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Florida Citrus Packinghouse Operations and Handling

W. F. Wardowski[1]

There are over 100 commercial citrus packinghouses in Florida, that in a season without freezing weather or other serious difficulties will pack over 72 million 4/5 bushel cartons (over 1,472,00 metric tons) of fruit.

Additionally, several hundred gift fruit packinghouses and roadside stands sell over 16 million cartons (over 327,000 metric tons). These businesses range from very small roadside stands to the world's largest citrus packinghouse (over 3 million cartons annually). Only 14% of the citrus grown in Florida is sold as fresh fruit, but that 14% is about twice the amount of citrus presently produced in China.

An industry this large is very diverse and difficult to describe in a few words. The publications cited in this paper provide a more complete understanding of the problems for fresh fruit and methods used in Florida citrus.

MATURITY STANDARDS

Citrus fruits grown in subtropical climates are very different from those grown in arid desert climates. China and Florida are both considered to have humid subtropical climates. Some of the characteristics of fruit grown in humid subtropic and arid desert climates are shown in Figure 1. Florida citrus and much of that grown in China has the characteristics of subtropical citrus: blemished and scarred peel that tends to be pale or even green, but a thin peel with a high juice and high sugar. A region such as Florida growing citrus in a subtropical cli-

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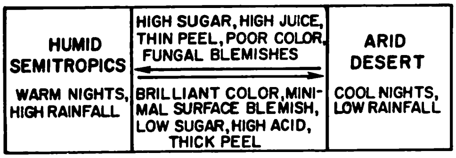


Fig. 1. Ecological effects of climatic extremes on grade and quality factors for citrus fruits (adopted from 6).

mate can emphasize the strengths of their citrus by establishing very high minimum maturity standards (7). Florida maturity standards and analysis methods are found in a University of Florida Bulletin (14). These standards include Brix (sugar), acid, Brix/acid ratio, juice content and color break. Color break is subjective and difficult to enforce.

HARVESTING

Approximately 25,000 men and women make up the harvesting work force for Florida citrus. They are predominately non-migrant blacks who are part of the local communities (12, 5). There are also numerous whites and in recent years, Spanish speaking people. Mechanical harvesting has been attempted in many forms, but unless the availability of harvesting labor becomes scarce or more expensive, hand harvesting will continue to account for over 99% of the fruit harvested. Additionally, the largest Florida orange cultivar is Valencia (50% of the oranges) which stay on the tree more than twelve months after bloom so that at harvest two crops are present. This double crop makes mechanical harvesting difficult, and a full labor force is needed for the late season Valencia.

DEGREENING

The markets for Florida fresh citrus fruits demand, except for limes, the peel not be green in color. However, Florida environmental condition produce high sugar, high juice and green-colored fruit early in the season. Additionally, Valencia oranges and grapefruit left on the tree will regreen in the late season when the weather gets hot; i.e., the orange or yellow peel will turn green again. The degreening process removes the green color and allows the orange or yellow to show. This process works well early in the season, but is only partially effective on regreened fruit late in the season.

The degreening process is well defined and the conditions are recommended in a University of Florida Circular (13). The best temperature for Florida citrus degreening is 29.4°C (85°F). Very high humidity is very difficult to obtain, but the value of reducing stem-end rind breakdown (9) and decay (3) is important. Relative humidity of 90 to 96% is recommended as well as fresh air ventilation of one air change per hour and good internal air circulation. The fresh air is needed to avoid the accumulation of carbon dioxide which can blow the degreening process. The air circulation is needed to expose the fruit to the degreening atmosphere. Five parts per million (ppm) ethylene is adequate for the maximum degreening rate using the above conditions (2). Ethylene should be slowly metered into the degreening room at a low constant rate during the entire degreening process. The ethylene level should be monitored with a portable ethylene analyzer as the conditions for each room are different and the ethylene metering can only be a rough estimate. Excessive ethylene levels need to be avoided because 5 ppm is adequate and higher levels (as well as longer degreening times at the same ethylene levels) result in higher stem-end rot caused by *Diplodia natalensis*. Ethylene in high concentrations of 3% (30,000 ppm) or more is explosive so safety precautions need to be taken to avoid leaks and accidents near ethylene tanks.

DECAY CONTROL

Decay is the greatest single hazard for Florida citrus after harvest. The major types of decay and other disorders are illustrated in a color publication by McCornack and Brown (8). The major types of decay are stem-end rot, molds and sour rot. Stem-end rot is caused by *Diplodia natalensis* (see Degreening above) and *Phomopsis citri* which is more common later in the season in nondegreened fruit. This decay usually begins at the button (calyx), but may also be found at other locations following injuries. Green mold *(Penicillium digitatum)* is the most common mold infecting Florida citrus, while blue mold *(Penicillium italicum)* is found only occasionally. Mold infects fruit through injuries, is most common during the winter months and does not spread by contact in packed cartons. Molds have developed resistance to some fungicides in most of the large citrus growing areas of the world. Sour rot (*Geotrichum candidum*) is a watery soft decay which infects fruit through injuries but also spreads from fruit to fruit. Sour rot is often found in mandarin cultivars, but may infect all types of citrus fruit.

Decay control includes all aspects of citrus fruit handling. Harvesting is frequently the cause of injuries leading to decay in Florida. Prompt handling from harvest to packing with high humidity conditions for degreening or other delays helps to reduce losses to decay. Packinghouse sanitation is also important for the control of decay, especially resistant molds and sour rot.

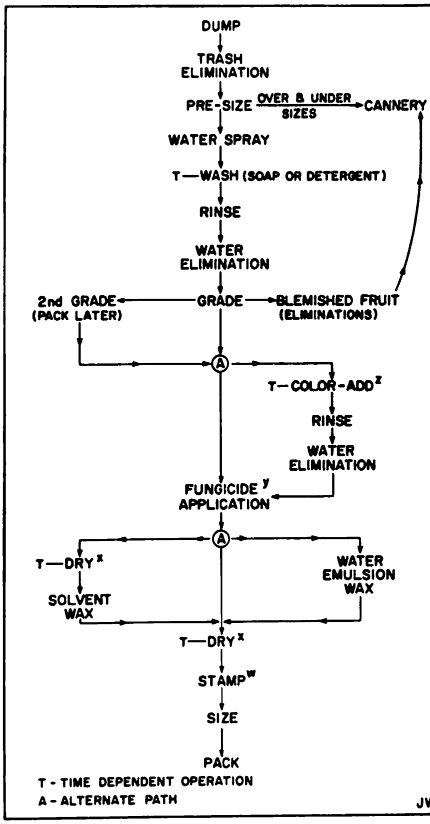
Fungicides are widely used for the control of citrus fruit decay. In Florida commercial citrus is required to be treated with one of several recognized fungicides (1). Of the three major kinds of decay, only stem-end rot and mold are readily controlled with these fungicides. The approved chemicals have very little effect on sour rot so that careful handling and sanitation are the most effective means of control. Several fungicides are recommended for the control of postharvest decay in Florida citrus (10). Benomyl (Benlate) and thiabendazole (TBZ) are the most effective against these decays. Each of these can be effectively sprayed over the fruit just before waxing or incorporated in water waxes (emulsion waxes). Benomyl is also sometimes sprayed on the fruit before harvest, especially during the degreening season on valuable or susceptible crops. Sodium o-phenylphenate (SOPP) is applied in soap, has some effect against sour rot, and is rinsed off with the soap. If SOPP is allowed to remain on the fruit surface, it will cause a peel injury. Biphenyl (diphenyl) is impregnated in paper (pads) which are placed in cartons of fruit. When Biphenyl is removed from the sealed plastic bag and exposed to air it vaporizes around the fruit and acts as a vapor-phase fungicide. A new fungicide, Imazalil, is very effective against resistant molds and is now available (4). When fruit is exported, any fungicide(s) applied must be specifically approved by the country receiving the fruit. Lists of countries approving fungicides for citrus are available (11), but it should be noted that these approvals are constantly changing so that current information is needed.

PACKINGLINE MACHINERY

Some principles are discussed in Packingline Machinery for Florida Citrus Packinghouses (6). Much of this material applies to citrus and even to other crops grown elsewhere. The capacity of two narrow packinglines is identical to that of one line with twice the width. The wide line would cost less than two narrow ones because the expense is not increased much by longer rollers, slats and brushes and wider belts. The expense is increased more by added frames along the side, duplicating motors, adding plumbing and electrical materials, and bearings, chains and sprockets. Additionally, a wide short line requires a smaller building than a narrow long line. Select the widest standard packingline equipment for your needs to obtain the best economy.

The sequence of packinghouse operations varies with the growing region, equipment manufacturer and tradition of the management. A logical sequence of packingline equipment for Florida is shown in Figure 2. Fruit that is going to be sent to the cannery should be removed as soon as possible from the line in order to make room for fruit that will be packed as fresh fruit. This occurs immediately after the dumper and trash eliminator with the presizer removing over and under sizes, and again after the washer when the graders remove eliminations. In Florida this early removal of fruit is important because 40% of the citrus delivered to packinghouses is eliminated and the various packingline treatments are expensive. Figure 2 indicates which processes are time dependent, or require a minimum time. The time dependent processes are washing, color-adding and drying. When planning a packingline adequate space needs to be made for the time dependent processes.

Some processes lead to others. For example, Florida citrus must be washed because of the presence of sooty mold, a black fungus that grows on the surface of the fruit. Washing disrupts the natural wax so that a wax must be applied to prevent dehydration. In turn, the fruit must be dried with heated air blowers to dry the wax. In recent years solvent based wax has become more expensive because of the increase in petroleum prices and packers have increasingly used water emulsion waxes.



[z] Optional and only for oranges and tangelos.
[y] Alternate locations for fungicide application are at the washer, in water emulsion wax or on pads placed in packed cartons.
[x] Hot air drying is prior to solvent was or following water emulsion wax. Drying following solvent wax is with ambient temperature air.
[w] Ink stamping can be done prior to solvent wax, but not prior to water emulsion wax. Paper labels are applied after waxing.

Fig. 2. Logical order for a packingline when only one grade is packed most of the time (from Grierson *et al.* 7).

GENERAL COMMENTS

As a general rule fresh citrus fruits should receive minimal treatments accepted in the markets. Degreening, artificial coloring, washing and waxing should be considered only if the customers demand such treatments. The less done to citrus fruit, the lower the cost and the less chance there is for injury by or during the treatments. In China, there is a very large domestic market for citrus and this market may accept a green or yellow peel on an orange if it is juicy and sweet.

Always, keep cosmetic treatments to a minimum for the market served.

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APS BUSINESS MEETING

Blacksburg, Virginia
Wednesday, July 31
7:00 - 9:00 p.m.

Check the ASHS Program for location