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Fruit Crops Fact Sheet: Fertilization of Young Citrus Trees[1]

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During the past 3 years approximately 10 million young citrus trees have been planted in Florida, with additional thousands of new acres being planned or developed (Figure 1). Fertilization is a major limiting factor in the growth of these young trees, primarily because of Florda's relatively infertile soils. Citrus

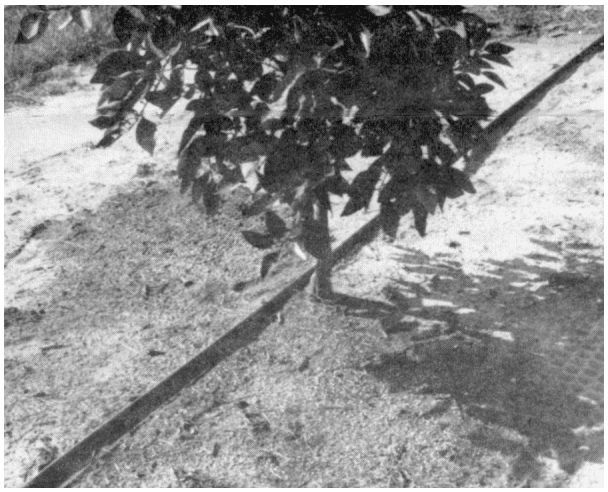

Figure 1 Fertigation of young citrus tree, using low volume irrigation system.

growers have traditionally applied readily soluble granular fertilizers 4 to 6 times per year to ensure a continuous supply of nutrients to the limited root systems of young trees. Such repeated applications demand a heavy investment in energy, time, labor, and machinery; can increase soil compaction; and may contribute to contamination of groundwater. An additional expense is the fertilization of isolated young trees replanted in established groves. Controlled or slow release materials can be applied less frequently, and fertigation, the application of soluble fertilizers through irrigation systems, can stimulate growth comparable to that obtained with readily soluble fertilizers, but these practices can reduce application frequency and associated energy costs.

The purpose of this fact sheet is to review briefly general concepts of fertilization, discuss current fertilization practices for young citrus trees, and consider how controlled release fertilizers and fertigation can reduce application frequency and energy costs.

General Concepts of Fertilization and Soil Fertility

Plant growth and development depend on the availability of 15 different nutrient elements. The major or macronutrients include carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, magnesium, sulfur and calcium. The minor or micronutrients include boron, molybdenum, iron, manganese, copper and zinc. However, since two of the major or macronutrients, nitrogen and potassium, leach readily from soil, these elements are usually the ones most limiting to growth of young citrus trees in Florida. Phosphorus, another macronutrient, and the minor elements are of less importance, particularly in replant situations where they may have accumulated in grove soils over years of fertilization. Natural deposits of phosphorus in reclaimed mine lands planted to citrus may also contribute to high soil levels of this element.

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However, phosphorus levels are quite low in many flatwoods soils and should be carefully monitored.

The key to success for any fertilizer program is a readily available soluble supply of essential nutrient elements. Availability depends on timely application of fertilizer and the capacity of soil particles to retain and release nutrients. Sandy soils are relatively infertile and lack this capacity to retain nutrents. Frequent applications of fertilizer are necessary to ensure that essential elements are available. Solubility is initially more important for granular than liquid fertilizers but in either case adequate soil moisture levels must be continually maintained to move nutrients to roots where uptake occurs.

Citrus trees utilize organic and inorganic forms of nitrogen, but nitrate (NO_3) and ammonium nitrogen (NH_4^+) are the most common forms. It is well documented that the source of these ions (electrically charged particles) is not important. However, their solubility in the root zone is important. Plant roots will not "distinguish" *nitrogen* applied as a granular material and made soluble using irrigation from *nitrogen* applied as a liquid fertilizer.

Fertilizers move by mass flow in the soil solution to roots, as the plants lose water through transpiration. Once nutrients reach the root, they are taken up by an active process powered by energy derived from respiration (energy released from the breakdown of plant compounds). Flooding, excessive irrigation, or low soil temperatures (less than 50° F) decrease respiration and reduce nutrient uptake.

Current Fertilization Practices

Current recommendations for young trees (Table 1) call for the application of approximately 5.6, 9.2, and 12.5 pounds/year of a balanced fertilizer which contains 0.4, 0.7, and 1.0 pounds nitrogen to 1-, 2- and 3-year old trees, respectively. These figures are average values within the given ranges for number of applications, pounds of complete fertilizer, and pounds of nitrogen. Low rates of fertilizer are applied with a high frequency to ensure even distribution within the limited root zone and to aviod root damage from excess salt concentrations in localized areas. Although studies have shown that 2 to 3 applications of granular fertilizer are sufficient for adequate growth during the first year, more frequent applications are recommended to ensure optimum fertilization under all Florida conditions with all application methods. Additional applications are seen as insurance against uneven fertilizer distribution when mechanical spreaders are used and when heavy rains move fertilizer through or away from the root zone.

Controlled Release Fertilizers

Controlled or slow release fertilizers are available in a variety of formulations with different analyses. These materials contain fertilizer granules coated with compounds that control the rate of release of nutrients. This rate of release is moderated by soil temperature and moisture and may vary from product to product. Controlled release fertilizers can be broadcast, incorporated after planting, applied as a pre-plant treatment, and can be utilized along with a fertigation program to ensure uniform distribution of nutrients throughout the rapidly enlarging root zone of young trees.

Current research indicates that controlled release materials applied at recommended rates two times per year can stimulate growth comparable to that of young trees fertilized six times per year with standard materials. Although controlled release fertilizers usually cost more than standard or readily soluble fertilizers, application rates, energy, and associated costs can be reduced. For example, when application frequency is reduced from six times per year to two times per year, application costs can be reduced by approximately 60% for both solid plantings (@140 trees/acre) and resets (5 trees/acre). When controlled release fertilizers are used, total fertilization costs (fertilizer cost + application cost) are generally lower than total fertilization costs for standard fertilizers for a small number of resets per acre but not for solid plantings.

Careful placement and retention of fertilizer within the root zone of young trees becomes more important with controlled release fertilizers that are applied less frequently than standard materials. Use of controlled release fertilizers in newly planted bedded groves with steep banks and minimal sod cover should be monitored to prevent fertilizer losses due to runoff during heavy rains. Since sulphur-coated fertilizers may increase acidity of the soil solution, pH should be monitored and adjusted when these fertilizers are used.

Fertigation

Fertigation (the application of soluble fertilizers through irrigation systems) has proven an efficient, effective means of fertilizing citrus trees in many areas of the world. With the widespread use of low volume irrigation in Florida, fertigation has been widely adopted

in fertilization programs for both young trees and mature groves.

A typical fertigation system consists of a storage tank for the liquid fertilizer, a unit for injecting fertilizer into the system, and a back-flow prevention device mandated by state law. Fertilizer may be injected using a Venturi tube which relies on pressure differences between the irrigation line and the storage tank to drive the injection system or by mechanical or electrical systems calibrated to distribute a predetermined unit of fertilizer/unit of water applied. The Venturi method requires no external power source or energy expenditure and is low in cost, but cannot be adjusted as accurately as a mechanical or electrical injector and usually cannot supply fertilizer at uniform rates under high demand conditions.

Operation of Fertigation Systems

System design and uniforrn emitter output and position are the keys to proper design of fertigation systems. The amount of fertilizer applied is directly related to the amount of water applied, fertilizer analysis, and fertilizer injection rate. Small variations in sprinkler or emitter output will greatly affect amount of fertilizer applied per tree, particularly on a seasonal basis. Emitters should be positioned for optimal distribution of nutrients to the limited root zone of young trees. Ongoing maintenance, including the use of screen or media filters, can prevent problems associated with clogging of emitters and damage to tubing.

Considerable controversy exists over proper fertigation rates and frequencies. Rates usually correspond to those used for granular application but frequency of application may range from weekly to bimonthly to monthly. Current research suggests that tree growth is similar whether materials are applied at weekly or monthly intervals provided that rates of irrigation and fertilization are equivalent. However, frequent applications guarantee that nutrients are being supplied to the tree and ensure against losses from excessive rainfall or irrigation. Since most growers will fertigate when they irrigate, there is no disadvantage to making frequent applications from an energy or cost basis.

Fertigation has many advantages over other fertilization systems. Fertilizer can be applied at any time during the year and at the frequency desired. If properly utilized, fertigation can also reduce fertilizer rates because nutrients can be applied when needed in a soluble form directly in the root zone. Fertigation systems also may be automated and computer controlled from remote locations, thus eliminating labor and equipment costs involved in fertilizer spreading.

Fertigation also has some disadvantages and may not be the right system for everyone. Cost for liquid versus granular materials are comparable, but the initial investment for storage tanks, valves and injectors, and back-flow prevention devices may be moderate to high. Some liquid formulations do not contain all necessary nutrients requiring additional foliar or granular applications. Fertigation systems must be properly managed to be effective. Constant monitoring of irrigation lines, emitters and fertilizer injection systems is recommended to ensure uniform coverage. During times of high rainfall where the soil becomes saturated, fertigation becomes inefficient because nutrients run off in irrigation water, are leached or are not rapidly taken up by the roots due to low oxygen conditions. Fertigation may increase total dissolved salts (TDS) levels of irrigation water and when used in combination with water already high in TDS may cause damage to trees. TDS levels above 900 ppm may cause damage to leaves and should be avoided.

Table 1. Suggested fertilization of young citrus trees up to 7 years of age.

Years in Grove	Number of Applications each Year	Pounds per Application per Tree* (Range)	Pounds N per Application per tree
First	5 - 6	0.75 - 1.25	0.06 - 0.10
Second	4 - 5	1.75 - 2.25	0.14 - 0.18
Third	3 - 4	3.0 - 4.0	0.24 - 0.32
Fourth	3 - 4	3.5 - 4.5	0.28 - 0.36
Fifth	3 - 4	4.0 - 5.0	0.32 - 0.40
Sixth	3 - 4	4.5 - 5.5	0.36 - 0.44
Seventh	3 - 4	5.0 - 6.0	0.40 - 0.48

*Use 8-8-8-1.6-0.4-0.2-0.025 mixure or equivalent
(adapted from Bulletin 536D)