tion and their application by viable processing industries are needed in order to reduce the losses and allow distribution through market outlets away from points of production.

Many of the horticultural crops produced in Florida are produced in the tropics or are suitable for production in certain regions of the tropics. Some of the temperate zone fruit crops can be grown at high altitudes in the tropics provided the chilling requirements are met. Likewise some of the temperate zone vegetables require cool temperatures which can be attained at high altitudes in the winter months in the tropics. Food technology investigations that develop knowledge for improved methods of processing and preservation of Florida's horticultural crops should also have application for improving the utilization of horticultural crops in the tropics.

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# SUB-TROPICAL PEACHES AND NECTARINES

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ABSTRACT

Florida has 2800 acres of commercial producing peaches and nectarines in an area where the coldest month averages 58 to 62°F. (14.4 to 16.7°C.). This is a new industry based on new varieties developed by breeding. These varieties of low-chilling requirement have promise for highland areas in the tropics and sub-tropical regions where high quality varieties have not previously been available.

## INTRODUCTION

Peaches that can fruit with very little winter cold have been available to the plant breeder for many years. Their fruit has been of very limited commercial value because of small size, soft flesh or other undesirable qualities. A breeding program was undertaken in Florida to develop types of peaches and nectarines that could be grown in an area where no industry was previously possible due to lack of adapted varieties suitable for commercial markets (3).

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## LITERATURE REVIEW

Olmo (2), in an extensive review of peach and nectarine varieties around the world mentions Brazil, Egypt, Hawaii, India, Paraguay and Venzuela as regions fhere peaches are grown that require very little winter cold. Commercial types from Europe and the U.S.A. failed and the local types that succeeded bear small, soft, white-fleshed fruits. Areas with little winter cold not mentioned, that also grow peaches are Columbia, Ecuador, Guatemala and, of course, Southern China which is considered the ancestral home of all very low-chilling-requirement peaches. Also many countries which have important peach industries, Argentina, Australia, Italy, South Africa and the United States, have extensive areas too warm to grow the standard varieties of good fruit quality.

In the United States, pioneer breeding work to produce good peaches with lower chilling requirements started in 1907, even before the problem was recognized as lack of winter chilling and was known simply as "delayed foliation" (2). Weldon and Lesley (8) introduced the 'Babcock' peach in 1933 and others were subsequently developed at Riverside, California (1). Drs. W. E. Lammerts and H. C. Swim are workers who bred and developed peaches for adaptation to southern California. Dr. Swim's varieties, such as 'Springtime', and 'June Gold', patented by Armstrong Nurseries, Ontario, California, have been grown

extensively for early market in areas with 650 or more hours of winter chilling at or below 45°F. Dr. J. H. Weinberger of the U. S. Department of Agriculture also developed varieties of similar chilling requirements, the 'Maygold' and 'Suwannee', which are grown commercially in northern Florida. In South Africa, it is interesting to note that 'Babcock' was one parent of three dessert peaches for export developed by breeding for an area where delayed foliation of many varities was a problem (6). Canning types selected from naturalized seedlings and later by breeding have been developed for South Africa and are being tested in Australia, where many of the California canning peaches are not very fruitful.

In South Africa and southern California winter chilling is more similar to northern Florida than to central Florida. Another important peach region which appears to experience similar chilling in many winters is the San Pedro area of Argentina where the average for July is 52°F. (11.2°C.) and delayed foliation is sometimes experienced with standard European and U. S. varieties (7).

Efforts to extend high quality commercial peaches to still warmer winter areas by breeding programs have been made apparently in only two regions of the world. In Brazil, Eng. Orlando Rigitano[1], working at Campinas, Sao Paulo started breeding in 1950. His attempts to fruit varieties from southern California and many introductions from Italy, Japan and the U.S.A. were complete failures. Introductions of old Florida varieties such as 'Jewel', 'Suber', 'Hall's Yellow' and 'Angel' and seedlings naturalized by early Portuguese settlers beginning about the end of the 16th century have been the basis for his breeding work. More recently, Eng. S. Sachs in Rio Grande do Sul, Brazil has introduced by seed, breeding material very similar to some of that used in the Florida program (4) such as 'Southland' x 'Hawaiian' and 'Southland' x 'Jewel' progeny.

There were no known sources of nectarines with low-chilling-requirement when breeding was started in Florida, and apparently, no other areas have programs yet for extensive nectarine breeding. The first nectarine release, 'Sunred', (5) has been well received and fairly large shipments of the fruit sold well in northern U. S. markets in 1968 and 1969. This nectarine has been of enough interest that growers in Peru, Southern California and Texas have *made increased* plantings.[2]

## The Florida Breeding Program

Breeding of peaches for Central Florida began in 1952 after tests (3) had disclosed no promising varieties from other areas. The early work was reported in 1961 (4) at which time a few promising selections had been obtained. 'Flordawon' was the only variety released at that time. It has been good for home planting but has too soft a tip for commercial uses in Florida.

From 1952 to 1961, 20,000 seedlings were grown. Since 1961, another 20,000 seedlings have been grown for fruiting types and quite a large number for rootstock types. No commercially satisfactory selections were obtained in the first 2 or 3 generations of breeding, because of poor fruit characteristics of the perents used to contribute the low-chilling-requirement genes. In recent years, selections used in breeding have been closer to commercial quality and a useful new variety can be expected from perhaps each 4000 seedlings grown.

With a few exceptions, techniques used in breeding are quite similar to those of other U. S. workers. Pollen stored 10 months or longer has been used extensively as a means of utilizing parentage of varieties from other areas. Seeds are removed from the pits at harvest and often germinated immediately by removal of seed coats, though in recent years, most seeds have been stratified for a month or two before planting directly in a shade house. By starting seeds in August, and growing in the nursery through the following winter and summer, it has been possible to screen them for dormancy break about March and send the high-chilling requirement seedlings to the more northern Florida Experiment Station branches at Quincy and Monticello.

There may be one unique feature of the Florida program. To date, private growers have furnished land and caretaking for growing about half of the seedlings to fruiting stage. This has been done partly because of limited public facilities and partly because of the growers' interest. It has had one very desirable result, that of a close relation between the breeder and the growers.

Considerable rosetting of seedlings is en-

[1]Personal communication 1967 and subsequently.
[2]Personal communication.

countered with stratified seed planted in August when temperatures average 80 to 82°F. There is a great difference in progenies and seasons. The percentages of severe rosette vary from none to 85% and such seedlings usually die before the end of the season. In a general way, the progenies known to be homozygous for low-chilling genes show the least rosette problem and progenies rated as 400 hour (below 45°) types or higher will rosette heavily. Some exceptions to this generalization are still found, therefore it is not certain how much natural selection for low-chilling genes results from the method used in starting the seedlings. Attempts have been made to evaluate this and the possibility that rosetting due to germination at high temperatures might be related to fruit bud failure due to high temperatures during dormancy. Obviously, if rosetted seedlings die, it is impossible to make the comparisons directly. Observations of mildly rosetted types which eventually recover have not get provided any conclusive evidence.

Through 1969, 6 peach varieties and 1 nectarine variety were released for central Florida trials and 1 peach and 1 nectarine for northern Florida. Emphasis on nectarine breeding has increased since 1965 and several promising selections are now under trial.

The central Florida industry surveys in April 1969 by Florida Crop and Livestock Reporting Service reported 2865 acres of commercial peaches. The 'Early Amber' peach led with 1140 acres, the majority being planted from 1965 to 1968. 'Early Amber' is a patented variety, bred by private interests, which utilized one of the Experiment Station's breeding lines. 'Sunred' nectarine (5), named in 1964, was planted on 750 acres and 'Flordasun' peach, also released in 1964, occupied 590 acres. The balance of the reported average, about 10% of the total, was divided between 6 varieties, none of which is likely to increase greatly. 'Tejon', the only southern California bred variety grown to any extent in central Florida has declined in acreage and is considered unsatisfactory for commercial shipment. It is becoming obsolete because of softness, poor shape, and insufficient color of fruit.

Of the varieties already important, 'Sunred' nectarine led in new plantings in 1967, 1968 and 1969. It has good firmness and shape, very high color, and excellent eating quality. There were severe problems of fruit scarring in some orchards in 1969, but others showed little damage. One of the causes was thought to be frost damage, from temperature minimums of 28°F occurring just before shuck-off stage. Another serious type of spotting occurred in orchards receiving no open-bloom or petal fall sprays, suggesting a disease problem yet to be determined.

The central Florida industry has several production problems, greatly increased labor costs in the past year, light soils, frost risks after bloom, and others. Marketing problems are small fruit size, short shelf life of some varieties, and insufficient color on some, especially 'Flordasun'. All of the popular varieties ripen the crop before many competing shipments from other areas, and the nectarine ripens nearly a month ahead of volume shipments from California. Better varieties are of course the key to the market problems mentioned and further improvements can be made in time. Varieties to extend the harvest period would be welcome, especially in nectarines, and progress is being made in developing them.

Gradually growers are acquiring experience in this new area, improving their fruit thinning, their picking and packing operations. All the shipments to northern markets are hydro-cooled. Marketing knowledge has been gained, such as the need for fruit of 1 7/8″ or preferably 2″ diameter minimum for satisfactory prices. The early varieties now grown are difficult to size well, particularly fruit from young trees. As trees age to 4 or 5 years, the situation is improved somewhat but growers are interested in varieties that mature 2¼″ to 2½″ fruit with heavy crops, ripening near the end of May or early June. In addition to size, these should be freestones in order to compete effectively with the early clings on the market from Georgia and South Carolina. A start for such a variety is 'Flordabelle', being released in 1969. Its chilling requirement is so low and bloom so early that it will have frost hazards in some of the peach orchards in central Florida. It has firm fruit, shipping well, but can lack good color when light-cropped and grown under high nitrogen levels. It appears to be a valuable new variety, however, for those areas where spring frost hazards are minimal after February 1.

### Tests and Exchange of Peaches With Other Sub-Tropical Regions

Peach seeds were evidently brought to Florida (as they were to Central and South America) in

the 16th Century. In northern Florida, seedling peaches brought by the Spanish were grown widely and spread north into Georgia and the Carolinas. In central Florida they were not as well adapted and not until white-fleshed peaches were introduced from southern China about 1870 were peaches generally grown in this area.

There have been additional seed importations into Florida from Brazil, the Canary Islands, Guatemala, India, Mexico, Peru, Spain and Venezuela since 1950. Material from Brazil and India have had chilling requirements considered right for central Florida, and these appear to be traceable to origins in southern China. Considerable interest it attached to the breeding material from Brazil which has only recently been obtained and not yet evaluated for fruit quality. Those from the other areas mentioned have shown delayed foliation at Gainesville and other central Florida areas. They have been rated generally about 500 to 550 hour chilling material, better adapted to northern Florida. They resemble in type the material of early Spanish origin, mostly yellow-fleshed, often clingstones, and late fruit maturity. Of course there are mixtures in some areas, such as in Guatemala where both white and yellow fleshed, and cling and freestone types are found. The limited sampling of this material suggests that the central Florida material would be adapted to somewhat lower altitudes or warmer winter regions in the tropics and sub-tropics than where peaches are now often grown. This would permit their use in a somewhat warmer growing season which might be desirable for best dessert quality of fruit.

A feature of the breeding both in Florida and Brazil has been emphasis on early ripening. In Florida, it has been necessary to enable marketing ahead of nearby competing areas. In Brazil, earliness has been emphasized to reduce prolonged fruit fly and other pest problems, and for more profitable early market characteristics, even though there are no nearby large producing areas.[3] Compared to fruit requiring 120 to 150 days to mature for most of the naturalized peaches grown from seed, some of the bred varieties will develop ripe fruit in 65 to 90 days from bloom under comparable warm growing conditions.

The newest varieties for central Florida have not been grown long enough in other warm winter areas for much evaluation. Some growers have not been very faithful in reporting either their failures or their successes. A partial list of areas where budwood or trees of named varieties and advanced selections have been sent is listed in Table 1. 'Okinawa' rootstock seed has also been sent to several areas where rootknot nematodes are problems.

Table 1. Areas where central Florida peach varieties and seedling selections are under test.

| Area | | Varieties |
|---|---|---|
| USA | | |
| | California | Sunred, Flordabelle |
| | Hawaii | Sunred and others |
| | Arizona, Texas | Flordasun, Early Amber and others |
| CENTRAL AMERICA | | |
| | Mexico (mostly Monterrey area) | Sunred, Flordasun, Early Amber |
| | Guatemala | All varieties, several selections |
| | Costa Rica | Sunred, Flordasun and others |
| SOUTH AMERICA | Venezuela | Flordawon, Flordasun, Sunred, Flordabelle, Flordared, several selections |
| | Colombia | Flordawon, Sunred and others |
| | Peru | Sunred, Early Amber and others |
| | Equador | Flordasun, Sunred, Flordabelle, Flordared, several selections |
| | Brazil | Most varieties, some selections (1969) |
| | Argentina | Flordahome, Flordasun, Flordawon, Sunred |
| ASIA | | |
| | Israel | Flordared, Flordabelle, Sunred, Sungold, Flordasun, several selections |
| | India | Several varieties and selections (1968) (not sure if established) |
| | Iran | Flordasun, Sunred (not sure if established) |
| SOUTH AFRICA | | Sunred and others (not sure if allowed through quaratine) |
| AUSTRALIA, NEW ZEALAND | | Sunred, Sungold, Flordasun, Flordawon, Flordaqueen selections |
| EUROPE | | |
| | Spain, Valencia | Flordasun, Sunred |
| | Italy | Flordawon, Flordahome, Flordasun Flordaqueen, Sunred |
| | Canary Islands | Flordasun, Sunred, *Flordabelle, Flordared,* several selections |

It is not expected that the central Florida varieties will be completely suitable for new areas. Few fruit industries in any country have been based completely on introductions. Peaches have especially local adaptations generally and local development programs could be expected to improve their adaptation. The potential value of the central Florida varieties might be greatest from a long range outlook as sources of new germ plasm. Some selections have been sent for test to other areas because they may have value there, while never quite right for Florida conditions.

[3]Personal communication, Eng. Orlando Rigitano, Campinas, Sao Paulo.

Table 2. Relation of accumulated chilling hours at and below 45°F. (7.2°C.), from October 1 to February 10, average January temperatures in Florida, and variety adaptation.

| 45 degree Chilling Hours | Type Area | January mean degrees F (C) | Representative well-adapted varieties |
|---|---|---|---|
| 0 to 50 | Homestead | 66 (20.0) | Okinawa, Red Ceylon (not commercial) |
| 110 | Avon Park | 64 (17.8) | Flordabelle, Flordared, Flordawon |
| 210 | Lakeland | 62 (16.7) | Flordasun, Sunred |
| 310 | Inverness | 60 (15.5) | Early Amber |
| 420 | Gainesville | 58 (14.4) | Tejon |
| 540 | Lake City | 56 (13.3) | Flordaqueen, Sungold |
| 660 | Quincy | 54 (12.2) | Maygold, June Gold, Springtime, Armgold, Suwannee |
| 700 | Tifton, Ga. | 52 (11.1) | None in Florida |
| 900 | Ft. Valley, Ga. | 49 (9.4) | None in Florida |

It might be helpful in suggesting trial areas to compare chilling requirements as commonly described in U .S. A. in terms of accumulated hours during dormancy at and below 45°F (7.2°C) with the coldest month mean temperature (Fig. 1). The latter information is commonly available while the former is not. It also seems certain that very low-chilling-requirement peaches can perform perfectly well without any hours below 45°F, requiring only perhaps some winter cold in the range of 55°F (12.8°C). For these reasons, the material presented in Table 2 is given for suggested comparisons, based on Florida observations and limited reports from other areas. Differing lengths of the cold period, dormancy induced by drought or defoliation, and local effects such as fog or lack of extremely warm periods can be expected to modify the comparison of Florida with other areas. However, the table suggests a starting point for locating variety trials of these Florida varieties.

The shipment of test material to a great many locations has become somewhat of a burden and it is questionable if Florida should be expected to continue furnishing material without development of better test arrangements by the recipients. Sometimes, it goes into private hands and is kept closely controlled. In others, government agencies change personnel or emphasize other programs, and provide no continuity to a test program.

There could be some very interesting developments in peaches and nectarines in tropical and sub-tropical areas. It would be extremely gratifying to be free of frost hazards to trees and young fruit. There could be tests of making two crops a year with control of water and defoliation. There are potentials for processing if suitable varieties can be found or developed.

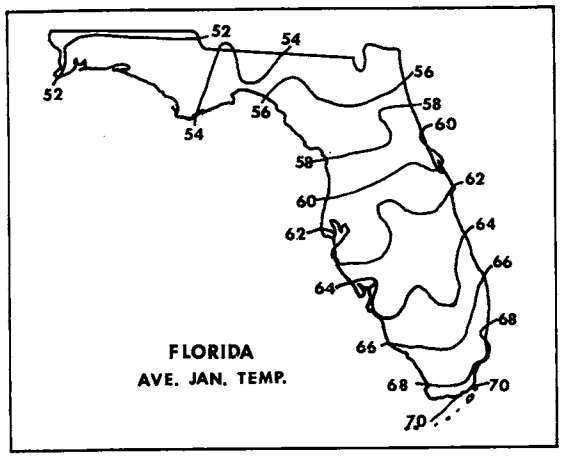


**Fig. 1. Average January temperatures in Florida (F°) (adapted from U.S.D.A. Yearbook of Agriculture, 1941).**

More research and development personnel are becoming involved and it will be interesting to see the results in a few years.

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