

Foliar Boron Bumps Cotton Yields

Southeastern study shows that at leaf boron levels below 40 ppm at first flower, foliar boron applications improved cotton yields.

Summary: In southeastern cotton, an average yield increase of 21 lbs/A lint was obtained with foliar applications of 0.5 lbs/A boron (B) where leaf tissue B was less than 40 ppm before first flower. There was no evidence of need for greater than 0.5 lbs/A of foliar-applied B. Where leaf tissue B exceeded 125 ppm, cotton yield reductions were observed.

The interpretation of boron (B) soil tests and plant analyses is a major key to answering the question of the probability of crop yield response to fertilization.

Today, we have excellent, precise chemical tests for B in soils and plants. There is a need to focus on interpretation of the test results.

The standard micronutrient advisory of university agronomists during the early 1960s was, "Don't recommend a micronutrient unless a need can be demonstrated." This advice presented a difficult problem. At that time, agricultural laboratories performed no routine B analyses for soil or plant tissue and there were no established interpretations for crop need although it was reported that hot water extraction for available soil B and plant B analyses were useful indices for B need in corn.

Over the past half century, progress has been made through the establishment of critical and sufficiency leaf tissue B levels for major crop plants. Also, among the 13 state laboratories in the southern region, nine can determine B upon request. Three laboratories routinely measure B on all soil samples and most private laboratories now determine soil B, thanks to the use of the Mehlich extraction of B, which

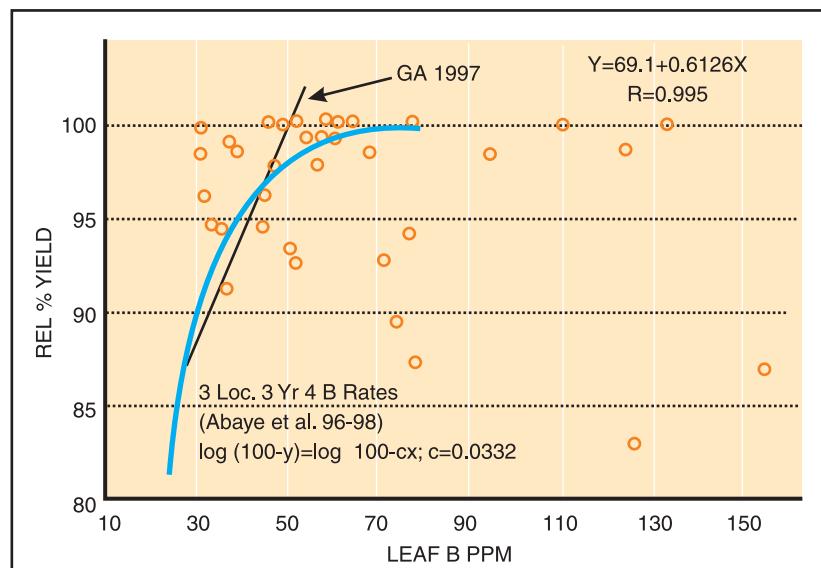


Figure 1. Regional cotton leaf B concentration versus percent relative cotton yields, 1996 through 1998.

correlates well with hot water B extraction and to B measurement with inductively coupled plasma atomic emission spectra detection instruments.

Crop responses to B fertilization have been reported on most major southern field, forage, fruit, and vegetable crops. Much of this past work can be reviewed in two publications: Boron and Its Role in Crop Production (C.R.C. Press, Inc, Boca Raton, FL, Mortvedt, J.J. and J.R. Woodruff, 1993, Technology and application of boron on fertilizers for crops, pp. 157-183; In U.C. Gupta [ed.]) and Boron in Soils and Plant Nutrition (2002, U.S. Borax, Inc.). Since cotton occupies the largest southern acreage routinely fertilized with B, this report will focus on cotton responses to B.

Early work

Much of the earliest soil fertility work with B on cotton began before and during the 1960s. Prior to those years, soil tests for B were not routinely performed. Thus, B fertilization was not

practiced, resulting in many soils in the southern region being low in B.

However, when studies began, cotton yield responses to B were observed on a number of sites. Not all test sites showed an increase in yield where B was applied but enough responses were observed that most mid-South and southeastern states began to routinely recommend 0.5 to 1 lb/A of B annually.

Points learned from the early studies of cotton response to B were 1) yield response of cotton to B fertilization was related to B concentrations in cotton leaf tissue, 2) B concentration in cotton leaf tissue was related to soil test B, and 3) where cotton responded to B application, soil test B levels were less than 0.2 ppm and leaf tissue B was below 20 ppm.

Recent history

During the mid-'70s, administrators of land grant universities, the USDA-ARS, and the fertilizer industry, prompted partly by the environmentalist

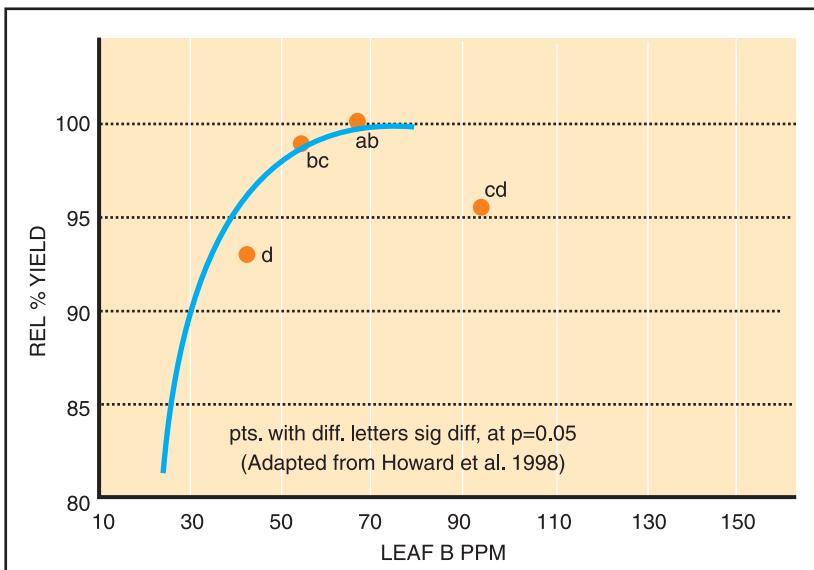


Figure 2. Tennessee cotton leaf B concentrations versus percent relative yield, 1996 - 1998

movement, demanded that those of us responsible for interpreting soil test reports and making fertilizer recommendations show our data and documentation of crop response to nutrients. Although soil fertility workers now have confidence that most current interpretations of soil and plant analysis data are generally valid based on experience from research and extension activities in the field, they often feel hard pressed to show definitive yield response data.

Agronomic and biological sciences, not being exact sciences, lean heavily on experience as well as numerical measurements. Those engaged in soil fertility research in the field have experienced difficulty showing immediate yield responses to nutrients other than nitrogen, making it difficult to document and predict nutrient needs. This has been true for major nutrients, and especially true for micronutrients, including B.

Current data

Using the modern tools of soil and plant analyses, the validation of current B recommendations is quite possible. Figure 1 shows 36 comparisons of cotton leaf B concentration versus relative percent cotton yields, illustrating how we can justify our

present interpretation of cotton need for B. The Mitscherlich yield response curve clearly fits the range of leaf tissue B generally interpreted as the sufficiency range (Georgia uses 20 to 60 ppm B). The fact that a significant B yield response was obtained within this range (Georgia, 1997) suggests that B fertilization might be beneficial even where leaf tissue B concentration falls within the sufficiency range.

The use of relative yield permits the combining of data from many locations or for many years into a single plot. Figure 2 shows cotton yield versus cotton leaf tissue B response. Superimposing the Tennessee data on

the response curve generated by a South Carolina, Georgia, and Virginia regional study shows how the Tennessee data fit the same response curve.

Table 1 presents a summary of the combined data across years and locations from the South Carolina, Georgia, and Virginia regional cotton study. Conclusions drawn from regional study:

- An average yield increase of 21 lbs/A lint was obtained with foliar application of 0.5 lb/A of B where leaf tissue B before first flower was less than 40 ppm B
- There was no evidence of need for greater than 0.5 lb/A of B foliar applied (split into three 0.166 lb/A increments at first flower, two weeks after, and four weeks after first flower)
- When cotton leaf tissue exceeded 125 ppm (five weeks after first flower), cotton yield reductions were observed
- Average lint yield increase of 21 lbs/A was exceeded in Georgia, where a 69 lbs/A increase was obtained by the applications of B, raising leaf tissue B from 36 to 5 ppm
- Economically, even if cotton price was 40 cents/lb, a half-pound of B costing \$2.50 would produce a return of \$8.40 from 21 lbs of lint, and a net return of \$5.90 (or 236%) on the B investment.

Future approach

Soil test B was less than 0.5 ppm at

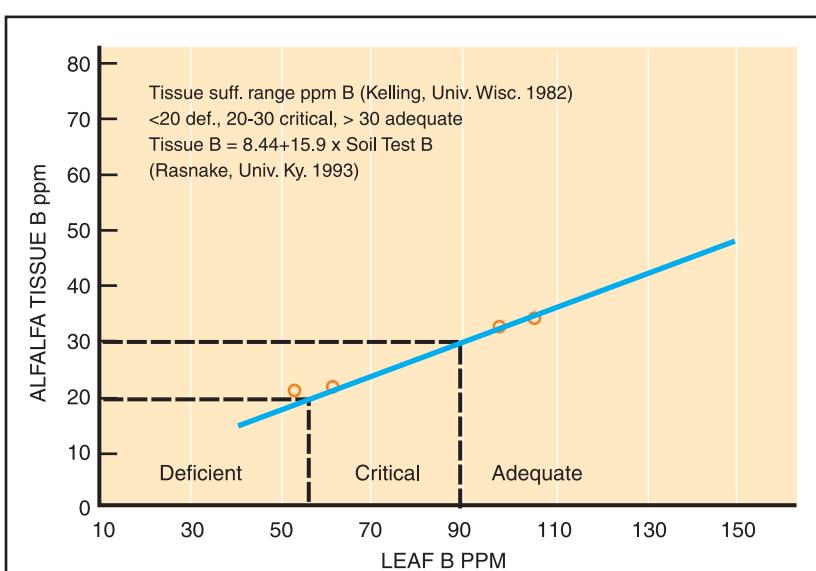


Figure 3. Alfalfa tissue B correlation with soil test B.

all locations in the regional cotton study, but was not measured for each field treatment plot. If soil test B values are determined for each plot in future work, along with leaf tissue B and yield, we can go one step farther to verify soil test B interpretations we are using for various soil and crop situations.

To illustrate this approach, a graph of the data from an alfalfa study is shown in Figure 3.

A linear regression of alfalfa tissue B on soil test B values was calculated. Using values of B tissue sufficiency ranges in alfalfa, the corresponding ranges of soil test B for deficient, critical, and adequate soil test values for B may be determined by drawing a horizontal line for the leaf tissue value on the vertical axis to a point on the regression line and dropping the vertical line to the corresponding soil test value on the horizontal axis as illustrated.

By this procedure, one small set of data can provide a soil test interpretation for a given crop on a given soil type. In this example, where soil test B is less than 0.75 ppm, the probability of a B yield response is high. Soil test values between 0.75 and 1.75 ppm B indicate the need of maintenance fertilization, and no B would be suggested where soil test B exceeds 1.75 ppm.

Currently, regional B projects in the Mississippi Delta with rice and soybeans are providing some excellent data showing the relationship between yield and plant tissue B, which will greatly aid predictions of the need of B fertilization on these crops.

Dr. Woodruff is an ag consultant with U.S. Borax. He presented this information in a talk entitled "Interpretation of Soil and Plant Analyses for Boron in Southern Crops" at the Oct. 2004 Southern Nutrient Management Conference in Olive Branch, MS. □