

Citrus Harvesting and Handling in Brasil and the U. S. A.

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The writer is a specialist in harvesting and post-harvest handling of fruits and hence these comments are primarily from the point of view of post-harvest handling, not of citrus growing.

The comments on the citrus industry of Florida are based upon professional experience. The comments relating to California and Brasil are from visits, observation and reading.

Although other citrus fruits will be mentioned, this discussion will be limited to oranges principally.

2. Size of the respective industries

The orange production of Florida was approximately twice that of California in the 1890's. Then two disastrous freezes between 1894 and 1897 reduced citrus growing in Florida drastically. Irrigation and improved trans-continental transportation stimulated Californian production and it was 55 years before orange production in Florida was again twice that of California. Today the annual orange crop of Florida is just short of 100,000,000 boxes. (In fairness to California I should point out that in addition to their citrus industry they also have an enormous crop of deciduous fruits, made possible by the great length of the state from north to south and the great differences in elevation).

By comparison Brazilian orange production may look small, but in terms of the world's fruit growing industries it is already of considerable size. In the United States we have developed most of our potential citrus areas and are beginning to lack new land suitable for planting to citrus. In Brazil the citrus industry is just starting to expand and no one can foresee its ultimate limits —its potentialities are enormous.

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(2) This article was prepared originally by the author as a talk given at a special course in citrus production at the Escola Superior de Agricultura «Luis de Queiros» at Piracicaba, S. P., Brasil.

3. *Citrus fruits grown in these areas*

Brasil: Although Brazilian scientific publications deal with a vast range of species and varieties, the great bulk of commercial citrus production is in sweet oranges.

California: The orange industry of California is justly famous; in addition the state has a virtual monopoly of the United States fresh lemon industry. There is a small California tangerine industry of about 4,000 acres and a small grapefruit industry. Californian grapefruit grown in the hot arid interior valleys with the aid of irrigation are of good quality, but very expensive to produce and hence not much grown. In the cool, moister coastal belt grapefruit are of very poor quality, but they are ready for harvest when no other grapefruit are in season and hence fetch a reasonable price.

Texas: The citrus industry of Texas is largely a grapefruit industry. A very good quality grapefruit is grown, but production has been checked several times by serious freezes. Oranges are largely for local market or for shipping to northern markets when other oranges are in short supply. The pride and joy of the Texas industry is the very high quality red-fleshed grapefruit.

Florida: Oranges are, of course, the principal citrus crop, but grapefruit (of which Florida produces something like 80% of the world crop) is of great importance, especially in the Indian River (East Coast) district. About 5,000,000 boxes of tangerines are grown. Strange to say these are almost all of the Dancy variety and hence the main crop is limited to such a short period that it is hard to dispose of so many tangerines profitably. Because of this, many attempts have been made to find some reliable way of making Dancy tangerines produce "off-bloom" fruit with regularity. Several other tender varieties, suitable for dessert use, are increasing. Of these the Temple (a chance seedling believed to be a *C. sinensis* x *C. reticulata* hybrid), the tangelo (of which there are various named varieties (all *C. reticulata* x *C. paradisi*) and the Murcott (another chance orange x tangerine hybrid probably) are the most promising.

4. *Duration of the harvesting season*

California has a cooler climate than Florida or Brasil and oranges are much slower in reaching maturity, Valencias taking about 18 months. This has the fortunate effect of giving California a year-round orange production with only two principal varieties, Valencia and Washington Navel.

Florida has far less variation in temperature between summer and winter and a much faster growing season. But this means virtually no summer crop. A few late strains of Valencia such as "Pope Summer" or "Lue Gim Gong" can be harvested as late as July (mid-summer), but most packinghouses shut down in June, July, August and September. The typical succession of varieties through the season

is: *early*, Hamlin and Parson Brown; *midseason*, Pineapple; *late*, Valencia. A few navels are grown, but in Florida they tend to develop to enormous size, coarse in texture and insipid in flavor. One horticulturist once aptly remarked that "The growing of navels in Florida is the ultimate tribute to human perversity"! With or without human perversity, Florida's season is limited to eight months of the year.

Brasil's season is shorter still and limited by overseas markets as well as climate and varieties.

Geography and climate

Citrus will grow in purely tropical districts such as Thailand (Siam) but in that region blooming and fruiting are so irregular as to be almost continuous, and typical fruit color never develops. For large scale commercial production it is necessary to have an almost frost-free climate with enough cool weather (below 50° F., or 10° C.) to develop good external color. Such conditions are not easy to find.

California is the most distant from the equator of the districts we are considering, the citrus districts there lying largely between 33 and 36 degrees north (equivalent to Montevideo or Buenos Aires). They have frequent light frosts, but usually no more than they can counteract with heaters and wind machines. Their fruit color is excellent, about the only exception being occasional regreening of Late Valencias or early navels that may need some ethylene degreening. But in general their oranges are of a brilliant color comparable to Mediterranean oranges. The appearance of their fruit is further helped by the arid growing conditions (irrigation is essential). I regret to remark that their clean bright fruit contrasts sharply and favorably with the Florida product.

Florida is entirely south of California, but still not quite within the tropics. (The Tropic of Cancer passes between Florida and Cuba). The citrus district is largely between 26° and 29° N., Florianópolis in Brasil would be about equivalent. The peninsular is entirely flat, never higher than 400 feet (122 m.) above sea level and not only is the peninsular only about 200 miles (280 kilometers) across, but it is also dotted with thousands of lakes and has large areas of marshy swamps. All this contributes to a usually warm, mild, humid climate that produces a very sweet juicy orange, with a tight thin skin and poor external color. In 1957-1958 Florida oranges had excellent external color, but only as a result of a series of rather damaging freezes. Usually we have to degreen with ethylene for several months of the year. Such degreened fruit is usually very pale in color and it has become customary to dye it orange with a warm dye emulsion ("color-adding").

Brasil's citrus district is almost entirely tropical (the Tropic of Capricorn passes between Sao Paulo and Campinas) but the altitude, about 2,000 ft. or 700 m., ensures enough cool weather for commercial citrus growing. Degreening is necessary for all early fruit, but fruit

color seems to be better than usually encountered in Florida, but not as good as in California.

6. *Economic factors affecting marketing*

Both California and Brasil rely on distant markets and hence the whole pattern of their industries has become the producing of citrus that must be capable of being shipped for considerable distances. Florida has no mountains to cross nor seas to travel and has huge markets within 3 to 6 days shipping distance. Because of this there is very little emphasis on keeping quality, but great stress on maturity laws and size and grade regulations. It is only in the last few years that we have had any special export regulations and they still need a great deal of strengthening. For Florida the home market is supremely important, and anything else is considered of far lesser importance.

In California cannery use is more profitable than throwing away off-grade fruit, but it is not really profitable. In Brasil major cannery outlets are lacking, and hence in these two districts every effort is made to pack as high a proportion of the fruit as possible.

In Florida low production costs and mass production methods help to make frozen orange concentrate a very profitable outlet for oranges, particularly of the Valencia variety. Because fruit having surface defects can be sent to the cannery at a profit, there is far less concern about the proportion of fruit that can be packed. In the writers opinion reliance upon cannery sales is becoming excessive and unwise, but that is not a generally held opinion. Grapefruit are usually more profitable as fresh fruit than when sold for cannery use and tangerines lack any large scale cannery use.

7. *Harvesting methods*

In both California and Florida the normal method of harvesting is to pick into wooden boxes that are stacked four-deep upon trucks. At the packinghouse these stacks are removed by means of clamp trucks, either manually operated or power trucks. These clamp trucks place the stacks (four boxes in each stack) on a "floor chain" that carries them into a mechanical dumping machine that picks up each box separately, dumps the fruit onto a belt and places the empty box on another belt. Such a method is not readily adaptable to Brasil due to the regulation that fruit for export must have wooden strips between the layers of boxes. This regulation would seem to be a wise one, but it does complicate harvesting methods since the boxes have to be unloaded singly.

In Florida cannery fruit has long been harvested by picking into boxes and dumping the boxes into narrow bulk trucks that can go through the groves. These small trucks empty their load into an elevator that fills a semi-trailer at the road side. These bulk semi-trailers carry about 400 boxes, the fruit being piled about 5 feet (1,75 meters) at the center of the load. Such handling is far too rough for fresh fruit (in my opinion it is too rough for cannery fruit!) but the method

has been successfully adapted to the handling of fresh citrus in Florida. The fruit is picked into little (25-box) trailers which are pulled by tractors. These empty into special vertical elevators that lift the fruit gently into a special semitrailer with padded baffles to catch the fruit gently. At the packing house such fruit is degreened in tall bins in which the fruit rests on baffles of soft strong cloth. The method is better and cheaper to operate than harvesting in boxes, but the initial expenditure for equipment is very high and hence only a few houses are using this method at present.

Where suitable lift truck equipment is available a cheaper alternative is now available using large "pallet-boxes" approximately 48" x 48" x 30" deep (or 1,25 x 1,25 x 0,80 for those who prefer metric measurements). Recent research has shown that oranges and grapefruit can be degreened successfully in such containers if the rooms are suitably designed.

Local peculiarities

In traveling around one notices some odd differences in customer preferences. Here in Brasil I note that tangerines are preferred a light orange color. In the United States and Canada tangerines are expected to be a deep orange, almost red, color. It was a real surprise to see green lemons for sale on the market in Sao Paulo. In any other districts with which I am familiar (Canada, England, U.S.A.) lemons are always sold bright "lemon yellow" and the California packers go to great trouble and expense to get them a clear light yellow regardless of their color at harvest. On the other hand Florida limes are expected to be green as grass. Here in Brasil I note that "lemons" (*C. limonia*) and "limes" (*C. aurantifolia*) are usually lumped together as "Limaos" thus saving a lot of trouble! Another such example is the "blood orange" that I remember as a favourite when I lived in England as a child. The few that reach the market in the U.S. are most unpoplar.

Post-harvest diseases

Penicillium molds are ubiquitous, the common ones being *P. italicum* Wehmer, the blue mold, and *P. digitatum* Sacc., the green mold. In Florida *P. digitatum* is by far the most troublesome of the two as fruit is seldom held long enough for the slower growing *P. italicum* to give much trouble. On the other hand the California lemon shippers find *P. italicum* very troublesome during their long, cool, curing period. The Penicilliums as a group are checked by very hot weather and stimulated by cool weather.

Florida and Brasil both have stem-end rot, which is a very difficult form of decay to contend with, as it comes from two fungus-organisms that are usually endemic in citrus groves in humid climates. These are *Diplodia natalensis* Pole-Evans (the causal organism of melanose) and *Phomopsis citri* Fawc. (that also causes various root, bark and twig rots). In Florida the normal succession of diseases is as follows: Early in the season (September, October, November) di-

plodia stem-end rot. This is unfortunate as it is the degreening season and *Diplodia* is greatly stimulated by ethylene. The cooler weather causes a sudden increase in *Penicillium*. As the warmer weather of March, April and May checks *Penicillium* the slower developing phomopsis stem-end rot takes over. It almost looks as though Nature had developed such a system as a challenge to the citrus shipper!

An important disease of California lemons is *Alternaria* rot of lemons. An interesting point is that 2, 4-D is used as a growth hormone to keep the "buttons" green as the dead button forms an invasion port for *Alternaria*. On the other hand with stem-end rot the spores are carried in the buttons and the sooner they fall out the better, and hence the use of 2, 4-D can cause a considerable increase in decay in a stem-end rot district.

There are other diseases such as waterspot of navels, sloughing of grapefruit, occasional *Botrytis*, *Colletotrichum* or *Phytophthora* rots but they are of less importance.

Shipping containers

The types of shipping containers used in the various districts afford a good example of how a single problem may have different solutions in different districts. In California most citrus is now shipped in cartons. Their labor costs are very high and cartons are suited to mechanised packing methods. They do not have stem-end rot (for which cartons form a favorable environment) and they usually have very good pre-cooling facilities. The California industry went straight from a wrapped pack in wooden boxes to a naked pack in cartons with consequent very great saving. In Florida the wire-bound box is still the most popular. It is cheap, easy to refrigerate and ships well. Brasil is still using the nailed box, and there is no real reason for advising an immediate change. They are much cheaper in Brasil than in the U.S.A., packing labor is readily available at economic wages and the box itself is well suit to long ocean voyages. So, for the time being, the problem of the "best box" has three different solutions for three different districts.



Fig. 1 Some containers commonly used for citrus in the U. S. A. From left to right (top row): a wireboard carton, from Florida which holds 45 pounds of oranges; (the California carton 40 pounds). A wirebound box holding 90 pounds of oranges, a common container in Florida. The large containers to the right are Florida field boxes used for harvesting and now rapidly becoming out-of-date. Bottom row, three different types of wirebound "half-boxes" holding 45 pounds of oranges. In front of them is a pile of net bags each holding five pounds for a single retail purchase. At bottom right is a "bagmaster" carton that carries eight five-pound polyethylene bags or five eight-pound bags.