Petiole Analysis and Nitrogen Fertilization

(T. C. Tucker)

The level of N fertility probably has more influence on the growth, behavior and yield of cotton than any other single plant nutrient. The N nutrition should be regulated in such a manner as to permit continued vegetative growth and fruiting. Deficiencies of N can limit growth and, subsequently, induction and development of the fruiting parts. Some evidence points to excessive N as a cause of reduced yield and a less fruitful, undesirable plant type on fine textured soils with poor aeration. The objective of a N fertilizer program should be to time the fertilizer applications so as to avoid deficiencies or harmful excesses.

Petiole analysis for nitrate-N can be used to determine the N status of the plant throughout the growing season. A soil analysis, made prior to planting time, for nitrate nitrogen is used as a guide to the early N needs of cotton in Arizona. If the early season N needs are determined by soil analysis or if N is applied at planting, the first petiole sample can be taken at the "square stage" of development. At this time the bracts that enclose the floral bud are obvious throughout the field. Samples can be taken during the early vegetative growth stages but are not necessary if early N application is made or a soil analysis shows adequate N present in the soil.

The petiole is selected from the most recently fully expanded leaf which is usually the third leaf from the terminal. It is broken from the main stem and then separated from the leaf blade. About 25 to 30 petioles per sample are adequate for laboratory analysis. These should be taken from uniform areas and represent the largest part of the field and serve as a basis for treatment of the entire field. Samplings are made at two-week intervals until it is too late to apply additional N.

The normal pattern of adequate petiole nitrate values ranges from a high level during early vegetative stages of growth to relatively low values during heavy fruiting. A rapid decline in petiole nitrate is normal for plants that are setting a heavy boll load. The effect of fruit initiation and development on petiole nitrate level is one of many factors that must be considered when interpreting the results during the season. Some other factors which must be considered are: source, rate and time of previous fertilization, previous cropping history, soil texture, and water supplied.

The fruiting pattern of cotton will vary some with climatic area and from season to season. It will to some degree determine the importance of N timing. In case of a "one peak" flowering pattern, which may be characteristic of a short season area, timing of N is very important to avoid early season N deficiency which will reduce the intensity of flowering and the duration of intense flowering. In "two peak" areas or long seasons the loss of flowers resulting from early N deficiency may be compensated by heavier fruiting during the second peak in late season with little or no loss in yield. Thus, N timing may be of less importance in long seasons. It is safer, however, to maintain adequate N throughout the season since in some years seasonal conditions may result in "one flowering peak" in a normal "two peak" area.

The levels of petiole nitrate suggested are for Arizona conditions (Table 1).

Table 1. Desirable levels of nitrate nitrogen in cotton petioles at various stages of plant development.

Stage of growth	Desired level of NO_3-N as ppm. N
First squares	15,000 - 18,000
First flowers	12,000 - 14,000
First bolls	6,000 - 10,000
First open bolls	4,000

The lower limits apply to the Acala varieties and the high values apply to rainbelt varieties. These levels are conservative in that slightly lower levels are not deficient at any particular period. Lower levels would indicate, however, that nitrate levels are declining too rapidly and that a deficiency can be expected in the near future. In cases of borderline levels it is desirable to take a sample between normal samplings. Thus, N fertilizer needs can be anticipated. Nitrogen can then be applied preventing the rapid decline of petiole nitrate. Nitrate levels materially below those suggested may not reduce yields seriously if corrected promptly by application of a nitrate source.

In Arizona, the nitrate-N in soil samples taken from the side of the bed after the preplant irrigation and before planting has been found useful in determining the need for early N application on cotton. The nitrate test cannot be used to predict the amount of fertilizer that must be added or the yield increase that will result. The test will help predict the yield only for which the soil N is adequate. If a good estimate can be made of the maximum yield possible, the nitrate test can be used to predict if N fertilizer is needed. The combination of soil and petiole analysis for nitrate-N can be best used to insure adequate N for the entire season. The interpretation of the soil nitrate test is based on a standardized method of sampling discussed earlier (Table 2).

Table 2. Relation of initial soil nitrate level to early season nitrogen needs of cotton.

Soil* nitrate ppm. NO_3	Stage of growth at which nitrogen fertilizer may be needed
0 - 10	At planting or as soon after as practical
10 - 20	By 6- leaf to square stage
20 - 30	By time of first flower
30+	Use petiole test to determine if needed

*When soil nitrate values are reported as N, multiply by 4.4 for use with this table.

It must be recognized that these techniques can serve as guides for developing an adequate but not excessive N fertilizer program. These tools can not be used to increase the maximum yeild possible or to correct any factor limiting yield that is not nutritional. Therefore, their most effective use will not always increase yields. They can aid only in insuring that adequate N is available for the attainment of the maximum yield possible under the existing conditions. In many cases the only benefit that the grower can derive from the use of these tools is the assurance that the N fertilizer program was adequate and that excessive fertilizer was not used. Some growers feel that other benefits are to be realized if they collect the samples. For example, the grower probably sees more of his cotton more often and takes a closer look at how the plants are growing and fruiting. He also learns of insects, water penetration, diseases and many other important factors that otherwise might go unnoticed though essential in the total management of the cotton crop.

Effect of Crop Residues, Nitrogen and Phosphorus on the Yield of Cotton

(T. C. Tucker, J. L. Abbott, and E. W. Carpenter)

The effect of barley and grain sorghum residue management has been studied in relation to N and P requirements of both crops since 1959 at the Mesa Experimental Farm. Consistent responses of both crops to N were shown. The N requirements of barley were greater than for grain sorghum. The amount of N supplied by the soil appeared to be greater for grain sorghum than for barley. Barley appeared to be less able to utilize soil P than grain sorghum as responses to P were most pronounced with barley.

In 1964 this field was planted to cotton, variety Acala 44-10. The control plots had not received P fertilizers since 1957 when a uniform application of P was made. The P treated plots have received 43.4 pounds of P (100 lbs. P_2O_5) each year.

The yield results are given in table 1 and figures 1 and 2. Yields were increased by N application at rates of 50 to 100 pounds per acre depending upon the P treatment. The effect of P is shown clearly in figure 1. An application of 50 pounds of N with P resulted in a higher yield than resulted from 100 or 200 pounds of N alone. It should be mentioned that these plots received 0, 100, 200, and 400 pounds of N per acre when planted to grain sorghum in 1963. Each preceding crop of barley or sorghum received 0, 50, 100, and 200 pounds of N per acre per crop each year. Thus, some carry over of N no doubt has occurred. The increase in yield for P was about 10 percent of the yield without P or about 90 percent of the yield with added P fertilizer when N was adequate.

The response pattern to N and P was influenced by the previous residue management. The results in figure 2 show the highest yield resulted from the application of N and P when the residues had been returned. Yields were higher for all fertilizer treatments when the barley and grain sorghum residues had been plowed under for the past five years as compared with removal of all above ground plant parts. Such a residue effect had not been indicated in the past with either grain sorghum or barley. It appears that the optimum fertilizer treatment was 50 pounds of N per acre plus P since the yield from this treatment was as high or higher than the 200 pound N treatment alone regardless of the residue effect. The residue management did not change the need for P nor the amount of N needed.