Potential use of DRIS for leaf nutrient diagnosis in Florida citrus

By Arnold Schumann

The Diagnosis and Recommendation Integrated System (DRIS) is an alternative method for the interpretation of mineral nutrient levels in plant tissues. DRIS was developed to overcome some of the limitations of traditional nutrient interpretation methods which rely on published leaf analysis standards. This article examines the weaknesses of traditional methods, how DRIS works, and how it could help Florida citrus growers to optimize their nutrient management programs.

TRADITIONAL LEAF ANALYSIS

Leaf nutrient analysis is an important diagnostic tool for optimizing the mineral nutrition of citrus and other perennial crops. Soil sampling and analysis are less useful for diagnosing the nutrient requirements in perennial crops than in annual crops. Optimal nutrition will maximize fruit yield and quality while minimizing environmental impacts caused by inefficient utilization of nutrients.

Citrus leaf nutrient diagnoses in Florida are usually made by sampling and analyzing 4- to 6-month-old spring flush leaves taken from non-fruiting branches. Traditionally, concentrations of nutrient elements in the leaves are expressed as fractions on a total leaf dry weight (DW) basis, either as percent (%, or parts per hundred) for macronutrients or parts per million (ppm) for micronutrients. Therefore the numerator in a calculation of leaf nutrient concentration is the weight of a given nutrient element in a sample and the denominator is sample DW. The reliance on DW as the denominator is one of the weaknesses in this popular method for presenting plant nutrients. An increase in DW for any reason due to accumulation of sugars, starch or other nutrients for example, will reduce the concentration of the nutrient of interest even if the total weight of that nutrient does not change in the leaf. This is known as the "dilution effect," and vice versa for "concentration effect" when DW decreases. A nutrient concentration which changes due to changing DW could then lead to inaccurate interpretation of nutrient results when comparing with standard published values or thresholds. For that reason, IFAS recommendations specify the standardized age of a leaf (4 to 6 month), flush season (spring), and proximity to fruit (non-fruiting) since those factors can all affect the leaf sample DW and therefore nutrient concentrations.

Figure 1, copied from IFAS Extension publication SL253, illustrates the recommended leaf sampling period from July to October when nutrient concentrations in mature leaves tend to be most stable. There are many other factors that could alter leaf sample DW, including changes in growth rates, leaf distortion or changes in morphology, either from diseases, pests, plant hormones, physical damage or extreme deficiencies or excesses of certain nutrients. Figure 2 illustrates some of these possibilities and combinations. One solution to the problem is to use leaf area instead of DW as the denominator in the expression of nutrient content. Scientific studies in plant physiology routinely express leaf nutrients on a leaf area basis for that reason.

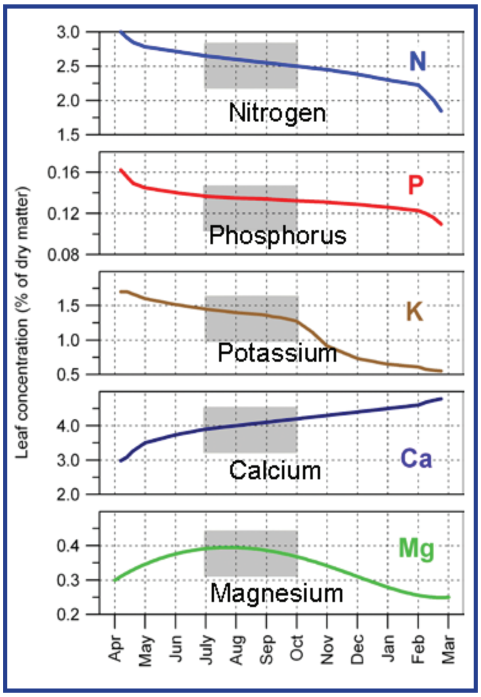
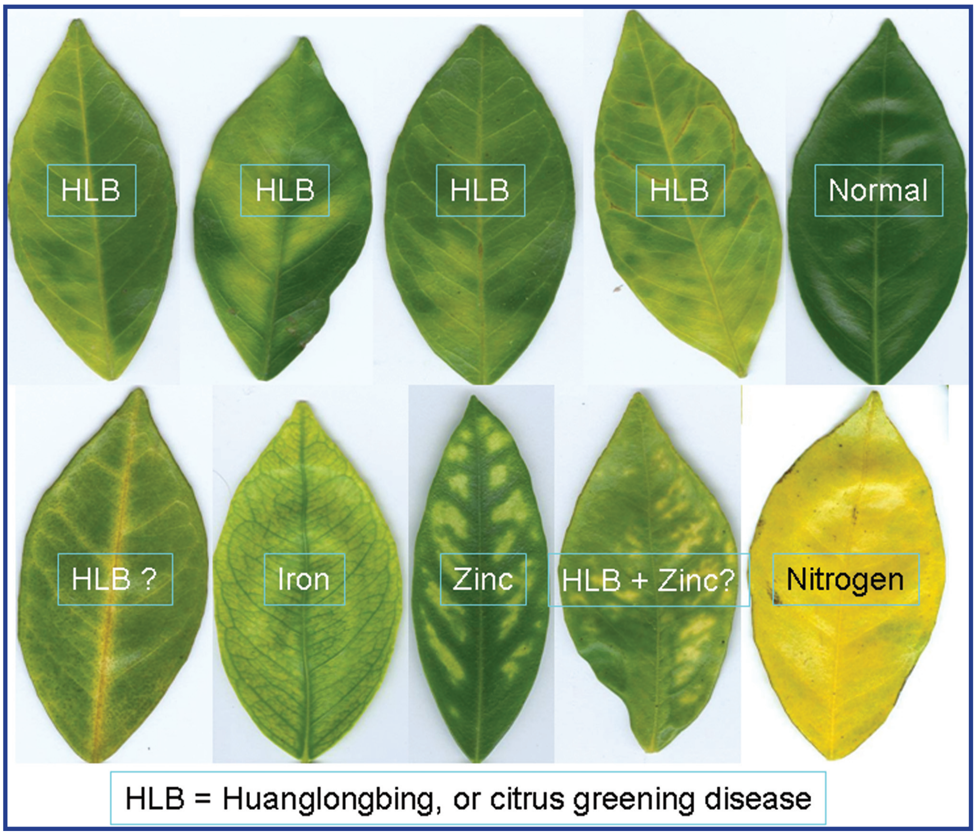


Figure 1, above: *Changes in concentration of plant nutrients with age and season.*

Figure 2, below: *Some disease and nutrient deficiency symptoms seen in Florida citrus.*



The other approach is to use the DRIS procedure for interpretation and diagnosis of leaf nutrient contents.

HOW CAN DRIS HELP TO INTERPRET LEAF NUTRIENTS ACCURATELY?

The DRIS technique of plant nutrient analysis was developed in 1973 by E. R. Beaufils at the University of Natal, South Africa. The method makes multiple two-way ratio comparisons between the concentrations in the leaf of all the measured plant nutrients (e.g., N/P, P/K, K/Ca, etc.) and aggregates these comparisons into a series of nutrient indices. These indices represent nutritional balance in the order of nutrient limitations. For example, zero indices indicate adequate nutrition, more negative indices imply increasing deficiency and more positive indices imply increasing excess. Thus the magnitude of the negative or positive indices indicates the severity of the deficiency or excess in the plant tissue and allows a ranking of plant nutrient deficiencies.

Since the DRIS method calculates ratios of nutrient concentrations, each of which is a fraction with DW as the denominator, the DWs cancel out. Thus nutrient interpretation with DRIS considerably reduces the bias from undesirable nutrient concentration or dilution effects due to uncontrollable changes in leaf tissue DW. Furthermore, variants of the DRIS computations are available which can estimate an index of the leaf DW (DWI).

In research studies with Huanglongbing (HLB)-infected blotchy mottled leaves where starch accumulation caused DW to increase, the DWI calculated by DRIS was correlated with measured DW. Analytical labs do not routinely report DW for leaf samples, but by using DRIS, we are able to calculate DWI and obtain an estimate of undesirable DW changes of which we need to be aware.

Preparation to use DRIS for a crop usually involves compiling a leaf nutrient database from high-yielding blocks with which optimum ratios for all nutrient combinations are determined. A preliminary small database has been assembled at the Citrus Research and Education Center for testing the DRIS procedure on research samples. We plan to expand the database and make the DRIS procedure available to growers through our CREC Web site.

The DRIS norms established for a specific crop are usually applicable to the same crop in any area of cultivation. DRIS has been successfully applied to many annual and perennial crops, including citrus in South Africa, Brazil, Spain and Venezuela.

The principal advantages of the DRIS system are that stage of maturity, plant part and variety are less important than they are for the traditional critical level or sufficiency range approaches to interpreting plant analyses. Thus, by using DRIS, it is possible to sample citrus at most times of the year. DRIS also offers some protection from other sampling discrepancies such as sampling from different canopy positions (inner versus outer), from fruiting branches, and from disease-affected foliage.

HOW CAN DRIS HELP UNRAVEL THE HLB-NUTRITION ENIGMA?

One of the recognized symptoms of the HLB infection in citrus leaves is a dramatic accumulation of starch, which can be easily measured with the iodine test and other methods. In diseased tissues, accumulations of starch capable of increasing the total leaf DW by nearly 50 percent have been recorded. Consequently most leaf nutrient concentrations show an apparent decline in HLB-infected blotchy mottled leaves due to dilution by the added weight of accumulated starch. For example, in a replicated study of 10 HLB-infected and 10 healthy Hamlin orange trees, the sulfur concentration in symptomatic blotchy-mottled leaves was 13 percent lower than in asymptomatic leaves from the HLB trees or the healthy trees. Analysis of the data with DRIS revealed that the amounts of sulfur in the different leaf samples were not significantly different. The same conclusion was reached by converting the sulfur concentration data to a leaf area basis (milligrams per square meter). We concluded that the sulfur "deficiency" in blotchy mottled leaves was false and likely caused by the accumulation of starch.

Most experience with DRIS elsewhere has shown that the evaluations should not be made disregarding nutrient concentrations altogether. Rather the two interpretative approaches should be used together for best results. DRIS should be useful for Florida growers to develop better fertilizer programs and to assist in recognizing false nutrient deficiencies in the presence of diseases. The DRIS procedure is now being used in IFAS research targeting the interactions of plant nutrients with the HLB disease–psyllid vector complex.

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