Harvesting and Handling Peaches

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Harvest and conveyance of ripe fruit to the packing house concludes the orchard management phase of peach production. It initiates a new phase of management that requires its own unique skills. A series of systematic quality-oriented harvest and post-harvest operations, beginning with harvest and ending when the consumer utilizes the product, is a key to success in any peach operation. Managers must assess fruit maturity to balance between the optimal quality of a truly tree-ripe peach and retention of resilience and durability required to harvest, transport, grade, package, and market fruit. Each time the fruit is handled or moved is a step that should be analyzed as an individual component to optimize fruit quality. An understanding of fruit physiology pre- and post-harvest and of conditions that maintain fruit quality is essential.

Harvesting

Proper Maturity at Harvest

Peaches must be picked at a stage of development that is advanced enough to allow the fruit to ripen to high culinary quality, yet early enough to minimize bruising and premature softening during storage and transit. Deciding when to pick is difficult. Selection of picking dates is as much art as science. Variability in maturity, quality, and anticipated durability after harvest place a premium on experience and decision-making. Although every tested variety has an estimated ripening date relative to that of Elberta, the grower must adjust to annual fluctuations in ripening.

Excessively green fruit or soft fruit are undesirable, and over-mature fruit will be subject to rapid deterioration. Harvest workers should be trained to select for size and maturity. Green and undersized fruit should be left on the trees until they reach shipping maturity.

Multiple pickings are usually required for each variety to cope with the variable ripening of peaches. Picking must be selective, removing only those fruit mature enough to ship. Color and firmness are the two factors most employed in selecting fruit for picking. Environmental factors such as chill or frost can affect color, size, occurrence of soft tips, or striping of peel color. Parameters for judging maturity will continue to change with the releases of new varieties. Level of acceptability is a sliding scale that changes within each season by variety.

Ground color is the best field indicator of peach maturity. Considerable research effort has been given to the development of harvest standards based on color. The ground color of a peach approaching maturity is light green. A break in color toward yellow is the first definite indication of maturity. Brightening of the red over-color of the skin is another, though less reliable, index of maturity. Red color is typically dull prior to the green to yellow break. When the underlying ground color breaks to yellow, the red brightens and can easily be selected. Color judgments are reliable with many older varieties, but new highly colored varieties with higher percentages of red over-color have diminished the usefulness of color in maturity determination.

Varietal tendencies must be understood to make proper picking decisions. Some varieties can hang on the tree longer when ground color has broken to yellow, although others may have so much red over-color that the green to yellow break is hard to detect.

With highly colored varieties, firmness and size are key determinants of ripeness. Some varieties are firm when mature, while others begin to soften as soon as ground color breaks. Firmness may vary year-to-year on the suture, opposite the suture, and at the tip. These variations limit the value of objective pressure testing by instruments. Day-to-day picking judgments must be made for each variety. Many newer varieties are firmer at eating maturity and can hang on the tree longer.

As breeding efforts introduce non-melting flesh into the germplasm, estimation of maturity will become even more challenging and quality parameters of acidity and soluble solids may become more important. Clearly, orchard history and the grower's experience are critical to the proper determination of fruit maturity.

Experience and the General Rule. A break in ground color and a perceptible cushioning of firmness are frequently the best indicators of maturity. Growers and picking crews must be sensitive to changes in fruit shape and size as the fruit moves through its final swell to packing maturity to minimize soft tips, sutures, and shoulders.

Orchard to Packing House: Optimal Fruit Handling to Reduce Handling Injury.

Injury from rough handling is a key cause of fruit quality reduction. Bruises, cuts, punctures, compression, and abrasion injuries can be found on almost any fruit in a retail display. Consumers consistently avoid damaged fruit if undamaged fruit are available. The physiology of fruit is altered dramatically by wounding: (1) respiration increases with a corresponding decrease in shelf life; (2) ethylene production increases, which accelerates deterioration of the wounded fruit and adjacent sound fruit in the container; (3) undesirable color changes, such as flesh browning, occur; and (4) open wounds are a point of entry for pathogens, leading to decay. An important objective for any crew or packing house manager is the reduction of handling injury during harvest and post-harvest operations.

Handling injury is cumulative. When several steps in the handling system wound fruit, injuries accumulate, sometimes to the point fruit are down-graded or unmarketable.

Picking is step one in harvest and post-harvest management. Ideally, picking should be done in early morning when temperatures are lower. Rapid conveyance to the packing house and shading harvested fruit will reduce overheating and slow the post-harvest ripening.

The hands of harvesters are the most important hands that touch the fruit. A single careless step in harvesting can injure a peach and render it unmarketable. Workers should not have long, sharp fingernails. Gloves are desirable. Workers should not drop or toss the fruit. They should be taught to empty their bags, boxes, or buckets carefully, especially if the receiving container is empty. They should not overfill any container that might later have another container stacked on top.

Picking bags, bins, buckets, boxes, trailers, and all other field containers should be frequently examined for sharp edges, protruding nails or staples, and sand or gravel that could cause injury to fruit. Padding should be used in containers whenever possible to reduce impact and abrasion injuries.

An often-cited harvest management study by Ramsey in 1912 highlights common-sense steps to improve quality. Decay was less when: smaller picking bags were used; the manager did not harvest, but was free to manage the harvest crew full-time; and the manager took time to randomly inspect product piece by piece for harvest injury as well as proper maturity.

Farm roads are seldom smooth surfaces and are difficult to maintain. Moderation in transport speed, use of shock absorbers on trailers or flatbed trucks, and the use of plastic rather than wooden bins are all steps that help reduce fruit injury.

Published Quality Standards in the U.S.

U.S. Department of Agriculture Standards must be met for each of the four grades if classified by the U.S. Department of Agriculture.

> **U.S. Fancy** requires that the peaches have at least 1/3 of their surface showing blushed pink or red color and that at least 90% of them meet this color standard. U.S. Fancy has a 2% allowance, or tolerance, for soft or overripe fruit at destination.
> **U.S. Extra No. 1** requires that the peaches should have at least 1/4 of their surface showing blushed pink or red color and that at least 50% of the fruit meet this color standard. As with U.S. Fancy, 2% are allowed to be soft or overripe at destination.

U.S. No. 1 peaches do not have a color standard, but should be mature with a 2% allowance for soft or overripe peaches at destination.
U.S. No. 2 has no color standards and it allows for a greater percentage of fruit that are poorly shaped. As with all USDA grades, the tolerance for soft or overripe fruit at destination is only 2%.
California Well Matured fruit are mature enough to complete the ripening process without additional ethylene exposure. The over-blush is usually 90% of total for a given variety. Ninety percent of the lot must meet the color standard. There is a non-severe open suture tolerance of 25%.
U.S. Mature covers all U.S. No. 1 peaches, stipulating that fruit are mature enough to complete the ripening process without additional ethylene exposure. There is a non-severe open suture tolerance of 25%.

Physiology of the Peach After Harvesting

Peaches are climacteric fruit, they can be harvested when they are still firm but physiologically mature, which means they will continue to ripen after harvest. This is analogous to the "California Well Matured" grade. A harvested peach is alive, and is physiologically active as it ripens and eventually becomes senescent. If the fruit is injured by storage at inappropriate temperatures or improper handling, its senescent phase is advanced, significantly shortening shelf life. In peaches, advanced senescence brings unfavorable mealy flesh textures and undesirable flavors, particularly the absence of typical peach flavor volatiles. Flesh discoloration and internal browning can be initiated by improper storage conditions. Temperature and humidity are the key post-harvest environmental factors influencing the quality and shelf-life of the harvested peach.

Softening of a harvested peach is prompted by cell-wall-degrading enzymes that become active during the final stages of ripening. Softening occurs more rapidly in freestone fruit than in cling peaches. The levels of ripening enzymes vary from one variety to the next, which affects their natural flesh firmness. Higher temperatures increase the activity of ripening enzymes. In general, a peach will ripen as much in a day at 70°F as it will in a week at 32°F. Obviously, refrigeration is an effective way of slowing the rate of ripening.

During the ripening process, respiring fruit utilize oxygen and metabolize sugars, converting sugars by enzymatic action into heat, chemical energy, carbon dioxide (CO_2), and water. Heat is given off by the fruit into the environment; the chemical energy is used to maintain cell and fruit integrity, to support enzyme activity, and for synthesis of ripening compounds; the CO_2 is expelled into the atmosphere; some water is used for enzyme activity, some accumulates in the tissues, and some evaporates. The production of energy from sugars is called respiration. Under proper conditions, respiration keeps the fruit in a fresh and constantly changing condition. Eventually, sugars and other stored components are depleted, which reduces flavor. Respiration can be slowed to prolong ripening. As respiration slows, fruit produce less heat, softening by enzymatic reactions is retarded, and flavor changes due to metabolism of sugars are reduced. Temperature reduction slows enzymatic action, as do reduced oxygen and increased CO_2, which in turn reduces respiration rate. A 10°C (18°F) increase in temperature increases peach respiration 2 1/2 times. Respiration peaks when fruit go from optimal ripeness to over-maturity or senescence. This physiological watershed between underripe and overripe is referred to as the climacteric. To maintain fruit quality, peaches must be picked early enough to reach the consumer before the fruit becomes overripe. The climacteric is easily reached in peaches stored at 50°F or above, which accelerates the progress toward fruit senescence, and deterioration of flavor and texture.

Temperature is the most important determinant of the shelf life of fruit. Uncooled fruit can deteriorate more in 1 hour at 90°F than in 1 day at 40°F or in 1 week at 32°F. Most of the physiological processes associated with fruit deterioration operate more rapidly at high temperatures. Understanding the relationship between temperature and fruit senescence is required in order to properly handle peaches during the post-harvest period.

During refrigerated storage of peaches, air exchange is required to dissipate CO_2 and heat of respiration. Slightly elevated CO_2 may reduce the respiration rate, but levels above 5% can induce flesh browning around the pit. Any interference in gas exchange that restricts oxygen absorption and causes internal build-up of CO_2 shortens the storage life of peaches and promotes development of off-flavors. Even heavy wax on the fruit surface may cause undesirable internal conditions (anaerobic respiration) that will cause the formation of alcohols detected as an off-flavor. The heat of respiration must be constantly dissipated. Warm peaches in an inadequately cooled and ventilated truck may actually grow warmer while in transit. It is very important to thoroughly cool fruit before shipping or storage.

Challenges to Meeting Quality Standards

The many fruit choices available to consumers mean peaches must be attractive, flavorful, and free of internal breakdown to sell competitively. The difficulties with harvesting southeastern peaches at tree-ripeness have been recognized for decades. The region's uneven growing conditions increase variability in maturity at harvest, with corresponding variability in the rate of softening.

Studies in South Carolina and Georgia have documented variability in firmness at harvest. Puncture pressures varied from 5 to 22 pounds. This great a range of firmness at harvest dramatically increases the range of firmness throughout storage, in the supermarket, and in the consumer's refrigerator. In the same studies, temperatures varied from 38° to 51°F over 5-day storage periods; storing peaches in this temperature range is very detrimental to quality. University of California studies have shown this temperature range encourages mealiness, internal browning of the flesh, and inconsistency of ripening.

Fruit held at ambient temperature (roadside market conditions) soften at a rapid rate. If these fruit are sold by the second day after harvest, the consumer will have a fruit of nearly perfect eating quality. By the third or fourth day, the fruit will be completely soft, so fruit picked at a tree-ripe maturity must be moved virtually overnight if they are held without cooling.

Temperature Management

Pre-cooling is the rapid removal of field heat to reduce fruit temperature. Ideally, the internal fruit temperature is reduced to the desired range (32° to 37°F) for shipment within 24 hours of harvest. Peaches are generally pre-cooled by hydro-cooling or forced-air cooling. In the Southeast, the traditional method of choice has been hydro-cooling. Simply placing the fruit in a refrigerated storeroom does not constitute pre-cooling. For the grower who is still flexible in the selection of cooling method, there are a variety of theoretical and practical considerations that should be reviewed.

Heat is removed from the pit and interior pulp to the surface by a process known as conduction and from the fruit surface to the cooling medium by convection. Cooling or heat transfer can be achieved through air or water flow. The rate of fruit cooling is influenced by the fruit's temperature at harvest, the thermal conductivity of the peaches, the temperature difference between the peach surface and the cold water or air, and on the heat transfer efficiency between the fruit surface and the cooling medium. Because water conducts heat more quickly than air, hydro-cooling is more rapid than forced-air cooling. It is important to continuously maintain the cooling medium close to the target temperature for the fruit, especially during the last portion of the cooling period.

Cooling time is influenced by product diameter, with larger fruit requiring more cooling time. Internal fruit temperature should be monitored every 30 to 40 bins to assess the effectiveness of cooling. Cooling schedules usually are designed to achieve seven-eights cool (Figure 1). Typically, peaches with an average temperature of 90°F should be cooled to at least 40°F before storage or shipment.

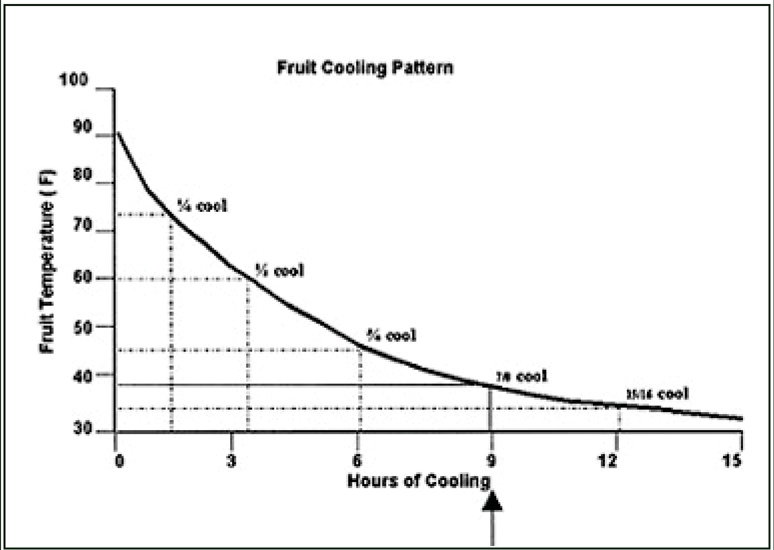

Figure 1. Fruit-cooling pattern in forced-air coolers. A similar pattern, with shorter times, is seen with hydro-coolers. Fruit should be left in the cooler until the fruit reach seven-eighths cool.

Hydro-cooling provides very rapid cooling (Table 1). Refrigeration capacity, Btu's/hr, required for hydro-cooling is therefore greater for hydro-cooling than for other, slower cooling methods. Table 1 lists the refrigeration heat loads and refrigeration requirements for hydro-cooling 100 bushels of peaches per hour at typical temperature reductions. Forced-air cooling is slower, so the refrigeration capacity required is proportionately less. However, more cooled space is required to cool a similar volume of fruit.

Table 1. Refrigeration requirements for hydro-cooling 100 bushels of peaches per

hour.

Temperature Reduction (°F)	Heat Load (Btu/hr)	Refrigeration Requirement (tons)
30	165,600	13.8
40	220,800	18.4
45	248,400	20.7
50	276,000	23.0
55	303,600	25.3
60	331,200	27.6

Hydro-cooling is popular because of its efficiency and speed. The heat transfer coefficient from the surface of peaches to water is up to 20 times greater than to air, depending upon the relative flow rates of the two cooling mediums. With hydro-cooling, 15 to 30 minutes is generally sufficient if the water is 35°F.

The chief weakness of hydro-cooling is potential contamination and spread of decay-causing organisms to clean fruit. Hydro-cooler water should be changed frequently and kept at a chlorination level which provides surface sanitation of the fruit.

Criteria for Efficient Hydro-cooling

(1) In shower-type coolers, water flow over fruit in shallow, single bin layers should be 7 to 10 gallons per minute per square foot (gpm/ft2) of cooling area. In double-stacked pallet bins, with about 4 ft. of product depth, flow rates should be 20 to 25 gpm/ft2.

(2) Hydro-coolers should be designed so that the water never falls more than 8 inches before reaching the fruit. A water-drop of more than 8 inches can cause surface injury. If the hydro-cooler water must fall more than 8 inches, bins should be covered with perforated lids to reduce effective water-drop height.

(3) Interference with contact between fruit and cooling medium, for instance, containers, film,s or tight fill, reduces cooling effectiveness.

(4) Although it is difficult in actual practice, water temperature should be ideally kept at 32° to 33°F.

(5) For adequate water flow through the package, containers must have top and bottom venting.

(6) In addition to bin design for free flow of water, bins should be kept free of leaves or other debris that block vents and cause water channeling.

(7) Use potable hydro-cooler water that is clean and free of decay-causing organisms to prevent spread of decay throughout the lot of fruit.

(8) Maintain chlorine levels of 50 to 150 ppm at a pH of 6.5 to 7.0. At lower pH levels, equipment corrosion problems and release of toxic chlorine gas can occur, and metals such as iron are more soluble and prone to cause inking. The hypochlorite ion that is formed above pH 7.5 is not very germicidal. Refer to hydrocooler water sanitation section for more recommendations.

(9) Change cooler water daily or more often depending on hydro-cooler usage.

(10) Cooler design should allow easy inspection of the water distribution pan for plugged holes. Remove debris and sediment from the reservoir frequently. Self-cleaning trash screens should be used.

(11) Unless all metal surfaces are stainless steel, maintain them with adequate paint coverage to reduce the corrosive effects of chlorine and contamination of hydro-cooler water with iron.

Forced-air cooling is commonly used in the western growing areas of the United States. Packaged fruit in vented containers are stacked in patterns with air baffles to channel cold air that is drawn or forced through the containers. With forced-air cooling, a tunnel is formed by bins or pallets of fruit. Air is pulled through the stacks of fruit by a fan. A slight pressure drop is formed across containers when the cooling tunnel is tarped. The movement of cold air across warmer fruit results in a more even, efficient form of room cooling. **Air flows of one to three cubic feet per minute per pound of fruit are recommended. A minimum of four hours is suggested to cool fruit by this method, but in practice six to eight hours are more likely required to accomplish the task.** The chief disadvantage of forced-air cooling is the requirement of a larger refrigeration system and more cooled space to compensate for the increased cooling time compared to hydro-cooling. The greatest advantage of forced-air cooling is its low propensity to spread fruit rots.

Preconditioning is a delay in cooling fruit to the target shipping temperature in order to allow the ripening process to begin prior to shipment. Some western shippers have adopted the practice, but it is not commonly employed in the Southeast.

Table 2 compares the advantages and disadvantages of hydro-cooling vs. forced-air cooling.

Table 2. Comparison of hydro-cooling and forced-air cooling processes.

	Hydro-cooling	Forced-Air Cooling
Container Design	Requires water resistant containers.	Package design for adequate air flow.
Speed	Fast thermal transfer through water.	Slow thermal transfer through air.
Space	Much less space required because fruit are moved through in less than one hour.	High volume capacity required to cool a similar amount of fruit in a packing facility.
Fruit Dehydration	None	May be reduced by short cooling periods and 80% relative humidity.
Tendency to Increase Fruit Rots	Water sanitized to reduce rots. Even with sanitation, use of water cooling medium increases prevalence of rots.	Slower field heat removal lowers overall tendency to rot compared to hydro-cooling.
Energy Efficiency	3.5 times more energy efficient than forced-air. Difficult to optimize and maintain at highest efficiency.	Easier to optimize and maintain at most energy-efficient conditions possible with forced-air.

Packing

A peach packing line is a tightly integrated series of individual operations designed to off-load, convey, wash, sort size, and package fruit with minimal damage to the fruit. Additional steps may be incorporated into the packing line: a cooling operation (either before the line or integrated in the line) and fruit waxing to improve fruit appearance and reduce water loss. A post-harvest fungicidal treatment can be considered to prevent fruit rots and may be more advisable if rots are abundant. The packing line should package well-graded, attractive peaches, and it is the manager's responsibility to do so economically and without over-handling of fruit. Each element in a packing line is an opportunity to improve fruit quality or prevent its deterioration. Growers operating orchards of 100 acres or less are typically well advised to arrange for packing of their crop at other packing houses if commercial shipments are desired.

Packing house layout demonstratively impacts efficiency, and planning begins with analysis of present and future hourly packing rates. Decisions on operational steps are needed to establish the specific sequence in fruit handling. Equipment selection and design of the layout are done simultaneously to optimize efficiency. A representative layout rated for a capacity of 350 bushels packed fruit per hour would often include the operations illustrated in Figure 2. The greatest cost in packing line construction is its length. Generally, packing designs that accomplish volume movement with wider conveyors cost less to build and operate than those that do so with longer conveyors. Conveyor velocity and width should be designed to accommodate fruit packing during peak loads.

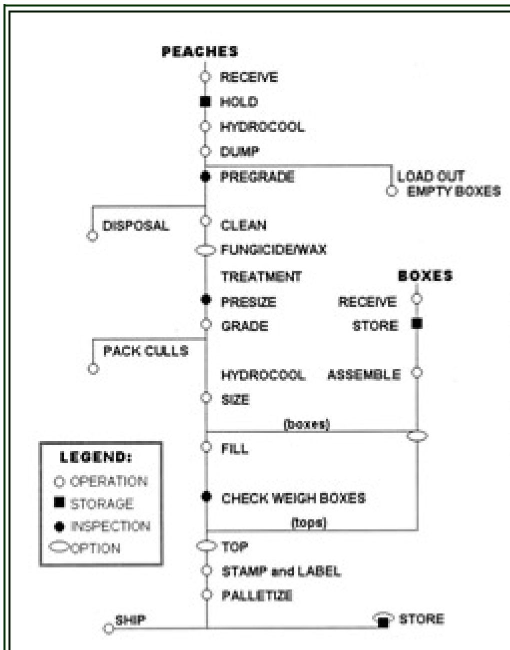

Figure 2. Sequence of operations in a typical peach packing house. (Adapted from Forbis, W.R. 1967. USDA-ARS Bulletin #52-19.)

The packing line itself can be a significant source of fruit injury, but it is one of the easiest areas in which to diagnose problems and implement solutions. Transfer points, where the fruit move from one machine to the next, are the most common problem areas. Strategic use of deceleration curtains and padding can virtually eliminate bruising in the packing house. Such modifications are inexpensive and effective.

Dumping of fruit from field bins onto the packing line must be accomplished with as little bruising and abrasion as possible. In the eastern United States, both wet and dry dumps are in use. The dumping operation is one of the most troublesome areas for impact injury. If fruit are dumped onto a dry surface, look for ways to minimize the distance that the product is dropped and utilize padding on rigid surfaces. The use of water dump tanks (tank capacities range from 500 to 1,500 gallons) can help reduce the shock of emptying fruit, but carefully manage the water quality to minimize the spread of fruit decay. Fruit are lifted from the dump tank water by simple conveyors, roller conveyors being the most common. Conveyor sides should be covered with padding to minimize fruit abrasions.

Pregrading for removal of trash, particularly leaves, along with removal of undersized or damaged fruit, follows dumping. This process can be accomplished on an apron conveyor or sloping belt trash eliminator, supplemented with hand separation to remove rots or splits.

Defuzzing is a standard practice in most peach packing houses. Defuzzing is usually combined with a wash. Fuzz is removed using wet knives, high-pressure streams of water, or by brushing. High-pressure water defuzzing uses high-pressure water sprays against fruit rotating on metal rollers. The spray pattern is flat and fan shaped and the force of the spray removes peach fuzz. This method reduces the hazard of brush abrasions, but does not produce the close and uniform defuzzing action of brushes. Brush defuzzing is generally done by moving fruit along banks of transverse rotating nylon brushes washed by fresh water sprays. If the flow of fruit is interrupted, fruit should be manually raked across the brushes to avoid excess brushing**. Surface moisture can be removed from peaches by use of polyurethane or sponge rollers. Rollers should be well washed in detergent before mounting and as part of the daily packing line maintenance to reduce the risk of purple or black discoloration.**

Peaches are sorted and sized by manual, mechanical, and electronic options. Mechanical devices effectively accomplish sizing, although in smaller packing houses manual sizing is practical. Dimension and weight sizers are the most frequently used equipment. Dimension sizing is based on moving fruit over a series of conveyors or tapered rollers with progressively larger openings. The small fruit removed at the narrow end are generally the less mature. Electronic systems for sizing and, in some cases, color sorting are also used. Most electronic sizing systems sort by weight, but newer optical technology is being developed to sort on the basis of spherical size. Electronic color sorters split the line into two or three conveyors based on hue properties of the fruit surface.

Control of fungal pathogens in peaches is an indispensable aspect of peach crop management. A good pre-harvest integrated pest management program of well-timed fungicidal applications is necessary. Water quality management and temperature are very important components of the decay-control program. Supplemental decay control is often desired. Packing line application of fungicidal compounds is the next line of defense for rot control. When post-harvest fungicides are used, they are introduced after the pre-grading and may be mixed with wax.

Waxing peaches can be an important cosmetic enhancement that reduces water loss from the fruit and has the additional value of providing a carrier for post-harvest fungicide application. A variety of commercially manufactured waxes employ either water-soluble paraffin base waxes or emulsifiable mineral or vegetable oils. If post-harvest fungicides are used, they can either be premixed into wax concentrates or can be sprayed onto the fruit prior to waxing. Wax is best applied over a bed of brushes. As with any brushing operation, fruit must be manually raked through the waxer if there is an interruption in flow or if mechanical rakes malfunction.

Grading occurs in an initial or pre-grading step, followed by a detailed grading, normally after sizing. Good fruit presentation on well-lit, flat-belt conveyors materially improves the quality sorting. Overripe, misshapen, or blemished fruit are removed in this operation.

In the southeastern United States, peaches are generally placed into 1/2 bushel (25 lb.) boxes by volume. Mechanical fillers normally handle eight to twelve boxes per minute. Volume filling can bruise fruit. Impact forces as much as four times the acceptable force have been measured at some fillers. Fruit bruising during box filling can effectively be minimized by elimination of excess impact force by shortening drops; use of well-placed curtains to slow fruit velocity; employing sloped box fillers to reduce drop distance; and use of box cushioning to allow transfer of impact force from the fruit to the cushioning device.

After check weighing on an over-under scale, boxes are lidded and conveyed to the stamp and labeling machine. Lidded and labeled boxes are then palletized before cold room storage or placement onto trucks for transport. Proper placement of boxes on the pallet facilitates efficient air movement when the fruit are stored prior to and during shipment.

Storage

Successful storage of peaches, whether for two days or two weeks, requires proper refrigeration and high humidity.

Most sound and well-matured peaches can be stored for two weeks at 31° to 34°F and 90% relative humidity with no significant loss in dessert quality. Some freestone varieties and most clings may be held for longer periods. If the peaches are underripe or if temperatures range from 36° to 50°F, some deterioration of flavor and texture occurs. Freezing occurs at 30°F or lower. At relative humidity lower than 90%, weight loss and shriveling occur.

Internal breakdown of peach pulp is expected to occur from 36° to 50°F. Packing house storage facilities have been seen to fluctuate in this range. Maintaining cold room temperature below 36°F is difficult, but important. Doors in coolers must be opened frequently to move fruit into or out of the rooms and even with well-maintained, flexible curtains, excessive air exchange often occurs. Also, warm fruit often is placed in the same room with chilled fruit, which makes it harder to maintain proper fruit temperature. Finally, adjustment of the delivery air to a lower temperature that can compensate for the heat load creates a risk of freezing fruit. Ideally, rooms should be equipped with very large heat exchange coils and effective thermostatic control systems to meet these challenges. Although southeastern peaches are seldom stored long enough for internal breakdown symptoms to become apparent, there is considerable interest in prolonging storage times to buffer the impact of poor prices. If storage is to be used in this way, temperatures must be consistently maintained in the 31° to 34°F range.

Refrigeration systems are expensive to install and costly to operate. Consult a professional refrigeration engineer in an analysis of any refrigeration project. The major refrigeration equipment requirements for cold room storage are the evaporator, compressor, and condenser. In addition, fans, valves, gauges, switches, and liquid refrigerants are required. The equipment must be compatible and capable of meeting the refrigeration requirements of the storage room during peak loads. Evaporator surfaces must be large enough to function with no more than a 2°F dry bulk temperature difference between the refrigerant temperature and the room air temperature. The compressor must have enough unloader capability to reduce capacity when peak loads are over.

Key factors in a properly constructed cold storage room are the vapor barrier and insulation. The vapor barrier consists of a watertight resin or polymer coating or a metal foil or plastic fiber placed on the cold side of the insulation. This barrier prevents the movement of moisture through the walls, which will saturate insulation and lessen its ability to insulate. The insulation should be three to six inches of materials of expanded polyurethane or polystyrene, or a urethane coating foamed on site. A well-designed vapor barrier and insulation system permits economical temperature control and the maintenance of the high humidities required for the storage of peaches. Cold room layout should consider placement of palleted loads or stacks of bins so fruit can be efficiently cooled through ventilation slots in the fruit boxes or forklift openings in bins via forced-air cooling.

Periodic, scheduled cleaning of the storage facility is imperative to reduce the level of disease inoculum that accumulates in cold rooms. Cleaners should have both cleaning and disinfectant properties.

Loading and Shipping

Prior to loading any trailer, inspect it for cleanliness. Require drivers to thoroughly clean and disinfect trailers after transit of unsanitary products. Pre-cool trailers prior to loading. Peaches should be loaded so they are protected from physical damage caused by container shifting and from overhead weight and vibration. Use stacking patterns that will promote adequate air circulation through the load to uniformly maintain flesh temperature. Facilitate airflow through the use of loading patterns that provide lengthwise air channels through the load so heat can be removed by the refrigeration system. To provide maximum access openings to all air channels, a starter stack should be placed against the front bulkhead of the trailer (Figure 3). Subsequent stacks should be loaded in a 7 x 6 pattern (Figure 4) that will provide air channels in alternating layers. So that airflow in the air duct will not be restricted, boxes should be loaded to a height that will be no closer than 10.5 inches from the ceiling of the trailer. One row of "floaters" may be loaded adjacent to the sidewall to within one inch of the ceiling of the trailer. All boxes should be loaded tightly from the front to the rear of the trailer, neither loosely spaced nor flush with the rear door. Boxes should not protrude beyond the extruded flooring at the rear of the trailer, as this hinders airflow and circulation. When space remains between the last stack and the rear door of the trailer, an end gate or other type of load-securing device should be placed against the rear face of the last stack in the load to prevent load shifting and to maintain the alignment of the boxes and loading pattern.

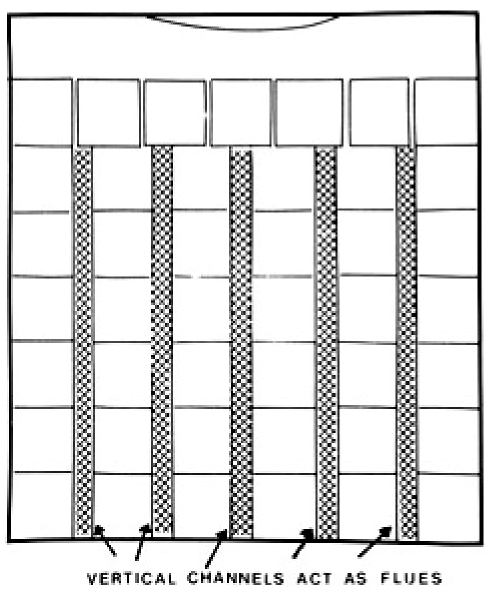

Figure 3. Proper construction of the first or starter stack next to the bulkhead wall of the trailer allows the formation of vertical air channels that act as flues. (Adapted from Wells et al. 1989.)

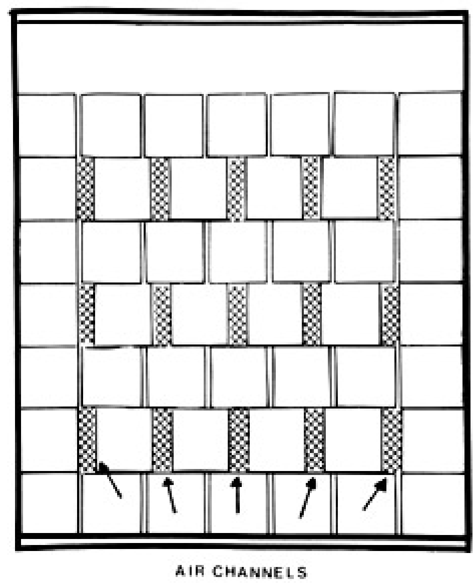

Figure 4. The loading pattern through the length of a highway trailer allows the establishment of air channels from front to rear. (Adapted from Wells et al. 1989.)

Under no circumstances should peach boxes be loaded beyond their stacking strength limitations. Generally, boxes with combination board weight strengths of only 350 lbs. for the body and 275 lbs. for the cover should not be stacked more than seven layers high.

Highway trailers should be loaded with 750 to 1,500 1/2 bushel boxes, depending on trailer length. Stacking of 8 or more layers high is excessive and may lead to crushing and damage. Trailer temperatures should be maintained at 32° to 34°F. Growers should be familiar with the truck driver, intended route and timetable, and the likelihood of mixed loads. Other horticultural commodities that have requirements compatible to peaches may be shipped with peaches in mixed loads.

Wholesale and Retail Handlers

Managers of wholesale warehouses and retail outlets are important participants in a peach quality program. Of special importance is temperature management. If peaches have been produced, packed, and shipped in a process that is well integrated and managed to assure uniformity of fruit condition, then the wholesale and retail managers may be able to manipulate temperature so that the fruit is ready to eat at the point of sale.

Everyone who handles peaches has a responsibility to the consumer to deliver the best possible quality.