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Guide to Olive Tree Nutrition in Florida[1]

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Introduction

A burgeoning olive (*Olea europaea*) industry already exists in the southeastern United States, but research and Extension information regarding olive fertilization recommendations in Florida is limited. While there are data and recommendations for olive from the University of California, the University of Georgia (UGA), and other institutions around the world, there are no data from which we can derive Florida-specific recommendations. In this guide, we use many of the existing recommendations for mature, high-density, and traditional grove spacing as guidelines until data specific to Florida production are generated.

Since planting densities and configurations vary, many of the recommendations found in the literature are made on a "per tree" basis instead of a "per area" basis. For the purposes of this document, we assume that trees are already established at a planting density of 600 trees/acre. A traditionally spaced mature olive tree may grow to 20–30 ft in diameter, but hedgerow configurations (common commercial configurations that use training and pruning practices) will alter canopy structure. This document provides guidance for commercial producers and homeowners alike.

Fertilizer must be broadcast uniformly within the dripline of the tree, not placed in a single mound. Substantial nutrient uptake will take time when granular fertilizer is broadcast around the tree because nutrients must first reach the root zone. Uptake also depends on nutrient requirements of the tree at any given time. Tree nutrient deficiencies may take some time to remedy. A nutrient management plan for olive should couple the information obtained from soil and plant tissue sampling with various influencing factors like weather and soil type (Mylavarapu 2010).

Guidelines for soil sampling to determine plant needs can be found in the EDIS document *Soil Testing for Plant-Available Nutrients* (Hochmuth et al. 2014). Hochmuth et al. (2015) also provide an excellent review of tissue sampling for plant nutrition assessment. UGA generally recommends soil testing to determine phosphorus (P_2O_5) and potassium (K_2O) fertilizer requirements in olive. However, the University of Florida recommends plant tissue analyses for perennial crops, since they can better predict nutrient requirements in those species (Mylavarapu 2010). A soil test and a complementary plant tissue test are therefore recommended to develop a sound nutrient management program for olive. At this time, soil test-based interpretations and recommendations are limited to P and

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K. Calcium (Ca), magnesium (Mg), boron (B), copper (Cu), and manganese (Mn) fertilizer recommendations are based solely on leaf tissue nutrient sufficiency ranges. These sufficiency ranges have been determined for California but have yet to be verified in the Southeast.

This guide describes leaf tissue sampling procedures and the sufficiency ranges upon which the key fertilizer recommendations are based. The sufficiency ranges, which are for June to early August, are followed by a summary of fertilizer recommendations from UGA and a discussion of N, P and K, and B fertilization. The guide ends with a discussion of concerns for olive production in Florida and a list of other resources that can be consulted for olive production in Florida.

Figure 1. A healthy Arbequina olive grove in Volusia County, Florida.
Credits: J. Gillett-Kaufman, UF/IFAS

Leaf Tissue Sampling Procedures

A long-term soil fertility management plan is needed to address the nutrient requirements of olive throughout its life. Nevertheless, it is generally recognized that leaf tissue testing is a better in-season indicator of nutrient requirements than soil testing (Marín and Fernández-Escobar 1996; Vossen 2006; Fernández-Escobar et al. 2009; Mylavarapu 2010; Boulal et al. 2013) because soil testing may not accurately reflect crop needs at any given growth stage. Since leaf nutrient concentrations vary during the season, tissue sampling should be conducted when nutrient concentration is most stable. In California, the most stable period is between June and early August (Chatzissavvidis et al. 2004; Sibbett et al. 2005). UGA also recommends sampling during this time (Kissel and Harris 2015).

The following procedures are recommended for olive leaf tissue sampling:

- Identify your sampling areas based on tree similarities (varieties, microclimates, soil types, irrigation systems, tree spacing, injured trees, etc.). Sample each area and keep these samples separate. This procedure will result in multiple samples from the same grove.
- The ideal period for tissue sampling is between late June and early August. If sampling during this time frame is not possible, then samples from healthy trees should be collected for comparison in order to diagnose a suspected nutrient disorder.
- Collect 150–200 leaves from the middle of non-bearing, current season shoots. Several leaves from many similar trees should be selected to provide a representative, composite sample.
- Label the sample with the information below. Although this information is not strictly needed to obtain a tissue nutrient report, it will assist growers, Extension agents, and consultants as they develop effective nutrient management programs for the orchard. Long-term recordkeeping is vital for successful crop monitoring programs.
- Submit your sample for analysis as soon as possible. Please refer to the plant tissue test form for additional information needed by the lab: http://edis.ifas.ufl.edu/ss182

Leaf Tissue Sufficiency Ranges

Olive leaf tissue sufficiency ranges have been determined for locations outside of Florida (Beutel et al. 1983; Sibbett et al. 2005; Vossen 2006; Connell and Vossen 2007; Bryson and Mills 2014). These recommended sufficiency ranges are shown in Table 1. The ranges shown in Table 1 are guidelines and are not strictly applicable in every situation. They are meant to assist with the diagnosis of suspected nutrient deficiencies.

When leaf tissue nutrient concentrations are below the sufficiency ranges in Table 1, fertilizer recommendations are provided by UGA (http://aesl.ces.uga.edu/publications/plant/Olive.asp). These are briefly detailed here:

- N: If leaf N<1.4%, apply an additional 20–30 lb N/ac.
- P: If leaf P<0.1% and soil test P is low, apply 25–50 lb PO/ac the following year.
- K: If leaf K<0.7%, apply 25–40 lb KO/ac.
- Ca: Keep soil pH 6.0–7.0.
- Mg: If leaf Mg<0.1%, apply 15–25 lb Mg/ac. If lime is needed, use dolomitic lime.
- S: If leaf S<0.1%, apply 10 lb S/ac.
- B: If leaf B<20 ppm, apply 0.5 lb of actual B/ac.

- Cu: If leaf Cu<5 ppm, apply 1 lb Cu/ac (equivalent to 4 lb copper sulfate/ac) each year until tissue concentrations are sufficient. Do not apply in excess. Be aware that copper sulfate pentahydrate can burn leaves.
- Mn: Unlikely to be deficient.
- Zn: If leaf Zn<20 ppm, apply 10 lb zinc sulfate/ac.

Nitrogen Fertility

Nitrogen recommendations for olive (and many other crops) are general "blanket" recommendations, and are not based on soil or tissue test values because soil N is ephemeral. As a result, these recommendations vary widely (Table 2). UGA recommends 80–100 lb N/ac (1.8–2.3 lb N/1,000 sq ft) for high-density plantings of 600 trees per acre, regardless of soil type (Kissel and Harris 2015). It is a good practice to split N fertilizer applications, with 50% applied in early spring and the remaining 50% applied prior to flowering. N fertilization after flowering can lead to excessive vegetative growth at the expense of reproductive growth. It also reduces cold hardiness and negatively affects oil quality. Excess N was shown to support larger pest populations in certain fruit trees, requiring added measures to manage pests. This can be especially problematic with plants that are under additional environmental stress (White 1984).

The goal of N fertilization is to apply enough to obtain 8–20 inches of new shoot growth per year (Connell and Vossen 2007), so the amount applied in any given field may be adjusted based on past experience. Growers should keep a record of the nutrients applied and the resultant shoot growth to allow for fine-tuning of nutrient applications during subsequent seasons. N application may not be required every year in areas that have soils with relatively high organic matter. However, in the southeastern US, native soil organic matter concentrations are low, averaging approximately 1% or less. N applications should not be made after September 1 in Florida because this will encourage new shoot growth that is susceptible to winter frosts.

Phosphorus and Potassium Fertility

Potassium deficiency in leaf tissue has been reported in olive grown on deep sands in northeast Florida (R. Hochmuth, personal communication, Jan. 2016), but it may not always be effectively corrected through foliar applications. A long-term soil fertility plan is needed to correct this deficiency. Both P_2O_5 and K_2O recommendations in Georgia are made based on soil test values and differ according to Georgia soil types (Kissel and Harris 2015).

For Coastal Plain soils, P_2O_5 recommendations are based on the equation:

P_2O_5 applied $_{(M-1)}$ = $102 - 1.509P + 0.00293P^2$,

where P is the soil test P (lb/ac) based on Mehlich-1 (M-1) extraction.

Similarly, K_2O recommendations in Georgia for Coastal Plain soils are based on the equation:

K_2O applied $_{(M-1)}$ = $123 - 0.779K + 0.00083K^2$,

where K is the soil test K (lb/ac, Mehlich-1).

Florida has adopted M-3 as the standard soil extraction procedure for all crops grown on acid-mineral soils in the state. There is high correlation between M-1 and M-3 for extractable soil P (R2=0.83) and soil K (R2=0.93) on Florida soils (Mylavarapu et al. 2017). Correlating the M-1 to the M-3 extraction gives the following equations for M-3 extractions:

P_2O_5 applied $_{(M-3)}$ = $136.05 - 1.8711P + 0.00363P^2$,

where P is the soil test P (lb/ac) based on M-3 extraction, and

K_2O applied $_{(M-3)}$ = $123.93 - 0.779K + 0.00083K^2$,

where K is the soil test K (lb/ac, Mehlich-3).

Figure 2. Potassium deficiency in olive.
Credits: R. Hochmuth, UF/IFAS

Boron

B recommendations are based on leaf tissue analyses. Since B moves relatively quickly through soil, it can be applied either as a soil application or as a foliar fertilizer (Hansen 1945; Tsadilas 2004; Rodrigues et al. 2011). Generally speaking, the range of values between B deficiency and toxicity is narrow, but olive appears susceptible to B deficiency (Shorrocks 1997; Tsadilas 2004). Evidence of severe B deficiency has been found in Pasco County through tissue sample tests. Soluble B can be applied as a foliar fertilizer at 0.5 lb B/ac if deficiency symptoms are observed. Soluble B is compatible with certain pesticides and may be tank mixed and applied with other compatible maintenance sprays. Always follow the label instructions carefully. Soil applications of B are also available.

Concerns for Olive Production in Florida

The primary nutrient concerns for olive are N, B, and K. Remember that the goal is to obtain 8–20 inches of new shoot growth per year; adjust your N fertilization accordingly. In sandy Florida soils, B and K may be leached rapidly, so these nutrients must be monitored. The range between B deficiency and toxicity is narrow, so correct deficiencies with small amounts of B.

Excessive irrigation is also a likely concern for olive grown in Florida. Remember, olive is grown in shallow, rocky Greek soils with medium to low fertility (Karyotis et al. 2014), although trees in Greece are fertilized and irrigated. Since many parts of Florida receive 60+ inches of rain per year, overwatering with supplemental irrigation is a concern.

There is a paucity of information related to best management practices for olive production in Florida. Research is needed under conditions that are unique to Florida in order to determine nutrient uptake and fertilization, irrigation requirements (if any), and successful orchard establishment practices.

Other Resources for Olive Production in Florida

For more information on olive culture in Florida and descriptions of olive floral structure and flowering characteristics, see EDIS publication EP515, *Olives for Your Florida Landscape* (Thetford et al. 2015). Learn more about olive pests and fungal diseases by reading EDIS publication IN1046, *Pests and Fungal Organisms Identified on Olives* (Olea europaea) *in Florida* (Gillett-Kaufman et al. 2014).

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Table 1. Leaf tissue sufficiency ranges for olive from June to early August, compiled from published data.

Element	Adequate Range:	Deficient below:	Excessive above:
N	1.5–2.0%	1.4%	
P	0.1–0.3%		
K	>0.8%	0.4%	
Ca	>1.0%		
Mg	<0.1%		
S	0.1–0.25%		
Fe	35–66 ppm		
Na			0.2%
Cl			0.5%
B	19–150 ppm	14 ppm	185 ppm
Cu	4–9 ppm		
Mn	>20 ppm		
Zn	20–50 ppm		
Mo	0.04–0.09 ppm		

Table 2. Summary of nitrogen application rate recommendations from selected locations.

Recommended Rate (lb N/acre)	Location	Reference(s)
80–100	Georgia	Kissel and Harris (2015)
40–100	California	Vossen (2006); Connell and Vossen (2007)
135	California	Hartmann (1958)
90 every other year	California	Vossen et al. (2001)
<20	Portugal	Rodrigues et al. (2012)