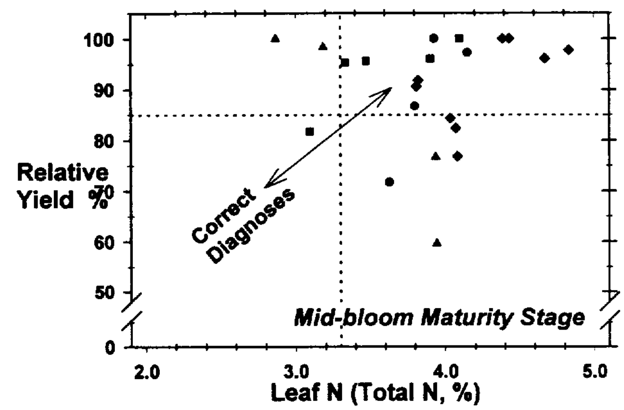

Figure 5. Accuracyof the leaf blade N test at mid bloom maturity stage.

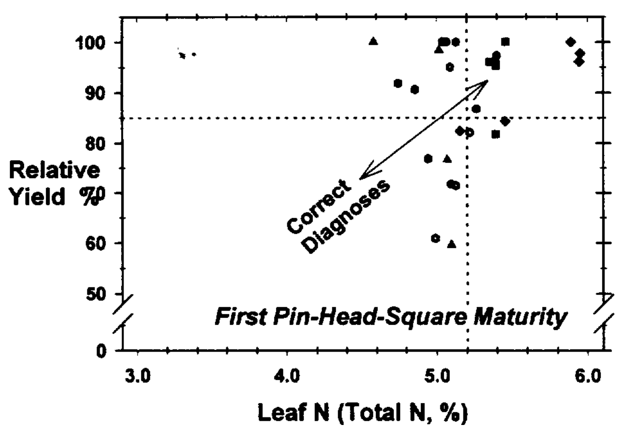

Figure 3. Accuracy of the leaf-blade N test at 1st pin-head square maturity stage.

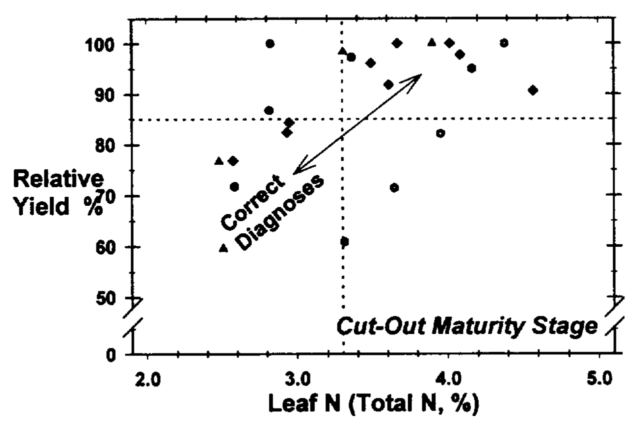

Figure 6. Accuracy of the leaf-blade N test at cut-out maturity stage.