Adjust fertilizer programs with leaf and soil sampling and research-based interpretations

By Mongi Zekri and Tom Obreza

Optimum growth and yield of high-quality citrus fruit cannot be obtained without sufficient plant nutrition. The deficiency or excess of an element will cause disturbance in plant metabolism and lead to poor productivity. Combining leaf tissue analysis, knowledge of soil fertility from soil analysis, and university recommendations can help producers develop a successful fertilization program.

PLANT ANALYSIS

Used in conjunction with other data and observations, tissue analysis aids in evaluating the nutrient status in the soil-plant system. Leaf-testing has proven useful to confirm nutritional deficiencies, toxicities or imbalances to identify "hidden" toxicities and deficiencies with no visible symptoms, and to evaluate the effectiveness of fertilization programs.

LEAF-SAMPLING

For reliable results and interpretation, citrus grove managers must follow standard procedures for leaf-sampling and handling because improperly collected leaves will provide misleading information about tree nutritional status. Considerable care is needed when taking leaf samples, which must represent the average tree condition of the sampled block.

Figure 1. *Leaf and soil sampling.*

Leaf samples (Figure 1) must also be taken at the proper time because nutrient concentrations in leaves change with leaf age. Nutrient elements in spring flush leaves are relatively stable when the leaves are 4 to 6 months old. Thus, the best time to sample spring flush leaves is July or August. (If samples are taken later in the season, it is easy to confuse the summer flush with the spring flush.)

To properly sample a block, visit 15 to 20 representative trees and remove approximately 100 total leaves from non-fruiting twigs (five to seven leaves per tree, removed in a circular pattern around the tree). Sampled trees should be the same variety and rootstock with the same fertilization program. Use a clean paper bag to hold the leaves. Each sample bag and its corresponding lab information sheet should be labeled the same way so samples and sheets can be matched in the laboratory.

Sampling techniques for leaves

- Avoid leaf ages outside of the four-to-six month window.
- Do not sample abnormal-appearing trees or trees on the edge of a block. (Edge trees are usually covered with road dust, which would cause a faulty lab result.)
- Do not include diseased, insect-damaged or dead leaves in a sample. Use good judgment.
- Select only one leaf from a shoot and remove it with its petiole (leaf stem).

Diagnosing growth disorders

- Collect samples independently from both affected trees as well as normal trees.
- Trees selected for sampling should be at similar stage of development and age.
- Whenever possible, confine the

sampling area to trees that are close to each other.

Handling of leaf samples

• Samples should be collected in clean paper bags and clearly identified.

• Leaves should be protected from heat and kept dry and cool (stored in portable ice chests), and placed in a refrigerator for overnight storage if the leaves cannot be washed and oven-dried the day of collection.

• For macronutrient analysis, leaves usually do not need to be washed.

• Leaves should be dried in a ventilated oven at 140°F–158°F (60°C–70°C).

Preparation for analysis

• Leaves that have been recently sprayed with micronutrients for fungicidal (Cu) or nutritional (Mn, Zn) purposes should not be evaluated for those elements because it is unlikely that all surface residues can be washed off.

• For accurate Fe and B or other micronutrient determinations, samples require hand-washing, which is best done when leaves are still in a fresh condition.

Standard Table for Assessing Nutritional Status and Adjusting Fertilizer Programs for Citrus. Leaf Analysis Standard for assessing current nutrient status of citrus trees based on concentration of mineral elements in a four- to six-month-old spring cycle leaves from non-fruiting terminals.

Element	Deficient less than	Low	Satisfactory	High	Excess more than
Nitrogen (N) (%)	2.2	2.2-2.4	2.5-2.8	2.9-3.2	3.3
Phosphorus (P) (%)	0.09	0.09-0.11	0.12-0.17	0.18-0.29	0.30
Potassium (K) (%)	0.7	0.7-1.1	1.2-1.7	1.8-2.3	2.4
Calcium (Ca) (%)	1.5	1.5-2.9	3.0-5.0	5.1-6.9	7.0
Magnesium (Mg) (%)	0.20	0.20-0.29	0.30-0.50	0.51-0.70	0.80
Sulfur (S) (%)	0.14	0.14-0.19	0.20-0.40	0.41-0.60	0.60
Chlorine (Cl) (%)	------	------	less than 0.5	0.5-0.7	0.7
Sodium (Na) (%)	------	------	less than 0.2	0.2-0.5	0.5
Iron (Fe) (ppm)	35	35-59	60-120	121-200	250
Boron (B) (ppm)	20	20-35	36-100	101-200	250
Manganese (Mn) (ppm)	18	18-24	25-100	101-300	500
Zinc (Zn) (ppm)	18	18-24	25-100	101-300	300
Copper (Cu) (ppm)	4	4-5	6-16	17-20	20
Molybdenum (Mo) (ppm)	0.06	0.06-0.09	0.1-1.0	2-50	50

SOIL ANALYSIS

Soil analysis helps a manager learn basic information about soil fertility status. Soil analysis is particularly useful when conducted for several years at a regular frequency so that specific trends, if any, can be identified.

Unlike leaf analysis, not all laboratories use the same methods and procedures to extract nutrients from soil samples. In Florida, soil tests for the relatively mobile and readily leached elements such as N and K are of little to no value. Soil tests are mostly used to measure soil pH plus extractable P, Mg, Ca and Cu. For Florida sandy soils, using the Mehlich-1 or double acid (hydrochloric acid plus sulfuric acid) extraction procedure adopted by the University of Florida analytical lab, 40 to 60 pounds/acre (20 to 30 ppm) of P, 70 to 120 pounds/acre (35 to 60 ppm) of Mg, 500 to 800 pounds/acre (250–400 ppm) of Ca, and 5 to 10 pounds/acre (2.5–5 ppm) of Cu are considered adequate for citrus. A Ca:Mg ratio of 7:1 seems desirable; ratios of higher than 10 may induce Mg deficiency. A Cu test higher than 50 pounds/acre may be toxic to citrus trees if the soil pH is less than 6.

Soil sampling

The accuracy of a soil test-based fertilizer recommendation depends on how well the soil sample represents the average tree condition and appearance within the grove. In Florida, the best time to collect an annual soil sample is the end of the summer rainy season, before fall fertilization (e.g., September/October). However, soil sampling may be conducted at the same time as leaf-sampling to save time and reduce cost.

Standard procedures for proper sampling, preparation and analysis must be followed for meaningful test results and accurate fertilization recommendations. Each soil sample should consist of 15 to 20, 6-inch deep soil cores, where one core is removed from the dripline of 15 to 20 trees within the area wetted by the irrigation system. The sampled area should have uniform soil and tree characteristics and should correspond to the area where the leaf sample was taken. Individual cores should be mixed thoroughly in a plastic bucket to form a composite sample (Figure 1). A subsample large enough to fill a labeled soil sample bag should be taken from the composite mixture. Soil samples should be air-dried, but not oven-dried before shipping to the testing laboratory for analysis.

CONCLUSION

Tissue and soil analyses are a powerful tool for confirming nutrient deficiencies, toxicities and imbalances, identifying "hidden hunger," evaluating fertilizer programs and studying nutrient interactions. However, if plant and soil sampling, handling and analysis are faulty, the results will be misleading. If properly done, tissue and soil analyses can point the way toward more economical and efficient use of fertilizer materials, avoiding excessive or insufficient application rates.

Consult UF-IFAS publication SL 253, "Nutrition of Florida Citrus Trees," at http://edis.ifas.ufl.edu/pdffiles/SS/SS47800.pdf for more details.

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