Canter, L. W. 1996. Nitrates in groundwater. Lewis Publishers, Boca Raton, FL. 263 pp.
Gomori, G. 1942. Modification of the colorimetric phosphorus determination for use with the photoelectric colorimeter. J. of Lab. and Clinical Med. 27:955-960.
McNeal, B. L., C. D. Stanley, L. A. Espinoza and L. A. Schipper. 1994. Nitrogen management for vegetables and citrus: Some environmental considerations. Proc. Soil and Crop Sci. Soc. of Florida 53:45-50.
Rump, H. H. and H. Krist. 1988. Laboratory manual for the examination of water, waste water, and soil. VCH Verlagsgesellschaft G.M.B.H. Weinheim, Germany.
Soil Survey Staff. 1951. Soil Survey Manual. U.S. Dept. of Agriculture Handbook No. 18. U.S. Govt. Printing Office, Washington, D.C. 503 pp.
Walkley, A. and T. A. Black. 1934. An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic and titration method. Soil Sci. 37:29-38.
Westly, R. L. and K. A. Kuhl. 1995. Citrus nitrate B.M.P.s and groundwater. Citrus Industry 76(8):34-37, 76-77.
Wutscher, H. K. and C. Hardesty. 1979. Concentrations of 14 elements in tissues of blight-affected and healthy 'Valencia' orange trees. J. Amer. Soc. Hort. Sci. 104:9-11.
Wutscher, H. K. and T. G. McCollum. 1993. Rapid, objective measurement of soil color with a tristimulus colorimeter. Commun. Soil Sci. Plant Anal. 24:2165-2169.

Reprinted from
Proc. Fla. State Hort. Soc. 109:92-96. 1996.

LEAF MINERAL CONCENTRATION, GROWTH, YIELD, FRUIT QUALITY, AND ECONOMICS OF 'AMBERSWEET' ORANGE ON TWO ROOTSTOCKS

Mongi Zekri
Jack M. Berry, Inc.
P.O. Box 459
LaBelle, FL 33935

Additional index words. Citrus, juice color, nutrition, tree canopy volume.

Abstract. **Because of the many concerns about fruit quality and productivity of the 'Ambersweet' cultivar, a study has been conducted in Florida to evaluate the performance of this cultivar budded on two citrus rootstocks and grown in three locations (central Ridge, east coast, west coast). The effects of Cleopatra mandarin (CM) rootstock on leaf mineral concentration, tree growth, yield, fruit quality, and economics were compared to those of Swingle citrumelo (SC). Earlier fruit maturity and higher soluble solids and juice content were obtained from trees grown on the flatwoods (east and west coasts) compared with trees grown on the central Ridge. Rootstocks were found to influence tree canopy shape and affect juice color score. With the exception of magnesium, no consistent difference in leaf mineral concentration was found between the two rootstocks. No difference was found in tree canopy size but significant differences in yield, fruit size, and fruit quality were found between the two rootstocks. Fruit produced on CM were large with rough, thick peel and poor color. Swingle citrumelo rootstock promoted higher yield, earlier fruit maturity, and better fruit and juice quality than CM. In 1995, the ratio between SC and CM in terms of yield was 13 to 1, 19 to 1, and 3 to 1 for the west coast (LaBelle), the east coast (Fellsmere), and the central Ridge, respectively. This study also revealed the financial advantage of SC over CM as a rootstock for 'Ambersweet' orange.**

'Ambersweet' is the first recorded orange cultivar developed through hybridization. It is a hybrid of [*Citrus reticulata* Blanco × (*C. paradisi* Macf. × *C. reticulata*)] × midseason orange [*C. sinensis* (L.) Osb.] developed by the USDA breeding program in Florida. This cross makes 'Ambersweet' fruit 1/2 orange, 3/8 mandarin and 1/8 grapefruit (Hearn, 1989).

Limited data through the years of development of 'Ambersweet' orange cultivar revealed several attributes and good characteristics. The tree is moderately cold hardy. The fruit ripens quite early in the season and serves both the fresh and processing markets. The fruit has good peel color and texture and is easy to peel. The juice has excellent flavor and a dark-orange color (Hearn, 1989). Because 'Ambersweet' juice exceeds the minimum color standards, it can be mixed with other juices that do not meet the government color requirements (Barros et al., 1990). This could make the processing industry less dependent on imports and/or on 'Valencia' juice that has to be stored from the previous year to blend with poorer colored 'Hamlin' juice.

'Ambersweet' orange was released to growers in February, 1989. Because it has many desirable qualities and attributes, this most recent released citrus cultivar was rapidly propagated and extensively planted throughout the Florida citrus industry. The inventory at the end of 1992 was estimated at more than five million planted 'Ambersweet' trees (Hearn, 1992).

For the past several years, without taking into consideration tree age, Florida citrus growers, fresh fruit shippers and juice processors have had concerns about the quality of fruit and juice from 'Ambersweet' trees. There has even been a perception that fruit productivity has been low. In general, 'Ambersweet' has not performed as well as expected by some people in the Florida citrus industry and a few growers pulled out or topworked their 'Ambersweet' trees.

Several more years of observations are needed to make fair evaluations on the role and performance of 'Ambersweet' trees. Evaluation of 'Ambersweet' trees under different field conditions, cultural practices, and stresses are very important to help make wise decisions in managing 'Ambersweet' successfully. Since on-site evaluation has many potential benefits for the local grower, a study was initiated to assess the performance of 'Ambersweet' trees budded on two popular rootstocks and grown in three different major locations representing the Florida citrus growing region.

Materials and Methods

Three experiments were conducted in three distinct locations: west coast (LaBelle, Hendry county), east coast (Fellsmere, Indian River county), and the central Ridge (Polk county) in Florida to evaluate 'Ambersweet' trees on two popular rootstocks. These experiments compare the effects of Cleopatra mandarin (*Citrus reshni* Hort. ex Tan.) (CM) with those of Swingle citrumelo [(*C. paradisi* (L.) × *Poncirus trifoliata* (L.) Raf.] (SC) on leaf mineral concentration, tree growth, yield, fruit quality, and economics of 'Ambersweet' orange trees.

The trees were planted at a spacing of 10 × 20 ft at a tree density of about 218 trees/acre. The trees were planted in such a way that the 2 rootstocks were side by side in separate rows and/or side by side within the same row. The trees were managed according to typical commercial practices. The trees were irrigated as needed using a microsprinkler irrigation system with one jet per tree delivering 10 gal/hr. Fertilizer was applied at recommended rates for Florida citrus (Koo et al., 1984) and adjusted based on leaf analysis.

For all experiments, samplings and measurements were conducted during the first half of November. Trunk circumference (C) was measured annually and trunk cross-sectional area (TCSA) was calculated using the following formula:

$$TCSA = C^2/4\Pi.$$

Tree height (H) and width in 2 directions parallel (W1) and perpendicular (W2) to the tree row were measured and tree canopy volume (TCV) was calculated based on the assumption that the tree shape was one half prolate spheroid:

$$TCV = \Pi/6 \times H \times W1 \times W2.$$

Fruit on each tree were counted. Samples of forty to fifty fruit per plot from experimental and neighboring trees were collected for fruit quality measurements and evaluations. Fruit weight, juice weight, total soluble solids (TSS) and titratable acid concentrations, and juice color number were determined in the laboratory using standard procedures (Mansell, 1980). For each rootstock, average fruit weight, boxes per acre, soluble solids/acid ratio, pounds soluble solids and juice per box (90-lb-field box) and per acre, and yield efficiency were calculated. The following formulas were used:

$$\text{Juice (lb/box)} = \frac{\text{Juice weight (lb)} \times 90\text{ lb/box}}{\text{Fruit weight (lb)}}$$

$$\text{Solids (lb/box)} = \frac{\text{Juice (lb/box)} \times \text{Brix (\%)}}{100}$$

$$\text{Yield (boxes/acre)} = \frac{\text{Fruit/tree} \times \text{Fruit wt (oz)} \times 218\text{ trees/acre}}{16\text{ oz/lb} \times 90\text{ lb/box}}$$

$$\text{Yield (lb solids/acre)} = \text{Boxes/acre} \times \text{Solids (lb/box)}$$

$$\text{Yield efficiency (lb/yard}^3) = \frac{\text{Fruit/tree} \times \text{Fruit wt (oz)}}{16\text{ oz/lb} \times \text{TCV (yard}^3)}$$

Expenses per acre were analyzed using costs of production practices or grove care and pick and haul. Costs of pick and haul per box were estimated at $1.80 from 1993 through 1995. Costs involving land investment and grove establishment were not included in the analysis. Returns per acre were computed using yield data and average seasonal prices of soluble solids. Prices of soluble solids per pound were estimated at $0.65, $0.85, and $1.05 in 1993, 1994, and 1995, respectively.

Eighty 4 to 6 month-old leaves per plot from non-bearing shoots were sampled. Leaf samples were analyzed for nitrogen (N) by the Kjeldahl method and for the other nutrients by the inductively coupled argon plasma (ICAP) spectrophotometer. With the exception of the data related to economics, statistical analysis was conducted using the t-test.

Experiment 1:

The trees were planted in December, 1989 in Hendry county at LaBelle on flatwoods soil in a non-bedded grove but with a lateral ditch for every ten tree-rows. The soil is a Boca sand, poorly drained with a sandy surface, subsurface and subsoil layers to a depth of 2 to 3 feet. It is underlain by limestone and has a high water table. The organic matter content and natural fertility of this soil are low. The experiment was initiated in 1993 and consisted of 5 replications of 4-tree plots for each rootstock.

Experiment 2:

The trees were planted in June, 1992 in Indian River county at Fellsmere on flatwoods soil in a double-row bedded grove. The soil is a Wabasso fine sand, poorly drained with a sandy surface and subsurface layers to a depth of 2 feet. The subsoil extends to a depth of 4 feet with the upper 8 inches coated with colloidal organic matter. A drainage system was installed to maintain the water table below 4 feet. The organic matter content and natural fertility are low but chicken manure has been supplemented at an average rate of 4 tons/acre/year. The experiment was initiated in 1995 and consisted of 5 replications of 5-tree plots.

Experiment 3:

The trees were planted in February, 1991 on the central Ridge in Polk county on Astatula fine sand. The soil is deep, well-drained, very sandy with low fertility and water holding capacity. The experiment was initiated in 1995 and consisted of 4 replications of 4-tree plots.

Results and Discussion

Effects of rootstocks on leaf mineral concentration, growth, yield, fruit size, and quality of citrus scion cultivars have been reported (Castle and Phillips, 1980; Castle and Krezdorn, 1975; Castle et al., 1988; Fallahi and Rodney, 1992; Roose et al., 1989; Wutscher and Shull, 1976a, 1976b).

Leaf mineral concentration. Leaf mineral status differed only in Mg concentration between the 2 rootstocks. Leaf Mg concentration was significantly lower for SC than for CM (Tables 1 and 2). These results were consistent with data obtained by Wutscher and Shull (1976a, 1976b) showing lower leaf Mg concentration in 'Orlando' tangelo and 'Marrs' orange on SC compared with CM rootstock. In the fall, leaf Mg deficiency symptoms were visible on trees on SC in LaBelle and on the Ridge. Magnesium deficiency symptoms and low leaf Mg concentration of trees on SC might

Table 1. Leaf mineral concentration of 'Ambersweet' trees budded on Cleopatra mandarin (CM) and Swingle citrumelo (SC) and grown in LaBelle for 1993, 1994, and 1995.

	1993		1994		1995	
Element (%)	CM	SC	CM	SC	CM	SC
Nitrogen	2.87	2.86	2.67	2.63	2.65	2.70
Phosphorus	0.18	0.17	0.17	0.18	0.21	0.22
Potassium	2.55	2.49	2.78	2.61	2.71	2.50
Magnesium	0.31	0.28	0.25*	0.20	0.30*	0.25
Calcium	3.19	3.26	4.07	4.32	3.42	3.41

For each year, within rows, mean values for the 2 rootstocks are significantly different: *at the 5% level.

Table 2. Leaf mineral concentration of 'Ambersweet' trees budded on Cleopatra mandarin (CM) and Swingle citrumelo (SC) and grown in Fellsmere and on the Ridge for 1995.

	Fellsmere		Ridge	
Element (%)	CM	SC	CM	SC
Nitrogen	2.12	2.07	2.78	2.93
Phosphorus	0.21	0.20	0.16	0.17
Potassium	2.18	2.21	2.47	2.62
Magnesium	0.41**	0.25	0.30*	0.22
Calcium	3.88	3.24	3.99	3.47

For each location, within rows, mean values for the 2 rootstocks are significantly different: *at the 5% level, **at the 1% level.

have been aggravated by translocation of Mg from leaves to satisfy fruit requirements of a relatively heavy crop for trees on SC rootstock.

Leaf mineral concentration values were compared to Florida citrus leaf standards (Koo et al., 1984). Leaf N concentration was within the optimum range for the trees growing in LaBelle and on the Ridge. It was at the deficient level for Fellsmere due to the noticeably reduced amounts of N fertilizer applied in 1995. For all 3 locations, leaf P concentration was at the satisfactory to the high level. Leaf K concentration was at the excessive range. It seems that 'Ambersweet' trees accumulate high amounts of K in their leaves. Leaf Ca concentration was within the satisfactory range. Differences in nutritional status among citrus rootstocks have been well documented. These differences could be attributed to the differential ability of the rootstocks to absorb water and nutrients and to the physical differences among the root systems (Castle and Krezdorn, 1975; Zekri and Parsons, 1989). These differences can further affect tree growth, yield, and fruit quality of the scion cultivar.

Tree size and growth. Rootstocks were found to affect tree shape and growth habit. Trees on CM had a distinctive upright growth habit, while those on SC had a more open and drooping canopy. The more drooping appearance for trees on SC might have been influenced by the relatively heavy crop load. The weight of fruit might have caused the branches to bend downwards which had made the trees on SC to have a more open spreading canopy shape compared with those on CM.

In general, trunk cross sectional area (TCSA) and tree canopy volume (TCV) were higher for trees grown on CM than SC rootstock (Tables 3 and 4). Significant differences in TCSA between the 2 rootstocks were only detected on the Ridge. However, significant differences in TCV were not detected. Although the trees on the Ridge were about 1.5 years older than those in Fellsmere, they did not differ in canopy size. Reduced growth of young trees on the Ridge could be attributed to cooler winter temperatures, soil nutritional status and chemical properties, and grove management in terms of irrigation and fertilization. From one year to the next, canopy volume of trees growing in LaBelle more than doubled. Canopy volume of 'Orlando' tangelo trees on SC was higher than that of trees on CM (Wutscher and Shull, 1976a), while canopy sizes of 'Marrs' orange (Wutscher and Shull, 1976b) and 'Valencia' (Monteverde et al., 1988) on SC and CM were similar. All these results indicate the differences in canopy size between trees on SC and trees on CM which could be affected by the scion cultivar and soil conditions.

Fruit size. Fruit from trees on CM were generally larger and heavier than those from trees on SC (Tables 3 and 4). Visually, fruit from trees on CM also had thicker peel and coarser rind and were greener than fruit from trees on SC. However, fruit from sweet orange trees on CM are usually small in size and have smooth, thin peel (Davies and Albrigo, 1994). This conflict between results could be attributed to the young age of the trees and the significant reduction in fruit number per tree for CM. In general, fruit size is negatively correlated with fruit number per tree. The fewer the fruit on the tree, the larger and heavier are the fruit.

Fruit yield. Fruit production differences were highly significant between the 2 rootstocks. Trees on SC produced more fruit than those on CM rootstock. This was consistent in all 3 locations and consistent every year in LaBelle (Tables 3 and 4). In 1995, the ratio between SC and CM in terms of fruit/tree or pound solids/acre was 13 to 1, 19 to 1, and 3 to 1 for LaBelle, Fellsmere, and the Ridge, respectively. For LaBelle, the mean fruit yield increased with age. From 1993 to 1994, fruit production increased 5 fold for SC and less than 3 fold for CM. From 1994 to 1995, fruit production doubled for SC but did not increase significantly for CM. Since trees on both rootstocks had similar TCV but trees on SC yielded more than those on CM, yield efficiency (yield/canopy volume) was higher for SC.

Although trees on both rootstocks bloomed similarly well, those on CM had poor fruit set which resulted in significant yield reduction compared with trees on SC. For 'Ambersweet' orange, in terms of yield, SC has been found to be a much superior rootstock than CM. These results support earlier findings concluding the slowness-to-bearing of CM rootstock for orange cultivars (Castle et al., 1993). Three to ten-year old 'Orlando' tangelo and 'Marrs' orange trees on SC were also found to be more productive than trees on CM (Wutscher and Shull, 1976a, 1976b). In the present study, 'Ambersweet' trees on CM rootstock grew well but

Table 3. Trunk cross sectional area (TCSA), tree canopy volume (TCV), fruit weight, yield, and yield efficiency (YE) of 'Ambersweet' trees budded on Cleopatra mandarin (CM) and Swingle citrumelo (SC) and grown in LaBelle for 1993, 1994, and 1995.

	1993		1994		1995	
Measurement	CM	SC	CM	SC	CM	SC
TCSA ($inch^2$)	4.83	4.23	8.55	7.88	13.29	10.15
TCV ($yard^3$)	4.28	4.08	9.95	9.13	21.18	18.53
Fruit wt (oz)	12.45	11.86	13.37**	10.72	13.83*	11.32
Fruit/tree	2.57	13.19**	7.39	61.43**	9.35	124.88**
Boxes/acre	4.84	23.68**	14.96	99.69**	19.58	214.01**
Lb solids/acre	16.17	96.85**	59.99	510.41**	75.77	1012.27**
YE ($lb/yard^3$)	0.47	2.40**	0.62	4.51**	0.38	4.77**

For each year, within rows, mean values for the 2 rootstocks are significantly different: *at the 5% level, **at the 1% level.

fruited relatively poorly during these first few years. However, in another study, Hearn (1989) did not find any significant difference in 10-year cumulative yield of 'Ambersweet' trees on 4 rootstocks including CM. It has been known that 'Hamlin' and 'Pineapple' are productive cultivars and bear well on CM, while 'Valencia', a naturally lower-yielding cultivar than either 'Hamlin' or 'Pineapple' is a "lazy" bearer on CM compared with most other rootstocks (Castle et al., 1993).

Table 4. Trunk cross sectional area (TCSA), tree canopy volume (TCV), fruit weight, yield, and yield efficiency (YE) of 'Ambersweet' trees budded on Cleopatra mandarin (CM) and Swingle citrumelo (SC) and grown in Fellsmere and on the Ridge for 1995.

	Fellsmere		Ridge	
Measurement	CM	SC	CM	SC
TCSA (inch^2)	7.61	6.35	8.62*	6.24
TCV (yard^3)	10.05	9.72	11.17	8.81
Fruit wt (oz)	12.07	11.75	13.57*	12.41
Fruit/tree	1.28	24.16**	26.81	81.25**
Boxes/acre	2.34	42.98**	55.08	152.65**
Lb solids/acre	9.48	187.39**	197.74	592.28**
YE (lb/yard^3)	0.10	1.83**	2.04	7.15**

For each location, within rows, mean values for the 2 rootstocks are significantly different: *at the 5% level, **at the 1% level.

Although the trees growing on the Ridge and in Fellsmere have similar canopy size, the trees in Fellsmere yielded significantly less fruit. This could be due to the younger age of the trees in Fellsmere as well as to differences in grove management. Trees in Fellsmere look more vigorous and have denser canopies. They have been pushed to grow more vegetatively with a heavy fertilizer program since they were planted through the fall of 1994. On the Ridge, leaf N concentration has been at the low to optimum range, while that in Fellsmere, with the exception of 1995, was generally kept at the high to excessive range (data not shown).

It is well known that excessive vigor can reduce flowering and that excessive fertilizer and water can delay fruiting of young trees. Excessive levels of leaf N in particular for young trees can induce excess vigor and promote a vegetative rather than a flowering tree. In Fellsmere, since the winter of 1995, fertilizer amounts were drastically reduced to promote fruit production. This caused leaf N concentration to drop to a deficient level by the end of the year.

Fruit quality. In all 3 locations, internal qualities of fruit from trees on SC were superior to those from trees on CM. Percent brix, pound solids and juice per box were all significantly higher for SC than CM (Tables 5 and 6). Differences between the 2 rootstocks in internal fruit qualities were expected because of differences in fruit size and fruit number per tree. In general, the larger the fruit and thicker the peel, the lower the juice content and soluble solids are in the juice. In another study, the brix levels in fruit from 14-year old 'Ambersweet' trees on CM, sour orange, and Carrizo citrange were very similar but higher than those from trees on rough lemon rootstock (Hearn, 1989).

Only in LaBelle, the percent acid and brix/acid ratio were significantly different between the 2 rootstocks (Table 5). Higher brix (total soluble solids) but lower titratable acid concentrations in the juice significantly increased the brix/acid ratio for SC compared with CM (Table 5). In Florida, brix and brix/acid ratio are the main factors judging fruit maturity. The higher the brix and the brix/acid ratio, the earlier is the fruit maturity. According to this, SC promoted earlier maturity of 'Ambersweet' orange than did CM rootstock. This is a very important advantage of SC over CM particularly for the fresh fruit market. The earlier the fruit reaches the market, the higher is the return.

The fruit from trees growing on the flatwoods (LaBelle and Fellsmere) had lower percent acid but higher brix to acid ratio, soluble solids and juice content than fruit obtained from the Ridge. These differences might be partly attributed to differences in climatic and soil conditions. The warmer, more tropical climate of the flatwoods areas might have accelerated fruit growth and maturity. Juice content and soluble solids all accumulate faster, while acidity declines much more rapidly in a warm tropical climate compared with a cooler night climate (Reuther and Rios-Castano, 1969).

The juice color was also different between the 2 rootstocks in the LaBelle location only (Table 5). Juice color number or score was higher for SC compared with that for CM. This study showed that juice color of the fruit from the scion cultivar can be affected by the rootstock. In early to mid-November, the juice color number ranged from 33.91 to 35.73. A score of 36 to 40 is necessary for Grade A orange juice, and 32 to 35 is needed for Grade B juice (Stewart, 1980). The juice from these 'Ambersweet' trees has not met yet the minimum color score of 36 needed to make Grade A orange juice.

In another study, juice color numbers of fruit from 15-year old 'Ambersweet' trees ranged from 35.3 to 36.3 in mid-October to mid-November, while they ranged from 36.5 to 38.0 in early to mid-December (Barros et al., 1990). These workers concluded that juice color improved as the season progressed and 'Ambersweet' orange was desirable to the processor for blending to improve the color of other orange cultivars. Differences in juice color number results between the present study and that of Barros et al. (1990) could be attributed to differences in tree age and sampling dates.

Table 5. Fruit quality of 'Ambersweet' trees budded on Cleopatra mandarin (CM) and Swingle citrumelo (SC) and grown in LaBelle for 1993, 1994, and 1995.

	1993		1994		1995	
Variable	CM	SC	CM	SC	CM	SC
Brix (%)	7.60	8.75*	8.45	9.85*	8.33	9.37*
Acid (%)	0.57*	0.54	0.54*	0.49	0.56*	0.51
Ratio	13.33	16.20*	15.65	20.10*	14.88	18.37*
Solids (lb/box)	3.34	4.09*	4.01	5.12*	3.87	4.73*
Juice (lb/box)	43.90	46.70*	47.41	51.93*	46.45	50.49*
Color number	—	—	33.91	35.12*	34.36	35.73*

For each year, within rows, mean values for the 2 rootstocks are significantly different: *at the 5% level.

Table 6. Fruit quality of 'Ambersweet' trees budded on Cleopatra mandarin (CM) and Swingle citrumelo (SC) and grown in Fellsmere and on the Ridge for 1995.

	Fellsmere		Ridge	
Variable	CM	SC	CM	SC
Brix (%)	8.02	8.37*	7.95	8.42*
Acid (%)	0.58	0.60	0.71	0.73
Ratio	13.83	13.95	11.20	11.53
Solids (lb/box)	4.05	4.36*	3.59	3.88*
Juice (lb/box)	50.51	52.04*	45.10	46.08*
Color number	35.27	35.60	34.18	34.47

For each location, within rows, mean values for the 2 rootstocks are significantly different: *at the 5% level.

Economics. The financial analysis showed a negative balance for both rootstocks at all 3 locations (Tables 7 and 8). In LaBelle, at 6 years of age, 'Ambersweet' trees on SC were about to a break-even point, while on CM they were still losing over $600/acre. The 3 year old trees in Fellsmere showed a difference of $114/acre between SC and CM and were losing $580 to almost $700/acre. On the Ridge, the 4.5 year old trees on SC showed a $239/acre advantage over those on CM. These results revealed the financial advantage of SC over CM as a rootstock for 'Ambersweet' orange. The early yield and return of SC compared with CM are of good benefit for citrus growers.

In conclusion, preliminary results indicated that 'Ambersweet' orange trees had performed much better on SC than on CM. Trees on SC were more precocious and more productive than those on CM. Based on this study, CM is not a good choice as a rootstock for 'Ambersweet' orange due to its poor yield, fruit quality, and juice. This study is still in progress to find out for how long this trend will continue. The early yield and return of SC still remain an important advantage over CM although fruit production and quality for CM could improve as the trees get older.

Table 8. Financial analysis of 'Ambersweet' trees budded on Cleopatra mandarin (CM) and Swingle citrumelo (SC) and grown in Fellsmere and on the Ridge for 1995.

Variable	Fellsmere		Ridge	
($/acre)	CM	SC	CM	SC
Production costs	700		650	
Pick & haul	4.21	77.36	99.14	274.77
Total expenses	704.21	777.36	749.14	924.77
Revenue	9.95	196.76	207.63	621.89
Balance (-)	694.26	580.60	541.51	302.88

Pick & haul costs are based on $1.80/box.
Revenue is based on $1.05/lb solids of early oranges for 1995.

Literature Cited

Barros, S. M., R. D. Carter and C. J. Hearn. 1990. 'Ambersweet orange'-Processed juice quality characteristics. Proc. Fla. State Hort. Soc. 103:269-272.

Castle, W. S. and A. H. Krezdorn. 1975. Effects of citrus rootstocks on root distribution and leaf mineral content of 'Orlando' tangelo trees. J. Amer. Soc. Hort. Sci. 100(1):1-4.

Castle, W. S. and R. L. Phillips. 1980. Performance of 'Marsh' grapefruit and 'Valencia' orange trees on eighteen rootstocks in a closely spaced planting. J. Amer. Soc. Hort. Sci. 105(4):496-499.

Castle, W. S., H. K. Wutscher, C. O. Youtsey and R. R. Pelosi. 1988. Citrumelos as rootstocks for Florida citrus. Proc. Fla. State Hort. Soc. 101:28-33.

Castle, W. S., D. P. H. Tucker, A. H. Krezdorn and C. O. Youtsey. 1993. Rootstocks for Florida citrus. Univ. Florida, IFAS, SP 42.

Davies, F. S. and L. G. Albrigo. 1994. Citrus. Redwood Books, Trowbridge, Wiltshire, Great Britain.

Fallahi, E. and D. R. Rodney. 1992. Tree size, yield, fruit quality, and leaf mineral nutrient concentration of 'Fairchild' mandarin on six rootstocks. J. Amer. Soc. Hort. Sci. 117(1):28-31.

Hearn, C. J. 1989. Yield and fruit quality of 'Ambersweet' orange hybrid on different rootstocks. Proc. Fla. State Hort. Soc. 102:75-78.

Hearn, C. J. 1992. Current inventory and the role of new citrus scion cultivars in Florida in 1992. Proc. Fla. State Hort. Soc. 105:50-52.

Koo, R. C. J., C. A. Anderson, I. Stewart, D. P. H. Tucker, D. V. Calvert and H. K. Wutscher. 1984. Recommended fertilizer and nutritional sprays for citrus. Univ. Florida Agr. Expt. Sta. Bul. 536D.

Mansell, R. L. 1980. Immunological tests for the evaluation of citrus quality. In S. Nagy and J. A. Attaway, Citrus Nutrition and Quality, p. 341-359, American Chemical Society, Washington, D.C.

Monteverde, E. E., F. J. Reyes, G. Laborem and J. R. Ruiz. 1988. Citrus rootstocks in Venezuela: Behavior of Valencia orange on ten rootstocks. Proc. Sixth Inter. Citrus Congress. pp:47-55.

Reuther, W. and D. Rios-Castano. 1969. Comparison of growth, maturation and composition of citrus fruits in subtropical California and tropical Colombia. Proc. First Inter. Citrus Symp. 1:277-300.

Roose, M. L., D. A. Cole, D. Atkin and R. S. Kupper. 1989. Yield and tree size of four citrus cultivars on 21 rootstocks in California. J. Amer. Soc. Hort. Sci. 114(4):678-684.

Stewart, I. 1980. Color as related to quality in citrus, p. 129-149. In: S. Nagy and J. A. Attaway (eds.). Citrus nutrition and quality. ACS Symposium Series 143. Amer. Chem. Soc., Washington, D.C.

Wutscher, H. K. and A. V. Shull. 1976a. Performance of 'Orlando' tangelo on 16 rootstocks. J. Amer. Soc. Hort. Sci. 101(1):88-91.

Wutscher, H. K. and A. V. Shull. 1976b. Performance of 'Marrs' early orange on eleven rootstocks in south Texas. J. Amer. Soc. Hort. Sci. 101(2):158-161.

Zekri, M. and L. R. Parsons. 1989. Growth and root hydraulic conductivity of several citrus rootstocks under salt and polyethylene glycol stresses. Physiol. Plant. 77:99-106.

Table 7. Financial analysis of 'Ambersweet' trees budded on Cleopatra mandarin (CM) and Swingle citrumelo (SC) and grown in LaBelle for 1993, 1994, and 1995.

Variable	1993		1994		1995	
($/acre)	CM	SC	CM	SC	CM	SC
Production costs	650		650		700	
Pick & haul	8.71	42.62	26.93	179.44	35.24	385.22
Total expenses	658.71	692.62	676.93	829.44	735.24	1085.22
Revenue	10.51	62.95	50.99	433.85	79.56	1062.88
Balance (-)	648.20	629.67	625.94	395.59	655.68	22.34

Pick & haul costs are based on $1.80/box.
Revenue is based on $0.65, $0.85, and $1.05/lb solids of early oranges for 1993, 1994, and 1995, respectively.