Moreover, the overall average tree density has increased by about 11%, as post-freeze plantings have averaged about 20% more trees per acre. At pre-freeze densities, nursery production could have planted another 3,000 acres.

With respect to future projections, the Annual Citrus Nursery Stock Survey (5) reports that 645,000 citrus trees were to have been delivered between 1 Jul. 1988 and 30 Jun. 1989. Approximately, 63% are grapefruit and nearly 53% are 'Rio Red'. In addition, there were approximately 1,300,000 rootstocks (seedbeds and unbudded liners) in Jul. 1988.

At present planting densities, the 645,000 new trees should establish about 4,500 acres. It should be noted that the nursery survey is conducted annually on 1 Jul., whereas the tree inventory is conducted biennially on 1 Jan. Consequently, an undetermined number of the 1988-89 new trees produced were already planted—and thereby counted—in the 1989 inventory.

Although the recovery of lost acreage is taking longer than expected, most observers still consider 50,000 total acres to be about the maximum acreage for the future. At present average planting rates of about 2,500 acres per year, it will take another 5 or 6 years to reach that level.

Despite the slower recovery, the outlook for the Texas citrus industry is extremely bright. Future production will be from vigorous, new plantings and some of the better orchards that are rehabilitated. Better quality, higher grades and the new market names to reflect the traditional Texas red grapefruit and the newer "super-reds" should assure good returns for Texas citrus in the years ahead.

AUTHORS' UPDATE
December 1989 Freeze Update

Since presentation of this manuscript, the Texas citrus industry was hard hit by another major freeze during 22-24 Dec. 1989. Subfreezing temperatures existed for about 50 hours, with over 7 hours at below 20°F and about 22 hours in the low-to-mid-twenties. Essentially, 60 percent of the grapefruit crop, 30 percent of early and midseason oranges and all 'Valencia' fruit were still on-tree and frozen, although some juice salvage operations were continued as long as possible.

Trees were considered to have very good cold hardiness because of a dry year without leaching rainfall to remove excess salts and because of a much colder than normal December preceding this freeze. Some bark splitting has been observed, but not to the extent as in earlier freezes. Bark cutting has revealed grey-brown cambial areas in grapefruit wood to 2-inch diameter. However, conclusions as to overall tree damage and recovery potential will not be realistic until a couple of months after the 1990 spring flush.

LITERATURE CITED

1. Sauls, J. W. and R. E. Rouse. 1985. Current Status of the Texas Citrus Industry. Proc. Fla. State Hort. Soc. 98:63-65.
2. Texas Agricultural Extension Service. 1985. Report on the Rio Grande Valley Citrus Industry—Analysis and Evaluation. College Station, TX.
3. Texas Department of Agriculture. 1985. Texas Citrus Tree Inventory Survey, Texas Crop and Livestock Reporting Service, Austin, TX.
4. Texas Department of Agriculture. 1987. Texas Citrus Tree Inventory Survey, Texas Agricultural Statistics Service, Austin, TX.
5. Texas Department of Agriculture. 1989. Texas Citrus Tree Inventory, Survey, Texas Agricultural Statistics Service, Austin, TX.

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YIELD AND FRUIT QUALITY OF 'AMBERSWEET' ORANGE HYBRID ON DIFFERENT ROOTSTOCKS

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Abstract. **'Ambersweet' is a hybrid of (*Citrus reticulata* Blanco x (*C. paradisi* Macf. x *C. reticulata*)) x midseason orange, *C. sinensis* (L.) Osb., developed in the USDA breeding program. Fruit can be harvested in central Florida for the fresh market from mid-October through December. Fruit for processing can be harvested from mid-November through December. The fruit resemble those of navel orange in size and appearance more than other types and have orange rind color at maturity. The rind can be removed easily and the juice has dark-orange color at maturity. The trees are vigorous, have a dense canopy, and are moderately cold hardy. Trees perform equally well on Cleopatra mandarin (*C. reticulata*), sour orange *C. aurantium* L.), and Carrizo citrange (*C. sinensis* x *Poncirus trifoliata* (L.) Raf.) rootstocks. Fruit yields are good on rough lemon (*C. limon* (L.) Burm. f.) rootstock, but fruit quality is less desirable than on other rootstocks. The fruit can be picked without clipping and with little rind plugging. Ambersweet fruit store well at 34° and 70°F, as do oranges.**

Origin and Description

'Ambersweet' resulted from a 1963 cross of 1-3-54 (Clementine tangerine x Orlando tangelo) x 15-3 seedling midseason sweet orange made by C. J. Hearn and P. C. Reece at Ft. Pierce, Florida.'Ambersweet' was selected in 1972 from 712 seedlings grown from the cross at the A. H. Whitmore Foundation Farm. Trees were grafted to 4 rootstocks in 1973, and the grafted trees were established in field tests in 1974 near Leesburg and Lake Wales, as selection 1-100-29, until 'Ambersweet' was released in 1989 by the Agricultural Research Service, U. S. Department of Agriculture.The parent tree of 'Ambersweet' was indexed for virus diseases in 1974, and was found positive for tristeza. Since the 15-year-old trees on sour orange rootstock appear healthy in 1989, it is likely that the tristeza virus is a mild strain.

Fruit of 'Ambersweet' are 3 to 4 inches in diameter, convex-shaped, and often tapered at the stem end. An occasional fruit may have a navel. The calyx usually remains on the fruit when the fruit is picked. The rind is 1/8 to 3/16 inches thick and can be removed with little difficulty, especially in November and December. The rind is relatively smooth with prominent oil glands and is yellow ocher (2) (orange) in color at maturity. The 10-12 segments are readily separable; the axis is solid, but becomes somewhat hollow when fully ripe. The flesh color is yellow ocher (2) and the fruit is juicy with little rag. The juice has excellent flavor and dark-orange color. The fruit is suitable for fresh and process markets. Fruit are seedless, or nearly so, when trees are grown in solid blocks, but may contain up to 15 monoembryonic seeds in mixed variety plantings. 'Ambersweet' trees are moderately vigorous and somewhat upright in shape with dense foliage. Young vigorous shoots may have short thorns. The trees are moderately cold hardy.

Fruit Production

'Ambersweet' trees grafted to 4 rootstocks with 5 replications were planted at Leesburg and Lake Wales in 1974.The trees at Leesburg were at 15' by 20' spacing, and yields were collected annually beginning in 1978 (Table 1), except 1980, when labor was unavailable. Fruit harvested in 1978 and 1979 were large and of poor quality, especially those from trees on rough lemon rootstock. Freezes occurred as noted in the table, and fruit yields were influenced in some seasons in spite of the use of heaters for cold protection. Fruit yields were statistically equivalent on the various rootstocks. Yields showed little yearly variation. Per acre yield equivalents can be calculated by multiplying the per tree yields by 145.

The trees at Lake Wales were planted at 18 x 25 ft spacing, and yields were collected beginning in 1979. Yields were not taken in 1980 and 1982 due to insufficient labor. No significant tree damage was observed following the various freezes. There was no significant difference in yields from trees on different rootstocks (Table 2). Yearly yields showed little fluctuation. Per acre equivalent yields can be calculated by multiplying the per tree yield by 97.

Fruit Maturity and Quality

When grown from seeds, some citrus trees produce juvenile growth for longer periods than others. The juvenility period of 'Ambersweet' trees was longer than average. Consequently, the trees were vigorous and had large, poor-quality fruit during some of the early crops.Total soluble solids (TSS) and total acids (TA) averaged about 10.5% and 0.65%, respectively, at maturity. Buds for distribution were cut from more mature trees and therefore, the vegetative growth period should be shorter and the quality of fruit from young trees should be superior to that of trees planted in 1974. Trees produced from the more mature buds should be less likely to produce thorns while young and vigorous.

The 1988 season represented an average year in terms of fruit maturity date and quality. Total soluble solids (TSS) and total acids (TA) at different stages of maturity are the most important components of fruit quality (Table 3). The TSS levels in fruit from trees on Cleo, sour orange, and Carrizo rootstocks were very similar, while those from trees on rough lemon tended to be lower in TSS. Data in other years (not shown) showed the same trends. The TSS levels peaked at more than 12% by the end of November in 1988 on rootstocks other than rough lemon. The TA levels were about 1% by 18 Oct. and declined as the fruit matured. The tendency for slightly higher TA in juice from fruit of trees on Carrizo in 1988 was not evident in other years. However, the tendency for lower TA from those on rough lemon was evident in other years. The lower TSS and TA levels with rough lemon rootstock have been reported by others for various citrus fruits (1). Based on the TSS, TA and the TSS:TA ratio, the fruit had attained the minimum requirements for the fresh fruit market in Florida by 18 Oct. (3). The minimum levels for canning were attained by early November. Minimum levels for FCOJ were attained by late November (3).

'Ambersweet' fruit from trees on Cleo and Sour orange rootstocks were processed 15 Dec. 1987 by S. M. Barros and R. D. Carter, Florida Department of Citrus, in a single extractor/finisher test. The data showed State Test Juice Yield at 5.17 lb-solids/90 lb box. Single strength (pasteurized) juice quality characteristics showed 12.06 Brix, 0.81% TA, 14.89 Brix/acid ratio, 4.3 ppm limonin (EIA method) and the color number was 37.4. Raw juice samples were collected on the following dates: 12 Dec. 1985, 13 Jan. 1986, 18 Nov. 1987, 23 Nov. 1987, 14 Dec. 1987, and 1 Dec. 1988, and the average color number was 38.2. Juice samples were extracted and measured for limonin content 12 Dec. 1985 by P. E. Shaw, USDA, ARS, using the HPLC method. Fruit from trees on Carrizo and Cleo rootstocks had 0.8 ppm, while those on sour orange rootstocks had 1.2 ppm limonin. He found 0.9 ppm in fruit of trees on Cleo 12 Dec. 1988. These limonin levels are about the same as those of frozen concentrated orange juice. Preliminary data collected in October 1989 showed that juice of imma-

Table 1. Average yields of 'Ambersweet' fruit per tree (1 3/5 bu boxes) when grown at the A. H. Whitmore Fouindation Farm near Leesburg. Trees were planted in 1974 and had cold protection using heaters during major freezes.[z].

Rootstock	Yield (boxes/tree) 1978	1979	1981[y]	1982[y]	1983	1984[y]	1985	1986[y]	1987	1988	Cumulative total
Cleopatra	0.1	0.9	2.0	2.2	3.0	2.2	4.3	4.7	8.6	6.5	34.5 a[x]
Sour orange	0.1	1.1	2.2	2.6	3.1	2.4	4.4	4.1	9.3	6.8	36.1 a
Carrizo	0.1	1.0	2.6	2.9	3.4	.8	4.7	5.5	9.1	6.8	36.9 a
Rough lemon	0.2	1.7	4.0	1.1	2.9	2.0	5.6	5.3	11.4	7.8	42.0 a

[z]Tree spacing was 15' x 20'.
[y]Freeze during winter prior to bloom.
[x]Separations by Duncan's multiple range test, 5% level, 5 replications.

Table 2. Average yields of 'Ambersweet' fruit per tree (1 3/5 bu boxes) when grown near Lake Wales. Trees were planted in 1974 and had no cold protection during freezes.[z]

Rootstock	1979	1981[y]	1983	1984[y]	1985	1986	1987[x]	1988	Cumulative total
Cleopatra	0.1	1.1	1.7	4.0	4.9	6.5	4.5	6.1	28.9 a[w]
Sour orange	0.1	0.8	1.4	3.5	4.8	6.7	4.1	4.7	26.1 a
Carrizo	0.2	0.8	1.1	3.6	5.3	7.0	5.4	6.5	29.9 a
Rough lemon	0.2	1.8	2.8	4.2	4.8	7.0	4.2	6.6	31.6 a

[z]Tree spacing was 18' x 25'.
[y]Freeze during winter prior to bloom
[x]Frost during bloom 1987.
[w]Separations by Duncan's multiple range test, 5% level, 5 replications.

Table 3. Seasonal changes in average total soluble solids and acids of 'Ambersweet' fruit during 1988 when grown on four rootstocks at the A. H. Whitmore Foundation Farm. Trees planted in 1974.[z]

	Total soluble solids (%)					Total acids (%)				
	Date					Date				
Rootstock	18/10	02/11	16/11	29/11	12/12	18/10	02/11	16/11	29/11	12/12
Cleopatra	10.7	11.3	11.4	12.3	12.1	1.04	.99	.95	.86	.83
Sour orange	10.7	11.5	11.8	12.2	12.8	.98	.90	.91	.84	.81
Carrizo	10.5	11.0	11.6	12.4	12.3	1.10	1.02	1.01	.95	.94
Rough lemon	9.9	10.8	10.3	11.0	11.5	.94	.92	.89	.80	.80

[z]20 fruit per sample and 5 replications for each rootstock.

ture 'Ambersweet' fruit may have higher than desirable levels of limonin and juice color numbers less than that from mature fruit.

Fruit Size

'Ambersweet' fruit from trees on Cleo and sour orange rootstocks had the same average fruit diameter of 3.4 inches, orange market size 64, 17 Dec. 1987. Commercial test shipments (114 field boxes) were sized 18 Dec. 1985 and 55% were market size 48-56, and 49% were size 64. In December 1986, test shipments (90 boxes) were sized and 27% were larger than market size 48, 26% were size 48, and 47% were size 64. On 14 Dec. 1987, 20 boxes of fruit were sized in two groups and 37% were 3 1/4 inch diameter or smaller and 63% were 3 1/4- to 4 1/4-inch diameter.

Fresh Fruit Handling Qualities

Test samples (3 reps of 80 fruit each) of fully colored 'Ambersweet' fruit were harvested 1 Dec. 1987 at the A. H. Whitmore Foundation Farm. They were washed, treated with benomyl and water-based wax, and one lot was stored at 34°F and the other lot at 40°F for 2 weeks. They were moved to 70° storage 14 Dec. 1987, and all fruit were in excellent condition. They were examined at weekly intervals beginning 21 Dec. 1987 through 4 Jan. 1988. Fruit stored initially at 34° showed practically no decay, and the condition was excellent at the end of the test. Although fruit stored initially at 40° showed more decay than those stored at 34°, the incidence of decay was low. Nearly all of the decay was caused by *Penicillium digitatum* Sacc. This suggests that 34°F is better for storage that 40°F.

'Ambersweet' fruit were harvested 24 Oct. 1988, and placed in a coloring room with ethylene gas for 57 hr. They were washed, treated with thiabendazol (TBZ) and water-based wax on 27 Oct. 1988, and stored at 34°F for 2 weeks. They were moved to 70° on 10 Nov. 1988, and examined on 17 and 25 Nov. 1988. Only 4 of 385 fruit showed stem-end rot by 23 Nov. 1988, 1 month after harvest. This indicates that the fruit store well, even after degreening for a long period.

The fruit was snapped at harvest and there was little evidence of rind injury (plugging).

Pollination Requirements and Seediness

In December 1987 samples of inside fruit (growing inside tree canopy) and outside fruit from open-pollinated flowers were collected and the seed content determined. The inside fruit contained an average of 6.1 seeds per fruit, while outside fruit had 10.7 per fruit. Trees of other varieties were blooming in adjacent rows.

In March 1988, several branches of 'Ambersweet' were screened during the entire bloom period. Another group of unscreened branches had flowers that were emasculated and not pollinated. A third group of unscreened branches had emasculated flowers that were hand self-pollinated. Fruit set was monitored until harvest in December 1988. The percentage of fruit set was the same for the 3 treatments, suggesting that cross-pollination by another variety is not necessary for fruit set.

In December 1988, fruit from open-pollinated 'Ambersweet' trees at another location were examined for seed content. 'Ambersweet' fruit on the side of a row growing beside a hybrid that produces no pollen had an average of 1.6 seeds per fruit and 44% were seedless. On the other side of the 'Ambersweet' row where a different hybrid was growing, the fruit had 4.0 seeds per fruit and 13% were seedless. This is additional evidence that 'Ambersweet' does not require cross-pollination for fruit set. In the ab-

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.

Literature Cited

1. Hearn, C. J.1987.The 'Fallglo' citrus hybrid in Florida. Proc. Fla. State Hort. Soc. 100:119-121.
2. Ridgeway, R. 1912. Color standards and nomenclature. The Author, Washington, D.C.
3. U.S. Department of Agriculture. 1983. United States standards for grades of orange juice. Effective January 1983.

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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.