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Proc. Fla. State Hort. Soc. 94:256-258. 1981.

FACTORS TO BE CONSIDERED FOR EXPORTING GRAPEFRUIT TO DISTANT MARKETS

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Additional index words. shipping container, quality, fungicides, packing, temperature control.

Abstract. **Fresh grapefruit continue to be the most important fresh citrus fruit exported from Florida. In 1981, the market value, upon arrival, of fresh grapefruit is estimated at $100 million, and it will probably exceed $150 mililon by 1985. Consequently, the delivery of grapefruit in the best possible condition at its overseas destination is of great importance. This paper presents specific and practical recommendations for the Florida grapefruit shippers to use on quality, pretransit treatments, shipping containers, packing, temperature control, and stacking and handling for export of grapefruit.**

It is my pleasure to participate in the Florida State Horticultural Society's first symposium on "Citrus Exports from Florida." The transportation of fresh grapefruit from Florida in both refrigerated van containers and in the refrigerated holds of ships has increased rapidly in recent years, and fresh grapefruit is now Florida's No. 1 exported citrus fruit (4). By 1985, the market value, upon arrival, of fresh grapefruit delivered to overseas markets probably will exceed $150 million, assuming that a good job is done in getting fruit to the markets. Consequently, proper packaging, temperature and humidity control, handling, stacking, unitizing, and loading, are of great importance to ensure that grapefruit will arrive at destination in the best possible condition.

In domestic marketing, after harvest, 3 to 10 days are required for the fruit to reach the consumer. In contrast, overseas export can require as long as 6 weeks to reach destination, and additional storage time may be required at the terminal market.

The purpose of this paper is to identify several factors that should be considered when exporting grapefruit to distant markets. These factors should not be considered absolute or final; they may change from time to time as we gain more information and accumulate data from our experiments and observations.

Quality. In all reports concerned with the export of citrus, the maximum transit and shelf-life after arrival can be attained only by selecting high-quality grapefruit (10, 20). Quality cannot be improved after harvest. Thus, the first consideration is always to ship the highest quality, U.S. No. 1 fruit. To obtain extended transit and shelf-life, the fruit must be free from skin breaks, mechanical injuries, bruises, and decay. It should also be remembered that early fruit havested in October and November is especially susceptible to low-temperature injury, and that late-season fruit harvested in May is more susceptible to decay (18). In addition, fruit harvested during October and November that are exposed to more than 48 hours of degreening with ethylene often develop excessive amounts of decay, and fruit undergoing this treatment are not recommended for export.

Pretransit treatments. Shippers should be aware of the approved fungicides and allowable tolerances by the country receiving the grapefruit (16). Fungicides should be applied and monitored closely. Fungicides applied during pregrading or during packing can be detected and, unless they are approved, the entire shipment can be confiscated on arrival and dumped or rejected for entry into that market. Results of our export shipping tests conducted during the last several years clearly indicate that the best decay control has been obtained when thiabendazole (TBZ) and sodium *o*-phenylphenate (SOPP) were applied to the fruit (19). Benomyl may be used in place of TBZ if approved by the importing country. To control additional decay and green mold sporulation in storage and in transit, one biphenyl pad should be placed over the bottom layer of fruit and one pad placed between the upper layers (17). For early shipments prior to January, use only one biphenyl pad to ensure the biphenyl residues will be within accepted tolerance levels, since early grapefruit tend to absorb more biphenyl than more mature fruit (21). All fruit should receive an approved wax application before being packed into shipping containers, so that moisture loss during transit will be minimized, and consumer appeal will be enhanced. Also, mois-

[1]This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation for use by the U.S. Department of Agriculture nor does it imply registration under FIFRA as amended.

ture loss and subsequent weight loss increases the fruit's susceptibility to deformation during shipment and storage (12).

Shipping containers. Containers used for domestic trips averaging 3 to 10 days in transit to markets do not provide adequate protection from overhead weight and the high humidity (85 to 90%) experienced during extended overseas shipments (11). For successful export shipments, the regular-slotted, single-wall, 2-piece, full-telescope style container should have a minimum strength of 350-lb-test fiberboard for the body (90-33-90) and 200-lb-test fiberboard for the cover (42-33-42). Wet-strength corrugated fiberboard and waterproof adhesives should be used throughout in both body and cover of the shipping container. For adequate ventilation, two 5/8- x 3-inch vent slots should be provided in each side panel. Before adoption by the industry as an approved container for citrus, any new-type design and/or style of container should be at least equal to or higher than these average levels of strength.

We observed grapefruit arriving in Japan, and found that seriously deformed fruit were more prevalent in the bottom layer of fruit than in other layers of the shipping container (9). Some of this damage was attributed to the pressing of fruit into the bottom gap of the box. Therefore, use of shipping containers in which all flaps meet (AFM body) or tray-type containers with solid bottoms should be used to reduce the amount of fruit deformation.

Packing. Do not overfill boxes (referred to by the industry as "bulge packing"). Reports of previous laboratory and shipping studies have shown that the higher the fruit extends above the box body, the more serious the adverse effect on the fruit's appearance (5, 19). All containers should be packed in compliance with Florida Citrus Industry Rule's Chapter 20-39.11, which states, "when a full telescope corrugated box is used as the immediate container, maximum bulge, measured from the bottom of the telescope cover to the bottom of the container, shall not exceed 1/2 inch at any point" (3). For optimum fruit arrivals, strive for a "flat-pack," and use the 1/2-inch-deeper box with inside dimensions of 17 x 10 5/8 x 10 1/8 inches (43.2 x 27.0 x 25.7 cm) to avoid excessive bulge (19). Shippers should also consider the use of honeycomb cell-pack containers as a means to provide maximum protection to very ripe fruit, especially with the larger 32 and 27 sizes (6, 8).

Temperature and humidity control. Grapefruit should not be shipped with other citrus fruits having different temperature requirements, because the resulting compromise temperature may not be suitable for either fruit. For export shipments of Florida grapefruit from October to January, a transit temperature of 60°F is recommended, and for the remainder of the shipping season, 50-52°F (14). Never ship grapefruit below 50°F. Relative humidity should be maintained at 85 to 90%. These temperature and humidity requirements should also be supplied to carriers and receivers to ensure proper storage at destinations.

Stacking and handling. Do not stack fiberboard boxes beyond their stacking strength. This is especially a potential problem in the holds of refrigerated ships. Generally, boxes with combination boardweight strengths of 350 lb for the body and 200 lb for the cover should not be stacked more than seven layers high. To avoid physical damage to the shipping containers during unitizing and handling, the following practices should be observed:

1. Containers should not be unitized in an interlocking box-stacking pattern every other layer as they will lose about 40% of their original stacking strength (13). If an interlocking stacking pattern is required for pallet stability, stack the lower layers in direct vertical alignment and interlock only the upper two layers of the pallet stack. All containers in the lower layers should be stacked in register, and in good vertical alignment.

2. When unitizing on wooden pallet bases or elevated pallet bases, avoid stacking patterns that allow containers to overhang the pallet. At least 50% reduction in container strength can be expected with a 1/2-inch overhang (2).

3. Containers must interface with the top deckboards on wooden pallets for the particular unitizing pattern being used. Pallets with widely spaced deckboards cause container damage and creasing, and the result is loss of container strength (15).

4. In van containers where space remains between the last two palletized units and the rear door of the van container, an endgate or other load-securing devices should be placed against the rear face of the last two pallet units to fill this void in the load. The gate will prevent load shifting and maintain the alignment of the boxes in the palletized units (7). All units should be loaded tightly from the front to the rear of the van container, with no space between stacks. These same loading rules should be observed when loading highway trailers that transport fruit to ports of embarkation.

5. In loading break-bulk refrigerated ships, all boxes should be stacked in register and in direct vertical alignment. Do not use wooden dunnage strips between layers of fiberboard boxes, because in a relatively short time they will press into the boxes and cause damage to the grapefruit (1). Conversely, wooden dunnage strips should be used in areas of a ship's hold, if irregularly shaped, to aid in maintaining the in-register, box-stacking pattern.

In conclusion, we must always remember that grapefruit arriving in overseas markets will be only as good as the initial quality at harvest and as affected by the picking, packinghouse treatments, packing, handling, and shipping procedures that it receives. It costs the same to ship a decayed, disfigured, or misshapened grapefruit as it does for one that arrives in a wholesome, attractive condition. For example, it costs 45¢ each to deliver size 27 grapefruit to Japan regardless of its arrival condition. So let's always be conscientious and demand the best job we can in getting our fruit to distant markets in the best possible condition.

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Proc. Fla. State Hort. Soc. 94:258-263. 1981.

INNOVATIONS IN CITRUS WAXING—AN OVERVIEW

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Additional index words. Coatings, Fungicides, Shrinkage, Thiabendazole, Wax Applicators.

Abstract. **Many factors are to be considered when the citrus packinghouse changes its method or type of wax process. These include the type of wax to be used and the market to which the fruit is to be shipped. Not all ingredients acceptable in the US are acceptable to all foreign market countries.**

Uniformity of coverage as well as the quantity of wax on the fruit can be a factor on how well the fruit holds up on the way to market. Over waxed fruit may develop off flavors, under waxed fruit will shrink (los weight) excessively. The applicator used is the single most important factor in uniformly applying the wax coating.

When fungicides are incorporated into the wax, allowances must be made for the rate at which the wax is applied and the fungicide concentration adjusted accordingly.

The comparative costs of ingredients will affect the formulators decisions on which products to offer and this will affect the cost to the packinghouse. Cost and a sure supply of ingredients will also be a factor to the packinghouse. New wax ingredients, new methods of application and adjustments in traditional ideas about citrus waxing may be necessary.

The appearance of citrus at the marketplace is often the only quality that affects the price paid and the potential for reorders. For this reason the packinghouse manager is usually very concerned with the coating that he uses on his fruit.

Since there are many different suppliers offering coatings, and each supplier often offering several different coating products, the question of which product is best is of concern to the packinghouse manager. Since there is no single answer to this question, we will consider several factors that affect that decision.

The desired end result of citrus waxing is to give the fruit a good shine that will last through the marketing process as well as to reduce weight loss by the fruit to the maximum extent possible without harming the fruit.

It has sometimes been said that citrus waxing is more art than science. This idea, which is in part true, has been furthered by the complexity of the waxing process and the failure of many scientists and laymen alike to differentiate between the various types of waxes. The differences between wax types and applicator types as well as their affect on the quality of the final product will be considered here.

The coatings used for citrus are usually called 'waxes' although modern products commonly available contain little if any wax of any kind (8, 37). The reason for this is that the earliest citrus coatings in commercial use were composed of waxes (1, 4, 5, 6) and this term has been since applied to all postharvest citrus coatings regardless of their composition.

In the history of citrus waxing, advances in the method of application are related to advances in formulation. As new methods of application are developed, new formulations are developed to take advantage of them. On the other hand as new 'wax' products are developed advances in application technology take place.

Types of Waxes

Solvent Wax

The most commonly used wax in Florida is the so called solvent wax (15). It is called such because it is based upon one or more resins dissolved in a petroleum solvent. The solvent will be different for each different formulation but they will have some characteristics in common. A typical solvent blend will be composed of 70-80% aliphatic hydrocarbons, up to 25% aromatic hydrocarbons and may include solvents such as acetone, ethyl acetate, etc. The blend will boil or distill between 200°F and 300°F for the most part and the lower boiling fractions will have a slightly higher proportion of the aliphatic hydrocarbons than the higher boiling portions.

In this solvent will be dissolved either a synthetic resin (coumarone-indene) or the calcium salt of a natural wood rosin that has been previously hydrolyzed with dimer acids. The latter resin in used almost exclusively for fruit destined for the Japanese market (22). Both types of resin formulation will also contain one or more plasticizing and/or leveling agents to assist in forming a shiny, flexible film on the surface of the fruit.

An important requirement of solvent waxes is that the fruit must be completely dry before waxing, whereas water waxes do not. Water waxes do require drying after application (16, 20, 24, 25, 26, 37). These two operations seem to