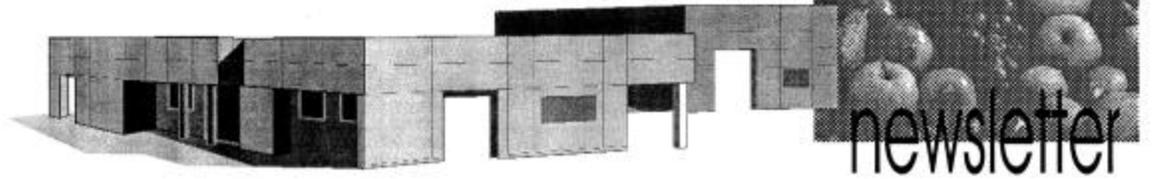




Central Valley **POSTHARVEST**

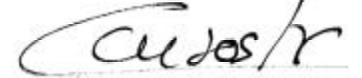


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 Carlos H. Crisosto, Editor

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TIPS TO INCREASE PEACH CONSUMPTION

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In the last decade, total production of new yellow and white flesh peach cultivars with different titratable acidities and flavors has increased rapidly. However, USA peach consumption has decreased to approximately 4.4 lb/per capita/per year during the last 20 years. Consumer surveys have associated low peach consumption mainly to the lack of consumer understanding between mature and ripe peaches, and to the presence of flesh

browning and flesh mealiness (chilling injury or internal breakdown). In both cases, consumers do not perceive potential peach flavor.

Short and long-term approaches to increase peach consumption are being tested. In the short-term: proper temperature management for packers, shippers, transportation, buyers and receivers, and preconditioning/preripening treatments at the shipping point are commercially used with success in California; and educational promotional programs on peach handling/ripening for peach shippers, buyers, retailers and consumers have been established. As a long-term solution, programs to understand the genetic and

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biochemical basis of flavor, antioxidant attribute pathways, and chilling injury genetic control by using available molecular genetics technologies are developing. The use of this new information and techniques for breeding programs will allow the development of peach cultivars with new flavor and improved antioxidant attributes and freedom from chilling injury.

Introduction

Americans eat approximately 4.4 lb of peaches per capita per year. Even though these fruits are seasonal, this value is small in comparison to other fresh fruit consumption such as apples (~35.2 lb) and bananas (~19.8 lb). One approach to increase stone fruit consumption is to determine what factors are leading to consumer dissatisfaction and deal with these issues. Following this approach, research, education and promotional programs must be targeted to respond to these issues. A survey conducted by UC Davis researchers indicated that hard fruit (unripe), mealiness, lack of taste, and failure to ripen are the main reasons consumers do not eat more stone fruit. These complaints are a consequence of two main problems: the fact that consumers do not understand the difference between mature and ripe (“ready to eat”), and the expression of internal breakdown (IB) symptoms.

After solving these two main problems, a detailed research program focusing on understanding peach quality attributes including sensory evaluation studies using trained panelists and consumer tests, industry quality surveys, and evaluation of the role of orchard factors on peach quality attributes should be pursued. A classification of the current peach cultivars in different organoleptic/flavor groups may be accomplished. The creation of these specific and well-defined peach flavor groups can be useful for promotion and marketing activities focused toward different ethnic groups.

The Lack of Ripening Problem

In California, peaches are normally picked when ripening has been initiated (high mature stage), thus producing sufficient ethylene to carry on ripening upon arrival to the warehouse. Therefore, stone fruits harvested at the “high maturity stage” do not need ethylene exposure to ripen properly. The rate of fruit ripening varies among peach cultivars and it is controlled by temperature. A fast rate of ripening is achieved at 20 to 25°C (68-77°F) and a low rate of ripening is accomplished by using lower temperatures. Temperatures higher than 25°C (77°F) will reduce the rate of ripening, inducing off flavors and promoting irregular ripening. Generally, white flesh peaches have a high rate of softening.

Flesh firmness is the best indicator of ripening and one predictor of the potential shelf life. Fruit that reach 6-8 lb are considered “ready to buy.” Fruit that reach 2-3 lb flesh firmness are considered ripe, (“ready to eat”). Thus, the end of ripening is determined by the firmness.

Fruit that arrives in your warehouse or retail store should be tested for flesh firmness using a standard fruit penetrometer. A ripening protocol based on warming should be established according to the anticipated consumption schedule (fruit turning schedule). Soft fruit are more susceptible to bruising and decay than hard fruit. To reduce potential physical damage occurring during transportation from the warehouse to retail stores and handling at the retail stores, we suggest transferring fruit to the retail store before fruit reach 6-8 lb for peaches (transfer/shipping point). The establishment of these transfer/shipping points is based only on our previous experience with fruit damage during retail handling. As bruising incidence varies among different retailer operations and among cultivars, you should fine-tune your own transfer points for your conditions.

Temperature conditions for peaches during and after ripening should be adjusted according to the desired speed of ripening. The rate of fruit softening (number of days to reach 2-3 lb) varies among peach cultivars and can be controlled by the storage temperature used. For example, mature 'O'Henry' peaches are usually harvested and shipped with flesh firmness between 12-14 lb. If these California 'O'Henry' peaches arrived at the distribution center with an average firmness of 12 lb and were placed in the 20°C (68°F) room, they will reach 2-3 lb ("ready to eat") after 6 days. To reduce bruises, we recommend that stone fruits be delivered to the retail store before they soften below 6 lb. Thus, the 'O'Henry' peach should be delivered to the retail store by day 3 after arrival. These peaches will be ready to eat (2-3 lb) by 48 hours after delivery to the retail store. As stone fruits will continue to ripen in the display case, they should be checked often and the softest fruit be placed at the front of the display. Checking fruit firmness daily is highly recommended to control ripening rate. To slow down ripening speed, stone fruits should be kept at low temperatures. Peaches, plums, and nectarines harvested at a lower maturity stage than the "well mature stage" may need added ethylene (100 ppm for 24 hours or longer) to ripen evenly.

The Internal Breakdown Problem

Some of the most frequent complaints by consumers and wholesalers are the presence of "off flavors", flesh mealiness, flesh browning, and black pit cavity. These symptoms are a consequence of internal breakdown (IB), also called chilling injury, dry fruit, mealiness, or woolliness. This disorder is the main limitation to the marketing of some peach cultivars. These symptoms normally appear after ripening fruit at room temperature following cold storage. For this reason, this problem is usually experienced by the consumers, not the growers and/or packers. Among IB susceptible peach cultivars the greatest expression of the internal breakdown symptoms occur at temperatures

between about 2.2° and 7.8°C (36°F and 46°F). While symptoms will still develop at 0°C (32°F) or below, they develop more slowly and normally become less intense than at higher temperatures. Because peach market life is shortened by exposing cultivars to temperatures between 2.2° and 7.8°C (36°-46°F), this temperature range has been named the "killing temperature range". Unfortunately, our survey indicated that 80% of domestic peach shipments arrived within the "killing temperature range".

In IB susceptible peach cultivars, market life is dramatically reduced when fruit is exposed for 3 to 7 days at this temperature range. For example, 'O'Henry' peach market life can be reduced from at least 4 weeks at 0°C (32°F) to only 1 week by exposing fruit to 5°C (41°F). In our peach storage test, California 'O'Henry' peaches developed visual mealiness symptoms after two weeks storage at 5°C; however, trained judges were able to detect "off-flavors" or mealy texture one week before the visual mealiness symptom was apparent. Flesh browning was observed after week 3, approximately one week later than the mealiness symptoms.

Several treatments to limit internal breakdown symptoms have been attempted. Among them, controlled atmospheres (CA) and pre-ripening have potential benefits when used properly. Use of controlled atmosphere (high CO₂/low O₂) conditions in combination with temperatures near 0°C (32°F) during storage/shipment has extended peach shipping life. CA has a satisfactory control of flesh browning but not as good for flesh mealiness. The limited success and reliability of this treatment depends on factors such as fruit size, position of the fruit on the tree, cultivar market life, shipping duration and temperature.

A preconditioned treatment to limit IB prior to shipment is being carried out successfully with consistent results under California conditions. Currently, there are several companies that are

offering high quality delivery programs based on this preconditioning treatment. Thus, California industry is offering preconditioned/pre-ripened fruit to a wide group of retailers. This new system allows the potential of delivering to retail stores peaches that are “ready to buy” or “ready to eat” with low occurrence of internal breakdown symptoms, and high consumer acceptance. This new fruit delivery system is one more approach to limit internal breakdown and protect the fruit eating experience for consumers. Delivery of preconditioned fruit should fit very well with our ripening protocol for retailers. Preconditioned fruit will tolerate very well temperature exposure within the “killing temperature range” during the postharvest handling.

Due to physical and chemical changes occurring to fruit during the preconditioning treatment, fruits are allowed to express higher eating quality. Fruit becomes tastier, more aromatic, and juicier, resulting in high consumer acceptance. A controlled preconditioning/pre-ripening treatment induces fruit softening to the “ready to buy” stage (approximately 2-3 lb for peaches). Under an efficient marketing program, preconditioned/pre-ripened fruit should have a consistently higher retail price.

As the preconditioning/pre-ripening treatment is limited to a group of orchards/cultivars, the supply of fruit handled under this new system is not available during the entire tree fruit season. If the program is not properly monitored, decay development, shriveling, and excessive softening may become a commercial problem. Fast cooling and maintaining temperature prior and during shipment are essential to protect fruit quality from fast deterioration. A high refrigeration capacity may be needed for this program. The product should be packed to specific marketing requirements depending on customer desires, such as being stickered with PLU (tree-ripe codes) and packed in attractive display-ready

pre-print cartons that are either single layer or double layer in depth. An aggressive marketing and promotion program is required. Retailer and consumer education on the handling of preconditioned/pre-ripened fruit is important to increase the demand of this new high quality fruit delivery system.

Over the long term, the best approach to eliminate the internal breakdown problem would be to breed cultivars resistant to it. To achieve this, new gene manipulation techniques and fundamental knowledge of internal breakdown need to be developed.

The SSC as a Quality Index

Currently, we do not have enough reliable information from different cultivars to justify the potential establishment of SSC as a quality index. We have such a diversity of potential flavors in our current 200+ peach cultivars that we cannot simplify this complex issue by choosing SSC without the support of solid research over a long period of time.

To define a high eating quality fruit, we are using the following steps: First, an industry quality survey of initial fruit quality attributes. This information will reveal the range of fruit quality attributes within the industry. For example, it will help to narrow the SSC and TA levels that will be used in our sensory studies. Second, preliminary studies on the role of preharvest factors in relation to these parameters should continue. It is very important to realize the cultivar quality potential, thus, our suggested quality indexes will be attainable by these industries. A trained panel test to identify the important components of taste quality such as sweetness, sourness, aroma, texture and overall peach flavor intensity and the interrelationship among them will be determined. Understanding the role of these quality attributes in consumer preference is important to design the “in store” consumer test to define a quality index(es). These “in store” consumer tests will be designed based on

the results of the trained taste panel and industry survey. After the completion of this program, the peach industry will have more information to discuss if the establishment of this index(es) will help to consistently deliver peaches of high eating quality.

Our preliminary “in store” consumer test indicated that high consumer acceptance is attained with our mid-season cultivars when peaches are free of internal breakdown and “ready to eat” prior to consumption. On the other hand, if a “tasty peach” is chill damaged during its postharvest handling the potential taste will be lost. Even though this fruit exceeds any proposed quality index, the chilling damage during postharvest handling will prevent the consumers from perceiving the flavor.

Final Comments

It is important to encourage our tree fruit shippers, receivers, and handlers to eliminate internal breakdown symptom development and enforce fruit ripening prior to consumption. Ripening protocols to assure fruit ripening prior to consumption have been developed for shippers, handlers, store produce managers, and consumers.

Consumer reaction of peach cultivars that are “ready to eat” and free of IB must be evaluated by different store retail companies.

Basic research programs to understand the genetic and biochemical basis of flavor, antioxidant attributes pathways, and chilling injury genetic control by using available molecular genetics technologies should be economically supported.

Intensive research to identify cultivars’ important taste components, “in store” consumer preference, industry quality potential, and the role of preharvest factors (orchards and climatic conditions) to meet these potential quality standards should be developed prior to any quality index(es) establishment.

Segregating peach cultivars according to their organoleptic characteristics should be pursued. Creation of these different groups according to taste attributes can be useful from the marketing point of view.

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PRECONDITIONING/PRE-RIPENING A NEW CALIFORNIA FRUIT DELIVERY SYSTEM – OVERVIEW

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A New Fruit Delivery System

Surveys carried out by the University of California personnel indicated that customer complaints center around lack of taste and texture abnormalities in peaches, plums and nectarines, specifically that fruit are too hard or have internal breakdown (IB) symptoms such as lack of taste, flesh mealiness and flesh browning. A University of California, Davis/Kearney Agricultural Center research program supported by the California Tree Fruit Growers has developed a preconditioning/pre-ripening treatment at shipping point that releases internal breakdown susceptible cultivars from expressing the IB symptoms and also prepares the fruit to be “Ready to Buy” for consumers. After fruits have been properly preconditioned, they may go through normal commercial operations without any requirements for special handling. Careful orchard selection, special cultural practices, controlled preconditioning/pre-ripening treatment, and adequate postharvest handling are keys to this new fruit delivery system.

In 1997, Kings Canyon Cold Storage in conjunction with University of California (Kearney Agricultural Center) carried out the first successful commercial shipments of preconditioned fruit. In the last four years, the Kaprielian family, owners of King Canyon Cold storage, developed a commercial program that includes this treatment that they named Ripe & Ready™. This commercial program was developed based on current information on fruit physiology, consumer preference studies, cultivar selection, cultural practices, and postharvest handling methods.

Three years ago, because of their commercial success, other companies such as Mountain View (Summer Ripe™), New Leaf, and Sunny Cal, developed their own high quality delivery systems and marketing programs using this preconditioning/pre-ripening treatment on the basis of their new postharvest handling process.

Currently, there are several new companies that are developing programs based on this preconditioning treatment. Thus, California industry is offering preconditioned/pre-ripened fruit to a wide group of retailers. This new system allows the potential of delivering to retail stores tree fruit that is “Ready to Buy” with low occurrence of internal breakdown symptoms, and high consumer acceptance.

This new fruit delivery system is one more approach to limit internal breakdown and enhance the fruit eating experience for consumers. Delivery of these preconditioned fruit should fit very well with our ripening protocol for retailers (Crisosto, 1999, 2000, 2001).

New System Advantages: Due to physical and chemical changes occurring to fruit during a well-controlled preconditioning treatment, fruits are allowed to express higher eating quality. Fruit becomes tastier, more aromatic, and juicier, resulting in high consumer acceptance. A well-controlled preconditioning/pre-ripening treatment induces fruit softening to the “Ready to Buy” stage (approximately 6-8 lbs for peaches and nectarines). Under an efficient marketing program, preconditioned/pre-ripened fruit should have a consistently higher retail price.

New System Disadvantages: The preconditioned/pre-ripened fruit supply may be restricted to a “normal” California year. As the preconditioning/pre-ripening treatment is limited to a group of orchards/cultivars, the supply of fruit handled under this new system is not available during the entire tree fruit season. If the program is not properly monitored, decay development, shriveling, and

excessive softening may become a commercial problem. Fast cooling and maintaining temperature prior and during shipment are essential to protect fruit quality from fast deterioration. A high refrigeration capacity may be needed for this program. The product should be packed to specific marketing requirements depending on customer desires, such as being stickered with PLU (tree-ripe codes) and packed in attractive display-ready pre-print cartons that are either single layer or double layer in depth. An aggressive marketing and promotion program is required. Retailer and consumer education on the handling of preconditioned/pre-ripened fruit are important to increase the demand of this new high quality fruit delivery system.

Pre-Conditioning/Pre-Ripening Process

To obtain a successful pre-conditioning treatment, to reduce and/or limit mealiness/flesh browning for IB susceptible cultivars, fruit should be exposed to 68°F for approximately 48 hours. Temperatures higher than 80°F can destroy flavor and affect texture. Therefore, I recommend pre-cooling fruit down to 65°F before placing in the ripening room. Bulk fruit in bins can be precooled from 90°F to 65°F in the center of the pallet within 7-20 hours using a room cooling system. If bulk binned fruit are forced air-cooled, it might take 2-3 hours to reduce the fruit temperature in the slowest position from 90°F to 65°F (Table 1). This temperature drop before beginning the preconditioning treatment is essential to assure postharvest quality and reduce potential condensation during the preconditioning treatment.

Table 1. Cooling times to reach half-cooling times for bulk fruit in bins (5-6% side-area vented) under two cooling conditions.

Arrival Temperature	Forced Air Cooling		Room Cooling
	0.8 CFM/LB at 0.7" pressure 2-3 hours	0.5 CFM/LB at 0.25" pressure 2-3 hours	20-40 FPM 7-12 hours
100°F	66°F ^z	66°F	66°F
90°F	61°F	61°F	61°F
80°F	56°F	56°F	56°F

^zTemperature measured in the slowest position. Cooling times are approximate and are to be used only as a guide. Calculations to reach desired temperature before pre-conditioning are being made based on information compiled in Thompson, J. F.; F. Gordon Mitchell, Tom R. Rumsey, Robert F. Kasmire, and Carlos H. Crisosto (eds), 1998. Commercial Cooling of Fruits, Vegetables, and Flowers. Publication 21567, Division of Agriculture and Natural Resources.

In summary, the total preconditioning treatment may involve approximately 3-12 hours to cool down to approximately 65°F, approximately two days to pre-condition/pre-ripen and probably another 3-6 hours to cool down to below 35°F. After the preconditioning, fruit should be forced air-cooled to a range of 32°F-35°F, and then placed in 32°F storage. Cooling

times to reach 7/8th-cooling times for packed fruit in corrugated containers (6% side area-vented) under 0.8 CFM/LB and 0.15" is 3 hours. If 0.5 CFM/LB and 0.04" conditions are used, then 7/8th-cooling time will be reached at 4 hours (Thompson et al., 1998). Using this information, it will take 4.0 and 5.3 hours to cool down from 68°F to below 36°F, if cooling

is carried out under 0.8 CFM/LB (0.15") and 0.5 CFM/LB (0.04") conditions, respectively, (Thompson et al., 1998).

After this preconditioning treatment, the fruit is no longer as susceptible to internal breakdown caused by temperature exposure within 36-46°F ("killing zone"). Thus, typical temperatures in the postharvest handling chain such as transportation, warehouse storage, retail display, and consumer handling will not affect fruit quality. The controlled application of this preconditioning/pre-ripening treatment may assure a premium eating quality.

Preconditioned/Pre-ripening Program Components

Quality Assurance (QA): A QA system should be established to collect data that will be rapidly summarized, analyzed, and disseminated to the growers, production managers, packinghouse managers, and marketing departments. It is important that data collected be immediately available to your company's different departments. This data should be simple but contain enough critical information to deduce information that will help your company in the decision-making process. Computerized data acquisition and delivery fit these system needs very well. Fruit quality attributes can be evaluated at four levels: orchard, arrival (packinghouse), after packaging or prior to preconditioning, and after preconditioning treatment. Quality attributes such as SSC, TA, firmness (strong and weakest position on the fruit), size, red color, ground color, etc. can be recorded, although some of these fruit quality attributes can be more or less important in the different postharvest steps.

At least one full-time person is needed for controlling incoming quality and monitoring the preconditioning/pre-ripening process. This person should also decide which fruit does not qualify for the program, and when fruit should be removed from the ripening room.

Orchard: Although stone fruit quality cannot be improved, only maintained, after harvest, little research has been conducted on the influence of preharvest factors on stone fruit postharvest quality and potential postharvest life. I believe that the maximum fruit quality for each cultivar can be achieved by understanding the roles of preharvest factors in fruit quality. During the last 8 years in cooperation with Day, Johnson and DeJong, we published several articles that review the influences of orchard factors – Maximize orchard quality potential by controlled nitrogen fertilization (Daane et al., 1995); foliar nutrient sprays (Crisosto et al., 1993b, 1995a; Crisosto et al., 1993a; and Cheng and Crisosto, 1994); irrigation (Johnson et al., 1992; Johnson et al., 1994; Crisosto et al., 1994b); girdling (Johnson and LaRue, 1989; Day and DeJong, 1990; Day et al., 1995); fruit canopy position (Marini, 1991; Saenz, 1991; Crisosto et al., 1995a), and pruning and training (Crisosto et al., 1997). Among all of them, crop load (Day et al., 1993, Crisosto et al., 1995) is one of the most important orchard factors to assure consumer acceptance. These publications are posted on the following web sites:

<http://www.uckac.edu/postharv/>;
<http://postharvest.ucdavis.edu/>;
<http://fruitsandnuts.ucdavis.edu/>;
<http://pom.ucdavis.edu/>; and
<http://caltreefruit.com/>

On the contrary, girdling may increase fruit acidity and astringency; thus, taste resulting from the additional sugars may be masked. Girdling can also cause the pits of peach and nectarine fruits to split, especially if it is done too early during pit hardening. Summer pruning and leaf pulling around the fruit increase red color formation when performed properly. Excessive leaf pulling or leaf pulling done too close to harvest can reduce fruit size and SSC in peaches and nectarines (Day et al., 1995).

Cultivars: This process involves selection of cultivars that have high taste potential with moderate/slow ripening rate, and low susceptibility to decay and bruising. Most of the current early cultivars are prone to split pit, low SSC/TA, and fast softening. Fast softening and high potential decay have been our experience during white flesh peach preconditioning. Our experience with white flesh nectarine is very limited. However, the

new generation of cultivars that included early, yellow/white flesh etc. may be suitable for this program. We recommend a careful evaluation of these new cultivars before including them in a commercial program. Girdled fruit or fruit with deep sutures should not be included in the program. These are cultivars that we have had successful experience using the preconditioning/pre-ripening process.

PEACH	NECTARINE	PLUM
Flavor Crest	Rose Diamond	Black Amber
Rich Lady	Spring Brite	Friar
June Lady	Summer Grand	Fortune
Zee Grand	Summer Diamond	Royal Diamond
Elegant Lady	Summer Brite	Roysum
Summer Lady	Royal Giant	Angeleno
Zee Lady	July Red	
O'Henry	Scarlet Red	
Red Top	Summer Fire	
Cal Red	September Red	
Autumn Flame	August Red	
	Red Jim	

These cultivars have been selected based exclusively on my "practical" experience. We use the ability to tolerate softening and a minimum taste in the ending product as criteria to select cultivars for this program. As I do not have experience with other cultivars, I am not including them in the list. The fact that some cultivars are not listed does not mean that they will not precondition well. It may only indicate my lack of experience with them.

Harvest Determination: The picking date is an important factor that contributes to maximizing the orchard quality potential. In all cases, the fruit should at least reach the CA well maturity stage. The use of the maximum maturity concept can be applied to determine how late an orchard should be picked. We

developed maximum maturity indices for stone fruit cultivars using bruising susceptibility measurements based on fruit firmness at the weakest point on the fruit (Crisosto et al., 1997, 1998). These critical bruising thresholds were calculated for different levels of fruit firmness and expressed as Gs (acceleration). These thresholds predict how much physical abuse fruit will tolerate at different firmness levels during packinghouse operations. The use of these thresholds allows us to decide how late we can pick without inducing bruising, thereby maximizing the quality potential of fruit from different orchards (Crisosto et al., 2001).

Strict supervision during harvesting is important in order to reduce potential for fruit injury; pickers, field handlers, and transport

personnel should be trained in order to maintain product quality; and sanitation protocols are strictly enforced.

Ripening Room: During the preconditioning/pre-ripening treatment, we recommend maintaining the temperature within 60-77°F, high relative humidity of ~85-90% RH, and low air velocity conditions. We suggest monitoring fruit and air temperature frequently during the pre-conditioning/pre-ripening period. As a rule of thumb, fruit should not have more than 2.0% weight loss during this treatment. Weight losses of packed fruit can be measured weekly to control your relative humidity conditions in your ripening room.

A small exhaust fan may be required in the room. Normal atmospheric concentration of carbon dioxide (CO₂) is 0.03% (300 ppm). Levels higher than 0.5% (5,000 ppm) can retard ripening of some products. If CO₂ levels reach this threshold then ripening rooms should be vented to reduce carbon dioxide levels. In conditions of potential high CO₂ accumulation, CO₂ should be monitored and room ventilation rate adjusted to maintain a constant safe level. Dependable CO₂ sensors can be purchased for \$500 to \$1000 per room (see following listing). The OSHA limit for human exposure to carbon dioxide is 0.5% (5,000 ppm) time weighted for an 8 hour period. The 15 minutes exposure limit is 1.5% (15,000 ppm) If necessary, detailed instructions on ripening facilities can be found in the Ripening Facilities chapter authored by Mr. Jim Thompson (<http://postharvest.ucdavis.edu>) in the Management of Fruit Ripening, Postharvest Horticulture Series No. 9, April 2000.

Management of the Preconditioning/Pre-ripening Program

Orchard: Evaluation carried out at the orchard level should include firmness as a maximum maturity index, and SSC/TA as a quality index, and can be used as a prediction of potential

fruit quality from a given orchard. The maximum maturity index will indicate how late that orchard can be harvested in order to maximize its orchard quality potential. The quality index will predict the potential consumer acceptance of fruit from that orchard. Fruit size measurements could also be included in these orchard level measurements. The relationship between fruit size and SSC for a given orchard can be useful to segregate based on SSC according to size into the program within that selected orchard. Also, this relationship between fruit size and firmness measured at the weakest position may be important to evaluate any advantage of further harvesting delays on that orchard. This quality/maturity attributes information can be used to segregate orchards, and sizes within the orchards, to be used in the preconditioning program. This selection should be based on taste (consumer acceptance of ripe fruit) and the ability to tolerate the delay-cooling period (preconditioning treatment).

Detailed instruction on how to measure quality parameters has been published in the Central Valley Postharvest Newsletter (Crisosto and Garner, 2001). Vendors for postharvest quality and maturity determinations equipment are listed in the last page of this article.

Arrival at the Packinghouse: Evaluation of quality/maturity attributes carried out at packinghouse arrival should include fruit temperature, firmness as a maximum maturity index, SSC/RTA (ripe titratable acidity) as a quality index, size, and red color. A cultivar characterization based on SSC/RTA may be appropriate for future record keeping. This can help establish your preconditioning process and your marketing program in the future. Percent of blemishes such as bruises, cuts, decay, etc. are also recommended to be determined. At this level, size distribution will help the packingline operator to organize the packaging of a given lot. Fruit temperature can be used to determine need for cooling and organize your postharvest handling.

As general guidelines, if fruit temperature is 80-100°F at arrival, a precooling down to 60-65°F is recommended prior to packaging and/or preconditioning/pre-ripening treatment. If fruit arrive with temperatures between 70-90°F, then fruit should be cooled down to 60°F before packing and conditioning. Fruit can be pre-cooled by using a hydrocooler or forced air-cooling. In some cases room cooling can be used as a precooling, when fruit temperature is not too high and packaging will be done late enough to allow a room cooled system to bring fruit temperature down to 60-65°F. If fruit arrive with temperature between 60-70°F, then fruit can be packed and preconditioned without precooling. Our goal is to pack fruit when fruit temperature is approximately 55-65°F and start preconditioning/precooling when fruit temperature is within 65-70°F. Firmness measured on the cheek will give the grower feedback on his/her selection of harvesting time, and firmness on the weakest spot will predict potential bruising damage during packaging. Critical bruising thresholds for most of the important California cultivars and bruising potentials (G) for several packinghouse situations have been determined. Additionally, firmness measurements will determine tolerance to preconditioning/pre-ripening treatment. In some cases, the duration of this preconditioning/pre-ripening period can be modified according to the initial firmness measured at the weakest fruit position.

Prior to preconditioning/pre-ripening:

Evaluation of fruit temperature and firmness are the two key quality attributes used to control and monitor this treatment. Fruit temperature should be within 60-75°F. Plums need to be held in the higher temperature range. Time of temperature exposure and firmness should be used to determine the end point of the treatment. The end point of the preconditioning/pre-ripening treatment for most of the peach cultivars should be at least 48 hours after harvest at 68°F and/or when the weakest position on the fruit reaches a firmness of 6-8 pounds (average of cheeks and weakest

point). For example, 'O'Henry' peach will be protected from internal breakdown after being exposed to 48 hours at 68°F; after that time fruit firmness at the weakest position can still be at 10-8 pounds. Thus, a longer exposure at 68°F to prepare fruit for immediate consumption can be applied (ripening). The pre-ripening period can be extended longer than the preconditioning time according to firmness requirements. Maximum pre-ripening end points for domestic market are approximately 6-8 lbs for peaches, approximately 8 lbs for nectarines, and 4 lbs for plums are suggested. Check it according to your buyer's suggestions. The end point of ripening is determined by the fruit susceptibility to bruising during postharvest handling during transportation, and handling at retail store displays. Our work on this problem indicated that peaches and nectarines tray packed couldn't be softer than 6.0 pounds. Peaches and nectarines tray packed are susceptible to transport and handling bruising, therefore, to tolerate this bruising pressure during postharvest tray packed fruit should be packed with slightly higher pressures. Firmness should be measured on warm fruit (55-77°F) using an 8-mm (5/16") tip.

To avoid decay incidence, be sure that fungicide and wax have been evenly distributed on the fruit especially inside the stem cavity and check postharvest fungicide residues frequently. Postharvest fungicide type and residues should be varied according to export markets. The best option is to subject fruit to the preconditioning/pre-ripening treatment after fungicide/wax application. In this way fruit are protected from decay and water losses during this delay-cooling period. In some cases, for example, when packing line is being used, a short part of the 48 hours preconditioning/pre-ripening treatment can be done before packing. Because of fruit softening and decay pressure, the least amount of time in this "front" preconditioning period is the best. If this preconditioning in "front" is being used, a

careful monitoring of fruit firmness and temperature is required.

Fruit Post-Preconditioning/Pre-ripening

Conditions: Evaluation of fruit temperature and firmness should be done immediately after conditioned fruit are forced air-cooled to a range of 32°F-35°F. It is essential to keep fruit temperature down to 32°F to extend market life of preconditioned fruit because of fruit softening. At this point, the fruit are no longer as susceptible to internal breakdown caused by temperature exposures in the “killing zone.” So, typical temperatures in the postharvest handling chain such as transportation, warehousing, retailing, and consumer handling will not affect internal breakdown development.

Fruit firmness measurements will help to control your preconditioning treatment and assure your receiver’s requirements. Fruit should be firm enough to tolerate the physical abuse during transportation and retail handling but soft enough to satisfy your buyer’s request.

The SSC/TA measurements and red color percentage can be used as an internal quality flexible index to assure your current and future position in the market. Also, be sure that fruit color is uniform within the box, and there is not fruit with cuts or bruises in the box. This fruit will decay very fast after arrival at the receiving end.

The controlled application of this preconditioning/pre-ripening treatment should assure a premium eating quality and more adaptability to standard postharvest handling conditions.

Retail Handling Instruction for

Preconditioned Fruit: Preconditioned fruit should be transported at 32°-35°F and ideally, retail stored at 32-35°F prior to transfer to dry display. However, storage temperature will depend on fruit firmness at arrival and retail turnover. In order to protect preconditioned

fruit, display should be no more than two layers deep. Also, it is very important to let your produce managers and consumers know that this is “preconditioned/pre ripened California fruit.”

Summary

Sound fruit with high quality and low decay potential should be segregated for this program.

Controlled delayed cooling can be used to precondition stone fruit susceptible to internal breakdown in order to enhance the consumer’s eating experience and extend market life. Delayed cooling can also be used to pre-ripen susceptible and non-susceptible stone fruit in order to deliver a “ready to buy” product to the consumer. It is important to know what you want to accomplish with each cultivar before changing your current program.

In general, a 48-hour cooling delay at 68°F is the most effective preconditioning treatment to extend market life of internal breakdown for most susceptible peaches and nectarines. However, decay development may be a problem in infested fruit without fungicide treatment. Therefore, we recommend applied preconditioning treatment on waxed/fungicide packed fruit. Ethylene exposure is not necessary for this treatment.

During the 48-hour delay at 68°F the fruit loses approximately 4 lbf firmness. If the fruit are stored at 32°F after the delayed cooling treatments the firmness quality of the fruit is maintained. If fruit is stored at 41°F following 48-hour delay at 68°F, then fruit softening may be a problem after ten days.

Preconditioning did not increase the market life of the plums tested within this storage period. For plums, maintaining fruit temperatures below 32°F but above the freezing point is an excellent way to extend market life. However plums will express their quality attributes much better after a controlled pre-ripening period.

Flesh firmness must be monitored on the weakest position on the fruit during the pre-conditioning treatment. Peaches and nectarines become very susceptible to vibration injury during transportation when flesh firmness is <5 lbf. To pre-ripen stone fruit, delay cooling at 68°F for the minimum period of time necessary to achieve the desired level of ripeness (6-8 lbf for peaches/nectarines, and 5 lbf for plums measured on the weakest position on the fruit).

Temperature management is the most important commercial tool for reducing symptoms of internal breakdown (IB). Rapid cooling down to at least 35°F after preconditioning is important to stop further fruit flesh softening, senescent breakdown, decay, and prevent prolonged exposure to 41°F temperatures.

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<http://pom.ucdavis.edu/>

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Postharvest Equipment Vendors

FIRMNESS TESTERS / PENETROMETERS

Ametek
37 North Valley Road Building 4
P.O. Box 1764
Paoli, PA 19301
(800) 473-1286
www.ametek.com

International Ripening Corp.
1185 Pineridge Road
Norfolk, VA 23502
(800) 472-7205
www.qasupplies.com

VWR Scientific Company
P.O. Box 7900
San Francisco, CA 94120
(800) 932-5000
www.vwr.com

VWR Scientific
P.O. Box 7900
San Francisco, CA 94120
(800) 932-5000
www.vwr.com

TITRATORS

Mettler Instrument Corp.
Box 71
Hightown, NJ 08520
(800) 638-8537
www.mtshop.com

Radiometer Instruments
Distributed by: Hach Company
5600 Lindbergh Drive
PO Box 389
Loveland, Colorado 80539
(970) 669-3050
www.radiometer-analytical.com

REFRACTOMETERS

Cole Parmer Instrument Co.
625 E. Bunker Court
Vernon Hills, IL 60061
(800) 323-4340
www.coleparmer.com

Davis Instruments
4701 Mount Hope Drive
Baltimore, MD 21215
(800) 368-2516
www.davisontheweb.com

Fisher Scientific
P.O. Box 58056
San Francisco, CA 95059-8056
(800) 766-7000
www.fishersci.com

International Ripening Corp.
1185 Pineridge Road
Norfolk, VA 23502
(800) 472-7205
www.qasupplies.com

Kernco Instruments Co.
420 Kenzao Avenue
El Paso, TX 79927
(800) 325-3875
www.kerncoinstr.com

GAS DETECTORS AND TUBES

Draeger Safety, Inc.
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Pittsburgh, PA 15230
(800) 615-5503
www.draeger-usa.com

Lab Safety Supply
P.O. Box 1368
Janesville, WI 53547
(800) 356-0783
www.labsafety.com

Matheson Tri Gas
U.S. Equipment Technology Center
166 Keystone Drive
Montgomeryville, PA 18936
(800) 416-2505
www.mathesontrigas.com

Sensidyne, Inc.
16333 Bay Vista Dr.
Clearwater, FL 33760
(800) 451-9444
www.sensidyne.com

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Cole Parmer Instrument Co.
 625 E. Bunker Court
 Vernon Hills, IL 60061
 (800) 323-4340
 www.coleparmer.com

Davis Instrumentation
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 Baltimore, MD 21215
 (800) 368-2516
 www.davisontheweb.com

Deltatrak, Inc
 P.O. Box 398
 Pleasanton, CA 94566
 (800) 962-6776
 www.deltatrak.com

Omega Engineering, Inc.
 P.O. Box 4047
 Stamford, CT 06906-0047
 (800) 826-6342
 www.omega.com

Onset Instruments
 536 MacArthur Blvd.
 P.O. Box 3450
 Pocasset, MA 02559
 (800) 564-4377
 www.onsetcomp.com

Ryan Instruments, Inc.
 P.O. Box 599
 Redmond, WA 98073-0599
 (800) 999-7926
 www.ryaninst.com

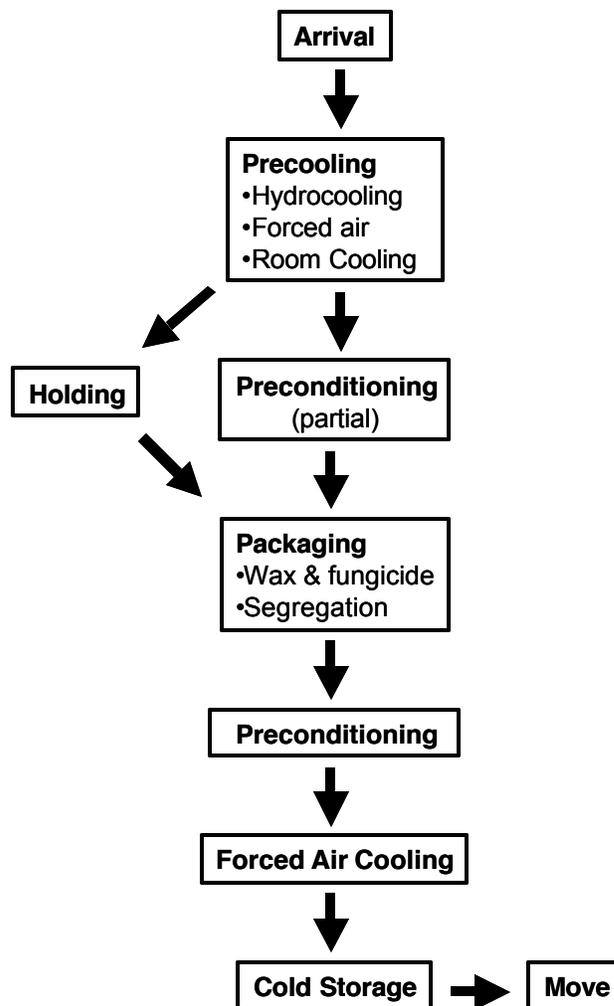


Figure 1. Product flow during the preconditioning/ripening process.

FOR POSTHARVEST THIS SEASON, TREAT CHERRIES WITH ELITE; FOR SUMMER TREE FRUIT USE SCHOLAR, TO MAKE ENDS MEET

J. E. Adaskaveg, H. C. Förster,
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Sometimes we have to be patient for the best to arrive! By early spring this year, we were hoping for a full registration of Scholar 50WP (fludioxonil) for postharvest use on all stone

fruit crops including sweet cherry. The latest update from EPA was for late summer due to timetable delays. Thanks to the California Grape and Tree Fruit League for re-submitting the emergency petition to state and federal pesticide registration offices, another emergency registration or Section 18 for the fungicide on apricots, peaches, plums, and nectarines was obtained.

With Rovral (iprodione) supplies for postharvest use nearly exhausted, most stone fruit packers will rely on Scholar, whereas sweet cherry packers will have to rely on Elite

(tebuconazole). In 1997, before we identified Scholar as a broad-spectrum postharvest fungicide, we were able to obtain a statewide Section 24C or special local need (SLN) registration for Elite on sweet cherry. Pre- and postharvest treatments with Elite on this crop resulted in residues that were less than the established tolerance of 4 ppm. This allowed approval of the SLN. Unfortunately, Elite was not registered on apricots and for summer tree fruits (peaches, plums, and nectarines) the tolerance was originally set much lower at 1 ppm. Pre- and postharvest treatments on peaches exceeded this tolerance and thus, postharvest treatments for the two commodities (sweet cherry and summer tree fruit) went their separate ways for the last few years (Table 1A).

Scholar is a highly effective wound-protection fungicide and excels previously registered postharvest fungicides in several ways. It is active against all major postharvest decays, including brown rot, gray mold, and *Rhizopus* rot in addition to other decays such as those caused by *Mucor* and *Gilbertella* species (Table 1C). The fungicide has been classified as a 'reduced risk pesticide' by the EPA and has an extremely low mammalian toxicity, thus accommodating packinghouse workers' and consumers' safety. In addition, its chemistry is based on a natural bacterial product that has been industrially synthesized. As in previous years, the application rate for Scholar is 8 oz of the product per 200,000 lb of fruit (Table 1B). Application volumes in water or a wax-oil emulsion may range between 8 gal and 100 gal per 200,000 lb of fruit to be used with controlled droplet, air-nozzle that use low volumes of 8-25 gal, or T-jet applicators that use high volumes of 26-100 gal (Table 1D). Fruit coatings can be used in the fungicide mixture because the fungicide is very stable in a wide range of products (vegetable-, paraffinic-, carnauba-, or mineral oil-based materials), concentrations (1-100%), pH values (pH 5-9), and temperatures. Residues of 0.5 to 1 ppm should be targeted to obtain excellent

decay control and residue tolerances will be 5 ppm, the same as last year.

Elite is also a very effective postharvest fungicide that not only inhibits wound-infections but also has excellent residual activity against infections that occur after fruit have been treated. Thus, this fungicide can also be used as a preharvest treatment for sweet cherry, peach, and nectarine (current preharvest label of Elite includes these crops) where it will provide benefits for postharvest decay control. Elite is very active against brown rot and it reduces gray mold and *Rhizopus* rot at the labeled use rate of 8 oz of product per 25,000 lb of fruit (Table 1B,C). The application volume is 100 gal of a diluted (1-5%) commercial fruit coating per 25,000 lb of fruit. The fungicide-water or fungicide-fruit coating mixture is applied as a spray treatment, which includes high-volume T-jet or flooding systems (Table 1D). Residues of 1.5 to 2.0 ppm should be obtained for excellent decay control and as mentioned above, the residue tolerance for Elite is 4 ppm (Table 1B).

Carnauba, paraffinic-, and mineral oil-based fruit coatings are commonly used on summer tree fruit, whereas, paraffinic and vegetable-based coatings are used on sweet cherry (Table 1E). The fruit coating concentration selected in the fungicide mixture depends on the commodity, the market destination of the commodity, the desired fungicide residue, and the length of storage time. The paraffinic-based coatings reduce water loss the most during fruit storage and when used in high concentrations provide the highest fungicide residue. For sweet cherries, coatings are important for maintaining green and succulent stems during storage and transportation. Different markets prefer different fruit appearances for peaches, plums, and nectarines. Thus, some markets desire a high shine for nectarines, while others like plums with a natural bloom. Generally, high fruit coating concentrations increase shine but, with plums, the treatment can remove the wax bloom of fruit. Water dilutions of

carnauba-based coatings may keep most of the natural bloom of the plum fruit provided that brushes are not used. Some markets restrict the use of some coatings like paraffinic-based materials because of the solvents used in the coating formulation.

Thus, the currently available options for postharvest decay control of stone fruits should keep postharvest decay losses to a minimum.

Table 1. Postharvest fungicides available for stone fruit crops in California for the 2002 season.

A.				
Fungicide	Active Ingredient	Chemical Class	Postharvest Commodity	Postharvest Registration for 2002
Elite 45WP	Tebuconazole	Sterol Biosynthesis Inhibitor	Sweet Cherry	Section 24c
Scholar 50WP	Fludioxonil	Phenylpyrrole	Peach, Plum, and Nectarine	Section 18

B.				
Fungicide	Product Rate	Volume	Residue Tolerance (ppm)*	Working Residue (ppm)*
Elite 45WP	8 oz/25,000 lb (3.6 oz ai)	100 gal	4	1-2
Scholar 50WP	8 oz/200,000 lb (4 oz ai)	8-100 gal	5	0.5-1

* - Residues for registered commodity.

C.				
Fungicide*	Efficacy Rating**			
	Brown Rot	Gray Mold	Rhizopus Rot	Others
Elite 45WP	+++	+	+	+/-
Scholar 50WP	+++	+++	+++	+++

* - Based on currently registered rate.
 ** - Ratings: +++ = excellent; ++ = very good; + = some benefit; and - = not effective.

D.				
Fungicide	Application Method			
	CDA	Air-Nozzle	T-Jet	Flooding
Elite 45WP	Not Used	Not Used	+	+
Scholar 50WP	+	+	+	+

E.				
Fungicide	Compatibility and Concentrations of Selected Types of Coatings			
	Paraffinic	Vegetable	Carnauba	Mineral Oil
Elite 45WP	+/1-5%	+/1-5%	Not Tested	Not Tested
Scholar 50WP	+/25-100%	+/25-100%	+/25-100%	+/100%

FUTURE EVENTS AT KAC

May 31, 2002

Summer Variety Display / Research Update (Irrigation Management) followed by Fresh Market Stone Fruits Workgroup – 8:00 a.m., Kearney Agricultural Center, Parlier.

For more information call: Scott Johnson (559) 646-6547; Kevin Day (559) 685-3309, Ext. 211; Harry Andris (559) 456-7557; Brent Holtz (559) 657-7879, Ext. 209; or Bob Beede (559) 582-3211, Ext. 2737.

June 28, 2002

Summer Variety Display / Research Update (Nutrient Deficiencies and Fertilizer Management) – 8:00 a.m., Kearney Agricultural Center, Parlier.

For more information call: Scott Johnson (559) 646-6547; Kevin Day (559) 685-3309, Ext. 211; Harry Andris (559) 456-7557; Brent Holtz (559) 657-7879, Ext. 209; or Bob Beede (559) 582-3211, Ext. 2737.

July 26, 2002

Summer Variety Display / Research Update (to be announced) – 8:00 a.m., Kearney Agricultural Center, Parlier.

For more information call: Scott Johnson (559) 646-6547; Kevin Day (559) 685-3309, Ext. 211; Harry Andris (559) 456-7557; Brent Holtz (559) 657-7879, Ext. 209; or Bob Beede (559) 582-3211, Ext. 2737.