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# Tung Oil Production in Florida[1]

Patrick Minogue[2]

Historically, tung tree (*Aleurites fordii* Hemsl.) oil production occurred within a 75- to 100-mile-wide belt through the Gulf Coastal Plain, from east Texas to Georgia and south into the Florida Gainesville area (Snow 2013). Tung trees are native to central and western China and are grown for their nuts, which contain 30%–40% high-quality, quick-drying oil used in the manufacture of lacquers, varnishes, paints, linoleum, resins, artificial leather, brake linings, and electronics insulation, to name a few (Duke 2001). Commercial tung oil production in the southeastern United States began with the first commercial processing plant in 1927 and increased rapidly from 1,000 tons produced in 1939 to 132,000 tons in 1952, yielding 42 million pounds of oil in this year of peak production (Potter and Crane 1957). There were 13,961 acres of Florida tung tree plantations in 1969, comprised of 42 farms, predominately in Jefferson, Jackson, and Leon Counties (Snow 2013). A series of years with late winter freezing temperatures and damage from Hurricane Camille resulted in the abandonment of commercial tung tree production in the Southeast (Robb and Travis 2013).

Presently, there is renewed interest in tung tree production in north Florida to help meet the demand for tung oil as a wood finish (Aleman 2014). Interest is also bolstered by the development of a later flowering cultivar 'Spiers', and more moderate winter temperatures occurring throughout the Southeast. Historically, cold injury to floral buds has been one of the greatest hazards in tung production (Spiers and Kilby 1973). The buds are formed by the late fall and have a chilling requirement of 260–360 hours at 45°F or below. After they have received their chilling requirement, buds will break dormancy following warm weather periods in late winter or early spring. At full bloom, temperatures of 29°F can kill floral buds. 'Spiers' flowering is estimated to be 2 weeks later than other commercial cultivars, making it less vulnerable to late frost injury (Rinehart et al. 2015). The unpatented 'Spiers' was released by the USDA Agricultural Research Service. It is expected that 80% to 95% of seed from open-pollinated mother plants should perform true to type, while growth habit, fruit production, and oil production are comparable or superior to older cultivars (Spiers and Kilby 1973; Rinehart et al. 2015).

## Description

Tung is a fast-growing deciduous tree species and can grow to 40 ft in height, with smooth bark and soft wood. Leaves are heart shaped, sometimes lobed, dark green and up to 6 or more inches wide. Flowers are produced in early spring, before foliage. Blooms are attractive, white with a rose-colored center and are borne in clusters from terminal shoots from the previous growing season. Fruits are spherical or pear-shaped, green to purple at maturity and contain 4 to 5 seeds. Seeds have a hard shell and a large endosperm from which tung oil is extracted. Tung oil is largely comprised of 75%–80% α-elaeo stearic, 15% oleic, and circa 4% palmitic oils (Duke 2001). All parts of the tung trees are poisonous, and the seeds are highly toxic to humans and animals. However, references stating “one seed can be fatal” are not founded. Our literature review found cases of accidental poisoning caused vomiting, abdominal pain, and diarrhea, there were no fatalities reported (Lin et al. 1996, Erickson and Brown 1942).



Figure 1. Tung tree (*Aleurites fordii*) showing the fruit (left) and our "Best Management Practices" (BMPs) research in Leon County, Florida, during foliar nutrient sampling in August 2018 (right).
Credit: UF/IFAS

## Ecology

Tung trees are very exacting in climatic and soil conditions. Trees grow best if planted on hilltops or slopes because good air drainage reduces losses from spring frosts. They require good soil fertility and well-drained loamy sands, such as the Ruston, Orangeburg, Red Bay and Norfolk series in Florida.

Tung tree is listed by the UF/IFAS Assessment of Non-Native Plants as low risk for invasion, with caution in the north zone to manage to prevent escape. It has naturalized in north and central Florida and in other Gulf states where it was cultivated.

## Cultivation

Nursery stock may be grown from seed (generative) or by grafting high-producing selections onto seedling rootstock (vegetative). In young orchards desired selections may be grafted onto established seedlings (budding) to improve yield (Duke 2001). Tung seeds are short-lived and should be planted during the dormant season or the spring following harvest. The seeds should be removed from the hull within the shell and air-dried before planting. Hulled seeds may be planted dry, but soaking seeds in cold water for five to seven days before planting hastens germination.

In nursery production, stratification in aerated, cold water or moist medium at 45°F or chemical treatment (dilute acid) increases the rate and uniformity of emergence. Duke (2001) recommended planting dry seeds no later than February, stratified seed by mid-March, and chemically treated seed by early April. Seeds may be planted in nursery beds by hand or using a modified corn planter set at a 2-inch depth. Seeds are spaced 6 to 8 inches apart, with rows 5 ft apart. Seeds germinate in 60 days or more, necessitating weed control. The development of selective herbicide options for tung tree production is a priority research need.

Nursery-produced rootstocks are planted into the orchard during the dormant season, optimally from December to the end of February. In contour-planting the number of trees and spacing on the row and between rows vary depending upon the slope, but trees 11 to 13 ft apart in rows 33 to 39 ft apart results in 100–142 trees per acre. In past practices, transplanted nursery stock was pruned back to 8- to 10-inch height at planting, but at present, optimum pruning practices at various ages remain an important research question.

Soils in the Florida tung belt are slightly to strongly acid, typically ranging from pH 5.0 to 6.5. Tung requires a moderately acid soil, but it is often recommended to lime acid soils to pH 6.0. This will increase available phosphorus and potentially cation exchange from soil colloids. Additionally, if leguminous cover crops are grown in a tung orchard, such as clover, they will perform better at pH 6.0 to 6.5. In nursery production, Duke (2001) recommends a side dressing of nitrogen (N), phosphorus (P), and potassium (K) fertilizer, in a band 8 inches from seedlings on each side of the row to supply 530 lb/acre 5-10-5 (N:P:K) as soon as seedlings emerge. Potter and Crane (1957) recommend significant annual N, $P_2O_5$, and $K_2O$ inputs (140–160, 60 and 200–250 lb/acre, respectively) to optimize nut production in bearing tung orchards. Experience with orchards of nut-bearing trees, such as pecans, suggests that increased fertilizer use efficiency is fostered by split applications at six-week intervals, timed when rainfall is expected.

A composite soil sample should be taken before establishing a tung orchard to determine inherent fertility and site suitability. Soil tests are useful for

helping to identify potential nutrient deficiencies, but including foliar sampling provides additional information about what was taken up by the trees. Potter and Crane (1957) published critical ranges for nutrient concentrations in tung leaves (Table 1). Our current research is verifying these critical nutrient guidelines and elucidating N and P fertilization regimes in new and established orchards to help develop Tung "Best Management Practices" (BMPs).

Table 1. Critical ranges for nutrient elements in tung leaves sampled in late July or early August.[1]

| Element | Calculated as elemental | Leaf dry weight composition |
|---|---|---|
| | (%) | |
| **Nitrogen** | N | 2.00–2.50 |
| **Phosphorus** | P | 0.14-–0.20 |
| **Potassium** | K | 0.70-–1.00 |
| **Calcium** | Ca | 1.00-–2.50 |
| **Magnesium** | Mg | 0.25-–0.35 |
| | (ppm) | |
| **Copper** | Cu | 4–5 |
| **Manganese** | Mn | 50–100 |
| **Zinc** | Zn | 25–35 |

[1] From Potter and Crane 1957.

## Tung Oil Production

Tung trees typically begin bearing fruit the third year after planting and may be commercially productive by the fourth or fifth year, under intensive culture. Maximum production occurs by the 10th to 12th year, and trees live approximately 30 years (Duke 2001). Fruits mature in late September and early November and fall to the ground. They are collected when the shells become brittle and dark, 3 to 4 weeks or more, and moisture content falls below 30%. In past practices, the fruits were placed in sacks and placed in the crotches of the trees to dry. Fruits must be dried to 15% moisture content before they are processed for oil extraction (Potter and Crane 1957). At peak production, tung orchards typically produce 2 to 2.1 tons of fruit per acre that contains 18.5% to 20% oil content by weight (Duke 2001).

## Summary

Tung tree seed is a potential alternative crop in northern and central Florida on sites having relatively well-drained, fertile soils and adequate moisture. Tung trees are fast-growing and produce high-value oil that is in demand for furniture finishing and other uses. Much of the information regarding tung orchard management and oil production was published in the 1950s or earlier when it previously was a commercial oil crop in the region. A review of the literature suggests these priorities for additional research:

- Examine macro and micro-nutrient fertilization requirements for optimal tree growth, nut yield, and oil content.
- Verify critical foliar nutrient concentrations (Table 1) for optimum tree growth, nut production, and oil content.
- Develop efficient fertilization BMP guidelines for tung tree cultivation in the Gulf Coast region.
- Develop selective weed control practices for nursery stock production and orchard establishment.
- Determine optimum orchard density and pruning systems for improved nut harvest and tung oil yield.
- Continuing phenotype selection and breeding for improved varieties.

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[2] Patrick J. Minogue, associate professor of silviculture, School of Forest, Fisheries, and Geomatics Sciences, UF/IFAS North Florida Research and Education Center; UF/IFAS Extension, Gainesville, FL 32611.

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