sence of cross-pollination, 'Ambersweet' fruit would be seedless or nearly so.

Observations during several seasons showed that 'Ambersweet' flowers produce limited quantities of pollen. This suggests that 'Ambersweet' would not be suitable as a pollinizer variety.

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A SURVEY OF FLORIDA CITRUS NURSERIES

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Abstract. **Florida citrus nurseries were surveyed during the spring and summer of 1988 to determine current production practices and identify areas of need for research and educational programs. Survey forms were mailed to 251 commercial citrus nurseries throughout Florida and 20 additional on-site interviews were conducted. Fifty-eight nurseries (24 field nurseries, 27 container nurseries and 7 combination field/greenhouse nurseries) with a combined annual production of over 8 million trees per year were represented between the usable survey responses and on-site interviews. Field nurseries were generally older and larger than container nurseries. Twenty of the 27 container nurseries included in the survey had been established in the last 5 years. The cultivars and rootstocks in use were similar for the 3 nursery types except that a larger percentage of container grown than field-grown trees were budded on Swingle citrumelo (*Citrus paradisi* Macf. x *Poncirus trifoliata* (L.) Raf.) rootstock. Although few nurserymen registered all their propagations with Florida's budwood registration program, about 73% of the trees represented by the survey were registered. Changes which have occurred in recent years include the introduction of a larger citripot, the increased use of bending and tying to force buds and modifications in fertilizer programs including various combinations of liquid, dry and controlled-release fertilizers. Research needs identified by nurserymen included information on fertilization practices, pesticide usage and economic analyses of nursery operations. Current nursery practices are described and discussed.**

Several descriptive accounts of Florida citrus nurseries have appeared in the literature since the late 1970s (1-3). In 1979, Castle et al. (2) described a container nursery system capable of producing finished nursery trees in about 12 months from seed. In 1982, Castle and Ferguson (3) reported an increase in the occurrence of container citrus nurseries in Florida and described the components and production practices involved. Currently in Florida, most citrus nursery trees are grown in field nurseries but the number of container-grown trees has increased in recent years. Reasons for the growing popularity of container nurseries compared to field nurseries include relatively shorter production cycles, greater control of the nursery tree environment (including cold protection), ease of site certification, increased land use efficiency and fewer problems with soil-borne pests and diseases.

Previous accounts of Florida's citrus nursery industry have documented changes in many aspects of citrus nursery management, especially in the new container nurseries. Our purpose was to survey current production practices in Florida's citrus nurseries and identify areas for future research and educational programs.

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Materials and Methods

Survey forms were mailed to 251 commercial citrus nurseries in 21 counties throughout Florida's central ridge and flatwoods citrus producing areas. Additionally, on-site interviews were conducted at 20 commercial citrus nurseries during the spring and summer of 1988. Usable survey information was obtained from 58 nurseries with a combined annual production of about 8,000,000 trees which was estimated to represent about 30% of Florida's commercial citrus nursery tree inventory.

Results and Discussion

Nursery size. Nursery size, measured as annual production, varied widely for all nursery types but container nurseries tended to be smaller than field nurseries. Among field nurseries, nearly 40% produced more than 100,000 trees per year. Annual production of container nurseries ranged from 6,000 to 500,000 trees, but most produced only about 30,000 to 90,000 trees annually. Nurseries producing 500,000 trees per year in containers are unusual in Florida. Size limitations of container nurseries may be due to high establishment costs, or because nurserymen feel that they lack the experience and knowledge needed to operate such systems. The one large container nursery included in our survey, reduced costs by constructing relatively inexpensive wood frame structures for growing plants (Fig. 1). Each structure had shade cloth sides and no roof. Benches were constructed of old irrigation pipe and welded wire and were supported by concrete blocks. During the winter months, the structures were covered with 4 mil polyethylene plastic. Microsprinklers located under the benches provided cold protection. These structures have provided adequate cold protection without supplemental heating.

Fig. 1. General view of the welded wire benches and inexpensive wood frame structure used to produce citrus trees in a large containerized nursery. Many plants are being grown in the large (6 x 6 inches) citripot shown above.

Nurseries using both field and container methods, or combination nurseries, tended to be large with annual production levels ranging from 4,000 to more than 1,000,000 trees. Like container nurseries, combination nurseries are more common now than in the past as more field nurserymen have begun to experiment with container nursery systems.

Field nurseries were staffed with more permanent and seasonal employees than container nurseries even when employee numbers were adjusted for annual production (one permanent employee per 20,000 plants for field nurseries versus one permanent employee per 23,000 plants for container nurseries).

Nursery age. Field nurseries ranged from 2 to 64 years of age while container nursery age varied from 1 to 7 years. Since the introduction of container nurseries in Florida in 1977, they have continued to increase in size and number; however, 80% of the surveyed container nurseries were 5 years old or younger. Additionally, 42% of the participating field nurseries were established during this same period. While interest in container nurseries continues, the traditional field industry is a result of high demand for nursery trees as the citrus industry continues to expand in southwest Florida and recover from heavy tree losses caused by freezes, tristreza and blight. Also, many nurseries were destroyed during the recent bacterial leaf spot (*Xanthomonas campestris*) episode. The leaf spot disease also caused the entire citrus nursery industry to be quarantined. As a result, many new private nurseries were established.

Nursery inventory. Sweet orange comprised the majority of nursery propagations followed by grapefruit and mandarin cultivars. Most nursery inventories consisted of 5 or more cultivars. Only about 20% of the surveyed nurseries had fewer than 4 cultivars in stock. In about 40% of the nurseries, a single cultivar comprised 50% or more of the plant inventory. Overall, cultivar inventories were similar for the different nursery types.

Carrizo citrange (*C. sinensis* (L.) Osbeck x *P. trifoliata*), Swingle citrumelo and Cleopatra mandarin (*C. reshni* Hort. ex. Tanaka) were the most widely used rootstocks regardless of nursery type. Collectively, these 3 rootstocks comprised over 80% of the nursery trees represented by the survey. Rootstock inventories were less diverse than scion cultivar inventories. Most nurseries (over 60%) propagated less than 4 different rootstocks and about 18% of the nurseries propagated only one rootstock. For those nurseries propagating only one rootstock, 6 nurseries grew Swingle, 3 grew sour orange (*C. aurantium* L.) and one grew Carrizo. Sour orange comprised less than 12% of the combined rootstock inventories for all nursery types. The low use of sour orange reported here is in general agreement with data from the Division of Plant Industry (DPI), Florida Department of Agriculture and Consumer Services which show an even sharper decline for registered sour orange propagations from 30% for all registered propagations in 1986-87 to 6% in 1987-88 (6). A larger percentage of container trees (64%) than field trees (27%) were propagated on Swingle.

Budwood registration. The DPI maintains a voluntary budwood registration program to facilitate the propagation of virus-free, true-to-type citrus nursery trees. About 73% of the trees represented by the survey were registered. While over half (63%) of the nurseries surveyed reported registering more than 50% of their nursery trees, only 26% registered more than 95% of their trees and approximately 11% of the nurseries reported registering their entire tree inventory.

Production schedule. One of the primary reasons for selecting container production systems is to reduce the time required to grow a marketable tree. The average production cycle for container-grown trees was about 16 months as compared to 18 months for field trees. Although a few container nurserymen reported production schedules of one year or slightly less, container-grown trees are generally of smaller caliper than field-grown trees and most nurserymen admit that only a portion of their container trees are of saleable size in 9 to 12 months.

Budding practices. Nurserymen obtained budwood from a variety of sources including budwood trees located on the nursery site (4), budwood trees located at other nurseries, commercial groves, tops of nursery trees, and DPI mother trees. Approximately half (48%) of the nurseries reported using more than one source of budwood. Overall,

the most common sources of budwood were scion trees located on-site, or at other nurseries. A larger percentage of field than container nurserymen maintained their own scion groves but many of the latter, especially new nurserymen, were planning to develop scion plantings. A significant number of nurserymen reported using tops of nursery trees as budwood sources, a procedure permitted under specified circumstances in the nursery tree registration program. However, routine use of nursery tops is not permitted when producing registered trees.

All nurseries reported using the inverted T-bud; however, a few nurserymen had experimented with chip budding as an alternative procedure during periods when the rootstock bark was not slipping. Budding height varied from 2 to 12 inches but was usually between 4 and 6 inches. No substantial differences in budding height were noted among nursery types. Almost all nurserymen bud seedlings after they are transplanted to the nursery row or to the containers in which the finished plant is grown. One nurseryman budded plants in seed beds constructed of lumber and welded wire, lined with porous cloth and then filled with a soilless medium (Fig. 2). A planting board was used to obtain uniform plant spacing and to facilitate budding. The young budlings were transplanted after 4 to 6 inches of scion growth had occurred.

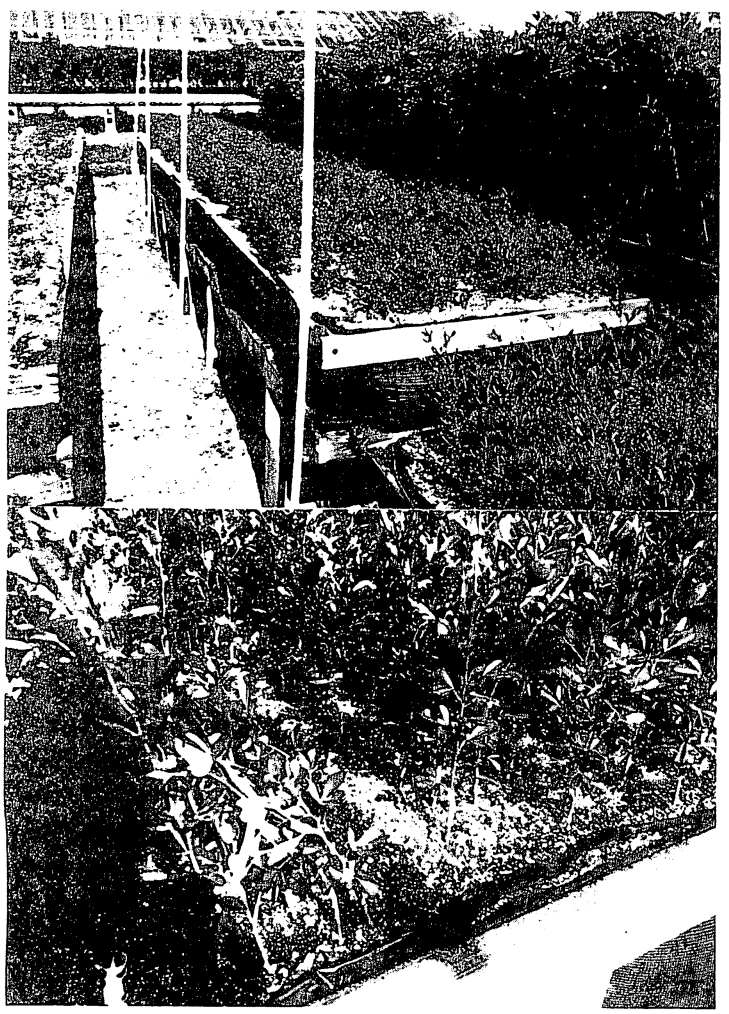

Fig. 2. An uncommon citrus nursery tree production method involves growing seedlings in a bed of soilless medium (top). The seedlings are then budded in place. A small metal wicket is used to expose a row of seedlings for budding (bottom).

Virtually all nurserymen used one or more of the following bud forcing methods: lopping, cutting-off or bending and tying. Lopping was most frequently used in field nurseries (70%) while cutting-off was preferred in container nurseries (61%). A significant number of nurseries (17% of field nurseries and 30% of container nurseries) used bending and tying to force buds. The recent interest in bending and tying may be the result of inadequate scion growth following cutting-off in container nurseries. Nurserymen commonly complained that cutting-off resulted in an initial flush of scion growth of only a few inches. A second flush is then required before topping and heading can be done. Studies comparing the various bud forcing methods have not demonstrated any consistent advantage of one bud forcing method over another. In a recent study in Texas (6), bending and tying resulted in greater early scion growth of container-grown citrus nursery trees provided basal leaves are left intact below the bud union. The percent budbreak was unacceptably low for bending and tying when basal leaves were removed.

A recent study conducted in Australia (5) showed that careful bud selection may hasten budbreak and enhance uniformity of scion growth in citrus nursery trees. Buds collected from the upper and middle portions of a flush grew quicker than buds taken from the basal portions of the same flush. Two Florida nurseries have reported improved budbreak and scion growth when buds from these portions of flushes were used for scion wood.

Many nurserymen contracted their budding. The cost ranged from $0.14 to $0.25 per budeye. Bud live was generally reported to be greater than 90%.

Plant spacing. In-row spacing for field-grown trees was variable but 4- to 6-inch spacings were most common. Between-row spacing varied from 24 to 52 inches but spacings of 36, 42 or 48 inches were most common. Several of the larger field nurseries had changed from double to single nursery rows. The number of trees per acre decreased slightly but the nurserymen reported that it was easier to manage single rows in terms of cultural practices such as digging, budding and forcing.

In container nurseries, liners were grown in a variety of polystyrene and rigid plastic trays, individual cells or in custom designed seed beds. Plant spacing for container-grown budded stock was primarily a function of container size and shape. Containers were usually spaced side by side resulting in tree spacings of 3 to 6 inches in either direction. A few nurserymen increased plant spacing as nursery trees increased in size. The reasons cited were reduced competition for light, increased air movement and more uniform application of water, fertilizers and pesticides.

The most popular container for growing budded trees was the standard citripot which costs about $0.20 to $0.25 each, but 3 to 6 mil polyethylene bags, at a cost of about $0.05 each, were preferred by some growers. In an attempt to increase tree caliper, some nurserymen were experimenting with a larger citripot (6 x 6 x 13 inches) which has a 1.5 gallon capacity (Fig. 3). Slightly modified versions of the standard citripot are also commonly used by the industry.

Media. Many different soilless media were used in container citrus nurseries. Common components include

Fig. 3. Many nurserymen are experimenting with the large citripot (6 x 6 x 13 inches) shown above.

Canadian peat, perlite and vermiculite. Other materials such as native Florida peat, wood chips, styrofoam (polystyrene) beads and sand have also been used to a lesser extent. Peat moss was the primary component of most mixes and was usually combined with substantial, but lesser, amounts of perlite or polystyrene pellets. The pHs of these media were reported to be between 6.0 and 6.5. The price of soilless media ranged from $15.00 to $27.00 per cubic yard. Some nurserymen have reduced media costs by using custom blends containing Florida peat, but the quality of Florida peat is highly variable.

Fertilizer practices. Fertilizer ratios of approximately 1N: .44 P: .83 K ($1N:1P_2O_5:1K_2O$) were commonly used in both field and container nurseries. Some fertilizer materials contained little or no P and higher levels of N. Most nurserymen used the same fertilizer analyses for seedlings and budded stock but not the same rate or frequency of application. Generally, higher analysis fertilizers were used for container-grown trees than for field-grown trees. High analysis fertilizers were virtually always applied in dilute concentrations via fertigation. Fertigation was the primary method of fertilizer application for container nurseries, but was often supplemented with applications of dry granular or controlled-release fertilizers. Use of controlled-release fertilizers, either alone or in combination with other fertilizers, appears to be increasing in popularity, especially in container nurseries. Fertigation and dry application of granular fertilizers were used about equally among the field nurseries surveyed.

In field nurseries, dry granular fertilizers were applied at 3- to 6-week intervals except during the winter when application frequencies were often reduced to once every 8 to 10 weeks. Fertigation frequencies for field nurseries varied from 3 or more times per week to once every 2 weeks. Almost all container nurseries were fertigated. Fertigation frequencies varied from constant feed (at each irrigation) to weekly applications with several fertigations per week being most common. Container nurseries using constant-feed fertigation reported applying fertilizer concentrations ranging from 200 to 400 ppm N at each application.

Precise annual fertilizer rates for most nurseries could not be determined from available data. Nevertheless, our observations, as well as those of some nurserymen, suggest that annual per acre N applications ranged from about 1500 to over 4000 lb. with rates of about 2000 lb. most common. Although optimum fertilizer rates for containerized citrus nursery trees have not been firmly established, the higher annual rates of N observed in this study are quite likely to be in excess of what is required for maximum growth. Excessive use of fertilizer, especially in container nurseries has resulted in Cu deficiency and phytotoxic levels of accumulated salts. Some nurseries are using leaf analysis and periodically checking TDS levels to better manage their fertility programs.

Irrigation practices. Irrigation practices differed among nursery types. Permanent overhead high-volume sprinklers were most common in field nurseries. Irrigation rates of 1 to 2 inches per week, applied in 1 to 3 applications were common during dry periods of the growing season. Individual applications ranged from 0.3 to 2.0 inches with 0.5 to 0.7 inches being most common.

Although some smaller container nurseries were irrigated by hand, most were irrigated with overhead microsprinklers or microsprinklers mounted on traveling booms. During summer months, irrigation frequencies varied from multiple irrigations per day to once each week, but irrigations at 3- to 4-day intervals were most common. Winter irrigation frequencies for most container nurseries were reduced to once every 3 to 10 days.

Criteria for scheduling irrigations were usually empirical rather than quantitative. Only one nursery reported using tensiometers to schedule irrigations. Most nurserymen relied on experience and overall soil and/or plant appearance. Rigid calendar schedules were employed by a few managers of container nurseries. Generally, more problems were observed from over-irrigating containerized trees than from lack of irrigation. Other reported uses of irrigation in field nurseries include cold protection and prevention of sandblasting of young liners during dry, windy periods.

Insects and diseases. Although insects and diseases were not generally considered to be major factors limiting production, many nurserymen expressed concern over the limited arsenal of pesticides which can be legally applied to citrus nursery trees, especially in indoor container nurseries. Spider mites were considered the most troublesome pest for both field and container nurseries. Additionally, scab and whitefly were listed as minor problems in field and container nurseries, respectively. Although not considered in this survey, reports of root weevil infestations in both field and container nurseries have caused some concern during the past year.

Summary. During the past decade, the Florida citrus nursery industry has continued to change. The number of nurseries has increased to meet the demand caused by replanting after freezes, tree loss to tristeza and blight and industry expansion to new land. The changes were clearly accelerated by the presence of bacterial leaf spot. The result was an enhanced interest in fully self-contained nurseries in which the owner had seed and budwood sources available on-site. Along with the many new nurseries have come a new group of managers, some with little or no prior experience in producing citrus nursery trees. Their relative inexperience has been beneficial, in part, because these managers have fewer prejudices and, therefore, are largely responsible for trying new approaches, or reviewing old procedures, e.g., bending to force budbreak.

Container production of citrus nursery trees has increased in importance, although fewer than 20% of all nursery trees are probably grown by this method. There are no indications that this situation will change significantly during the next decade.

The major issue facing citrus nurserymen today concerns the general area of plant nutrition and in particular the potential for groundwater contamination. Our conclusion is that this is the priority area for research and extension support. A second area of need concerns budwood quality, selection and bud forcing. Recent research elsewhere (R. E. Rouse, personal communication) shows the usefulness of plant growth regulators to promote budbreak at forcing and heading. Initiating and continuing research and extentsion activities in these areas should help to improve the efficiency of citrus nursery operations.

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RELATIONSHIP BETWEEN TREE COUNTS AND CITRUS GROVE PRODUCTION

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Abstract. **Grove mapping is an important part in determining the status of trees in groves managed by the Haines City Citrus Growers Association (HCCGA). Grove owners joining the HCCGA must have their groves mapped upon being accepted into membership. A study of 3 typical groves in Polk County was made to determine from ground surveys the relationship and yield comparisons between tree counts with full, partial potential mature tree stands, and actual counts of different size trees. Results of the comparisons indicated that reduction of tree stand to 64.63% lost a hypothetical production of 2,589.15 boxes at an estimated value of $1,192.00 per acre (fresh fruit) and $1,143.30 per acre (processing) (1987-88 prices). Estimated production costs were the same whether the grove had a potential 100% stand or a low of 64.63%, so that groves with low counts (656 instead of 1,015) not only lost yield, but had higher production costs per tree, $24.00 instead of $15.51.**

Variations in groves limit the possibility of finding a single method, practice, or group of factors that will maximize yield and profit for all groves. A program may give good yields in one grove but will seldom work well in another grove if used without modifications. Successful growers consider the grove record a valuable piece of equipment and they keep it in use regardless of current fruit prices. Maintenance of accurate grove records contribute a great deal to the efficiency of the enterprise. Tree counts and grove maps provide baseline information that will enable managers to make accurate decisions (2, 6).

Annual tree counts provide a growth and development chart for monitoring grove progress to determine if tree production is profitable or whether the trees should be replaced (1, 2, 8). The method most commonly used for grove mapping involves the use of a diagram on graph paper and marking desired symbols, letters, or numbers in a square to record a particular tree's condition. The use of plastic overlays has been successfully tested (3). The majority of groves in HCCGA range from small (less than 20 acres) to medium (from 100 to 660 acres) in regular blocks with even spacing between trees and with 2 or 3 different varieties within a grove. There are no standard types of groves. Thus, production managers have to adapt management and operations to each grove.

This presentation deals with the conventional method of grove mapping to demonstrate how tree counts can be used in estimating grove production and potential income when compared to the potential production of a mature grove.

Materials and Methods

Best grove maps were obtained with quarter-inch graph paper on a legal size clipboard. Each square represented a tree and was marked with an appropriate symbol indicating the health condition, size of tree, as well as the variety. Field information forms attached to each grove map provided information required by other departments to assign costs and labor expended (Table 1).

Grove mapping was quite tedious in groves where many varieties were intermixed as sequential trips were made to verify the correct identification of both scion and rootstock. In these experiments, no information was recorded on tree nutritional deficiencies, herbicide use, or damage.

Once a grove map was made, it was duplicated (6 copies) and incorporated with other grove records such as:

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