tial if we could produce it here in adequate quantities. It has problems, however, related to pollination, soil-borne diseases, and nematodes. Research attention can and will make a positive difference with this crop.

It may be hard to determine what element of the blueprint will be realized next, but watching and taking part in the effort promises to continue to be exciting and rewarding. The Spaniards have an old proverb, a refrán, that goes like this: "Después de España cielo, y entonces un agujercito para verlo" which can be loosely translated, "After Spain Heaven, and even then a little hole through which we can see Spain." Looking at Spain is not a vital concern of mine, but I can understand those for whom it is. Thus, I can say this about Florida, and horticulture in Florida, in all sincerity: there is no place in all the world I would rather be, right now, waiting to see what is going to happen next, than here! This is an exciting place to be, and it's an exciting time to be alive and working. If you have any dull, tiresome facts to the contrary, please don't confuse me with them.

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Proc. Fla. State Hort. Soc. 100:268-272. 1987.

COMMERCIAL FRUIT PRODUCTION IN DADE COUNTY 1900-1987

WM. H. KROME
P. O. Box 596
Homestead, FL 33090

SEYMOUR GOLDWEBER
Agricultural Extension Agent, Retired
P. O. Box 570156
Miami, FL 33157

Abstract. **Commercial production of citrus and tropical fruits in Dade County commenced in the Miami area in the early 1900's, moving to the southern part of the county as the northern part became urbanized. This process, with accompanying changes in crops and methods, is recounted. The chief horticultural problems, especislly those peculiar to the area, with the solutions that have been found, are described.**

In 1848 the U.S. government sent William Jackson, a surveyor, to run a survey line in what is now south Dade County. Jackson's notes and report are filed in Tallahassee. My father obtained a copy of them before he made a similar survey to Cape Sable in 1903. Jackson wrote, "This area consists of low, rocky pineland transected by narrow marshy glades which are frequently under water. It is sometimes called 'the Indian Hunting Grounds' because the Indians would go there to hunt deer." He continued, "Because of its rocky nature the land would be difficult to farm and the great storms which sweep across the tip of the peninsula in the fall would make it impractical to grow tree crops"

There have been times in the past when I felt that Jackson was right, but when I consider what has been accomplished in South Dade since it was settled in the early part of this century I wish William Jackson could see it now.

Although vegetables, especially tomatoes, were the first crops produced commercially, the settlers in the 1890's and early 1900's were well acquainted with a variety of tropical and subtropical fruits. They were common as yard trees, and in the first decade of the twentieth century commercial orange and grapefruit plantings were made in the Miami area. In 1901 George Cellon established a nursery and avocado grove in what is now the heart of Miami. Cellon was the first to propagate avocados by budding, and he was also the originator of the Lula cultivar, possibly the first hybrid between two different races of avocado in Florida. The first large avocado grove was planted by John S. Collins on, of all places, Miami Beach.

The great back-to-back freezes of December, 1894 and February, 1895 decimated trees and crops of north Florida. These two disasters soon resulted in the establishment of commercial citrus plantings of some size in Dade County, which had escaped the worst of those two freezes. Prior to those events citrus and other fruits were planted in scattered small groves all over eastern Dade County.

New plantings from that period on through the 1920's became established on Miami Beach in the vicinity of 41st Street and Pine Tree Drive, in northeast and northwest Dade near settlements and near downtown Miami (the

Orange Bowl Stadium stands on the site of an early orange grove).

In the 1920's the City of Coral Gables planted a grapefruit tree in the backyard of every new home. Dade County became famous for its grapefruit and many gift box shippers of grapefruit, round oranges, king oranges and tangerines could be found from downtown Miami to outlying sections of the county.

One grove, packing house and gift box shipper, Floyd's Fruit Farm, was located on LeJeune Road between the Tamiami Trail and West Flagler Street. It was a well known and interesting stop for tourists and all tour busses. Visitors drank fresh squeezed fruit juice, bought "tree rippened" citrus, and had gift boxes of citrus shipped home. They also walked designated paths in the grove and took pictures of each other in front of bearing trees. However, unauthorized fruit picking became a problem so warning signs, "Beware of Rattlesnakes", were placed alongside the designated walks. Those signs effectively discouraged all but the sneakiest from picking fruit.

I should mention that this Society has been interested in the commercial development of tropical fruits from the first. The index to the Proceedings which included the meetings of 1892 through 1924, devotes nearly two columns to references to avocados, starting in 1902. There are 43 references to mangos and several to carambolas, lychees, mameys and anonas, as well as to numerous fruits which have not succeeded commercially. The names of the contributors of these articles are a veritable hall of fame of tropical horticulture in Florida—David Fairchild, Wilson Popenoe, Egbert Reasoner and his son Norman, Edward Simmonds, C. I. Brooks, Harold and Mabel Dorn, George Ruehle, my father, Wm. J. Krome, S. J. Lynch, T. W. Young, to say nothing of the contributions of present day members of this Society.

In some instances these men operated as individuals, in others they worked with or through agencies such as the Agricultural Extension Service, the local branch of the State Experiment Station or the U.S.D.A. Plant Introduction Station. In fact, it is my impression that David Fairchild was responsible for the establishment of the Plant Introduction Station. It was established in 1898 at Buena Vista, a short distance north of Miami, then moved to Brickell Avenue and finally in 1923, to its present location at Chapman Field, which had been a military aviation training field in World War I. The Agricultural Extension Service was established in 1914 with an office in Miami. It was later moved to Homestead, and now has four offices in Dade County serving both commercial agriculture and numerous urban horticultural interests. The local branch of the State Experiment Station was originally called the Subtropical Experiment Station. It is now the Tropical Research and Education Center, T.R.E.C. It was started about 1930, with Leonard Toy, who had worked for my father, as its Acting Director. Among the notables who were Directors subsequently were Herbert Wolfe and Willard Fifield, who may be attending this meeting.

But to get back to my subject: The pineland south of Miami was settled, albeit sparsely, before 1900. While those settlers were chiefly interested in raising winter vegetables on the marl prairies, some groves, mostly grapefruit, were planted on the higher portions of the pineland. The building of the Florida East Coast Railroad through the area in 1903 gave impetus to both vegetable and tree crop farming, as transportation by rail was much easier and faster than hauling the produce to Cutler, on Biscayne Bay, and transporting it to market by boat.

A few groves of avocados and mangos were planted in the early 1900's. My father started planting grapefruit in 1906 and he put in a small block of avocados in 1908 which has survived the freezes and hurricanes of the past 80 years and is in good condition today. This cannot be said of most of the grapefruit groves. The destruction of grove trees in order to eradicate citrus canker, from 1914 to 1918, dealt Dade County grapefruit a severe blow. Then in the '20's many groves were taken out for subdivisions. Many of the subdivisions and the groves which escaped them were casualties of the collapse of the real estate boom in 1926 and the hurricane of September in that year. So South Dade agriculture had a head start on the rest of the country in the depression of the 1930's. But during that time of hardships we learned quite a bit about improving our methods. Let me discuss briefly a number of the most important problems that the early grove operators had to deal with.

The first, of course, was what to plant. As I have indicated, the first groves were of citrus, and grapefruit seemed particularly suited to Dade County. The trees grew and produced as well as in the best locations farther north in the state. It turned out, however, that grapefruit was especially vulnerable to destruction by hurricanes—the better the tree the farther the wind rolled it from its base—and when hurricanes, citrus canker and real estate developments combined to make grapefruit production here unprofitable, the next commercial groves were mostly avocados and limes.

Important things were happening with avocados. About 1918, Will Booth, a Homestead grower, planted 10 acres of avocado seedlings and many of them turned out to be hybrids between the West Indian and Guatemalan races. The trees had hybrid vigor and were prolific bearers. The fruit had characteristics of both parents and matured in fall and winter instead of in summer as the West Indians do. Several were good enough to justify commercial planting, and were given numbers, Booth 1, Booth 2 and so on. Although many other hybrids have been found since then the Booth cultivars still furnish about 20% of the Florida crop today.

The worst problems with avocados were competition from Cuban avocados and flooding followed by phytothphora root rot. The breaking of commercial relations with Cuba in 1960 effectively ended Cuban competition and the construction of a system of drainage canals throughout the area was most helpful in reducing damage from flooding.

Persian or Tahiti limes were not planted much until the late '40's. We had to develop a foothold in the market for acid citrus that had been held by smaller, seedy Mexican or Key limes, and we had some serious disease problems. The worst disease, blotch, proved to be a genetic disorder which was eliminated by budwood selection. Psorosis, exocortis and tristeza, all virus diseases, were reduced by the same budwood selection practices that were developed for oranges and grapefruit farther up the state. With production problems under control we have capitalized on the seedless character of this excellent acid fruit to the extent

that it has replaced the seedy Mexican lime almost completely in the U.S. markets.

David Fairchild, addressing this Society in 1931, predicted that the mango would some day be of commercial importance, due to the development of cultivars in Florida. At that time there was no important commercial production here but the Haden cultivar gave an indication of what might be expected from chance hybridization among the diverse strains that had been brought here from the Orient. Sure enough, a profusion of such hybrids soon appeared from which several cultivars have been selected that are used here and in many other mango growing regions throughout the tropics. These cultivars, plus improvements in cultural practices developed locally, have changed mango production from a hobby to a business rivaling that of avocados and limes.

There has been an appreciable production of papayas in Dade County at least since the 1920's. Because of the problems caused by distortion ring spot virus and the papaya fruit fly, papaya growing has been a struggle and most of the large U. S. market has been supplied by Hawaii, puerto Rico and the Bahamas. A procedure that seems to effectively control the fruit fly has been developed by a local grower, and we foresee the possibility that sophisticated genetic manipulation techniques may give us papaya strains that are more tolerant of the ring spot virus. So we have a prospect of increasing our papaya production in the future.

We continue to search for other exotic fruits with commercial possibilities. The Plant Introduction Station at Chapman Field, the Rare Fruit Council and T.R.E.C. all join in this fascinating pursuit. At the moment the carambola, the mamey sapote and the lychee seem to be the most promising but small acreages of a number of other so-called "minor fruits" are also being planted. The total acreage of these crops in Dade County probably approaches 700. It will be several years before we can tell which, if any, of these can satisfy the exacting requirements for commercial production.

The first groves were planted between the stumps after the pine trees had been cut for timber. Some of the larger stumps remained in the groves for 10 or 15 years. The rock close to the tree was broken up with a pickaxe or grub hoe to afford a better medium for the roots. I acquired such a grove and hired a big tractor and drag to smooth down the rocky pinnacles. I recall vividly how that drag would skin off the top rock and soil, leaving the rock below smooth and white. Each time the drag passed a tree it would reveal the side of a large black circle in the otherwise white surface, where the rock around the tree had been laboriously broken up with a pick. Al Lindgren and Anton Waldin had big steam tractors which pulled heavy drags, with or without teeth, to smooth the land. In the 1930's Lindgren constructed a big hammer mill on a steel sled which pulverized the top few inches of rock as it was drawn by a large tractor. This represented a great improvement in land preparation but it was almost immediately made obsolete by an invention of two other land clearers, Charles Cox and Shep Holland. That was the rock plow, a device which fit on a frame in front of a heavy bulldozer and sheared off one to two inches of the rock in a sheet 36 to 42 inches wide. Any chunks of rock which were torn out in the process were pushed directly under the tracks of the bulldozer where they were crushed. By plowing the field four to six times in this fashion a six inch bed of crushed rock mixed with what topsoil was there originally was produced. A modification of the rock plow was used to make trenches 12 to 18 inches deep and about as wide. The trees were planted in these trenches. Frequently two sets of trenches at right angles to each other would be made, and the trees would be planted where the trenches intersected. This gave them much better anchorage against hurricane winds and also let the roots go down where the moist rock supplied them with water when the surface soil was dry. This revolutionary development was documented in an article by Colburn and Goldweber in the 1961 Proceedings. There has been no change in that method of land preparation since then.

The limited amount of high ground in Dade County available for groves varies in elevation from five to twenty feet above sea level. The water table in this land was usually close enough to the surface to supply trees with moisture by capillarity during periods of drought. But much of the land was subject to flooding during the rainy season, making it unsuitable for tree crops. Some drainage canals were dug during the second and third decades of the century but they were primarily to drain the marl prairies for vegetable farming; their effect on flooding of the higher pineland was not great. In the 1950's, after two serious floods that affected parts of the residential areas around Miami as well as South Dade, the federal government was persuaded to construct a comprehensive system of canals designed to prevent future floods. They have been reasonably successful in this, and at the same time a considerable amount of land that was previously too low has been made available for tree crops. However, in achieving these objectives the entire water table was lowered three or four feet so that plants can no longer get moisture from the ground by capillarity during the dry season. Now it is necessary to provide all crops on the pineland, be they fruit trees or vegetables, with irrigation. Fortunately, the soft, porus nature of the rock makes an abundant supply of water easily available. A 10-inch well 30 feet deep will usually supply all the water that is desired.

With easily obtainable water, the growers have utilized several different methods of irrigation, to wit: large portable units using a single large nozzle at very high pressure that can irrigate as much as two acres from a single position; smaller pumping units that supply portable pipes with many smaller sprinklers; permanent systems with underground pipes supplying either over-tree or under-tree sprinklers; and drip systems which use relatively small pumps. The "big rigs" and portable pipe systems are most commonly used in vegetable fields, while the permanent and the drip systems are used for tree crops.

With the exception of the drip system all these methods of irrigation are useful in frost protection. Because of the abundance of relatively warm water (about 68°F.) we are able to prevent serious damage to fruit trees from temperatures down to the low 20's in radiation freezes. Of course, if the cold is accompanied by wind the effectiveness of irrigation is limited. Such conditions are not as common as radiation freezes in South Florida. All in all, cold protection by irrigation is a big improvement over the old methods that attempted to protect by burning wood, fuel oil or old tires.

The "great storms in the fall" that William Jackson mentioned have continued to plague us. One in 1906 severely damaged what few groves there were, and major hurricanes in 1926, 1929, 1945, 1960, and 1965 devastated them. Many lesser hurricanes have done their share of damage also. The practice of rock plowing and trenching has given the trees much better anchorage, greatly decreasing the liklihood of their overturning. Another relatively new procedure, developed primarily for another purpose, has reduced the wind resistance of the trees, with consequent reduction in damage. That is the practice of hedging and topping grove trees. This has been made necessary because many groves were planted too close, and trees in all groves now tend to grow larger because of improved cultural methods. So most groves are hedged to keep the rows open and to prevent the formation of a canopy top. They are topped to make spraying and harvesting easier. The result is a smaller tree with better anchorage and less damage by storms. I will admit that the fact that we have not had a major hurricane in the past 20 years has probably been even more instrumental in minimizing the damage.

I remember Wilson Popenoe laughing at Florida citrus soils, "98% silica and the rest is sand", Well, the soils, so called, of South Dade aren't much better. I have already described the preparation of our limestone. The only plant nutrient that it supplies sufficiently is calcium. As with the groves in the Ridge, most of the important nutrients for our trees come out of a bag. Our problems with fertilizers closely parallel those of the citrus industry on the deep sands farther upstate. In the early days the usual fertilizer derived its nitrogen primarily from organic sources, had a high phosphate content, and used sulfate of potash as the principal source of potash. As time passed we had to go to inorganic sources of nitrogen and we learned that large applications of phosphate are only beneficial on new land. Muriate of potash is frequently used in place of sulfate, as it is cheaper. We still lack good information about some aspects of our N-P-K fertilizer programs, especially for mangos.

Even in the early days we had problems with deficiency of zinc, manganese, magnesium and iron, although we weren't sure exactly what was causing the trouble. I remember my father trying all kinds of soil amendments and tree injections in an effort to cure "frenching", as we called zinc and manganese deficiency. As the foliar symptoms and effective remedial measures for each deficiency were learned for citrus and other crops, the information was adapted to our limes, avocados and mangos, with the same dramatic results that were obtained elsewhere. Now one seldom sees foliar symptoms of zinc or manganese deficiency in a well kept grove. Magnesium deficiency is fairly common, particularly in lime trees on their own root. It can be controlled with foliar applications of magnesium nitrate, however, and magnesium deficiency is not now regarded as a serious problem. Possibly our most difficult deficiency to cure is that of iron. It is easy enough to recognize the foliar symptoms of iron deficiency but the chelated iron which will cure it on our limestone soils costs more per pound than beefsteak and growers usually wait until there is quite a bit of yellowing before applying the expensive material.

Most fruit crops are subject to a wide variety of pests and diseases, and those in Dade County have their share, sometimes in spectacular fashion. The first really critical disease was citrus canker, in 1914. We suffered with the rest of the Florida citrus industry. The destruction of trees necessary to eradicate canker was especially *hard on us* because most of our citrus was grapefruit, the most susceptible host. At one time Dade County was sixth among Florida counties in grapefruit production; it never regained that position after the canker episode. But, as you know, the disease was eradicated, the first time in history for a bacterial plant disase.

Then in 1927 we suffered, along with the rest of the state, from the first infestation of Mediterranean fruit fly. Again, without the means of combating this pest that we have today, we had to use draconian measures, destroying wild host plants and the crops on our host fruit trees. To everybody's surprise the measures worked and the pest was eradicated, a first for insect control. The fact that both citrus canker and medfly have recurred in Florida does not diminish those original achievments; it only emphasizes the importance of the port inspection and plant quarantine services that are our protection from these and many other pests and diseases that exist in foreign countries.

I should like to point out that just as our fruits originated in foreign lands, so do their pests and diseases come from abroad. The plant inspection service and quarantine regulations are frequently criticized by consumer advocates as restricting unduly the supply of fruit and causing inconvenience to travelers who bring in fruit and plants from abroad. These groups do not realize that the very existance of our domestic fruit industry depends on this protection.

The fight against the medfly is a continuing one. In spite of many interceptions by inspectors at ports of entry some flies occasionally get by and survive to create local infestations. Our system of trapping enables such infestations to be discovered before the pest becomes widespread, and the procedures which are then put into effect—quarantine of infested areas, bait spraying and the release of sterile males—have enabled the infestations to be wiped out rather quickly. We can look forward to continuing the fight in this fashion ad infinitum.

We have not had this success with the Caribbean fruit fly. It is not as serious a pest to commercial fruit production as is medfly, and no effort to eradicate it was made, so it became established beyond the possibility of eradication, and is a major pest of a large number of minor tropical fruit. Partial control can be achieved by release of a small wasp which parasitizes the larvae, but it remains an important obstacle to commercial production of many tropical fruits in Dade County.

Developing a new fruit industry requires handling and marketing equipment and skills. There was ample precedent for handling the citrus in the early days, and the succeeding crops, avocados, limes and mangos, followed the practices developed for citrus with such modifications as experience dictated. In the case of avocados we have found that due to the short shelf life of the fruit it is necessary to get the heat out of them as soon as possible, and then to keep it out. So hydro-cooling and refrigeration—cold but not too cold—are used for avocados. For limes, the physiological breakdown of the fruit, a condition peculiar to the Persian lime, can be greatly reduced by waiting

to pick them until fairly late in the day when their turgor pressure is lower. Post-harvest decay in mangos is reduced by a hot water bath.

The problem of quality in avocados and limes has been helped by maturity and grade regulations administered under federal marketing orders. These orders specify a minimum juice content for limes, while for avocados there is a rather complex schedule of minimum weights and dates for most of the cultivars grown in commercial quantities. The problem of too many different avocado cultivars, and of some which have poor eating or shipping quality remains with us. Mangos, like avocados, come in too many shapes, sizes and colors, as well as wide variation in their eating quality. These problems usually occur as an industry develops; we can look forward to improvement in the future.

Today, after eighty years of trial and error, the southern half of Dade County produces over a million bushels of avocados, close to two million bushels of limes and 300,000 bushels of mangos yearly, with promise of other exotic fruits to come. Cultivars and cultural practices developed here have been carried to many other parts of the world, repaying them for the gifts of fruit we have received from them. I believe Dr. Fairchild and my father would be pleased, and I suspect William Jackson would be astonished.

Proc. Fla. State Hort. Soc. 100:272-275. 1987.

POSTHARVEST RESPONSE OF CARAMBOLAS TO STORAGE AT LOW TEMPERATURES

CRAIG A. CAMPBELL
J. R. Brooks & Son, Inc.
P.O. Drawer 9
Homestead, FL 33090

DON J. HUBER
Vegetable Crops Department
University of Florida
Gainesville, Florida 32611

KAREN E. KOCH
Fruit Crops Department
University of Florida
Gainesville, Florida 32611

Abstact. **Carambola (*Averrhoa carambola* L.) is a tropical fruit crop relatively new to Florida, but despite its increasing popularity, little is known about optimum procedures for harvesting, handling, or storage. The fruit are yellow when ripe and have a distinct star-shape in cross section. The present study was undertaken to determine the optimum storage conditions for Florida carambolas and to assess changes in quality of fruit exposed to these treatments. 'Arkin' and 'Golden Star' carambolas stored at 10°C were of better quality than those held at 15°C or 20°C. Despite concern about chilling injury in carambolas stored below 10°C, fruit kept at 5°C had a better appearance, less weight loss, and less reduction in levels of soluble sugars (glucose, fructose, and sucrose), and organic acids (oxalic and malic) than did fruit stored at higher temperatures. Storage at 5°C followed by 6 days at room temperature (23°C) showed that fruit developed no symptoms of chilling injury, and retained the capacity to ripen normally. Results demonstrate that Florida carambolas therefore can be stored most effectively at 5°C.**

Averrhoa carambola L. Oxalidaceae is a small tree (common name "carambola" or "starfruit") grown commercially in South Florida for its attractive star-shaped fruit. Carambola was introduced into Florida more than a century ago but did not gain commercial status until recently (2, 8). There are 75 hectares of carambola orchards planted in Florida, with more planned (4). Because the carambola industry is new, optimum cultural practices are unknown and there is inadequate information on postharvest handling practices for the tender fruit. Most orchards are young; therefore, many potential problems associated with monoculture of a species may await carambola growers, packers, and researchers.

A strong national interest and demand for tropical fruits has fostered a young, but expanding, fresh-fruit industry in South Florida. Carambola is one of several tropical fruits that have recently become popular commercial crops in Dade County, Florida (3). These fruit are grown in southern Florida and marketed in many states throughout the nation. Postharvest losses are a significant problem in these new crops, and in carambola as well. The scarcity of information on postharvest handling of many tropical fruits has forced producers to rely on a trial-and-error approach to harvest and storage practices. The resulting losses may occur at harvest, in the packinghouse, and during transit and retail sale.

If carambola fruit could be stored successfully for four weeks before sale, then the irregularity in supply of carambolas could be minimized. Retailers are reluctant to purchase new commodities when consistent and high quality supplies cannot be guaranteed. Carambola brokers at present cannot provide adequate amounts of fruit continuously throughout the season. Rather, abundant supplies of fruit are available only about every two weeks during the two bearing seasons for carambola. One of the primary difficulties is a need for information on precisely what constitutes optimum, or even acceptable, postharvest handling procedures for carambolas. Research on the development and postharvest biology of this fruit will hopefully lead to improved handling procedures which will in turn reduce losses and strengthen the industry.

The objectives of this study were to determine the optimum postharvest storage temperature for Florida carambolas, and to document changes which occur in fruit exposed to these conditions. Fruit color, appearance, water content, and levels of soluble sugars (glucose, fructose, sucrose) and acids (malic and oxalic) were measured during and after storage. The overall goal of this research was to examine potential methods of extending the effective storage life of this unique Florida crop.