



# Using Tissue Analysis to Monitor Cotton Nutrition

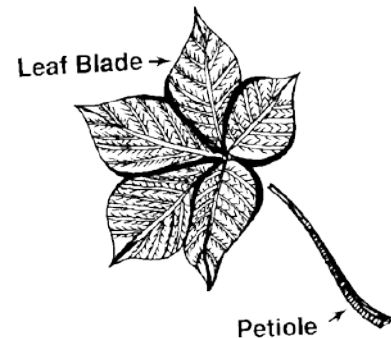
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The N.C. Department of Agriculture & Consumer Services encourages growers to use tissue analysis to optimize cotton yields. Tissue analysis can be used to fine-tune fertilizer application rates and to detect hidden hunger. Because it is difficult to get nutrients into cotton plants after the 3<sup>rd</sup> to 5<sup>th</sup> week of bloom, we recommend collecting a total of three samples: one the week before first bloom, one at first week of bloom and a final one at third week of bloom. This schedule allows time for fertilizer adjustments to be completed at least by the 4<sup>th</sup> week of bloom. Further, we recommend submitting tissue samples any time a problem is observed to determine if poor nutritional status is involved.

## Collecting Tissue Samples

***Cotton tissue samples should include both leaf blades and petioles.*** Petioles should be separated from the blades in the field. The analysis this year will include concentrations of NO<sub>3</sub>-N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, B in the petiole and concentrations of total-N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, B in the leaf blade. ***The total fee for analysis of leaves and petioles is \$7 per sample.***



Accurate recommendations from tissue analysis depend on good sampling technique, including 1) collecting samples at the same time of day preferably between 9 a.m. and 1 p.m.; 2) selecting the proper plant part (the most recent mature leaf, which is usually the 4<sup>th</sup> leaf from the growing point on the *main stem only*); 3) submitting sufficient material (25–30 leaf blades and petioles per sample); 4) separating the entire petiole from leaf blade at sampling; and 5) providing all details—growth stage and week, planting date, fertilization history, environmental conditions, appearance, problems, disease/insect pressure—on the *Plant Sample Information* form.

Providing details for each sample on the *Plant Sample Information* form will help ensure more accurate recommendations. It is important to indicate the current growth stage and week of the crop (Table 1). Using the recommended protocol, collect the first sample one week prior to first bloom. This is usually two weeks after pinhead-square formation. It is coded as growth stage E, week 4 on the form. Collect the second sample at the first week of bloom (code as B1). “Bloom” typically begins 21 days after pinhead square formation (or flower initiation) and is recognized by the presence of about five open flowers per 25 row feet. Collect the third sample two weeks after B1 and code it as B3. Rather than tissue sampling from every field, collect samples from fields that represent average conditions on your farm.

<b>Table 1. Consecutive growth stage and week designations for cotton tissue samples</b>															
S = SEEDLING, 4 WKS 1–4				E = EARLY VEGETATIVE GROWTH, 4 WKS 1–4				B = BLOOM, 4 WKS 1–4				F= FRUIT, 4 WKS 1–4			
S1	S2	S3	S4	E1	E2	E3	E4	B1	B2	B3	B4	F1	F2	F3	F4

Table 2 shows how to code the samples on the *Plant Sample Information* form. [In real practice, the prebloom, week 1 and week 3 samples would not be included on the same form.] Leaf blade and petiole samples should be listed separately on the form along with the correct designation for PLANT PART. The code is M (most recent mature leaf) for the leaf blade and P for the petiole. For the petiole sample, check NO<sub>3</sub>-N under EXTRA TESTS.

<b>Table 2. Correct entries for completing each individual <i>Plant Sample Information</i> form*</b>						
Sample Time	Crop	Growth Stage	Week	Plant Part	Position	NO <sub>3</sub> -N
1 <sup>st</sup> sample	Cotton	E	4	M	U	
1 <sup>st</sup> sample	Cotton	E	4	P	U	✓
2 <sup>nd</sup> sample	Cotton	B	1	M	U	
2 <sup>nd</sup> sample	Cotton	B	1	P	U	✓
3 <sup>rd</sup> sample	Cotton	B	3	M	U	
3 <sup>rd</sup> sample	Cotton	B	3	P	U	✓

\* If soil conditions are dry, try to wait 48–72 hours after a rain event to sample.

***Dry conditions and limited soil moisture are important factors to consider when collecting a cotton tissue sample.*** Research currently being conducted at NCSU indicates that when soil moisture is limiting, concentrations of nitrogen and potassium decrease in cotton petiole tissue (Holt JS, personal communication). The implication for cotton tissue analysis is that it may not always be a reliable indicator of fertilizer needs under dry conditions. Therefore, rather than sampling on a precise schedule, it may be preferable to wait for a rain event and collect tissue samples 48–72 hours afterwards, if possible.

Boron is crucial during flowering and boll development of the cotton plant. NCDA&CS soil tests do not measure boron, so an application of 1 pound of actual boron per acre (preplant) is recommended to meet this need. It is also recommended that a foliar application of about 0.5 pound per acre of actual boron be applied at early bloom on sandy soils to offset the leaching potential of boron in the soil. An alternative is to apply 0.25 pound of actual boron foliarly at early bloom and repeat the application two weeks later. This splitting of foliar-applied boron will ensure availability during bloom and boll filling on very deep sandy soils. It should also be noted that during dry weather boron in the soil is less available, so a foliar application of boron during drought, regardless of the soil type, could be beneficial (refer to NCSU's *2010 Cotton Information*, available online at [ipm.ncsu.edu/production\\_guides/cotton/contents.pdf](http://ipm.ncsu.edu/production_guides/cotton/contents.pdf)).

## Interpreting Plant Analysis Results for Cotton

Refer to Tables 3, 4 and 5 when interpreting data values on the NCD&CS *Plant Analysis Report*. Ongoing research in North Carolina is being conducted to establish optimal concentrations of petiole P and K for our soils and production practices. Table 5 provides sets of petiole-K critical values for comparative purposes: a set based on N.C. research as well as values used in other states. At early bloom, petiole P should be about 800 ppm (0.08%).

Well-organized records—such as tissue and soil reports, fertilizer application rates, environmental conditions, yield and price—are resources the cotton farmer can use to assess fertilizer management for future crops.

**Table 3. Leaf blade sufficiency ranges \***

Nitrogen (N)%	3.5–4.5
Phosphorus (P)%	0.2–0.65
Potassium (K)% **	
seedling (S) – early bloom (E)	1.5–3.0
bloom (B)	1.2–2.5
fruit (F) – maturity (M)	0.75–2.5
Calcium (Ca)%	1.25–3.0
Magnesium (Mg)%	0.25–0.5
Sulfur (S)%	0.25–1.0
Manganese (Mn), ppm	20–350
Iron (Fe), ppm	50–250
Boron (B), ppm	20–60
Copper (Cu), ppm	5–25
Zinc (Zn), ppm	20–40

\* Ranges correspond to NCD&CS indexes of 50–75.

\*\* K sufficiency range depends on growth stage.

**Table 4. Desired range of petiole nitrate-nitrogen (ppm) by growth stage and week**

Week	Seedling (S)	Early (E)	Bloom (B)	Fruit (F)	Mature (M)
1	16,000–30,000	12,000–18,000	6,000–12,000	1,000–6,000	200–2,500
2	15,000–25,000	10,000–16,000	5,000–11,000	500–5,000	150–2,000
3	14,000–22,500	8,000–14,000	3,500–10,000	250–4,000	100–1,500
4	13,000–20,000	7,500–13,000	2,000–8,000	100–3,000	50–1,000

**Table 5. Petiole K (%) critical values and/or sufficiency ranges used in the Southeast and California**

Growth Stage	Week	N. Carolina	Georgia	California	Arkansas
E	3				
E	4	4.0			
B	1	4.0	3.0–5.0	4.0–5.5	3.7
B	2	3.5	2.5–4.5		3.0
B	3	3.0	2.0–4.0		2.8
B	4	2.5	> 1.5		2.2
F	1	2.0	> 1.5	3.0–4.0	2.0
F	2	2.0	> 1.5		1.0
F	3		> 1.5	1.5–2.5	