



Leaf and soil samples can help citrus growers evaluate their fertilizer programs.

# Leaf tissue and soil sampling and testing

By Mongi Zekri, Kelly Morgan, Tom Obreza and Arnold Schumann

**N**utrient deficiency or excess will cause citrus trees to grow poorly and produce sub-optimal yield and/or fruit quality. For this reason, diagnosis of potential nutritional problems should be a routine citrus-growing practice. Quantifying nutrients in soils and trees eliminates guesswork when adjusting a fertilizer program.

## BENEFITS OF LEAF ANALYSIS

The goal in tissue analysis is to adjust fertilization programs so that nutritional problems and their costly consequences are prevented. Considerable research involving citrus leaf testing has established its reliability as a management tool, but sampling guidelines should be followed precisely to ensure that analytical results are meaningful.

Leaf tissue analysis:

- Determines if the tree has had a sufficient supply of essential nutrients.
- Confirms nutritional deficiencies, toxicities or imbalances.

- Identifies hidden toxicities and deficiencies when visible symptoms are not present.
- Evaluates the effectiveness of fertilizer programs.
- Provides a way to compare several fertilizer treatments.
- Determines the availability of elements not tested for by other methods.

Leaf tissue analysis tests all the factors that might influence nutrient availability and uptake.

## LEAF SAMPLING CONSIDERATIONS

Procedures for proper sampling, preparation and analysis of leaves have been standardized to achieve meaningful comparisons and interpretations. If the procedures are done correctly, chemical analysis reliability, data interpretation, fertilization recommendations and fertilizer program adjustments will be sound. Considerable care should be taken from the time leaves are selected for sampling to the time they are received at the laboratory for analysis.

### Timing

- Leaf samples must be taken at the correct time of year because nutrient concentrations within leaves continuously change. As leaves age from spring through fall, nitrogen (N), phosphorus (P) and potassium (K) concentrations decrease; calcium (Ca) increases; and magnesium (Mg) first increases and then decreases. However, leaf mineral concentrations are relatively stable from four to six months after leaf emergence in the spring.
- The best time to collect 4- to 6-month-old spring flush leaves is July and August. If leaves are sampled later in the season, summer leaf growth can be confused with spring growth.

### Technique

- One leaf sample should represent an area not to exceed 20 acres. The sampler should make sure the selected trees are representative of the average within the block being sampled.
- Each leaf sample should consist of approximately 100 leaves taken from nonfruiting twigs of 15 to 20 uniform trees of the same variety and rootstock that have received the same fertilizer program.
- Use clean paper bags to store the sample. Label the bags with an identification number that can be referenced when the analytical results are received.
- Avoid immature leaves due to their rapidly changing composition.
- Do not sample abnormal-appearing trees. Also, trees at the block's edge or at the end of rows should not be sampled as leaves from these trees may be coated with soil particles and dust.

- Do not include diseased, insect-damaged or dead leaves in a sample.
- Select only one leaf from a shoot, and remove it with its petiole (leaf stem).

#### Special Case: Diagnosing Growth Disorders

- Collect samples from both affected trees as well as normal trees and label each bag separately.
- Trees selected for comparison sampling should be of the same age, scion type and rootstock.
- If possible, confine the sampling area to trees that are in close proximity to each other.

#### Handling

- Protect leaves from heat and keep them dry. Place them in a refrigerator for overnight storage if the leaves cannot be washed and oven-dried during the day of collection.
- For macronutrient analysis, leaves do not need to be washed. Macronutrients include N, P, K, Ca and Mg.
- For micronutrient determinations, leaf samples should be washed by hand soon after collection and before the leaves dehydrate. Leaves should be rubbed between the thumb and forefinger while soaking them in a mild detergent solution and then thoroughly rinsed with distilled or deionized water. It is difficult to remove all surface residues, but this procedure removes most of this contamination.
- Dry the leaves in a ventilated oven at about 140°F.

## ANALYSIS AND INTERPRETATION

- The laboratory determines the total concentration of each nutrient in the leaf sample. Since total concentration is determined, there should be no difference in leaf analysis results between different laboratories.
- To interpret laboratory results, compare the values with the leaf analysis standards in Table 1. These standards are based on long-term field observations and experiments conducted in different countries with different citrus varieties, rootstocks and management practices. The tabulated standards are used to gauge citrus tree nutrition throughout the world.
- The goal in nutrition management is to maintain leaf nutrient concentrations within the optimum range every year (Table 1). If the level of a particular nutrient is not optimum, various strategies can be used to address the situation. These might include supplemental foliar or soil applications of the appropriate nutrients.

## BENEFITS OF SOIL ANALYSIS

Soil analysis is helpful in formulating and improving a fertilization program because soil testing measures organic matter content, pH and extractable nutrients. Soil analysis is particularly useful when conducted for several consecutive years because trends can be observed. However, a citrus grower cannot rely on soil analysis alone to formulate a

**Table 1.** Guidelines for interpreting orange tree leaf analysis based on 4- to 6-month-old spring flush leaves from nonfruiting twigs. (Note: The information contained in this article pertains to healthy citrus trees. The values for some nutrients in HLB-affected trees may not conform to Table 1 values.)

Element	Unit of Measure	Optimum
Nitrogen	%	2.5–2.7
Phosphorus	%	0.12–0.16
Potassium	%	1.2–1.7
Calcium	%	3.0–4.9
Magnesium	%	0.30–0.49
Sulfur	%	0.20–0.40
Chlorine	%	< 0.20
Sodium	%	< 0.15
Manganese	mg/kg or ppm <sup>1</sup>	25–100
Zinc	mg/kg or ppm	25–100
Copper	mg/kg or ppm	5–16
Iron	mg/kg or ppm	60–120
Boron	mg/kg or ppm	36–100
Molybdenum	mg/kg or ppm	0.10–2.0

<sup>1</sup>ppm = parts per million

fertilizer program or to diagnose a nutritional problem in a grove. Leaf sample analysis and observations of leaf deficiencies and toxicities should also be used.

Similar to leaf analysis, organic matter and soil pH determination methods are universal, so results should not differ between laboratories. However, soil nutrient extraction procedures can vary from lab to lab, including the University of Florida Extension Soil Testing Laboratory. The University of Florida now recommends the Mehlich 3 extraction procedure.

The single most useful soil test in a citrus grove is for pH. Soil pH greatly influences nutrient availability. Some nutrient deficiencies can be avoided by maintaining soil pH between 5.5 and 6.5.

## SOIL SAMPLING CONSIDERATIONS

Standard procedures for sampling, preparing and analyzing soil should be followed for meaningful interpretations of the test results and accurate recommendations.

#### Timing

- In Florida, soil samples should be collected once per year at the end of the summer rainy season and before fall fertilization (August to October).
- It is convenient to take annual soil samples when collecting leaf samples to save time and reduce costs.
- The accuracy of soil test interpretations depends on how well the soil sample represents the grove block or management unit in question.

#### Technique

- Each soil sample should consist of one soil core taken

about 8 inches deep at the dripline of 15 to 20 trees, within the area wetted by the irrigation system in the zone of maximum root activity.

- Sampled areas should correspond with grove blocks where leaf samples were collected. The area should contain similar soil types with trees of roughly uniform size and vigor.
- Thoroughly mix the cores in a nonmetal bucket to form a composite sample. Take a subsample from this mixture and place it into a labeled paper bag.

#### Special Case: Diagnosing Growth Disorders

- Collect soil samples from beneath affected trees as well as normal trees, and analyze them separately.
- If possible, confine the sampling area to trees that are close to each other.

#### Preparation for Analysis

- Soil samples should be air-dried before shipping to the laboratory for analysis.

## ANALYSIS AND INTERPRETATION

- The basic soil analysis package run by most agricultural laboratories includes soil pH and extractable P, K, Ca and Mg. Organic matter is sometimes part of the basic package, or it may be a separate analysis. Extractable copper (Cu) is normally determined upon request.
- Since **extractable** nutrients are measured, the magnitude of soil test values may differ between different laboratories. This difference is not a concern as long as the extraction method is calibrated for citrus.
- The laboratory interprets each soil test result as very low, low, medium, high or very high, or as low, medium and high in the case of Mehlich 3. The laboratory may also provide fertilizer recommendations. Citrus growers can independently interpret the numerical results according to UF-IFAS guidelines based on the extractant used.
- The interpretations should be used to make management decisions regarding soil pH adjustment or fertilizer application.

## SUMMARY

Tissue and soil analysis are powerful tools to confirm nutrient deficiencies and toxicities, identify “hidden hunger” (a situation in which a plant needs more of a given nutrient yet shows no deficiency symptoms), evaluate fertilizer programs, study nutrient interactions and determine fertilizer rates. However, if any steps in site selection, sampling or analysis are faulty, the results may be misleading.

Experience interpreting sample results is essential due to the many interacting factors that influence the concentrations of elements in soil and leaf tissue. Tree age, cropping history, sampling techniques, soil test interpretations and leaf analysis standards all must be considered before making a final diagnosis. If done properly, tissue and soil analysis will lead to more economical and efficient use of fertilizers because excessive or insufficient application rates will be avoided.

Use this checklist as a guide for starting a soil- and leaf-tissue testing program:

- A sampling program is most effective if it is done annually at the same time of year.
- Leaf tissue testing is valuable for all elements.
- Soil testing is most useful for pH, P, K, Ca, Mg and Cu.
- Use the standard sampling procedures for soil and leaves described in this article.
- Be aware that spray residues or dust on leaf surfaces affect sample results; wash leaves for accurate micronutrient analysis. Avoid sampling recently sprayed trees.
- Be aware that a number of different soil extracting solutions exist, and they can differ in their ability to extract plant nutrients, especially P.
- Interpretation of leaf and soil tests should be used to make fertilizer or liming decisions. Wise use of the results allows optimal citrus production and minimizes fertilizer loss. 🍊

*Mongi Zekri is a multi-county citrus Extension agent, Kelly Morgan is an associate professor, Tom Obreza is a senior associate dean and associate director, and Arnold Schumann is a professor — all with the University of Florida-IFAS.*

## What's Shakin'

**CALIFORNIA WINE GROWERS** realize the importance of harvesting grapes with mechanical systems. In the January 2012 issue of *Wines and Vines*, Thomas Ulrich wrote an article, “Harvest Technology Comes of Age,” in which he explained how grape growers were benefiting from mechanical harvesting systems.

During 2011, grape yields were lower than expected from California’s north coast as a result of bad weather that produced infertile flowers, shot berries and a shorter-than-average onset of ripening. Growers

were forced to cull a significant amount of immature fruit. For example, a block of Pinot Noir that normally produces 4 tons of grapes yielded only three-quarters of a ton that year.

Steven Rogstad, winemaker for Cuvaion Estate Wines, said that “the harvesting machines processed grapes more quickly and selected berries more carefully than fruit harvested and sorted by hand.” To read this article, click on the link on the Citrus Mechanical Harvesting website (<http://citrusmh.ifas.ufl.edu>). 🍊