NEWS & VIEWS

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Plant Tissue Analysis— A Valuable Nutrient Management Tool

MOST good farmers and crop advisers rely on intensive soil sampling programs to develop nutrient management plans designed to limit or reduce the chance that soil fertility and plant nutrition could limit crop yields and potential profits. Sometimes, however, this approach alone can result in some surprises and disappointments. One way to take the nutrient management program to the next level is to use plant tissue analysis as a supplement to soil testing.

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Plant tissue analysis can often identify in-season nutrition problems in time to take corrective action. It can be used to build confidence in the success of the nutrient management plan. Some use plant tissue analysis to confirm the nutrient imbalance associated with obvious visual symptoms. If yields end up being short of expectations, earlier plant tissue analysis can be used to help identify other factors besides fertility that may have limited crop growth and yield. Plants integrate the combined effects of soil fertility and other production factors such as: Soil compaction, cold soils, wet soils, drought, nematodes and other diseases, insects, herbicide injury, and root pruning associated with cultivation. If the liming and fertilization program is progressive, yet tissue analysis identifies shortages, then these other factors can be more thoroughly investigated as possible limitations.

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Several points should be considered in planning for success with plant tissue analysis. The first and most important is collection of a representative sample before plants may have stressed enough to severely limit dry matter production. A minimum of 20 to 30 plants should be sampled when plants are nearing reproductive growth. Thirty to 60 plants should be sampled when plants are less than 12 inches tall. When sampling corn, wheat, rice, sugarcane, and most forages that are young and less than 12 inches tall, the entire above-ground portion should be collected. For crops like soybeans and cotton, the most recently mature or fully-expanded leaves should be collected. These leaves are usually at the fourth node below the terminal of the plant. Care should be exercised to avoid sampling plants which have been contaminated with dust or soil, or which have experienced insect or disease damage. Although early-season sampling is preferred in diagnosing problems for corrective action, most interpretations have been developed from research sampling of plants at or just prior to reproductive development. Therefore, early-season samples usually have a higher concentration of most nutrients than samples collected later in the season. If tissue nutrient levels are low early in the season based on nutrient sufficiency ranges established for plants at or near reproductive development, one can assume that a nutrient shortage is present.

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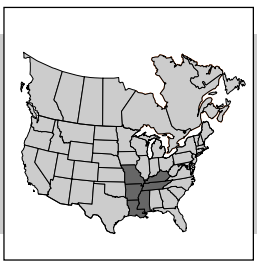

Samples should be placed in clean paper bags and be allowed to dry as quickly as possible. Making perforations in the paper bag with a hole-puncher can aid drying and help prevent condensation of moisture in the bag. If samples are placed in plastic bags, they can mold in shipment and lose dry weight, preventing accurate analyses. Samples should be delivered to the testing laboratory within 24 to 48 hours after collection. This can be accomplished with many over-night or next-day shipping services. Many labs have preferred sampling and submission procedures and should be consulted before sample collection. Most modern laboratories can return tissue analysis results and interpretations by fax, the Internet, or e-mail to the crop adviser or farmer within 24 to 48 hours of receipt of the sample. This often allows the crop manager to apply any limiting nutrients in time to prevent significant yield losses or in time to increase yields with favorable growing conditions. For many, the turn-around time from sampling to fertilizing can be as short as three to four days.

Carefully follow the sampling instructions of the lab where plant tissue will be analyzed.

If there are obvious contrasting areas in fields, separate tissue samples should be collected from the "bad" areas and also from "good" areas to allow the best chance to accurately diagnose problems. This paired sampling should be done as soon as differences are recognized and before significant stunting has occurred.

Table 1. General total nutrient sufficiency ranges for selected crops in the South at or near reproductive growth (taken from numerous published sources).

Nutrient	N	P	K	S	Ca	Mg	Fe	Mn	Zn	Cu	B
Concentration	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm
Field Crop (plant part)											
Corn (Ear leaf at initial silking)	2.5 to 3.5	0.25 to 0.45	1.70 to 3.0	0.21 to 0.5	0.25 to 0.50	0.13 to .30	21 to 250	15 to 300	20 to 100	6 to 20	5 to 25
Cotton (Most recent fully developed leaf)	3.5 to 4.5	0.3 to 0.64	0.9 to 2.0	0.3 to 0.75	1.9 to 3.5	0.3 to 0.75	30 to 300	30 to 300	20 to 100	5 to 25	20 to 60
Rice (Y-leaf or youngest fully developed leaf)	2.8 to 3.2	0.20 to 0.29	1.5 to 2.5	0.15 to 0.30	0.20 to 0.40	0.18 to 0.40	75 to 200	50 to 200	30 to 60	8 to 25	6 to 8
Sorghum (3rd leaf below head at bloom)	3.3 to 4.0	0.23 to 0.35	1.4 to 1.7	0.21 to 0.5	0.30 to 0.60	0.20 to 0.5	65 to 100	10 to 190	15 to 30	2 to 30	1 to 10
Soybean (uppermost mature trifoliate leaf)	3.6 to 4.7	0.31 to 0.5	1.5 to 2.5	0.20 to 0.60	0.6 to 1.4	0.30 to 0.8	50 to 350	17 to 100	21 to 50	5 to 30	20 to 60
Sugarcane (4th mature leaf from plant top)	1.50 to 2.60	0.18 to 0.30	1.50 to 1.80	0.15 to 0.20	0.28 to 0.50	0.15 to 0.35	40 to 250	25 to 400	20 to 50	7 to 20	4 to 30
Wheat (flag leaf)	3.0 to 4.5	0.25 to 0.5	1.5 to 3.0	0.20 to 0.5	0.30 to 1.0	0.16 to 1.0	25 to 300	20 to 475	16 to 70	6 to 25	6 to 20
Alfalfa (top 6 inches)	4.5 to 5.0	0.26 to 0.70	2.5 to 3.5	0.26 to 0.5	1.8 to 3.0	0.30 to 1.0	30 to 250	25 to 100	21 to 70	7 to 30	30 to 80
Fescue (whole top)	3.2 to 3.6	0.34 to 0.45	2.8 to 4.0	0.18 to 0.40	0.40 to 0.58	0.20 to 0.32	—	—	—	—	—
Hybrid bermudagrass (whole top)	2.0 to 4.0	0.25 to 0.60	2.00 to 3.0	0.18 to 0.50	0.25 to 0.40	0.18 to 0.30	50 to 350	25 to 300	20 to 50	5 to 25	6 to 30

When growth limitations persist long enough, it is possible for the tissue concentration of some nutrients to actually increase in stunted plants. This can lead to false interpretations because nutrient concentrations are expressed on a dry weight basis. When sampling tissue in "bad" and "good" areas, it is also wise to consider collecting soil samples for comparison. Probing soils in these different areas can often diagnose compaction. Extremes in soil pH and moisture can also be detected.

There are several excellent plant nutrition and plant analysis books that can be referred to for interpretation of tissue analysis results. **Table 1** is shown as a quick reference for several major field crops produced in the southern region. The values shown represent "sufficiency" levels that are considered adequate for normal growth and development.

The concentrations of nitrogen (N), phosphorus (P) and potassium (K) generally decrease in the plant with age, as these nutrients are mobilized to developing seed and/or fiber. Older leaves tend to have lower concentrations of N, P and K as plants mature, whereas the concentrations of sulfur (S), calcium (Ca) magnesium (Mg) and micronutrients are lower nearer the plant tops since mobilization from older to newer tissues is limited for these nutrients. In addition, the crop and cultivar, age and stage of growth, and plant part all affect the sampling strategy and the interpretation of the analytical results.

For nutrients like S, it is important to evaluate the tissue concentration and the N to S ratio. For most crops, it is best to maintain the N to S ratio at 17 to 1 or lower. For example, if one were to only look at the N analysis and observe that it was below the sufficiency range, without knowing the tissue S level, the conclusion might be that more N would be needed. However, if a complete tissue analysis had been done, it may have been concluded that S was also low. Poor S nutrition may have been limiting uptake and utilization of N. A complete tissue analysis is recommended for most field situations, including the major, secondary, and micronutrients, to prevent misdiagnosis of tissue nutrient imbalances. Complete tissue analysis is worth the small additional expense. The greatest expense associated with tissue sampling and analysis is usually the cost of collecting the sample.

All plant nutrient management plans should be flexible and subject to periodic evaluation with plant tissue analysis. Plant tissue analysis helps ensure that soil fertility objectives are met and that nutrition does not limit yield potential. Coupled with a sound, site-specific soil testing program, it can be an excellent diagnostic tool.

Consider the value of plant tissue analysis in taking your nutrient management program and yield potential to a higher level. Consult certified crop advisers, fertilizer dealers, Extension agronomists, and analytical laboratories for assistance and more information on how to collect and submit samples, interpret the results, and react to the crop's nutritional status**. Remove soil fertility and plant nutrition as factors limiting crop yields and profits by using the second most important tool in the nutrient management tool box…plant tissue analysis**. ■

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