2018-2019 FLORIDA CITRUS PRODUCTION GUIDE:

Nutrition Management for Citrus Trees[1]

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The following description of citrus fertilizer uptake, soil and leaf testing and nutrient recommendations were taken from SL 253* and reflects citrus nutrient management for healthy trees prior to citrus greening or HLB entering Florida. Additional information on nutrients obtained since the publication was released appear in this document as "the effect of HLB" on various aspects of citrus nutrient management and are noted as such with published papers cited.

***Nutrition of Florida Citrus Trees, 2nd Edition** By Thomas A. Obreza and Kelly T. Morgan (2008)

FERTILIZER, NUTRITION UPTAKE AND YIELD RESPONSE

This section describes the typical citrus yield increase with added fertilizers. The increase in yield with increase fertilizer rates is called the yield response curve. The shape of this curve is similar for a range of crops and conditions (Fig. 1).

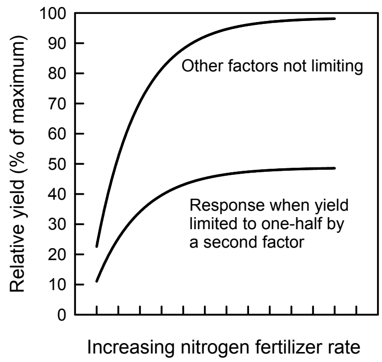

Figure 1. Generic response of citrus yield to N fertilizer rate.

Fertilizer nitrogen (N) is used in this example, but the nature of the response curve is similar for other nutrients. At very low N rates there is a large increase in yield with each added unit of N. As yield increases, each additional unit of N results in a smaller increase in yield. This smaller response to increasing fertilizer amount is also referred to as the law of diminishing returns. The two response curves in Figure 1 compare the effect of N rate when the amount of fertilizer nutrients in the soil do limit or reduce yield and the yield when yield is limited to one-half by low concentrations of a second fertilizer nutrient. The shapes of the curves are similar, and the rate of N where the slope levels off is only slightly higher for the more productive grove.

Experiments with healthy citrus have rarely demonstrated a benefit of N fertilizer rates higher than about 200 lbs/acre, regardless of the production potential. Instead, yield declined in several experiments when N rate was increased beyond the optimum range. Nutrients removed with the harvested crop must be replaced. The amount the crop removes varies from a fraction of a lb/acre for some of the micronutrients to as much as 100 lbs/acre of N or K from a high-producing grove. For oranges, approximately 0.12 lbs N/box is removed with the harvest. Therefore, crop removal ranges from 12 lbs N/acre for a 100 box/acre yield to around 100 lbs N/acre for a grove producing 800 boxes/acre.

Nutrient uptake from applied fertilizers is not 100% efficient, that is not all the fertilizer applied is taken up by the tree, so more nutrients must be applied than the minimum required by the tree. N use efficiency, expressed as lbs N removed by the crop divided by lbs N applied, ranges from 0.2 to 0.4 in groves with low to moderate yield. For healthy citrus trees, N efficiencies around 0.5 have been observed in groves with a good production record. Application of 200 lbs N/acre supplies sufficient N for an 800 box/acre orange yield when N use efficiency is 0.5.

[1] This document is modified from SL253, one of a series of the Soil and Water Science Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Original publication date: October 2007. Modified: May 2017. Visit the EDIS website at **http://edis.ifas.ufl.edu**. For a copy of the Florida Citrus Production Guide, request information on its availability at your county extension office.

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Effect of HLB on Nutrient Uptake

Citrus uptake efficiency of HLB affected trees may be at the low range of N use efficiency because of root loss (up to 80% depending on HLB severity) and vascular impairment. Therefore, an HLB affected citrus grove picking 300 boxes per acre requiring 12 pounds of N per 100 boxes would need only 36 pounds of N. However, at an N use efficiency of 0.2 the amount of fertilizer N required for the year would be 36 divided by 0.2 or 180 pounds.

LEAF AND SOIL TESTING

Leaf analysis is a useful tool to detect problems and adjust fertilizer programs for citrus trees because leaf nutrient concentrations are the most accurate indicators of sufficient nutrition of fruit crops. Leaves reflect nutrients taken up from the soil and redistribution throughout the plant, so the deficiency or excess of an element in the soil is often reflected in the leaf. Nutrient deficiency or excess will cause citrus trees to grow poorly and produce lower yields and/or fruit quality. Determining potential nutritional problems should be a routine citrus-growing practice. Quantifying nutrients in trees or soils with leaf and soil analysis eliminates guesswork in adjusting a fertilizer program.

Leaf analysis should include N, phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), manganese (Mn), zinc (Zn), copper (Cu), iron (Fe), and boron (B). Chlorine (Cl) concentration is sufficient under most field conditions, but Cl may become excessive where soils or irrigation water are saline. Similarly, molybdenum (Mo) deficiency or toxicity is rare. The goal in tissue analysis is to adjust fertilization programs such that nutritional problems and their costly consequences from higher costs and lower yields are prevented.

Leaf analysis integrates all the factors that might influence nutrient availability and uptake. It shows the relationship of nutrients to each other. For example, potassium deficiency may result from a lack of K in the soil or from excessive Ca, Mg, and/or sodium (Na). Similarly, adding N when K is low may result in K deficiency because the increased growth requires more K.

Tissue analysis:

- Determines if the soil is sufficiently supplying the essential nutrients.
- Confirms nutritional deficiencies, toxicities or imbalances.
- Identifies "hidden" toxicities and deficiencies when visible symptoms do not appear.
- 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.
- Studies interactions between nutrients.

STEPS IN LEAF ANALYSIS

Citrus trees affected by HLB are typically low to optimum for many nutrients, but sampling guidelines should be followed precisely to insure that analytical results are meaningful.

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

Leaf sample 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, N, P, and K concentrations decrease, while Ca and Mg increase. However, leaf mineral concentrations are relatively stable from 4 to 6 months after emergence in the spring.
- The best time to collect spring flush leaves of this age is July and August. If leaves are sampled later in the season, summer leaf growth can easily be confused with spring growth.

Leaf sampling technique

- A sampled citrus grove block or management unit should be no larger than 20 acres. The sampler should make sure that the leaves taken represent the block being sampled.
- Each leaf sample should consist of about 100 leaves taken from non-fruiting twigs of 15 to 20 uniform trees of the same variety and rootstock, and under the same fertilizer program.
- Use clean paper bags to store the sample. Label them 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, trees at the edge of the block, or trees at the end of rows because they may be coated with soil particles and dust or have other problems.
- 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).

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.

- The laboratory usually interprets each result as deficient, low, optimum, high, or excess, but the citrus grower can also interpret the results using UF/IFAS leaf analysis standards (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, and 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. If the interpretation for a particular nutrient is not optimum, various strategies can be used to address the situation (Table 2).

SOIL NUTRIENT ANALYSIS

Soil analysis measures organic matter content, pH, and extractable nutrients, which are useful in formulating and improving a fertilization program. Soil analysis is particularly useful when conducted for several consecutive years so that trends can be observed.

Similar to leaf analysis, methods to determine organic matter and soil pH are universal, so results should not differ between laboratories. However, soil nutrient extraction procedures vary from lab to lab. Several accepted chemical procedures exist that remove different amounts of nutrients from the soil because they vary in strength. To draw useful information from soil tests, consistency in use of a single extraction procedure from year to year is important to avoid confusion when interpreting the amount of nutrients extracted.

A soil extraction procedure does not measure the total amount of nutrients present, nor does it measure the quantity actually available to citrus trees. A perfect extractant would remove nu-

TABLE 1. Guidelines for interpretation of leaf analysis based on 4 to 6-month-old spring flush leaves from non-fruiting twigs

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. Adjusting a citrus fertilization program based on leaf tissue analysis

Nutrient	What if it is less than optimum in the leaf? Options:	What if it is greater than optimum in the leaf? Options:
N	Check yield. Check tree health. Review water management. Review N fertilizer rate.	Check soil organic matter. Review N fertilizer rate.
P	Apply P fertilizer (see Chapter 8).	Do nothing.
K	Increase K fertilizer rate (see Chapter 8). Apply foliar K fertilizer.	Decrease K fertilizer rate.
Ca	Check soil pH.	Do nothing.
Mg	Check soil pH. Apply dolomite or Mg fertilizer.	Do nothing.
Micronutrients	Check soil pH. Apply foliar micronutrients. Include micronutrients in soil-applied fertilizer.	Check for spray residue on tested leaves. Do nothing.

trients from the soil in amounts that are exactly correlated with the amount available to the plant. Therefore, the utility of a soil testing procedure is how well the extractable values correlate with the amount of nutrient a plant can take up. The process of relating these two quantities is called calibration.

A soil test is only useful if it is calibrated with plant response. Calibration means that as a soil test value increases, nutrient availability to plants increases in a predictable way (Fig. 2). Low soil test values imply that a crop will respond to fertilization with the particular nutrient. High soil test values indicate the soil can supply all the plant needs, so no fertilization is required (Fig. 3).

In Florida, soil testing for mobile, readily leached elements like N and K has no value. In addition to organic matter and pH, soil testing is important for P, Mg, Ca, and Cu. The University of Florida soil test interpretations for P, K, and Mg using Mehlich 3 extraction were established from experiments conducted for many years (Table 3).

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. Deficiencies or excesses (toxicities) are more likely when the pH is outside this range.

In some cases, soil tests can determine the best way to correcting a deficiency identified by leaf analysis. For example, Mg deficiency may result from low soil pH or excessively high soil Ca. Dolomitic lime applications are advised if the pH is too low, but magnesium sulfate is preferred if soil Ca is very high and the soil pH is in the desirable range. If soil Ca is excessive and soil pH is relatively high, then foliar application of magnesium nitrate is recommended.

STEPS IN SOIL SAMPLING

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

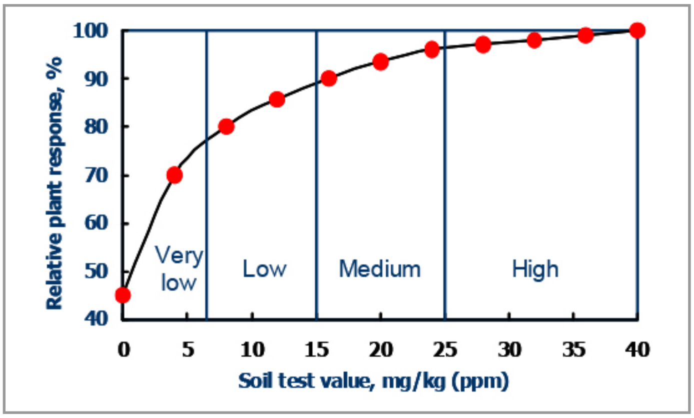

Figure 2. Ideal soil test calibration curve.

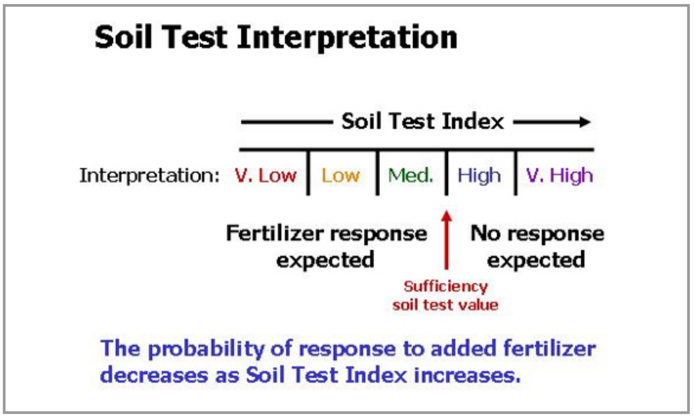

Figure 3. Soil test interpretation categories and their relationship to expected fertilizer response.

TABLE 3. Interpretation of soil analysis data for citrus using the Mehlich 3 extractant

	Soil test interpretation				
	Very Low	Low	Medium	High	Very High
Element	mg/kg (ppm)[1]				
P	< 10	10 – 15	16 – 30	31 – 60	> 60
Mg[2]	---	< 15	15 – 30	> 30	---
Ca[2]			250[3]	> 250	
Cu			< 25[4]	25 – 50[5]	> 50[6]

[1] parts per million (ppm) x 2 = lbs/acre.

[2] A Ca-to-Mg ratio greater than 10 may induce Mg deficiency.

[3] The Univ. of Florida Extension Soil Testing Laboratory does not interpret extractable Ca. Work with Florida citrus trees suggests that a Mehlich 1 soil test Ca of 250 mg/kg or greater is sufficient.

[4] Cu toxicity is unlikely even if soil pH is less than 5.5.

[5] Cu toxicity is possible if soil pH is less than 5.5.

[6] Cu toxicity is likely unless soil pH is raised to 6.5.

SOIL SAMPLE TIMING

- In Florida, if soil samples are collected once per year, the best time would be at the end of the summer rainy season and prior to fall fertilization (September and October).
- Alternatively, annual soil samples can be taken at the same time as leaf samples to save time and reduce cost.

SOIL SAMPLING TECHNIQUE

- The accuracy of soil test interpretations depends on how well the soil sample represents the grove block or management unit sampled.
- 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.
- Areas sampled should correspond to the grove blocks where leaf samples were taken. They should contain similar soil types with trees of roughly uniform size and vigor.
- Thoroughly mix the cores in a non-metal bucket to form a composite sample. Take a subsample from this mixture and place it into a labeled paper bag.

PREPARATION FOR ANALYSIS

- Soil samples should be 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 also part of the package, but also may be a separate analysis. Extractable Cu is normally determined upon request.
- The laboratory interprets each soil test result as very low, low, medium, high, or very high, and may also provide fertilizer recommendations accordingly. A citrus grower should independently interpret the numerical results according to UF-IFAS guidelines based on the Mehlich 3 extractant used (Table 3).
- The interpretations should be used to make decisions regarding soil pH control or fertilizer application (Table 4).

RECOMMENDED FERTILIZER RATES AND TIMING

Young tree (1 to 3 years after planting)

NITROGEN

Recommended rates of N for the first three years a citrus tree is in a grove can be found in Table 5. A constant supply of N is essential to achieve maximum tree growth and early fruit yield. It is recommended that controlled release fertilizer or fertigation be applied frequently (Table 5).

PHOSPHORUS

If soil testing justifies P fertilizer application, test the soil again the following year and compare with Table 3 to determine if P fertilization can be decreased or omitted. A leaf tissue testing program for P should begin at this time, comparing the results with the standards in Table 1.

TABLE 4. Adjusting a citrus fertilization program based on soil analysis

Property or nutrient	What if it is below the sufficiency value in the soil? Options:	What if it is above the sufficiency value in the soil? Options:
Soil pH[1]	Lime to pH 6.0.	Do nothing. Use acid-forming N fertilizer. Apply elemental sulfur. Change rootstocks.
Organic matter[2]	Do nothing (live with it). Apply organic material.	Do nothing.
P	Check leaf P status. Apply P fertilizer if leaf P is below optimum (see Chapter 8).	Do nothing.
K	Apply K fertilizer.	Lower K fertilizer rate.
Ca	If soil pH is < 5.3, apply lime. Apply gypsum.	Do nothing. Check leaf K and Mg status.
Mg	If soil pH is < 5.3, apply dolomite. Check leaf Mg status.	Do nothing.
Cu	Do nothing.	Lime to pH 6.5.

[1]The sufficiency value for soil pH is 6.0.
[2]There is no established sufficiency value for soil organic matter.

POTASSIUM

Apply K fertilizer at a K_2O rate equal to the 1.25 times the N rate.

CALCIUM

If the soil pH is in the optimum range of 5.5 to 6.5, there is no need to apply Ca. If soil pH is below 5.5, the soil should be limed to pH 6.5, which will supply needed Ca. If soil pH is above 6.5, the soil will contain abundant Ca.

NUTRIENT MANAGEMENT

Applying fertilizer in several small doses increases fertilizer efficiency by maintaining more constant nutrient availability, and by reducing leaching if unexpected rain occurs (Table 4). A minimum of 4 to 6 applications of dry fertilizer is recommended. Splitting fertigation into 10 to 30 applications per year is common and desirable. The cost of liquid injection during irrigation is relatively small, particularly if the injection can be automated. One or two applications of controlled-release fertilizer is satisfactory because nutrients are protected from leaching rains. Controlled-release formulations may be applied pre-plant, incorporated after planting, or broadcast to insure uniform distribution of nutrients throughout the enlarging root zone of young trees.

Bearing trees (4+ years in grove)

Nutrient management for bearing trees requires many of the same considerations important for non-bearing trees. Nitrogen continues to be the most important element for tree growth, fruit yield, and fruit quality, but others also have substantial effects on production and fruit quality. Removal of elements by harvesting the crop becomes significant, but accounts for only part of the fertilizer requirement.

TABLE 5. Recommended N rates and minimum number of applications for non-bearing citrus trees

Year in grove	lbs N/tree/year (range)	Lower limit of annual application frequency: Controlled-release fertilizer	Lower limit of annual application frequency: Fertigation
1	0.15 – 0.30	1-4	10-20
2	0.30 – 0.60	1-4	10-20
3	0.45 – 0.90	1-4	10-20

NITROGEN

Recommended N fertilizer rates (Table 6) provide enough N for canopy expansion towards containment size while producing maximum economic yields of high quality fruit. The chosen N rate will depend on soil characteristics, yield potential, and tree needs as indicated by leaf analysis interpretation (Table 1).

- For grapefruit, the recommended annual N rate is **120 to** 160 lbs/acre.
- For oranges and other varieties, the recommended annual N rate is **120 to 200 lbs/acre**.

Mature bearing trees (years 8+ in the grove).

Once trees reach containment size, further canopy growth is not desired, so nutrition inputs can be stabilized and possibly reduced. Nitrogen fertilizer management should focus on replacing N exported with the harvested crop plus that needed to maintain tree biomass. The guidelines for annual N fertilizer rates accounts for the needs of both vegetative growth and crop removal (Table 6).

- For grapefruit, the recommended annual N rate is **120 to 160 lbs/acre**. For groves producing more than 800 boxes/acre, 180 lbs/acre may be considered. The chosen N rate will depend on soil characteristics, desired fresh fruit quality characteristics, yield potential, and tree needs as indicated by leaf analysis interpretation (Table 1).
- For oranges, the annual N rate should fall within the range of **125 to 245 lbs/acre**. The recommended rate for a specific grove depends on either **expected yield potential** (for 8 to 11-year-old trees) or **4-year running average production history** (for 12+ year-old-trees) expressed as either fruit yield or soluble solids production). When basing N fertilization on expected yield potential, the rate should be chosen considering 1) how well the young, bearing trees have produced, and 2) leaf tissue analysis. If leaf N is maintained in the optimum range, additional fertilizer will not likely produce additional fruit and may reduce quality.

TABLE 6. Recommended N rates and minimum number of applications for bearing citrus trees

Year in grove	Oranges	Grapefruit	Other varieties	Lower limit of annual application frequency		
	------------ lbs N/acre/year (range) ------------			Controlled-release fertilizer	Dry soluble fertilizer	Fertigation
4 through 7	125 – 200	120 – 160	120 – 200	1	3	10
8 and up	125 – 245 Yield-based (Fig. 8.1)	120 – 160	120 – 300	1	3	10

Leaching rain rule. If more than 3 inches of rainfall accumulates within a 72-hour period after an N fertilizer application, "replacement" fertilizer may be applied up to one-half of the N rate used in the preceding application (not to exceed 30 lbs/acre).

PHOSPHORUS

Determine the need for P fertilization using leaf tissue and soil test results.

- Sample leaves and soil.
- Compare the analytical results with the interpretations provided in Tables 1 and 2.
- Follow the P fertilization guidelines in Table 7.

POTASSIUM

Apply K fertilizer at a K_2O rate equal to the N rate. If leaf K is consistently below optimum, increase the K_2O rate by 25%, especially if the grove soil is calcareous.

CALCIUM

If the soil pH is in the optimum range of 5.5 to 6.5, there is no need to apply Ca. If soil pH is below 5.5, the soil should be limed to pH 6.5, which will supply needed Ca. If soil pH is above 6.5, the soil will contain abundant Ca.

Effect of HLB on Micronutrient requirements

Leaf chlorosis develops as a result of infection with *Candidatus Liberibcter asiaticus* (CLas) including interveinal chlorosis of young leaves, similar in symptomology to Mn and Zn deficiencies that develop early in the growing season, followed by blotchy mottling of older leaves which develop later in the growing season. Nutrient deficiency-like symptoms develop in HLB-affected trees, including K, P, Mg, Ca, Mn, Zn, and Fe. HLB causes fibrous roots to decline within a few months after infection and before foliar symptoms develop. Fibrous roots are responsible for the bulk of nutrient uptake and their decline likely explains the deficiency symptoms that develop in the canopy. Research has demonstrated that HLB symptoms can be reduced by foliar applications of micronutrients, especially Ca, Mg, Mn, and Zn. These responses have promoted development and use of enhanced foliar nutritional programs in Florida. Efficacy of these programs have been a topic of considerable discussion and debate. Fertilization programs have varied considerably among growers, and have consisted of various rates and application schedules of essential macro- and micronutrients.

Foliar nutrition applications is not likely to lead to past production levels in the short term. Research* has found that maintaining leaf concentration of essential nutrients increased canopy volume and occasionally yield. Application of the current UF/IFAS foliar recommendations (Table 8) applied three times per year following flushes in March, May and September was found to maintain leaf concentrations in the optimum range with improved canopy density and yield. For example, the UF/IFAS recommendation for Mn and Zn is five pounds metallic per acre per year, thus trees receiving 3X times UF/IFAS recommendation would receive three applications for a total of 15 pounds metallic per acre per year.

* Kelly T Morgan. Robert.E. Rouse, and Robert.C. Ebel. 2016. Foliar Applications of Essential Nutrients on Growth and Yield of 'Valencia' Sweet Orange Infected with Huanglongbing. HortScience 51(12):1482-1493.

TABLE 7. Recommendations for P fertilization of bearing citrus trees based on leaf tissue and soil tests

If leaf tissue P is…	…and soil test P is…	…the recommendation for P fertilization is:
Excessive High	Very High High Medium Low Very Low	Do not apply P fertilizer to the soil for 12 months following leaf and soil sampling, then sample again and re-evaluate.
Optimum	Very High High Medium	
Optimum	Low Very Low	Apply 8 lbs P_2O_5/acre for every 100 boxes/acre of fruit produced during the current year. Sample leaves and soil again in 12 months and re-evaluate.
Low	Low Very Low	Apply 12 lbs P_2O_5/acre for every 100 boxes/acre of fruit produced during the current year. Sample leaves and soil again in 12 months and re-evaluate.
Deficient	Low Very Low	Apply 16 lbs P_2O_5/acre for every 100 boxes/acre of fruit produced during the current year. Sample leaves and soil again in 12 months and re-evaluate.

TABLE 8. Recommended methods, timing, and rates for micronutrient application to citrus groves

		Mn	Zn	Cu	B	Fe
Method	Foliar	Yes	Yes	Yes	Yes	No
	Soil	Yes[1]	No	Yes	Yes	Yes
Timing	Foliar	When spring flush leaves reach full expansion				
	Soil	Any time as needed				
		-------------------- lbs metallic equivalent/500 gallons of water --------------------				
Rates	Foliar	3.75	5.0	3.75	0.25	---
		------------------------------ lbs metallic equivalent/acre ------------------------------				
	Soil	9	---	5	1	See below[2]

[1]Soil applications of Mn are not recommended on calcareous soils.

[2]Acid soil: Fe-EDTA, 20 grams/tree; Calcareous soil: Fe-EDDHA, 50 grams/tree.