



# Texas Agricultural Extension Service

## Texas Citrus Packingline Operations

Alfred B. Wagner and Jullan W. Sauls\*



Packinglines vary greatly in layout and in the order of various fruit treatments. Most packing-houses handle two grades of fruit, both grapefruit and oranges, but a substantial proportion of incoming fruit is graded out or sized out as eliminations to be sent to processing. There is no reason to apply fungicides and waxes or to dry, color and stamp fruit which will not be packed fresh. Every fruit that will not be shipped fresh should be removed from the line as soon as possible. The following discussion is based on the most logical order of fruit treatment to accomplish that objective.

### Dumping and Surge Control

Boxes of fruit are emptied mechanically into the packingline. Dumpers range from simple hoist devices to elaborate cot-chain feed, destacking, dumping and restacking sections to handle a continuous flow of fruit automatically. The dumper itself consists of a lid with a trap door and hydraulics to raise and tip the box toward a conveyor. Thus, the fruit rolls out of the box through the trap door as the box is tipped from horizontal to past vertical. Water dumping is not recommended, even though water is easier on fruit, because of potentially severe contamination with decay-causing organisms.

To assure a steady flow of fruit to the line, surge control can be roughly regulated by the dump operator or can be accomplished mechanically. Mechanical surge-control can be achieved with twin belts (one fast, one slow), return flow belts with a traveling shear or a wide, short, slow-moving belt from which stacked layers of fruit are slowly fed into the line.

### Trash Elimination, Presizing and Pregrading

Trash can be eliminated by parallel bars over which the fruit rolls as it is dumped, or a sloping belt trash eliminator can be used. Self-cleaning, pintle rubber-wood roller conveyers to remove stems would not be necessary if harvest crews were better-disciplined.

A presizing unit is used to separate undersized fruit, dropping it onto a take-away conveyor to the processor bin. The number of oversized fruit is probably not sufficient to justify separate sizing rollers, as such fruit can be removed readily in pregrading and grading.

Pregrading to remove rotten and split fruit can be staged on either end of the presizer. Such fruit must be removed prior to the washer to prevent wash water contamination with disease organisms and juice acidity. Pregraders also should remove stems and any grossly oversized fruit.

### Washing

Washing removes dirt, sooty mold, scales, spray residues and most of the fruit's natural wax. Fruit is thoroughly pre-wetted on roller-conveyors as they pass under a series of coarse spray nozzles. Initial rotating brushes will remove most debris, after which foamed soap or detergent is dribbled onto the fruit to enhance cleaning as the fruit continues across the brushes. Adequate cleaning usually requires about 20 seconds on the brushes, but particularly dirty fruit should be exposed for 30 seconds. Brushes should be horsehair grade, rotating at about 100 rpm.

Fruit then is thoroughly rinsed as it passes over the last of the brushes or a roller conveyor just

\*Extension food technologist and Extension horticulturist, The Texas A&M University System.



beyond the brushes. Excess water on the fruit can be eliminated with sponge rubber rollers (donuts). Water is squeezed from donut rollers by spring-loaded wringer rollers mounted underneath, with the wringers being wiped by fixed neoprene blades. Horsehair-grade plastic brushes also are used to remove water from the fruit. Water on the brushes is removed by metal "flick bars" which barely touch the underside of the rotating brushes.

### **Grading**

Grading traditionally has been the last operation before sizing, but the economics of packinghouse operating costs dictate that grading be done immediately after washing. Fruit that does not meet grading standards is removed to the processing bin. Remaining fruit then is sorted into grades of uniform appearance with respect to color and blemishes. Texas citrus grading standards are discussed in detail in the Extension publication *Citrus Marketing Regulations*.

Most grading is done by hand as the fruit revolves backward while it travels along roller conveyors. Power rollers to revolve the fruit forward (reverse-roll) can increase grading efficiency, if properly adjusted and used. Electronic graders which sort for color and blemishes are being used by some California packers.

Cool, white fluorescent lamps should be used to provide about 180 footcandles of light at the fruit. Elimination and grade separation chutes should be flush with the grading table to preclude excessive lifting. Fruit flow should be diverted into several streams with three or four graders per stream, the most experienced graders being located at the end of the grading table. Graders tend to remove about 30 fruits per minute, regardless of quality, so the rate of fruit flow or the number of graders should be varied according to the overall quality of a given lot of fruit.

Packinghouses are noisy and fruit grading is monotonous and tiring. Every effort should be made to provide comfortable grading tables, even if that means using enclosed, air-conditioned rooms to deaden noise levels. Graders make the decisions that determine the fate of each fruit that reaches them. Experienced graders working in comfortable surroundings will generate maximum packout.

Most packinghouses use a second line to size and pack lower grade fruit, which may partly explain why most grading tables are located at the sizer. Even with a significant quantity of lower grade fruit, it is rarely economical to operate a second line. Lower grade fruit logically could be diverted at the grading table to accumulator bins, to be returned to the line following completion of the higher grade fruit.

### **Color-adding**

Color-adding is an optional treatment used only on oranges early in the shipping season. Consequently, it may be best to locate the color-add tank as a by-pass to the main line. Citrus Red No. 2 dye is applied as a dip or drench for 4 minutes at 120° F, followed by a rinse. The rinse prevents bleeding of the dye through the wax and ensures compliance with the FDA residue tolerance of 2 ppm. Rinsing is best done on washer-brushes on moving rollers to ensure good rinsing.

A water elimination system is used following rinsing. The water eliminator can be combined with a bed of horsehair-grade brushes, which also can be used to apply fungicide if a water-emulsion wax will be used. Solvent waxes can only be applied to completely dry fruit, so good water elimination will reduce time spent in the drier.

### **Waxing and Stamping**

Most of the fruit's natural wax is removed during washing, so it must be replaced to reduce moisture loss and impart a shine to the fruit. Both solvent-type and water-emulsion waxes are used. The solvent-type waxes must be applied to dry fruit only, so a drier must be installed in front of the waxer. Brushing is not necessary in the drier and can be quite damaging to fruit, consequently a roller conveyor in the drier is preferable. Air from the drier should be exhausted outside the building, as recirculating warm, moist air slows down drying and increases heat and humidity in the immediate vicinity. Solvent waxes are applied as a fine mist as the fruit passes through the waxer.

Water-emulsion waxes do not require completely dry fruit, so the drier is unnecessary. The wax is applied as a foam, dip, spray or brush wipe. Spraying is most common, using a pair of traveling



nozzles (wig-wag) over a bed of slowly rotating (not more than 100 rpm) horsehair brushes. Brushes can be cleaned with flick-bars on a sliding rack beneath the brush bed. A steam line connection to the wax-emulsion line may be installed for easy steam cleaning of the line.

Waxed fruits are dried on a "wax-setter," which is a two-sectioned slat conveyor 20 to 40 feet long. The outlet end of the first conveyor is a few inches above the inlet end of the second one so that fruit will flip over as it moves onto the second conveyor. Both solvent-waxes and water-emulsion types are self-polishing.

Stamping for color-add, grade, brand or other reasons commonly is applied through inked rollers. All grapefruit transported, marketed or sold in Texas must be stamped with state or country of origin. The stamp can be applied following water-emulsion waxing, but must be applied before solvent-waxing. The use of pressure-sensitive adhesive labels is increasing, although they are more expensive than ink stamping.

### Fungicide Application

Fungicidal treatment of fruit is essential to post-harvest quality control, as post-harvest diseases on citrus fruit most commonly show up after shipment. Several fungicides are effective in preventing post-harvest decay. Materials and rates are covered in the Extension publication *Texas Citrus Disease Management Guidelines*.

Both chlorine and sodium o-phenylphenate (SOPP) can be used in the wash water, with SOPP replacing the detergent during washing, or they can be used in the rinse water. The effectiveness of chlorine is dependent upon water pH, time of exposure and the amount of free chlorine present. SOPP affixes to minor surface lesions in the peel, but it too requires water pH control.

Thiabendazole (TBZ) and benomyl can be applied as non-recovery sprays after washing and water elimination. Benomyl can be applied in solvent waxes and all three (benomyl, TBZ and SOPP) can be applied in water-emulsion waxes. Diphenyl commonly is impregnated into treated pads to be enclosed in the final packing carton and often is used in conjunction with SOPP.

The selection of fungicides is such that the packinghouse operator can choose those that are most economical in a particular packingline operation. However, it is important to note that only those fungicides used during or just after washing are applied to ungraded fruit; the others can be applied after grading to preclude treatment of culls and eliminations.

### Sizing

Citrus are sorted into size categories for uniformity, eye appeal and ease of packing. Sizes correspond to half of the respective ring size of fruit. Belt-and-roll sizers are used most commonly, either longitudinal or central units, although transverse sizers and some weight sizers are used.

The longitudinal belt-and-roll sizer may be up to 40 feet long, involving several cylindrical (spindle) rollers and a belt inclined at about 30° to cause the fruit to rest against the rollers. Both belt and roller speeds are critical to cause fruit to spin on its equatorial axis and permit proper sizing. Research has shown proper belt speed to be about 225 feet per minute and roller speed to be 102 rpm. Thus, each roller separates only one size of fruit, one fruit at a time, dropping the smallest size first and the largest size last. The longitudinal sizer typically is set up over packing tables so that packing must be done in conjunction with sizing.

The central belt-and-roll sizer has the same characteristics as the longitudinal sizer except that several lines of sizers are incorporated into one central unit. Consequently, all fruits of a given size are collected on one conveyor line rather than being scattered over several different sizers across the packinghouse. Sized fruit then can be conveyed to packing stations for immediate packing or they can be accumulated in bins for later packing.

Both types of belt-and-roll sizers can be adjusted for oranges, grapefruit or tangerines. The transverse sizer has pairs of rollers which open up as they move along the machine, but they do not perform well on grapefruit and tangerines because those fruit have insufficient momentum to spin on their equatorial axis, which is necessary for proper sizing. Neither drop (perforated-belt) sizers nor weight sizers are used much in citrus sizing because of low capacity or cumbersome operation.

### Packing

Most citrus fruit in Texas is packed into standard cardboard cartons holding 7/10 bushel of fruit or into standard mesh bags. Gift fruit, however, is packed in a wide assortment of containers, as the shipment of such fruit is not regulated. Packed fruit is sold by weight but filling is by count.

Most citrus in Texas is hand-packed, but some mechanical aids are useful and complete automation is possible. Pre-assembled boxes (bottom and top pieces) are conveyed from an assembly area to the packing station for filling and closing. The packing station consists of a series of rollboard tables, where fruit is delivered by size to the top of the table where it rolls down in a single layer to the individual packer.



Most packers use movable stands to hold the cartons during packing, with filled cartons being rolled off the stand onto a conveyor to be palletized. The packing stand can be equipped with knee joints that can be tripped by the packer to automatically transfer filled cartons to the conveyor. Some packinghouses place the filled-container conveyor under the rollboard tables to better utilize space.

### Post-packingline Operations

Following packing, the packed fruits are placed on pallets and assembled into orders for loading and shipping. Containers may be stamped for size, grade, count, variety or other reasons as they move along conveyers to the pallets. Samples can be spot-checked for weight and grade verification. Containers are stacked by hand and secured onto pallets for subsequent handling.

Most Texas citrus is shipped in refrigerated trucks, although some export movement is by ship after truck-transfer to the dock. Depending on the season and distance to market, the palletized fruit may be pre-cooled in-house prior to loading or in-trailer during transit.

Some citrus is particularly sensitive to chilling injury in which sunken lesions or pits coalesce on the peel. Browning, water breakdown and scalding also are symptoms of chill injury. Grapefruit is quite sensitive to chill injury, but it can be stored successfully at lower temperatures by progressive pre-conditioning at higher temperatures.

Grapefruit should be stored and shipped at the same temperature, depending upon the season. An early season temperature of 60° F is gradually

reduced to 50° F in late season, except that fruit harvested beyond bloom should be treated as early season fruit and stored and shipped at 60° F. Oranges maintain maximum shelf life when stored at 32° to 34° F, but short-term storage and transit at 50° F is adequate.

Relative humidity in storage should be maintained near 90 percent. Ventilation during storage and transit should be maintained to preclude an increase in carbon dioxide and ethylene.

### Packinghouse Costs

A study was completed in January 1987, to estimate packinghouse costs for Lower Rio Grande Valley citrus. The study evaluated the 1982-83 season as that was the last complete season prior to the 1983 freeze. Data were collected, analyzed and aggregated for several cooperating packinghouses.

Average total packing cost per 40-pound carton during the 1982-83 season was \$2.01, which included fixed costs of \$0.38 and variable costs of \$1.63. This would translate to \$100.50 per ton of packed fruit. However, actual packing costs per ton would be expected to vary based on percent of actual packout. Few packinghouses would be expected to pack more than 80 percent of each ton of fruit received, i.e., 40 cartons packed and 10 carton-equivalents culled or eliminated to processing.

California reports higher costs per carton and uses smaller cartons. Equivalent costs per ton of packed fruit are \$143 and \$139 for grapefruit and oranges, respectively, in California. Florida packing costs were not available for the 1982-83 season for comparison.

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Issued in furtherance of Cooperative Extension Work in Agriculture and Home Economics, Acts of Congress of May 8, 1914, as amended, and June 30, 1914, in cooperation with the United States Department of Agriculture. Zerle L. Carpenter, Director, Texas Agricultural Extension Service, The Texas A&M University System.

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