Phosphorus recommendations and soil pH amendments

By Kelly T. Morgan and Davie Kadyampakeni

Most information provided in the 2020 3rd edition of Nutrition of Florida Citrus Trees is still sound for healthy citrus trees under Florida production conditions. Past information on nutrients, application methods, leaf and soil sampling, and irrigation scheduling are also effective for management of huanglongbing (HLB)-affected trees. However, research conducted since HLB was detected in Florida in 2005 has established changes in many production practices, including nutrient application rates and timing as well as soil pH management.

LEAF AND SOIL SAMPLES

Nutrient deficiency or excess will cause citrus trees to grow poorly and produce lower yields or poor fruit quality. Diagnosis of potential nutrient problems should be a routine citrus-growing practice. Quantifying nutrient concentrations in soils and leaf tissues eliminates guesswork when adjusting fertilizer programs and reduces the potential for underapplications or overapplications. Leaf nutrient concentrations are the most useful tool to detect problems and adjust fertilizer programs.

Leaves reflect nutrient accumulation and redistribution throughout the plant. Leaf samples must be taken at the correct time of the year to be effective because nutrient concentrations within the leaves continuously change (Figure 1). Leaves produced in the spring have reduced phosphorus (P) concentrations but are most stable during the summer months.

Therefore, University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) recommendations are to collect 6-month-old spring leaves from early July to late September. Many growers have started the practice of collecting leaf samples at various times of the year in an attempt to address fertilizer needs of HLB-affected trees. Once started, nutrient concentration in leaves must be compared to samples taken at the same time of the year.

Leaf P concentrations in the range of 0.12 to 0.16% are considered optimum for maximum potential fruit yields (Table 1, page 16). This table can be found on page 30 of Nutrition of Florida Citrus Trees and page 86 in the 2021–2022 Florida Citrus Production Guide. Concentrations lower than optimum indicate the need for more P. Concentrations greater than optimum may not improve yields, and in some cases result in increased leaf production and lower yields.

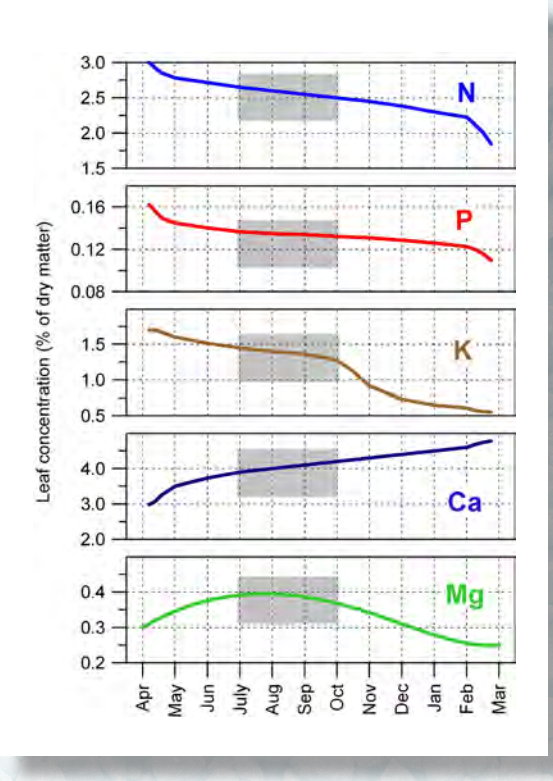

Figure 1. Changes in leaf nutrient concentrations in spring with leaf age

Soil sample results should be evaluated in the same timeframe. Soil organic matter content, pH and extractable nutrients can be good bases for the evaluation of past fertilizer programs and potential needs for future applications.

A soil extraction does not measure the total amount of nutrients present in the soil nor does it measure the quantity actually available to citrus trees. The value of a soil-testing procedure depends on how closely the extractable nutrient concentration correlates with the amount of nutrient a plant can take up. Past research has established a range of soil concentrations, called the soil nutrient index, that indicate soil concentrations that are low, medium or high. A table containing the

Table 1. Leaf sample nutrient concentrations by recommended ranges

Element	Unit of measure	Deficient	Low	Optimum	High	Excess
N	%	< 2.2	2.2–2.4	2.5–2.7	2.8–3.0	> 3.0
P	%	< 0.09	0.09–0.11	0.12–0.16	0.17–0.30	> 0.30
K	%	< 0.7	0.7–1.1	1.2–1.7	1.8–2.4	> 2.4
Ca	%	< 1.5	1.5–2.9	3.0–4.9	5.0–7.0	> 7.0
Mg	%	< 0.20	0.20 – 0.29	0.30–0.49	0.50–0.70	> 0.70
Cl	%	---	—	< 0.2	0.20–0.70	> 0.70[1]
Na	%	---	—	—	0.15–0.25	> 0.25
Mn	mg/kg or ppm[2]	< 18	18–24	25–100	101–300	> 300
Zn	mg/kg or ppm	< 18	18–24	25–100	101–300	> 300
Cu	mg/kg or ppm	< 3	3–4	5–16	17–20	> 20
Fe	mg/kg or ppm	< 35	35–59	60–120	121–200	> 200
B	mg/kg or ppm	< 20	20–35	36–100	101–200	> 200
Mo	mg/kg or ppm	< 0.05	0.06–0.09	0.10–2.0	2.0–5.0	> 5.0

[1] Leaf burn and defoliation can occur at Cl concentration >1.0%.
[2] ppm = parts per million.

Table 2. Soil test interpretations based on selected soil sample extractants

Extractant	Nutrient	Soil test interpretation				
		Very Low	Low	Medium	High	Very High
		(Less than sufficient)			(Sufficient)	
Mehlich 1	P mg/kg (ppm)[1]	< 10	10–15	16–30	31–60	> 60
Mehlich 3[2]		< 11	11–16	17–29	30–56	> 56
Ammonium acetate pH 4.8[3]		≤ 11			> 11	
Bray P1[3]		≤ 40			> 40	
Bray P2[3]		≤ 65			> 65	
			Low	Medium	High	
Mehlich 1	Mg mg/kg (ppm)		< 15	15–30	> 30	
Mehlich 3[4]			< 25	25–33	> 33	
Ammonium acetate pH 4.8[5]			< 14	14–26	> 26	
		Less than sufficient			Sufficient	
Ammonium acetate pH 7.0[3]		≤ 50			> 50	
		Less than sufficient			Sufficient	
Mehlich 1	Ca mg/kg (ppm)	≤ 250			> 250	
Mehlich 3[4]		≤ 200			> 200	
Ammonium acetate pH 4.8[5]		≤ 270			> 270	
Ammonium acetate pH 7.0[3]		≤ 250			> 250	

[1] parts per million (ppm) x 2 = lb/acre.
[2] Estimated from unpublished correlation data (T. A. Obreza 2006).
[3] From Koo et al. (1984).
[4] Estimated from correlation data (Alva 1993).
[5] Estimated from correlation data (Sartain 1978).

soil P concentrations for these index values using a number of soil extracts is provided on page 31 of Nutrition of Florida Citrus Trees and in Figure 3 on page 82 in the Florida Citrus Production Guide.

GROWER ADVICE

Before deciding to apply P fertilizer to young citrus trees, compare soil P with the medium values in Table 2. Apply no P fertilizer if soil is in the high or very high range. Apply 50% of the nitrogen (N) rate if soil concentrations are in the medium range and 75% of the N rate if soil concentrations are in the low or very low range.

P recommendations for trees greater than 3 years of age are based on a combination of both leaf and soil P concentrations. Leaf and soil applications should be based on recommendations found in Table 6 on page 63 of Nutrition of Florida Citrus Trees. No P fertilizer is recommended if leaf P concentrations are in the high or excessive range regardless of soil P concentrations. For groves with leaf samples in the optimum range, no P fertilizer is recommended if soil P concentrations are sufficient or higher. If leaf P concentrations are in the optimum range and soils are below

sufficient range, 8 pounds of P_2O_5 per 100 boxes of fruit are recommended. For groves with leaf samples in the low or deficient range, recommendations would be 12 and 16 pounds P_2O_5 per 100 boxes of fruit per acre, respectively.

Because HLB symptoms worsen in groves irrigated with well and surface water containing dissolved bicarbonates, soil pH should be maintained in a range of 5.8 to 6.5. The is because soil pH lower than 5.5 and higher than 7.0 reduces availability of calcium, magnesium, iron, zinc and manganese.

Research found that in groves with high bicarbonate levels, feeder root density and root lifespan decreases, and function in nutrient uptake is reduced. However, not all rootstocks are equally sensitive; Swingle is the most sensitive.

Soil and water quality should be managed by frequent application of water and nutrients to root systems reduced by the effects of HLB. Because of its benefits to soil fertilizer and its increased availability since the 1990s, organic matter addition has become more practical and beneficial for trees affected by HLB. In poor and depleted soils that are low in organic matter, compost benefits soil structure and water-holding capacity, buffers changes in soil pH and provides an additional source of plant nutrients.

Controlled-release fertilizers have the advantage of inducing more growth and yield due to a continuous rather than a fluctuating supply of nutrients. Reduced rates and frequency of fertilizer application minimizes potential negative environmental effects of fertilizer leaching and brings substantial savings in labor, time and energy.

Liquid fertilizers applied weekly, biweekly or monthly appear to improve the performance of HLB-affected trees. Repeated applications of small amounts of nutrients improves canopy size, trunk growth, root development and fruit yield by synchronizing nutrient applications with tree seasonal nutrient demand.

Kelly T. Morgan is a professor in the Soil and Water Science Department at the University of Florida in Gainesville. Davie Kadyampakeni is an assistant professor at the UF/IFAS Citrus Research and Education Center in Lake Alfred.

Grower Referendum Explained

By Rick Dantzler, CRDF chief operating officer

Next month there will be a referendum on whether to preserve the mechanism that allows growers to tax themselves up to three pennies per box of fruit to fund citrus research. This mechanism is called the Citrus Research Order. Funds raised through the order, along with legislative appropriation, is how the Citrus Research and Development Foundation (CRDF) is funded.

The vote will not be on whether to assess three pennies of tax (or any amount, for that matter); the vote will be only whether to keep the mechanism for assessment in place. Here's how the process works:

By law, the CRDF board of directors serves as the advisory council to the Florida Department of Agriculture and Consumer Services (FDACS) for the order. In June of every year, the advisory council meets to decide whether to recommend to FDACS that an assessment be made, and if so, how much the assessment should be (no more than three pennies). CRDF simply makes a recommendation; the assessment becomes operative only by action and with the concurrence of FDACS.

An assessment is not required, and CRDF will do as the industry wishes. Why? Because CRDF exists to serve growers and is set up organizationally to make sure that happens. By statute, 10 of the 13 board members are growers. Five are nominated by Florida Citrus Mutual, and five are nominated by the Florida Department of Citrus, so grower control on the board is ensured.

CRDF's committees also have a supermajority of growers serving on them. For example, CRDF has just combined both of its research committees into one, and 13 of the 17 members of this committee are growers. The Select Committee on Plant Improvement has a similar supermajority of growers, too.

The point is, CRDF will do what growers desire because it is growers we serve.

As you consider how to vote, there are several considerations to keep in mind.

First, when seeking funding from legislators, those who have represented CRDF in Tallahassee and Washington have said it helps to be able to say that growers are paying part of the bill.

Second, sooner or later, HLB is going to be behind us but there will be other research needs to deal with emerging threats, cultivar improvements and production practices. If legislative funding dries up, it would be helpful for growers to have a mechanism in place to help themselves.

Finally, if the mechanism is lost, what are the chances of it ever coming back?

I am not encouraging you to vote either way. In fact, CRDF is not allowed to lobby. My goal, instead, is to help growers understand that it is the mechanism they are voting on whether to keep in place, not the tax itself.

We're all disappointed that the research has not been more successful, but we are on the cusp of significant breakthroughs. If you want to speak with me or want me to speak to your group, I'm happy to do so.

CRDF Grower Dollars at work for you

Column sponsored by the Citrus Research and Development Foundation