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TOTAL MINERAL NUTRIENT CONTENT OF FLORIDA CITRUS NURSERY PLANTS

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Abstract. **The objective of this study was to determine the mineral nutrient use in 8 Florida commercial citrus nurseries and to quantify the amount of nutrients removed from each nursery when budded trees are transferred to the grove. Four field (2 Ridge and 2 flatwoods sites) and 4 container-tree nurseries were selected. Pertinent information on fertilizer use was obtained at each nursery; also, 10 each of citrumelo seedlings at liner size, liners at budding size and finished 'Valencia' [*Citrus sinensis* (L.) Osb.] trees on Swingle citrumelo [*C. paradisi* Macf. x *Poncirus trifoliata* (L.) Raf.] rootstock were collected for mineral nutrient analysis. Budded plant density ranged from about 32,000 to 63,000 plants per acre in the field to over 170,000 for plants grown in containers. Budded plants generally received between 1,000 and 2,000 lb. per acre annually of nitrogen (N) and potassium. Budded plant dry weight ranged from 0.9 to 7.0 oz/plant largely because of differences in plant age. Field-grown trees were 6 months older and had larger weights than container-grown trees. The mineral nutrient content of the budded trees was also related to tree size and age with the larger plants containing about 5 lb. N/1000 trees and the smaller trees about 1 to 2 lb. Total plant nutrient content accounted for about 5 to 20% of the nutrients applied.**

Florida citrus nursery trees are produced in about 18 months after seed sowing. Fertilizer is applied frequently throughout this period and usually as a liquid through an overhead irrigation system (5).

Current nutritional programs in Florida citrus nurseries emphasize maximum growth. Vigorous growth is encouraged by high fertilization and irrigation rates (2, 5). The foundation for this approach is largely empirical. Nursery fertilization practices are based on the same principles of citrus nutrition developed for older trees; however, in the absence of any systematic nutritional studies in nurseries, producers have had to rely almost exclusively on their own trial and error experiences to develop specific information regarding fertilizer rates, formulas, and application frequencies. It is not known if these are the "best" or most economical fertilization practices. Furthermore, there are important environmental concerns related to fertilizer use in both field and container-tree nurseries. Therefore, in order to conduct an investigation of citrus nursery tree nutrition, we elected to begin with a survey. Our objective was to determine fertilization rates in representative Florida citrus nurseries, determine the total mineral nutrient content of seedlings, liners, and budlings from these nurseries, and compare the amount of nutrients applied with the amount removed in finished trees. In this report, we have presented only the general information describing the nurseries and plants, and the macronutrient results pertaining to budded trees.

Materials ad Methods

Plants for mineral nutrient analysis were collected from 8 nurseries: 4 field nurseries, 2 on the central Florida Ridge, 2 on flatwoods sites, and 4 container-tree nurseries. Only established nurseries representing current production systems, and producing above-average quality trees, were selected.

Ten plants each of Swingle citrumelo seedlings and liners were collected from each nursery plus 10 finished 'Valencia' on Swingle budlings. We attempted to obtain similarly aged plants within each group. The plants were usually collected randomly from within a nursery block and completely intact except for the field-grown budlings. These, taken from one location within each nursery, were machine dug which allowed for retrieval of about 80% of the root system.

Each plant was separated into leaves, stems, and root system, and oven-dried at 70°C for at least 24 hr. The above-ground plant parts were not washed prior to drying. Washing is the usual practice to remove any surface contamination from foliar nutrient applications which was a common fertilization method among the surveyed nurseries. We chose not to wash the plants because our primary purpose was to determine nutrient content regardless of whether nutrients were part of the tissues sampled or present on the surface. The dried material was ground in a Wiley mill and weighed. Subsamples were analyzed for N by semi-micro Kjeldahl. Additional samples were digested with nitric-perchloric acid and analyzed for P, K, Ca, Mg, Zn, B, Cu, Mn, and Fe by inductively coupled plasma spectrophotometry. The data reported are only for the 5 macronutrients. Plants were treated individually except in a few instances where some were combined to provide adequate sample weights for analysis.

Information on nursery facilities and site, plant age, the production cycle, and fertilization practices applicable to the plants harvested was obtained at the time of the initial nursery visit and confirmed with, generally, 2 follow-up conversations. Fertilization rates were standardized on a per acre and annual basis so that data were comparable between nurseries. Total mineral nutrient content data were calculated by multiplying the mean ($n = 10$) nutrient concentration (data not given) of each plant part by the appropriate dry weight and then summing these values for each plant type.

Florida Agricultural Experiment Station Journal Series No. N-00323. The nurserymen who participated in our survey provided plants and information most willingly and showed a keen interest in the project. We appreciate their cooperation.

Results and Discussion

There was some variation in the production cycle when the 2 nursery types were compared. The principal difference was in the length of time between budding and a finished plant. Virtually all the nursery tree producers reported that seedlings were grown for 4 months before transplanting but liners were grown for 3 to 6 months before budding in the field nurseries and only 2 to 4 months as containerized plants. The time to produce a tree after budding was typically 12 months in a field nursery for a total time of about 20 months and 8 and 16 months, respectively, for the container-grown plants.

The planting density and spacing of field nursery trees ranged from about 32,000/acre with trees planted in single rows 24 to 48 inches apart, to 63,000 with trees in double rows 12 inches apart and 38 inches between the double rows. Two container-tree nurseries used the 4 x 4 inch citripot and 2 nurseries used the 6 x 6 inch citripot. These containers, when placed with no spaces between containers, have a density of 392,040 and 174,240 pots/acre, respectively.

Plant density is an important consideration in fertilization because it is directly related to fertilizer application and use efficiency. Fertilizer is generally applied most efficiently in field nurseries as compared to the container tree nurseries. This is because the planted area in a field nursery is about 75% of the area wetted by the overhead irrigation system. Application efficiency, however, greatly increases with plant age as the root system fills most of the planted area. Fertilization of newly-planted seedlings is inefficient. Plants in container-tree nurseries are grown on benches with walkways between the benches and are fertigated with an overhead system. Fertilizer application efficiency is between 40 and 60%, i.e., in the plant-growing structure, only about 50% of the total floor space is covered by plants. The most efficient fertilization practice was encountered in nursery F (Table 1). The plants in that nursery were container-grown and fertilized with a slow-release material manually applied as a topdressing to each pot. Furthermore, they were frequently but lightly irrigated to prevent leaching.

Liquid fertilizer was the most commonly used type reported in our survey with overhead irrigation being the typical method of application. Frequency varied from 1 to 4 applications/month on liners and budlings depending on the time of year. The lowest frequencies were used when dry or slow-release fertilizer was being applied.

Annual fertilization rates on budlings were reasonably consistent for each element across the 8 nurseries with one exception (Table 1). The amount ranged from about 2,000 to nearly 3,000 lb. N/acre. The rate in one containerized nursery was 1,055 lb. Phosphorus in field nurseries was usually applied preplant but in nursery C, additional P was regularly added as part of the weekly soluble fertilizer application. There was a 3-fold difference in P rates within the container-tree nurseries and a 4-fold difference among the field nurseries. In some of these nurseries, P was applied in the fertilizer or was added when the plant medium was being prepared. Potassium was applied only as a fertilizer element at rates between 800 and 1800 lb./acre. In 4 nurseries, Ca apparently had not been applied. Nursery D was on a calcareous site and suffiient Ca was naturally available. Calcium and Mg are normally supplied to field-grown nursery plants via liming with dolomite. In nursery A, routine leaf and soil sampling had indicated that an adequate soil reserve of these elements was present when the plants we sampled were established in the field. The plants produced in nursery E received their Ca from a $Ca(NO_3)_2$ spray, and those in nursery G and H were provided Ca and Mg from medium amendments which appeared to be the common way those nutrients were supplied for container-grown plants.

Micronutrients were supplied in the regular fertilization program and frequently in supplemental foliar sprays. The composition and rates of the micronutrient materials used varied greatly but Fe was a commonly applied element.

Budded plant dry weight was related to plant age but also to the production system (Table 2). Container-grown trees averaged 15 months in age but weighed considerably less than the field-grown trees which had an average age of 21 months. These differences in age and size are representative for finished plants raised in the field or containers.

Table 1. Annual mineral nutrient application rates (lb/acre) for budded trees in 8 Florida citrus nurseries.[z]

Nursery	N	P	K	Ca	Mg
Field					
A	2230	505	1840	—[y]	7
B	1945	165	810	435	280
C	1930	695	800	165	25
D	2140	320	—	1680	670
Container					
E	2895	235	945	—	
F	2330	365	1020	2430	1530
G	1055	170	980	?	?
H	2740	610	1515	3270	1605

[z]The amount for each element is the quantity applied to a given ground area. It does not represent the amount actually applied to the nursery trees because of different application efficiencies related to, e.g., spaces between benches, and unplanted areas within the coverage of an overhead irrigation system in a field nursery.
[y]Nutrient was not applied (—), or, was applied but the amount was unknown (?).

Table 2. Mean dry weight and total mineral nutrient content of 'Valencia' trees on Swingle citrumelo rootstock.[z]

Nursery	Dry wt, oz/plant	Mineral element, lb./1000 plants				
		N	P	K	Ca	Mg
Field						
A	7.0	4.7	0.5	4.0	4.8	0.4
B	2.1	2.2	0.1	1.5	2.0	0.1
C	5.6	6.1	0.5	3.5	3.4	0.8
D	5.7	6.3	0.6	4.4	5.3	0.7
Container						
E	0.9	0.9	0.1	0.5	0.4	0.1
F	1.7	2.1	0.2	1.8	1.2	0.2
G	1.2	1.5	0.1	1.1	1.0	0.1
H	1.9	1.4	0.1	1.0	1.4	0.1

[z]Data are based on 10-plant samples.

Plant total mineral nutrient content for each element also reflected the dry weight differences (Table 2). The quantity of N "harvested" was less than 2 lb./1000 plants to about 5 lb. for container and field-grown trees, respectively. The calcareous nature of the site where nursery D was located was evident in the plant Ca content.

The data in Table 2 are not complete without considering the roots left in the soil after digging field trees or the stems and leaves removed when the trees are headed, and prepared for shipment. The container-grown trees were clipped once or twice but the field trees were commonly clipped 3 to 4 times between budding and shipping; also, all trees had the portion of the rootstock seedling above the bud union removed. We determined from samples of these additional tissues, or from estimates, that the total amount of nutrients removed from the nursery increased about 10% for the container-grown trees and 20% for the field trees when the removed tissues are included.

The nutrient quantities in the plants are about 5 to 20% of the amount applied. Such levels of "recovery" are difficult to interpret. The fate of the remaining portions of the nutrients applied is unknown. Some nutrients may have been present in the field soil or container medium or were leached. The amounts "recovered" seem reasonable when our results are compared with studies of older plants (3, 4). Nevertheless, Bridges and Youtsey reported in 1977 that in Florida citrus nurseries, annual rates of 800 to 1,000 lb. N/acre were common (1). They expressed the opinion that these rates were probably excessive. Our study showed that fertilizer rates have increased considerably and the production time for a field-grown nursery tree has decreased since 1977. The shorter production cycle may be directly related to a higher fertility level but this is not known. Our results suggest that further study is needed to determine if the current nursery fertilizer rates are necessary and the extent of leaching that might be occurring.

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AN ECONOMIC ANALYSIS OF REPLANTING EXISTING GROVES VS. BUYING NEW LAND FOR CITRUS PRODUCTION

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Abstract. **The recent December 1989 freeze has forced many citrus growers in northern citrus production areas to reevaluate the production of citrus at their current locations and/or investigate the possibility of purchasing land further south. The research presented in this paper analyzes the economics of the decision to replant existing grove land as opposed to the purchase of new land for citrus production in other southern production areas. The two strategies are compared based on capital budgets prepared for a fifteen-year planning horizon. Various production alternatives and cultivars are also considered in the analysis and reported in the paper.**

The decade of the 1980s was a period of expansion for the Florida citrus industry as new plantings increased dramatically in Southwest Florida. Much of the establishment of new groves in Southwest Florida was precipitated by the decision of grove owners and managers to relocate groves that were severely damaged or destroyed in the freezes of the 1980s rather than risk replanting in the colder Central Florida area. Although Central Florida and the Ridge area, in particular, have proven to be highly productive growing regions, many producers are reassessing their grove locations in light of the 1989 December freeze. This paper addresses under what condition a Central Florida citrus grower would want to relocate to Southwest Florida.

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Methodology and Data

An investment decision may depend on financing, cash flow, and perceived risk (3,4). However, the primary consideration should always be profitability (2). If the investment is not profitable, then the other facets of the decision-making process will not be considered. One measure of profitability is called the internal rate of return. The internal rate of return (IRR) is simply a measure of what percentage profit is made on an initial investment over the life of the investment. The IRR is an annual rate of return, however, so that it can readily be compared to other investments, such as certificates of deposit or other savings plans.

The approach taken in this paper is to compare the profitability of the production of 'Hamlin' oranges in Central and Southwest Florida without accounting for land costs. In today's land market a possible gain in land transactions may be realized when land in the Central region is sold and land is purchased in the Southwest region. The gain in the land transactions can then be added to the initial investment cost in the Southwest cash flow and in-