CENTRAL VALLEY POSTHARVEST NEWSLETTER

COOPERATIVE EXTENSION **UNIVERSITY OF CALIFORNIA**
Kearney Agricultural Center, 9240 South Riverbend Avenue, Parlier, CA 93648

September 1997
Vol. 6, No. 1 & 2

Carlos H. Crisosto
Editor

Contents

FINAL PRECONDITIONING GUIDELINES FOR KIWIFRUIT SHIPPERS

Dr. Carlos H. Crisosto
Pomology Department
University of California, Davis

This protocol will deal specifically with preconditioning at shipping point. Kiwifruit ripening is triggered by an ethylene treatment but ripening changes are slowed down by decreasing the fruit temperature. As the fruit warms up at the warehouse/retailer stores, ripening will continue.

Harvest - Kiwifruit should be picked according to soluble solids content (SSC). In accordance with the California Kiwifruit Marketing Order, kiwifruit must be picked to correspond with the actual minimum maturity index of at least a 6.5% soluble solids content (SSC) when inspected at the shipping point. To assure fruit quality and consumer acceptance, we recommend picking kiwifruit when it reaches a minimum of 7.0% SSC measured in the field or approximately 14% SSC after forced ripening. Research clearly states that higher sugars at harvest increases the consumer acceptance, storage and shelf-life of kiwifruit. Make sure to check the refractometer and standardize it against distilled water (0%) and/or 20% sucrose solution.

To precondition well mature kiwifruit, 100 ppm ethylene exposure per 12 hours is recommended. A short ethylene exposure of 6 hours is enough to precondition well mature kiwifruit which have been in storage for one week. This preconditioning treatment is only necessary on kiwifruit that have been in cold storage for less than 4-5 weeks.

Preconditioning for Long Distance Shipping (2-3 weeks) - Place cold kiwifruit in any type of container with polyliners at 32^{o}F in a 40-48ft. truck or ripening room with a temperature setting control. The types of kiwifruit containers such as tray packs, volume fill packages, or tri-wall containers with box polyliners does not interfere with the preconditioning treatment. We recommend the use of polyliners to protect the kiwifruit from water loss and premature shriveling. The ripening treatment should take place far away from any packing facilities to avoid ethylene contamination of long-term storage of kiwifruit.

Ethylene applied at 100 ppm for 12 hours within 32^{o}-68^{o}F temperature range will induce uniform kiwifruit softening and starch conversion into sugars (ripening). A 6 hour ethylene treatment is enough to precondition kiwifruit which have been in storage at least one week. After venting, cold ethylene-treated kiwifruit can be stored back in your cold storage but in a separate room away from your long term storage of kiwifruit. Kiwifruit treated at near 32°F- 34°F and maintained at near 32°F may last up to 3 weeks for weak kiwifruit and up to 6 weeks for strong kiwifruit. After being transferred to higher temperatures, kiwifruit will soften according to flesh temperature (Table 1).

Preconditioning for Short Distance Shipping (4-7 days) - Place warm or cold palletized kiwifruit in a 40-48 ft. truck or room at 68°F and high relative humidity. The types of kiwifruit containers such as tray packs, volume fill packages, or tri-wall containers with box polyliners does not interfere with the preconditioning treatment. We recommend use of polyliners to protect the kiwifruit from water loss and premature shriveling. The ripening treatment should take place far away from any packing facilities to avoid ethylene contamination of long-term storage of kiwifruit.

The temperature during shipping should be set near 32-36°F. We recommend precooling kiwifruit before preconditioning to reduce potential decay, shriveling and undesirable fast fruit softening during postharvest handling.

The post treatment temperature management should be adjusted according to the anticipated consumption schedule using Table 2.

If shipping is delayed after treatment, kiwifruit will reach 3 lbs. within approximately six days when held at 32°F. To assure reaching maximum storage potential, the kiwifruit temperature during storage and shipping should be close to 32°F.

Table 1. Approximate Rate of Kiwifruit Softening After Cold Ethylene Preconditioning Treatment (32-36°F) on Cold Kiwifruit.

Temperature	Pounds Lost Per Day
32°F	1.2
41°F	1.4
55°F	1.5
68°F	2.7
77°F	3.0

Table 2. Approximate Rate of Kiwifruit Softening After Warm Ethylene Treatment (68°F)

Temperature	Pounds Lost Per Day
32°F	1.5
45°F	2.0
68°F	3.0 to 4.0

II. ETHYLENE TREATMENT SYSTEMS

The "Shot" and "Flow-Through" systems are the two techniques by which ethylene can be applied to kiwifruit. In either case, make sure your ripening room or truck are Awell sealed@. These two ethylene application systems can be done by using compressed ethylene from a cylinder.

The Shot System - A measured amount of ethylene is introduced into the room. The room can be completely full. Ethylene shots from a cylinder may be applied by flow using a gauge that registers the discharge of ethylene in cubic feet per minute. The required ethylene application is made by adjusting the regulator to give the appropriate flow rate and then timing the delivery of gas. The amount of gas needed for a room is calculated by using the following information:

C = ppm of ethylene required
V = volume of room in cubic feet
F = flow rate of gas (measured from flow meter) in cubic feet per minute (CFM)
T = time (in minutes) for which gas is allowed to flow

Plug this information into the following formula:

$$T = (C \times V) / (F \times 1{,}000{,}000)$$

For a 48-foot trailer (2,825 cubic feet), a desired ethylene concentration of 100 ppm and an ethylene flow rate of 0.018 CFM, (or approximately 0.5 liters per minute), the equation would be as shown below:

$$(100 \times 2{,}825) / (0.018^{*} \times 1{,}000{,}000) = 15.7 \text{ minute}$$

* To convert the above equation from cubic feet per minute to milliliters per minute, multiply by 28.32.

Flow time is easily measured with a stopwatch. The room should be ventilated before each application by opening the doors for at least one-half hour. In the case of kiwifruit just harvested or stored for less than a week, kiwifruit should be treated for at least 12 hours. If kiwifruit have been in cold storage for more than a week, a 6 hour ethylene treatment will trigger ripening. In both cases, a ventilation fan should be provided.

The Flow-Through System - With the "Flow-Through" system, ethylene is introduced into the room continuously rather than intermittently by using compressed ethylene from a cylinder or ethanol from a catalytic generator. The room can be filled to capacity with fruit. The flow of ethylene is very small and it must be regulated carefully. Regulate ethylene by reducing pressure using a two-stage regulator and passing the gas into the room through a metering valve and flowmeter. To prevent buildup of CO_2 or C_2H_4, fresh air is drawn into the ripening room at the rate which ensures a change of air every six hours (360 min.). The air should be vented through an exhaust port in the rear of the room. Fan size or Ventilation Fan Delivery, (measured in cubic feet per minute), is calculated using the following formula:

$$\text{Ventilation Fan Delivery} = \text{Volume of Room (cubic feet)} / 360 \text{ (min)}$$

The ethylene flow rate (in CFM) needed to maintain 100 ppm in the room is calculated as follows:

$$\text{Ethylene Flow Rate (CFM)} = \text{Ventilation Fan Delivery (CFM)} \times 100/1{,}000{,}000$$

In milliliters per minute, the flow rate is:

$$\text{Ethylene Flow Rate (ml/min.)} = \text{Ventilation Fan Delivery (CFM)} \times 2.8$$

Monitoring gas in a "Flow-Through" system can be done with a "sight glass" in which ethylene bubbles through a water trap on its way to the ripening room.

III. ETHYLENE SOURCES

Presently, there are two sources to commercially apply ethylene to kiwifruit: (1) ethylene generated from alcohol as ethylene source (catalatic) and (2) compressed ethylene from a cylinder.

Ethylene Generator - The ethylene generator is a machine in which a liquid (ethanol and catalyst agent) produces ethylene when heated. The generator combines a simple heater with a system for attaching a bottle of a generator liquid. Ethylene can be applied by using ethylene generators in position 1, in a Awell sealed@ 48 foot-trailer (2,825 cubic feet) or position 2, in a trailer not well sealed. We recommend measuring ethylene levels initially in the season for each operation.

There are two companies who have included kiwifruit on their California labels:

American Ripener Company Inc.
803 Presley Road, Suite 106
Charlotte, NC 28217
Tel (800) 338-2836

Precision Generators Inc.
200 Golden Oak Court
Reflections II, Suite 117
Virginia Beach, VA 23452
Tel (757) 498-4809

Ethylene Cylinder - Use only explosion-proof mixtures. Check with your provider.

Dual Stage Regulator - Ethylene tanks require a regulator with a CGA-350 fitting. Regulator delivery pressure should not exceed 250 psi.

Product Example - Matheson Model 3122 CGA-350. Matheson telephone: 510-793-2559.

Flowmeter - Two types available:

1. Direct read, scaled in liters per minute of air.

2. Flow rate determined by chart, scaled in millimeters. Both meters measure only air content.

Product Example - Matheson model FM-1000 glasstube flowmeter with 65 mm tube. Part number J1-4C101-J410 (0.5-9.5 SLPM). Matheson telephone: 510-793-2559.

Connecting Fittings - Flowmeter must be securely attached to the regulator. It must be oriented vertically to operate properly.

Product Example - Sunnyvale Valve and Fitting Company. Brass 4" hex long nipple (B-4-HLN-4.00); Reducing street elbow (B-4-RSE-2); 1/8" NPT to 1/4" ID hose connector (B-4-HC-1-2). Sunnyvale telephone: 408-734-3145.

IV. SAFETY PRECAUTIONS

Mixtures of ethylene gas and air are potentially explosive when the concentration of ethylene rises above 3.1 percent by volume, which is 30,000 times greater than the concentration required to initiate kiwifruit ripening.

1. Do not permit open flames, spark-producing devices, fire, or smoking in a room containing ethylene gas or near the generator.

2. All electrical equipment, including lights, fan motors and switches, should comply with the National Electric Codes for Class 1, Group D equipment and installation.

<u>HARVEY'S METHOD OF FORECASTING STORAGE DECAY</u>

Reprinted with permission from Grape Notes, September-October 1996

Bill Peacock,
Farm Advisor, UCCE Tulare County
Joseph Smilanick,
USDA-ARS Research Plant Pathologist

John Harvey, USDA plant pathologist, developed a forecasting method in the 1950's that helps managers make decisions on the decay potential of specific lots of fruit at harvest (Harvey, 1984). The forecast method is fairly simple: five hundred berries are sampled from a specific lot, surface sterilized, incubated for ten days at room temperature and high humidity, and then evaluated for Botrytis decay. He found an excellent correlation between the level of decay forecasted at harvest and the level of decay developing in cold storage.

Sample Collection

The forecast requires collecting at least 500 berries from a specific lot. For the forecast to be accurate, the sample must truly represent the lot. Berries can be collected at packing stands by clipping single berries from packed fruit. The accuracy of the sample increases with the number of packages sampled (five berries from 100 packages should be adequate). Or, berries can be sampled directly from the vineyard during harvest. The 500 berries are collected in the vineyard by walking up and down rows clipping one or two berries from a single vine and sampling clusters located throughout the fruiting zone (high, low, inside, outside).

Carefully clip berries from the cluster to avoid injuring the fruit and choose only sound fruit. A minimum of time should elapse between taking the sample and running the forecast.

Sterilization

Surface sterilize the berry sample by fumigating with sulfur dioxide. The sample can be fumigated at the same time as the lot from which the sample was taken. Harvey used traditional initial fumigation (5000 ppm for 30 minutes). Rather than using sulfur dioxide, berries may also be surface sterilized by submersion in a solution of 0.5% NaOCl (bleach) for one minute. A concentration of 0.5% NaOCl is achieved by diluting 1 part Clorox (5.25% NaOCl) with 9 parts water. After surface sterilization with either sulfur dioxide or bleach, be careful to keep the sample sterile and to prevent outside contamination from spores drifting in the air.

After surface sterilization, place berries in either glass jars (30 to 40 berries per jar) or petri dishes (six to eight berries per petri dish) or plexiglass sheets with holes drilled to support and separate individual berries (about 100 berries per square foot of plexiglass). Glass jars or petri dishes are placed on cafeteria trays so they can be more easily handled. Regardless of what container is used they must be sterilized to avoid contamination.

Incubation

The surface sterilized berries (either in glass jars or petri dishes or on plexiglass sheets) are placed inside a clear plastic bag along with a small dish of water (for humidity) and the bag is sealed. Containers, bags, water, etc. must all be aseptic to prevent recontamination of the surface sterilized fruit. The samples should be held at room temperature (about 70°F) for ten days.

Examination

Examine berries one by one after a 10-day incubation period. Most of the decay that develops will be Botrytis. However, some "Black Spot" from Cladosporium and Alternaria may also be present. They are easily distinguished. Botrytis causes the skin of the berry to separate from the underlying tissues, and when an infected berry is touched the skin slips away easily from the flesh. In the later stages of decay the whole berry is covered by a velvety, gray growth of mold.

Cladosporium rot is a black, rather firm type of decay that usually affects only a small portion of the berry, forming a rather sharp margin between the affected and sound tissue. In the moist incubation forecast, an olive green growth of mold appears on the surface of affected areas. The color, the restricted growth, and the texture of the decay make it easy to distinguish Cladosporium from Botrytis.

Alternaria rot commonly develops in the area where the capstem is attached to the berry. Decay caused by this mold is rather soft in texture and brown in color. Alternaria rot may also affect other portions of the berry, causing decayed areas that are not as firm, as dark in color, or as well defined as those caused by Cladosporium rot. Mold growth on the surface of such areas is white to olive green and is more fluffy in texture than the Cladosporium fungus.

Interpretation

To meet the grade for U S. No. 1 table, the federal-state inspection service allows no more than 0.5% decay by weight (see table). Therefore, the forecast of decay should indicate <u>less</u> than 0.5% in order to grade U.S. No. 1 after long term storage and to account for some secondary spread of decay. For long term storage, the forecast should indicate no more than two berries with decay (Botrytis + "Black Spot") out of 500 berries incubated, and ideally, no berries should express decay in the forecast.

A forecast greater than 0.5% is a red flag indicating the fruit should be observed very carefully and frequently while in storage, and probably should not be stored for an extended period of time if a U.S. No 1 table grade is desired. It should be noted, however, that the California Agricultural Code allows 5% decay by weight and this fruit is usually marketed locally. A 5% forecast of decay results when 25 berries express decay out of 500 berries incubated. A 0.4% forecast results when 2 berries express decay out of 500 berries incubated.

It is not uncommon to have a forecast greater than 5% immediately after a significant storm. The forecast will usually drop after 5 to 7 days of dry weather; however, when harvest resumes, the forecast of decay is usually higher than it was prior to the rain. Each storm or period of high humidity increases the level of latent Botrytis and reduces the opportunity for long term storage.

With late season table grapes, the length of storage has less effect on postharvest decay than the environment to which the fruit is exposed before harvest (Harvey, 1955). Late season grapes should be harvested when they reach maturity. Delaying the harvest increases the potential for the development of latent Botrytis and postharvest decay.

To meet the grade for U.S. No. 1 table, the federal-state inspection service allows no more than 0.5% decay by weight. The number of decayed berries allowed per 21 pounds of fruit will vary considerably depending on berry weight. For example, the typical range of berry weight for Ruby Seedless is 3.5 to 5.5 grams depending on cultural practices subsequently, 8 to 14 decayed berries per 21 pounds of fruit would equal 0.5% decay by weight. Only 4 to 7 berries would be allowed for Red Globe with berries that range from 6.5 to 11.5 grams. The table shows the maximum number of decayed berries allowed for U.S. No. 1 table for different cultivars. Calculations are for 21 pounds of fruit adjusted to account for stem weight.

Summary

Predicting the storage quality of fruit is based on the level of exposure of fruit to rain or high humidity before harvest, knowledge of the storage history from a specific vineyard or variety, the general appearance of the fruit at harvest, and the ability of the crew to properly trim and pack the grapes. All these factors must be considered when determining the storage potential of a specific lot of fruit. John Harvey developed a laboratory technique to forecast latent Botrytis in fruit at harvest, and the forecast provides additional information for the manager to estimate the keeping quality of a specific lot of fruit. The forecast is not complicated and requires 10 days to complete.

Harvey's forecast does not eliminate the need for frequent examination of randomly selected boxes of fruit while in cold storage. While in storage, all fruit should be inspected for decay on a weekly basis, and fruit subject to decay (late harvest, rain or high humidity prior to harvest, susceptible variety, high forecast) should be given extra attention.

References:

Instructions for Forecasting Decay in Table Grapes for Storage. 1984. J.M. Harvey. Publication ARS-7, United States Department of Agriculture, Agricultural Research Service, Fresno, California.

A Method of Forecasting Decay in California Storage Grapes. 195 5. J.M. Harvey. Phytopathology 45:229-232.

Reprints of the above references are available at the Tulare County Cooperative Extension Office, 2500 W. Burrel Avenue, Visalia CA, 93291; phone (209) 733-6363.

Chart showing maximum number of decayed berries allowed for U.S. No. 1 table grade (0.5% decay).

Table Grape Cultivars	**Typical Range of Berry Weight (Grams)**	**Total No. Berries in 21 lbs of Fruit[2]**	**No. Berries Equaling 0.5% of 21 lbs of Fruit**
Christmas Rose	4.5 to 6.5	1400 to 2000	7 to 10
Crimson Seedless	4.0 to 6.5	1400 to 2200	7 to 11
Emperor	4.5 to6.5	1400 to 2000	7 to 10
Fantasy Seedless	5.0 to 7.5	1200 to 1800	6 to 9
Flame Seedless	4.0 to 6.5	1400 to 2200	7 to 11
Thompson Seedless	4.0 to 6.5	1400 to 2200	7 to 11
Red Globe	6.5 to 11.5	800 to 1400	4 to 7
Ribier	5 to 7.5	1200 to 1800	6 to 9
Ruby Seedless	3.5 to 5.5	1600 to 2800	8 to 14

[1] Based on 21 pounds of fruit.
[2] Adjusted to account for stem weight.

<u>CTFA PROGRESS REPORTS</u>

<u>Project Title</u>:
Epidemiological Studies & Evaluations of Cultural, Biological and New Chemical Pre- and Post-Harvest Treatments for Management of Brown Rot of Fresh Market Stone Fruits

James E. Adaskaveg and Themis J. Michailides

Objectives of this portion of the 1996 project were: 1) Evaluate bloom and pre-harvest applications of new experimental fungicides as compared to registered fungicides for control of brown rot blossom blight and pre- and postharvest brown rot fruit decay; 2)

Determine the efficacy of new (e.g., myclobutanil - Rally 40W, propiconazole - Orbit 3.6EC, tebuconazole - Elite 45DF) or existing fungicides registered on other crops as postharvest treatments and identify materials for registration; and 3) Evaluate new alternative or supplemental methods to chlorine as postharvest sanitation treatments of fruit.

Blossom and preharvest fungicide treatments for brown rot control. Treatments of Rovral-oil significantly reduced the incidence and severity of disease as compared to Rovral alone in brown rot blossom blight management trials, as well as, in preharvest trials for control of brown rot of fruit on peaches and nectarines. On Elegant Lady and Fairtime peach at KAC, Rovral treatments were less consistent when applied at 14 and 7 days PHI than in previous years. On these two peach varieties, Rovral-oil or Rovral-oil-Kinetic treatments had the lowest incidence of brown rot of the Rovral treatments. Changes in the preharvest Rovral label that increased the PHI from 1 to 7 days may effect the consistent performance of the fungicide based on these initial tests and thus, additional tests are needed. Oil did not improve the efficacy of Rally for brown rot control at the two rates evaluated (4 and 6 oz). Elite and oil mixtures were inconsistent: in one trial, efficacy was improved, whereas in another trial Elite and Elite-oil treatments were similar. Additional tests are needed for comparisons of Elite and Elite-oil mixtures.

Other fungicides such as Orbit, (propiconazole), Elite (tebuconazole), Rally (myclobutanil), Indar (fenbuconazole) and Vangard (cyprodonil, CGA219417) were all shown to be very effective as concentrate spray applications for brown rot control on blossoms and fruit on the stone fruit crops evaluated. On peaches, Orbit and Elite were the most efficacious. Rally applied as a concentrate spray was more consistent in efficacy as compared to trials in previous year. Vangard was also effective against brown rot and Botrytis fruit decay. The new fungicide, Abound (azoxystrobin), was effective against brown rot blossom blight, however, it was not effective against either fruit decay at the rates evaluated. Interestingly, Abound lowered the incidence of total decay caused by fungi other than brown rot in these preharvest efficacy studies for postharvest fruit decay.

Postharvest studies. Based on the cancellation of the postharvest label of iprodione (Rovral 50WP), our primary focus was to find suitable fungicide replacements for postharvest brown rot management. Our trials evaluated several fungicides that were currently registered on stone fruit crops (dicloran - Allisan), previously registered for postharvest use on stone fruit crops (thiophanate-methyl - Topsin M), registered on other crops for postharvest use (thiabendazole - Mertect 340; imazalil - Deccocil), or new fungicides that were registered for preharvest use on stone fruit crops (tebuconazole - Elite; myclobutanil - Rally; propiconazole - Orbit). All treatments were compared to iprodione-wax/oil treatments. Several of these fungicides, however, had obvious drawbacks. Both thiabendazole and thiophanate-methyl are known benzimidazole fungicides and benzimidazole-resistant populations of the brown rot fungi, *Monilinia fructicola* and *M. laxa,* occur in most stone fruit growing areas. Myclobutanil, although effective against brown rot, was known to be ineffective against gray mold *(Botrytis cinerea).* Regardless, these materials were evaluated because of manufacturer or regulatory support.

Several laboratory and experimental packing line studies on Red Diamond nectarine, Elegant Lady peach, and Casselman plum compared relative effectiveness of fungicides. Imazalil and thiabendazole were somewhat effective against brown rot but not effective against gray mold and Rhizopus rot. As expected, myclobutanil and thiophanate-methyl were effective against brown rot when these fungicides were used for wound protection. Neither were effective against Rhizopus rot. In additional tests, dicloran was not effective even at high concentrations against brown rot, and moderately effective against gray mold. **Tebuconazole was identified as the most efficacious fungicide against brown rot and, excitingly, this fungicide was also very effective against gray mold and Rhizopus rot as a wound protection treatment**. Compared to thiophanate-methyl or iprodione, tebuconazole was also more effective for control of the decay organisms evaluated than either fungicide for wounded or non-wounded protection of fruit when higher rates were used. Furthermore, no known resistance has occurred with tebuconazole in populations of *Monilinia* as with benzimidazole fungicides such as thiophanate-methyl. Other materials including biological controls (e.g., *Candida oleophila* - Aspire) were also evaluated. None of these, however, provided effective control compared to the synthetic, organic fungicides tested. In cooperation with Dr. Walker Miller in South Carolina in filing pesticide clearance requests and based on our research, tebuconazole has been accepted into the 1997 IR-4 program for full registration of a minor-use pesticide from states with fresh market stone fruit crops in the United States. Full registration of a fungicide in the IR-4 program could be anticipated within two to three years. A Section-18, emergency registration has been recommended to stone fruit industries of California for 1997. This would allow stone fruit growers and packers to have a registered fungicide in 1997 for postharvest brown rot control of fresh market stone fruit crops.

A new alternative chemical sanitation treatment to chlorine is currently being developed. The new material, polyhexamethylene biguinide (PHMB), surpasses the efficacy of chlorine by disinfecting non-wounded and wounded fruit. PHMB represents a new class of water sanitation treatments and is already registered with EPA for swimming pools in the United States. Potentially, this new treatment could replace or supplement chlorine treatments as a postharvest sanitation treatment of fresh market stone fruit crops in California.

<ins>Project Title</ins>:
Consumer Response to Utility Grade Fruit

Christine M. Bruhn

Consumer purchasing practices and satisfaction with U.S. Number 1 and utility grade peaches, nectarines, and plums were measured by actual in-store sales test and personal in-store interview with consumers in four regions of the country. Within each region, three stores were selected to feature utility and U.S. No. 1 fruit. Participating markets were Terryville, Bristol, and New Britain IGA in CT; Bi-Lo in Augusta, GA; Rice Food Market and Price Buster in Houston, TX; and New Deal in Modesto and Turlock, CA. Professional Home Economists were hired in each region to administer a brief questionnaire in the produce department of the market after the customer selected either U.S. Number 1 or utility grade fruit. After completing the questionnaire, each customer was given a postage-paid, addressed post card to complete after eating the fruit. The market test took place during a two week period in September. The test started on different dates depending on fruit delivery. In each region, most interviews took place on the weekend; however, some were also scheduled during the week.

In total, 1342 interviews were conducted and 441 post cards returned. The results indicate consumers feel appearance is very important in fruit selection. Scars and marks affect appearance, but color, size, and absence of bruises are also important appearance factors. Even with a higher level of cosmetic damage, utility grade can be acceptable because of ripeness, color, size, and price. Price was the most important reason for selecting utility grade fruit and the research shows there is a group of consumers who are willing to purchase it.

Project Title:
Evaluations of Cultural, Biological, and New Post Harvest Treatments for Management of Brown Rot of Fresh Market Stone Fruits

Themis J. Michailides and James E. Adaskaveg

Part One - Evaluations of Cultural, Biological, and New Post Harvest Treatments for Management of Brown Rot of Fresh Market Stone Fruits

The research objectives were to determine study brown rot inoculum sources in the spring, identify predictive and alternative control strategies for *M. fructicola*.

A total of 100 twigs blighted by *M. fructicola* were flagged and examined weekly for sporulation by *M. fructicola* starting from mid February until the end of March. In addition, approximately 30 mummified fruit were collected periodically from trees and 30 from the ground during November 1995 to March 1996. After each examination of the twigs and mummified fruit, the *M. fructicola* colonies were recovered and incubated and recorded for *M. fructicola* sporulation.

Only one sporodochium was observed on a blighted twig after incubation. Also, *M. fructicola* colonies were not observed on any of the 774 plates inoculated with washing from mummified fruit collected in winter 1996. Approximately 42% of the mummified fruit sampled in December showed *M. fructicola* sporulation, 7.2% in January, and 1.6% in February and no sporulation of mummified fruit collected in March or later. Comparatively, *M. fructicola* survival was even less and for a shorter duration from the mummified fruit sampled from the ground when compared to mummified fruit sampled from trees during winter. Based on these results, conidia produced on diseased tissues are unlikely to serve as a major source of primary inoculum to initiate the blossom blight phase of stone fruit in spring in California. These results indicated the primary inoculum source of brown rot in California orchards has been changed from what was thought to be, and strategies for control of this disease should be changed accordingly.

In addition, the application of biological agents and non synthetic compounds in two tests showed no effects on the disease due to very low levels of disease. In a third test, there was some effect in suppressing post-harvest brown rot, but none was at economic level. Rototilling orchards in winter may disrupt the process of apothecia development. Definitely preventing apothecia development can affect pre-harvest brown rot levels as shown in this study.

Although in previous years we obtained significant relationships of latent infections and disease incidence at harvest and post-harvest, in 1996 the incidence of latent infections was very low due to unfavorable environmental conditions during the time of development of the green fruit.

Part Two - Potential of Individual Apothecia as a Source of Primary Inoculum for Brown Rot of Stone Fruits in California Orchards

The sources of primary inoculum for brown rot epidemics at the blossom blight stage have been studied for over 100 years. It is known that Conidia produced on infected tissues in the previous season remain viable in the spring and new conidial sporulation of *M. fructicola* occurs on these old infected tissues. In the spring, ascospores are released from apothecia which develop on mummified fruit on the orchard floor. This study seeks to provide quantitative information on the importance of these sources of primary inoculum.

One hundred and fifty-four apothecia of *M. fructicola* were collected from commercial orchards and examined in the laboratory for their ability to discharge ascospores. The disks of these apothecia measured from 5 to 24 mm in diameter. Average duration of ascospore discharge of individual apothecia was 6 days. Maximum daily ascospore discharge from individual apothecia averaged 1 million ascospores per apothecium, with a maximum of 9 million ascospores per apothecium. Total number of ascospore discharge from individual apothecia averaged 2 million ascospores per apothecium, with a maximum of 36 million ascospores per apothecium. The total number of ascospores discharge increased as disk size of the apothecia increased.

Part Three - Thinned Fruit: Significant Substrate of Secondary Spore Inoculum for Brown Rot in California Nectarine Orchards

The objective of this study was to determine the significance of thinned fruit as a substrate for production of secondary spore inoculum of *M. fructicola* in nectarine orchards. In addition, the study investigated the relationship between density of thinned fruit and pre-harvest fruit brown rot.

The significance of thinned fruit serving as a substrate for production of secondary spore inoculum was investigated in five commercial nectarine orchards. The incidence of pre-harvest fruit brown rot increased as the density of thinned fruit on the orchard floor increased. The incidence of pre- and post-harvest brown rot was significantly greater on fruit from plots where thinned fruit were not removed than where thinned fruit were completely removed. These results suggest the control of fruit brown rot can be achieved by removing thinned fruit immediately after thinning or preventing thinned fruit from infection by and sporulation of *M. fructicola.*

<u>Project Title:</u>
California Utility Grade Data Collection and Analysis Project

Dennis L. Nef

The research project collected detailed information on fruit defects with the goal of providing a basis for estimating the amount of fruit that might be packed under exemptions or might otherwise be culled but could meet the utility grade at various times of the year in different regions. A stratified sample that would yield sufficient defect data to render statistically significant findings was designed. The sample gathered data on the amount of fruit that is misshapen or suffers some damage but still meets minimum California Agricultural Code requirements. The sample also accounted for possible differences across regions (Kern compared to Fresno/Tulare), season (early, mid, and late) and packer size (small, medium, large).

About 11% of peaches in the cull bin in this study meet the requirements established in the agricultural code. This number rose from 8% in the early part of the season to almost 12% in the late season. Last year, about twice this level (about 22%) met the agricultural code. For nectarines, about 6% met the agricultural code and an additional 6% failed the marketing order standards but met U.S. No. 1 grade. Almost 22% of plums in the cull line met agricultural code requirements. On average, about 80% of the peaches, 78% of the nectarines, and 72% of the plums culled failed the agricultural code requirements. The percentage was smaller in the early season and greater in the late season for peaches while it went up and down in nectarines and in plums. The most common defect in peaches and nectarines was mis-shaped fruit accounting for over half the fruit that met agricultural code. Open sutures and scarring accounted for most of the rest of the defects in these commodities. These results are similar to those found in 1995. In plums, which were evaluated in 1996 only, approximately two-thirds of the defects were classified as scarring while about one third was misshapen.

Project Title:
Effectiveness of Using PLU Stickers on Peaches, Plum, and Nectarines

James Thompson and Tom Hinsch

The use of price look-up stickers (PLU's) for fresh fruits and vegetables is increasing. Retailers have been quoted as saying that a 90% stick-on rate is required at the store level. This study was conducted to determine the performance and commercial feasibility of high-speed, in-line, commercially-available equipment designed for placing PLU's on bulk-packed peaches, plums, and nectarines.

The study was conducted after the fruit was packed and found the machine stickering rate to range from 67% to 98%, with the lowest and highest rate of stickering on nectarines. The average rate of stickering was 85% for peaches, 86% for plums, and 89% for nectarines. Fruit temperature at the time the PLU was placed on the fruit ranged from 35 to 60°F. All fruit was damp to wet, except for peaches which were always wet. The study concluded that there was no apparent effect of stickering rates as a result of changes in belt speed, or oil or emulsion application rates. Fruit temperature at the time the stickers were applied did not affect rates. It was noted however, that added water increased the stickering rate for peaches compared to damp fruit. In addition, no loose PLU stickers were observed in the shipping box after packing, cooling, or delivery to the retail store. This seems to suggest that once the PLU sticker is on the fruit, it will stay there until it is purchased by the consumer.

Project Title:
Survey of Retailers and Importer/Exporters Concerning Utility Grade Tree Fruit

Dennis H. Tootelian

The objective of this study was to determine retailer awareness of, and perceptions concerning, Autility@ grade tree fruit. This was accomplished through the use of a mail survey which sampled a broad cross-section of approximately 1,650 retailers and others in the industry who could purchase utility grade fruit. Retailers included national, regional, and independent retail chain grocery stores. Also included in the population were importer/exporters in both the United States and in foreign countries. The survey results are based on 190 total responses from national retailers and importers/exporters and 52 responses from foreign countries.

Based on the findings of this study, a number of conclusion could be drawn. First, most domestic respondents were aware of utility grade fruit while the majority of foreign respondents had not. Of those who were aware of the utility grade, 30% of the domestic and 40% of the foreign retailers and importers/exporters have purchased the fruit at some point. Price was the main reason cited for purchasing utility grade among both domestic and foreign respondents. Consumer response to the utility grade was mixed. Domestic respondents tended to indicate that consumer reaction to the appearance and quality of utility grade fruit was critical, but their reaction to price was complimentary. Foreign respondents reported that consumer reactions were somewhat more complimentary.

In conclusion, the results of the survey indicates respondents had differing views as to the long term impact of utility grade fruit. Generally, domestic respondents thought the grade would adversely affect sales of U.S. No. 1 fruit and thought California growers should discontinue using the grade. In addition, the respondents felt the utility grade would have no impact on demand for fruit among the public. However, foreign respondents tended to view utility grade as having a positive impact on overall demand for fruit in lower income areas and of those who had purchased the grade in the past, stated they would do so again. The foreign respondents believed California growers should continue with the grade.

Abstracts

POSTHARVEST RESEARCH PRESENTED IN VARIOUS MEETINGS DURING THE 1997 SEASON

APPLE

HortScience - June 1997, 32(3):507
Abstract 469 - Conference of the American Society of Horticultural Science

ReTainJ, A New Harvest Management Tool for Apple Production

*Warren E. Shafer**[1], *Gregory Clark*[2], *Robert Fritts, Jr.*[2], and *Derek Woolard*[2]; Depts. of [1]Plant Science and [2]Field Development, Abbott Laboratories, Chemical and Agricultural Products Division, 1401 Sheridan Road, North Chicago, IL 60064

ReTainJ is an organic, water-soluble formulation that contains 15% (w/w) of aminoethoxy-vinylglycine (AVG). AVG, a naturally occurring plant growth regulator, competitively inhibits ACC (1-aminocyclopropane-1-carboxylic acid) synthase, the enzyme responsible for the conversion of S-adenosylmethionine (SAM) to ACC, the immediate precursor of ethylene in plants. ReTain has been under commercial development for the past 6 years, which includes U.S. IPA-approved Experimental Use Permit (EUP) programs in 1995 (Shafer et al., 1996, Proc. 23rd Annu. PGRSA Mtg, p. 233-234) and 1996. Under the 1996 EUP, ReTain was tested on nearly 4000 acres of apples in 18 states. When used according to label directions (i.e., 50 g AVG/acre applied 4 weeks before anticipated harvest) with a nonionic surfactant, <u>ReTain effectively reduced preharvest drop and generally resulted in fruit of higher quality than untreated (control) or naphthaleneacetic acid (NAA)-treated fruit.</u> ReTain can delay fruit maturity (as indexed by starch conversion) by .7 to 10 days. ReTain-treated fruit were typically firmer (by 0.5 to 1.0 lb), produced significantly less ethylene, and maintained notably greater firmness through storage. <u>The incidence and severity of watercore in 'Delicious' was significantly reduced by ReTain, as was the frequency of fruit cracking in 'Fuji' and 'Gala' in several trials.</u> Based on this benefit profile, ReTain can be an effective harvest management tool for apple growers. U.S. IPA approval for the commercial registration of ReTain is anticipated prior to the 1997 use season.

HortScience - June 1997, 32(3):554
Abstract 726 - Conference of the American Society of Horticultural Science

Factors that Influence Biosynthesis of Volatile Flavor Compounds in Apple Fruits

*John K. Fellman**; Horticulture and Landscape Architecture, Washington State Univ., Pullman, WA 99164-6414

Volatile ester molecules are important contributors to the perception of fruit taste. Biosynthesis of volatile compounds occurs via several biochemical pathways. Ongoing studies have concentrated on alcohol acetyl transferase, the terminal step in the acetate ester synthesis pathway. Our studies on volatile biosynthesis in apples have revealed several interesting phenomena. <u>First, the nature and amount of volatile compounds are cultivar- and strain-dependent. Studies with</u>

'Delicious' show a relationship between amount of peel coloration and flavor volatile content of tissue. Second, it is possible to manipulate the preharvest growing environment to influence the content of some volatiles in the fruit. Third, generation of volatiles is closely linked to the onset of climacteric ripening. Other experiments show the response of apples to different storage conditions with regard to volatile ester synthesis. In some cultivars softening apparently provides ester precursor molecules, leading us to speculate that there are glycosidically bound intermediates that are liberated by the action of cell-wall degradation.

International Controlled Atmosphere Conference
July 1997 - Davis. Page 16

Flesh Browning of Fuji Apples in Response to High Carbon Dioxide Gas Atmospheres

R. K. Volz[1], *W. Biasi*[2], and *E. J. Mitcham*[2]; [1]Horticulture and Food Research Institute of New Zealand, Hawkes Bay Research Center, Havelock North, New Zealand, [2]Department of Pomology, University of California, Davis, CA 95616

Fuji apples were harvested from eight California orchards at 170, 190, and 210 days after full bloom. Fruit were exposed to 50% CO_2 in air at 20°C for 1, 2 or 3 days; 20% CO_2 in air at 20°C for 3, 5 or 7 days; or 2% CO_2 and 2% O_2 at 0°C for 150 days. For all gas atmospheres, incidence and area of internal flesh browning increased linearly with advancing harvest date across orchards but varied considerably amongst orchards at any one harvest date. For fruit held at 20°C, flesh browning increased with increasing time of exposure to CO_2. More browning occurred at 50% than 20% CO_2 after 3 days exposure. Fruit with flesh browning had higher ethanol concentrations than fruit with no browning; however, this relationship differed for each gas atmosphere. Across all harvest dates and orchards, correlations between flesh browning incidence after CA storage at 0°C and fruit maturity indices, fruit quality attributes, or internal gas atmospheres measured at harvest were not high. Flesh browning incidence during CA storage at 0°C was best related to that at 20% CO_2 after 3 days. CO_2 induction of flesh browning at harvest may provide a useful method of predicting CO_2 damage in Fuji apples stored in controlled atmospheres.

International Controlled Atmosphere Conference
July 1997 - Davis. Page 84

'Fuji' Apple Storage Characteristics in Relation to Growing conditions and Harvest Maturity in Washington State

John K. Fellman[1], *D. Scott Mattinson*[1], *X. Fan*[2], and *James P. Matteis*[2]; [1]Dept. Of Horticulture and Landscape Agriculture, Washington State University, Pullman, WA 99164-6414, [2]Tree Fruit Research Laboratory, USDA/ARS, 1104 N. Western Avenue, Wenatchee, WA 98801

In the Pacific Northwest region of the USA, 'Fuji' apples have emerged as a popular "new" cultivar. Storage experiments over the past few years show that Northwest-grown 'Fuji' usually does not undergo a "classical" climacteric ethylene emission, making harvest maturity estimations more difficult. Repeated experiments determined the best storage regime for long-term quality retention to be 0°C and 10% oxygen. In fact, firmness, soluble solids and color are retained regardless of storage regime, but acidity and volatile ester production are affected by oxygen level. We then examined the relationship between growing climate and volatile ester production in 'Fuji'. Apples were harvested at six weekly intervals from two sites in central Washington, considered a "warm" growing location and a "cold" growing location. Climacteric status was assessed as well as ester content and emission measured at harvest and after storage, immediately upon harvest/removal and after a 7 day ripening period. It appears that fruit from the cooler site had more purgeable volatile content earlier in the harvest period, while fruit from the warmer site had slightly higher ester emission after removal from CA storage.

ASIAN PEARS

International Controlled Atmosphere Conference
July 1997 - Davis. Page 94

CA Storage Extends the Storage Life of 'Niitaka' Pear Fruit

Yong-Joon Yang and *Eun-Jin Lee*; Dept. of Horticultural Science, Sangmyung University Anseo Dong, San 98-20, Chonan 330-180, Korea

How long the storage life is to extend by a CA and what is the best combination for a CA storage of pear fruit (cv. Niikata), have been until now not reported. The CA treatments in a first storage season (1995/96) were combined as follows: % CO_2/% O_2 = 1/1, 1/3,3/1 and 3/20. In the second season (1996/97) the CA treatments for small chambers were recombined; % CO_2/% O_2 = 0/20, 1/1, 1/3, and for the CA pilot storage system (2.5 ton per room); % CO_2/% O_2 = 1/4.0-5.0 and 1.0/16.0-17.0. Three storage treatments (% CO_2/% O_2 = 1/1, 1/3, 3/1) induced no injury symptoms for 90 days after storage but only the combination of 3% CO_2 and 20% O_2 led to the partly blackening at 22 days after storage. No symptoms were found even in a same CO_2 concentration when combined with 1% O_2. Firmness was at best retained in a CA combination of 3% CO_2 and 1% O_2, but other physiological features such as SSC, vitamin C, TA, electrolyte leakage and acetaldehyde evolution were little changed in a CA of 1% CO_2 and 1% O_2 during storage for 90 days. In the second season the CA effect was reconfirmed to prevent injury symptoms and to extend the storage life until 5 months after storage both in small chambers and in the pilot system. And the fruit were marketable evaluated with a better quality in the <u>O_2 concentration of 4-5% than in that of 15-16% when combined with 1% CO_2.</u>

International Controlled Atmosphere Conference
July 1997 - Davis. Page 95

Postharvest Factors Inhibits the Skin Blackening in 'Niitaka' Pear Fruit

Yong-Joon Yang and *Eun-Jin Lee*; Dept. of Horticultural Science, Sangmyung University Anseo Dong, San 98-20, Chonan 330-180, Korea

The skin blackening of Korean pear fruit (cv. Niitaka) was induced when stored at low temperatures immediately after harvest. It has been only discussed that causes of blackening might be related to postharvest factors such as carbon dioxide, high ethylene atmosphere and relative humidity. In an effort to obtain a cause of skin blackening of the fruit, sixteen storage treatments were evaluated; CO_2 factors (1%, 3%, 10%, 50% CO_2) supplemented with 20% O_2, C_2H_4 (0 and l ppm), and two humidity conditions (40-50% r.h. and 98% r.h.). Carbon dioxide treatments with 3%, 10% and 50% led to a skin discoloration at 9 days after storage while alone 1% of the gas inhibited injury symptoms. In all CO_2 treatments, when ethylene was present, the skin discoloration was induced; moreover, injury symptoms were observed at 46 days after storage when the drier air (40-50% r.h.) was combined. Only the fruit treated with 1% CO_2 was marketable and remained uninjured at the surface for 90 days of storage. <u>It appears from these results that the induction of skin blackening could be triggered firstly by high carbon dioxide over 1% and followed by high ethylene</u>

atmosphere. In addition to above combined factors, low relative humidity affected distinctly injury symptoms.

CHERRIES

International Controlled Atmosphere Conference
July 1997 - Davis. Page 98

Modified Atmosphere Storage of Cherries

Susan Lurie and *Nehemia Aharoni*; Department of Postharvest Science, Volcani Center, ARO, Bet Dagan 50250, Israel

Three cherry cultivars were tested during the 1996 season for their response to MAP (modified atmosphere packaging). Burlat, and early season cultivar, was used to determine fruit respiration characteristics, and to help in design of further experiments. Chinook was stored for two weeks and Bing was stored for up to three months. The plastic film used was Xtend (Stepak, Carmiel, Israel) film with microperforation. The gas concentrations of fruit packaged and held at 0°C stabilized after 2 days whether the Xtend film had microperforations or not. However, when transferred to 20°C sealed fruit became anaerobic while fruit in microperforated packages did not. When compared to 40 polyethylene film (PE) CO_2 concentrations were higher and relative humidity lower in Xtend film than in PE film. Xtend film also maintained green stem color while PE packaging did not.

Bing cherries stored well for up to two months in MAP using Xtend film, but their quality deteriorated rapidly during the third month of storage. Xtend MAP decreased weight loss, decreased decay and maintained green stem color compared to unsealed control fruit. MAP did not affect fruit firmness, soluble solids content, titratable acidity or the amount of surface pitting, compared to control fruits. MAP packaging of cherries using Xtend film is beneficial for extending storage and shelf life of cherries.

KIWIFRUIT

International Controlled Atmosphere Conference
July 1997 - Davis. Page 30

Quality Maintenance and Physiology of Fresh-Cut Kiwifruit Slices

I. Tayfun Agar[1], *Betty Hess-Pierce*[2] and *Adel A. Kader*[2]; [1]Department of Horticulture, University of Cukurova, 01330 Adana, Turkey, [2]Department of Pomology, University of California, Davis, CA 95616

Quality and physiology of fresh-cut kiwifruit slices *(Actinidia deliciosa* cv. Hayward) were investigated in low O_2 (0.5%, 1%, 2% and 4%), high CO_2 (air + 2.5%, 5%, 10%, 20%) and their combinations (O_2%/CO_2%: 2/5, 2/10, 4/5, 4/10) at 0.5°C and 90-95% RH. Storage of kiwifruit slices in 4% O_2 +10% CO_2 was also tested at 0.5°C, 5°C and 10°C. A 1% $CaCl_2$ dip treatment was used in all experiments.

Fresh-cut kiwifruit slices were analyzed initially, and after 3, 6, 9, and 12 days of storage, for color (L* a* b*), pH, titratable acidity, total soluble solids and slice firmness. CO_2 and C_2H_4 production of the kiwifruit slices was also measured during the storage period. Organic acids and sugars were quantified by HPLC. Acetaldehyde, ethanol and ethyl acetate concentrations were determined with a gas chromatograph.

Atmospheres of 0.5% and 1% O_2 did not significantly extend the shelf-life of kiwifruit slices when compared to 2% and 4% O_2. No visible CO_2 damage was observed in slices stored in air + 10% or 20% CO_2. Atmospheres of 2% and 4% O_2 as well as atmospheres of 5% and 10% CO_2 were the most effective atmospheres tested in extending the shelf-life of fresh-cut kiwifruit slices. When low O_2 (2% or 4%) and elevated CO_2 (5% or 10%) were combined, they acted synergistically to extend the shelf-life of kiwifruit slices. Shelf-life of kiwifruit slices held at 0.5°C was significantly longer compared to slices held at 5°C or 10 °C. In conclusion, it is possible to extend the shelf-life of fresh cut kiwifruit slices to 9-12 days if kept at 0.5 + 0.5°C in 4% O_2 + 10% CO_2.

International Controlled Atmosphere Conference
July 1997 - Davis. Page 28

Shipment of Kiwifruit Under CA Conditions from New Zealand to Europe

N. Lallu[1], *D. Billing*[2] and *B. McDonald*[3]; [1]The Horticulture and Food Research Institute Ltd., Mt. Albert Research Centre, Private Bag 92 169, Auckland, New Zealand, [2]Industrial Research Limited, P.O. Box 2225, Auckland, New Zealand

Kiwifruit which had previously been stored under controlled atmosphere (CA) conditions was shipped to Europe in either a conventional shipping container or in one of two types of CA shipping containers. A comparison was made between the performance of the flush type CA container in which N_2 flushing and purafil were used to maintain the set atmosphere, and that of the static type CA container in which lime and purafil were used to control CO_2 and C_2H_4 levels, respectively. In addition, the quality of fruit from 3 orchards was assessed upon arrival in Europe and a comparison made between fruit shipped under CA or air conditions. Neither the static type nor the flush type CA container maintained the desired atmosphere of 2% O_2, 5% CO_2. The O_2 level in the static type container increased steadily during the voyage to 10% O_2 and the CO_2 level was in the range 3-4%. In contrast, the O_2 level was 2.0-2.5% and the CO_2 level approximately 1% in the flush type container. Upon arrival in port, C_2H_4 levels were less than 20 ppb in all 3 containers. Fruit temperatures were approximately the same between fruit in different containers and in general remained between -1 to +1°C throughout the voyage. At equilibrium, relative humidity in the containers was in the range 80-87%. Fruit quality varied significantly depending on orchard and container. Weight loss from fruit was significantly higher in the flush type container (1.4%) than in the air container (1.0%), and was least in the static container (0.8%). In general fruit shipped under CA were slightly firmer and had a lower incidence of physiological pitting than fruit shipped in air. Up to 8% of the fruit in the conventional container developed physiological pitting symptoms. Occurrence of stem end rots and other storage defects were less than 1% and similar between fruit in different containers. It is concluded that the CA shipment of kiwifruit can result in benefits to fruit quality but for fruit from some orchards the benefits may be slight. To optimize benefits to fruit quality consistent and/or improvements in performance of CA shipping containers may also be required.

International Controlled Atmosphere Conference
July 1997 - Davis. Page 48

Condition of Kiwifruit on the European Market After Storage Under CA in New Zealand

Veronique M. Parmentier and *Maurice M.P. De Proft*; Department of Applied Plant Sciences, Faculty of Agricultural and Applied Biological Sciences, Katholieke Universiteit Leuven, Willem de Croylaan 42, 3001 Heverlee, Belgium

New Zealand kiwifruit was stored during three months under CA (2% O_2 and 5% CO_2) or air in open bins. Before transported to the European market during a I month marine shipment in air, fruit was repacked. At arrival fruit was placed at room temperature and tested for flesh firmness, soluble solid content (SSC), ACC content, ACO activity and ethylene production during shelf life. CA stored fruit was significantly firmer at repack in New Zealand. Upon arrival in Europe, no significant differences were found between both storage types. Only the ACC content of CA stored fruit was significantly lower than the air stored fruit, but this did not result in a change in ethylene production. <u>So far the CA storage will give no advantage nor disadvantage in shelf life behavior of kiwifruit on the European market.</u> The only advantage of CA storage is that it can give more flexibility at the time of industrial grading in New Zealand.

International Controlled Atmosphere Conference
July 1997 - Davis. Page 101

Relationship Between Kiwifruit Size and the Rate of Softening Under Controlled Atmosphere Conditions

C.H. Crisosto[1], *D.T. Garner*[1] and *K. Saenz*[2]; [1]Pomology Department, University of California, Davis, CA 95616, [2]Department of Statistics, University of Concepcion. Chile

The rate of fruit softening under controlled atmosphere and air storage conditions was investigated for different sizes of kiwifruit. The availability of a technique to cold store kiwifruit for approximately 12 weeks in the bin before packaging will help to reduce packinghouse pressure, cooling delays, and re-packaging costs. During the 1996 season, large (~101 g), medium (~93 g), and small (~81 g) size 'Hayward' kiwifruit were stored in either ethylene-free air or 5% CO_2 + 2% O_2 at 0°C (32°F). The rate of fruit softening during the 16 weeks cold storage period was related to fruit size and storage conditions. However, soluble solids concentration accumulation was independent of the fruit size and the storage conditions. Under both storage conditions, large size fruit had a slower rate of softening than medium and small size kiwifruit. The rate of fruit softening was always slower under CA than air conditions. <u>Air stored kiwifruit softened approximately 2.5 times faster than CAstored fruit.</u> Because kiwifruit are more susceptible to physical damage during packaging when they soften below 17.8 N (8 mm tip), we determined the number of weeks to reach this firmness under each of the different size-storage conditions. Under air conditions small, medium, and large size kiwifruit reached 17.8 N fruit firmness by 11, 12, and 13 weeks, respectively. Small, medium, and large size kiwifruit under CA conditions were estimated to reach 17.8 N fruit firmness by 25, 35, and 57 weeks, respectively. Thus, the length of the bin cold storage period prior to packaging will depend on fruit size and storage conditions.

International Controlled Atmosphere Conference
July 1997 - Davis. Page 97a

Influence of Short Term - Low Oxygen Treatment at Ambient Temperature on Apricot Quality

Fabio Mencarelli, Rinaldo Botondi[2]*, Giuseppe Esposito*[2]*, Riccardo Massantini*[2]*,* and *Gabriele Anelli*[2]
[1]Instituto di Industrie Agrarie, Universita di Pisa, Via S. Michele 4, 56124 Pisa, Italy, [2]Instituto di Tecnologie Agroalimentari, Universita di Viterbo, Via DeLellis. 01100. Viterbo, Italy

For several aromatic fruits such as stone fruits and tropical fruits, maintenance of aroma is one problem of distribution. For tropical fruits the reason is only related to early harvest. For stone fruits beyond the early harvest, the other reason of loss of aroma is the use of cooling. <u>Low temperature is very effective in maintaining commercial quality characteristics but very detrimental for</u>

<u>the aromatic compounds, because of the slow ripening out of the tree.</u> In an attempt to solve this problem, we decided to use ultra low oxygen (0.25%, 2%) or nitrogen at ambient temperature 15-17°C for a short-term period (1 up to 6 days), looking to the quality characteristics such as firmness by Instron and penetrometer, color by colorimeter, sugar content acidity, ethylene production, respiration, ethanol and acetaldehyde accumulation.

It was interesting to observe that the longer the maintenance in 0.25% O_2 or in N_2 the lower the response in terms of ethylene production. This slower response was followed by a slow decrease in firmness and SSC. Respiration was less affected by the exposure time. All samples kept in low O_2 or in N_2 showed a peak in ethylene higher than that from fruits kept only at low temperature. Ethanol increased a little during the treatment when the treatment was longer than 3 days. After the removal of the atmosphere, the ethanol disappeared completely and was not revealed by taste evaluation. Fruits maintained in N_2 were firmer and more yellow than red soon after the removal from gas treatment. After 4 days of shelf life the red component increased and the firmness decreased with the increase of SSC. Upon subjective evaluation in the laboratory no off odors and flavors were detected and the aroma was indeed pleasant.

OLIVES

International Controlled Atmosphere Conference
July 1997 - Davis. Page 118

Identification of Optimum Preprocessing Storage Conditions to Maintain Quality of Black Ripe 'Manzanillo' Olives

I. Tayfun Agar[1], *Betty Hess-Pierce*[2], *Mohamed M. Sourour*[3], and *Adel A. Kader*[2]; [1]Department of Horticulture, University of Çukurova, 01330 Adana, Turkey, [2]Department of Pomology, University of California, Davis, CA 95616, [3]Department of Horticulture, Suez Canal University, El-Arish, Egypt

Black ripe olives (*Olea europaea* cv. Manzanillo), used for processing into canned olives or oil, were stored at 0°C, 2.2°C and 5°C in air or 2% O_2 (balance N_2). Olive samples were analyzed initially, and after 2, 4, and 6 weeks for fruit quality based on color (L* a* b*) and firmness. CO_2 and C_2H_4 production of the olives were monitored during the storage period. Weight loss (%), and decay incidence (%) were recorded. Visual quality of the olives was assessed on a 1-9 Hedonic scale. Fatty acid composition of the olives were determined by gas chromatography.

Fruit firmness declined by 15.4 to 22.5% after 2 weeks storage in both the air and 2% O_2 treatments irrespective of storage temperature. Olive fruit firmness was not significantly different between the air and 2% O_2 stored fruit. Ethylene production and respiration rates were much higher at 5°C than at 0°C or 2.2°C. Ethylene and CO_2 production rates of olives stored in air were significantly higher than those of olives stored in 2% O_2. Decay incidence increased with storage temperature and duration but it was lower in black ripe olives kept in 2% O_2 than those stored in air. After 6 weeks all treatments had more than 2% O_2 was 9.2, 8.2, 7.7 in olives kept at 0, 2.2, and 5°C, respectively. <u>In conclusion, black-ripe 'Manzanillo' olives can be stored at 2.2°C to 5°C in 2% O_2 for up to 4 weeks between harvesting and processing.</u>

PERSIMMONS

Changes in Fruit Skin Blackening, Phenolic Acids and Ethanol Production of Non-astringent 'Fuyu' Persimmon Fruits

During CA Storage

Y.S. Park; Department of Horticultural Breeding, Mokpo National University, Chonnam, 534-729, Korea (Current Address: Department of Pomology, University of California, Davis, CA 95616)

Non-astringent 'Fuyu' persimmon fruits *(Diospyros kaki* L) were stored in CA (4% O_2 + 10% CO_2, 6% O_2 + 10% CO_2), MAP (packaged in 0.06mm polyethylene film) or air for 28 weeks at 0°C. Flesh firmness was consistently highest in persimmon stored in either of the CA treatment. The occurrence and severity of the fruit skin blackening dramatically increased after 12 weeks of storage and was most severe in the MAP and air treatment. Polyphenol oxidase activity in the tissue and skin significantly increased after 10 weeks of storage and was higher in the MAP and air than in the CA kept persimmons. Among all treatments the chlorogenic acid, p-coumaric acid and caffeic acid content of persimmon fruit flesh declined significantly with storage time, while vanillic acid, catechol and protocatechuic acid only slightly decreased during storage. Ethanol production increased considerably after 10 weeks in storage and the air stored persimmons had the highest levels among all treatments. Acetaldehyde concentration in fruit tissue decreased slightly over time in all treatments tested.

POMEGRANATES

Hort Science, June 1997 - Vol. 32(3):496
Abstract 409 - Conference of the American Society for Horticultural Science

Changes in Anthocyanin Concentration, Phenylalanine Ammonia Lyase, and Glucosyltransferase in the Arils of Pomegranates Stored in Elevated Carbon Dioxide Atmospheres

Deirdre M. Holcroft[1], *Maria I. Gil*[2], and *Adel A. Kader*[1]; [1]Dept. of Pomology, Univ. of California, Davis, CA 95616; [2]Dept. of Food Science and Technology CEBAS (CSIC), P.O. Box 4195, Murcia, E-30080, Spain

The influence of CO_2 on color and anthocyanin concentration in the arils of 'Wonderful' pomegranate *(Punica granatum* L.) was investigated. Pomegranate were placed in jars ventilated continuously with air or air enriched with 10% or 20% CO_2 at 10°C for 6 weeks. Samples were taken initially, and after 1, 2, 4, and 6 weeks and anthocyanin concentration was measured by HPLC. The arils of the pomegranates stored in air were deeper red than those stored in CO_2-enriched atmospheres. This increase in red color resulted from an increase in anthocyanin concentration. Arils from fruit stored in air +10% CO_2 had a lower anthocyanin concentration than air-stored fruit, and atmospheres enriched with 20% CO_2 suppressed anthocyanin biosynthesis. Anthocyanin concentration was well-correlated to the activity of phenylalanine ammonia lyase (PAL), but not to glucosyltransferase (GT) activity. Moderate CO_2 atmospheres (10%) prolong the storage life and maintain the quality of pomegranates, including an adequate red color of the arils.

International Controlled Atmosphere Conference
July 1997 - Davis. Page 119

Changes in Pomegranate Anthocyanins, Phenylalanine Ammonia Lyase and Glucosyltransferase in Response to Carbon Dioxide Treatments

Maria I. Gil[1], *Deirdre M. Holcroft*[2], and *Adel A. Kader*[2]; [1]Department of Food Science and Technology, CEBAS-CSIC, P.O. Box 4195, Murcia, E-30080, Spain, [2]Department of Pomology, University of California, Davis, CA 95616

Our objective was to investigate the influence of CO_2 on the changes in arils pigmentation in pomegranate and on activity of phenylalanine ammonia lyase (PAL; EC 4.3.1.5) and UDP-glucose: flavonoid 3-O-glucosyltransferase (GT; EC 2.4.1.91) in California-grown 'Wonderful' pomegranates. Pomegranates were placed in jars and ventilated with air or air enriched with 10% or 20% CO_2 at 10°C and were analyzed initially, and after 1, 2, 4 and 6 weeks. Six anthocyanins (delphinidin 3-glucoside and 3,5-diglucoside, cyanidin 3-glucoside and 3,5-diglucoside and pelargonidin 3-glucoside and 3,5-diglucoside) were identified and quantified by HPLC.

<u>CO_2 treatments inhibited the growth of decay organisms compared with air stored fruits. CO_2 had no effect on pH, titratable acidity, and soluble solids content of pomegranate juice. However, the total anthocyanin concentration of the fruit increased during storage in air, and to a lesser extent in air + 10% CO_2, but not in air + 20% CO_2.</u> Monoglucoside derivatives from pomegranates held in air and air + 10% CO_2 increased during storage while the diglucosides showed no changes. PAL activity, expressed as pkat/mg protein, increased with time at 10°C for fruit stored in air and air + 10% CO_2, reaching a maximum at 4 weeks. On the contrary PAL activity of fruit stored in air + 20% CO_2 decreased during storage. The activity of GT did not differ among treatments and storage durations.

International Controlled Atmosphere Conference
July 1997 - Davis. Page 135

Carbon Dioxide-enriched Atmospheres Extend Postharvest Life of Pomegranate Arils

Betty Hess-Pierce and *Adel A. Kader*; Department of Pomology, University of California, Davis, CA 95616

Arils of 'Wonderful' pomegranates were exposed to air or air enriched with 10, 15, or 20% CO_2 at 5°C and 10°C. Rates of respiration and ethylene production were determined daily. Visual quality, color, titratable acidity, pH, and soluble solids content were determined initially and after 4, 8, 12, and 16 days. Respiration rates of the arils ranged from 1.5 to 3 ml/kg.hr at 5°C and from 3 to 6 ml/kg.hr at 10°C. Ethylene production rates ranged from 5 to 15 nl/kg.hr at 5°C and from 15 to 30 nl/kg.hr at 10°C. Arils that were mechanically-damaged during separation from other fruit tissues appeared water-soaked and mushy and were more susceptible to decay incidence beginning after 8 days at 10°C or 12 days at 5°C. After 8 days arils in all treatments except those kept in air at 10°C were of marketable quality. After 12 days at 10°C arils in all treatments were unmarketable except those stored in air + 20% CO_2, which were at the limit of marketability. After 16 days, only the arils kept in air + 15% CO_2 or air + 20% CO_2 at 5°C were above the limit of marketability. Decay incidence was the main cause of deterioration, especially of mechanically-damaged arils. Changes in color, pH, titratable acidity, and soluble solids content were small and were not affected by the treatments. <u>In conclusion, the postharvest-life of pomegranate arils can be extended to 16 days at 5°C by keeping them in 20% CO_2-enriched air.</u>

TABLE GRAPES

International Controlled Atmosphere Conference
July 1997 - Davis. Page 65

Development of a Carbon Dioxide Treatment for California Table Grapes

Elizabeth Mitcham, Shijun Zhou and *Veronique Bikoba*; Department of Pomology, University of California, Davis, CA 95616, USA

Three pests have been identified as of quarantine concern for California table grapes to be shipped to Australia. A controlled atmosphere treatment has been developed to address these concerns. Two controlled atmosphere (CA) treatments [45% CO_2 + 0.5% O_2 and 45% CO_2 + air (11.5% O_2)] significantly increased mortality of omnivorous leafrollers *(Platynota stultana* Walsingham), Pacific spider mites *(Tetranychus pacificus* McGregor) and western flower thrips *(Frankliniella occidentalis* Pergande). The small difference in response of arthropods to the two CA treatments indicated greater response to 45% CO_2 + 11.5% O_2. Temperature (0 and 5^{o}C) had a significant effect on arthropod mortality, i.e., arthropods treated at 0^{o}C showed greater mortality. Visual, compositional, and sensory analyses were conducted on table grapes exposed to the insecticidal CA. We detected no effects on the table grapes of exposure to the CA treatments for 10 or 15 d at 0^{o}C. A large-scale commercial test was conducted in two marine containers. Four cultivars of grapes were included in the test. Insect and mites in small mesh-topped containers were placed into grape boxes in various locations within the container. Treatment for 12 days with 45% CO_2 + 11.5% O_2 at 0^{o}C provided complete control of the three table grape pests without injury to the table grapes.

STONE FRUIT

HortScience - June 1997, 32(3):434
Abstract 040 - Conference of the American Society of Horticultural Science

Postharvest Performance of 'Elegant Lady' Peach Grown with Different Nitrogen Sources

Paul Wiley, Carlos H. Crisosto, R. Scott Johnson,* and *Harry Andris,* Dept. of Pomology, Univ. of California, Davis, CA 95616

Fruit quality, storage potential, and consumer acceptance were evaluated for 'Elegant Lady' peach fruit from non-conventional and conventional fertilizer management systems. Conventional treatments were fertilized with synthetic sources of nitrogen (ammonium nitrate), while the non-conventional plots received organic sources of nitrogen such as vetch cover, biosolids compost, grass compost, chicken manure, or steer manure. Fertilization treatments were applied at high (300 N unit per acre) and low rates (100 N unit/acre) 2 years before the first postharvest evaluation. Evaluations were carried out for three seasons. There were no significant differences in fruit firmness (N) measured at different fruit positions, soluble solids concentration (%), pH, titratable acidity (% malic acid), water loss susceptibility (%), rate of softening, red color (%), or inking incidence. The incidence of flesh browning, mealiness, and flesh bleeding was only related to storage time and not to the fertilizer source. Therefore, the storage potential was not affected by the nitrogen fertilizer source. In our in-store consumer preference test during the 1995 season, 950 consumers did not perceive any taste differences between fruit from the different nitrogen fertilizer sources. Despite this, consumers still would prefer to buy fruit produced using an organic source of nitrogen rather than synthetic sources.

HortScience - June 1997, 32(3):434
Abstract 042 - Conference of the American Society of Horticultural Science

Determination of Maximum Maturity for Stone Fruit

Carlos H. Crisosto, David Slaughter, R. Scott Johnson, Luis Cid, and *David Garner**; Dept. of Pomology, Univ. of California, Davis, CA 95616

Maximum maturity indices for different

packing-house conditions based on cultivar critical bruising thresholds and bruising potentials were developed for stone fruit cultivars. The critical bruising thresholds, based on fruit firmness, and the bruising probabilities varied among stone fruit cultivars. In general, plums tolerated more physical abuse than yellow-flesh peach, nectarine, and white flesh peach cultivars. Impact location on the fruit was an important factor in the determination of critical bruising thresholds. Potential sources of bruising damage during fruit packing were located using an accelerometer (IS-100). A survey of different packinghouses revealed that bruising potentials varied from 21 to 206 G. Bruising potential was reduced by adding padding material to the packinglines, minimizing height differences at transfer points, synchronizing timing between components, and reducing the operating speed. Bruising probabilities for the most-susceptible California-grown cultivars at different velocities and Gs have been developed. Development of a practical sampling protocol to determine fruit firmness during maturation was studied.

HortScience - June 1997, 32(3):497
Abstract 415 - Conference of the American Society of Horticultural Science

Avoiding Internal Breakdown of Stone Fruit by an "Off" the Tree Preripening Treatment

Carlos H. Crisosto, R. Scott Johnson, Gayle M. Crisosto, John Labavich,* and *David Garner;* Dept. of Pomology, Univ. of California, Davis, CA 95616

During the past two seasons, the relationship between fruit ripening "ON" or "OFF" the tree and internal breakdown incidence was studied with 'Elegant Lady' and 'O'Henry' peach cultivars. Internal breakdown (IB) visual symptom development was delayed in fruit harvested at different physiological maturities and exposed to different "OFF" the tree pre-ripening treatments. As a follow up, different pre-ripening treatments (controlled delayed colling) were tested for several peach, nectarine, and plum cultivars susceptible to IB. This pre-ripening treatment delayed flesh browning, mealiness, and off-flavor development after a simulated shipment and retailer handling period for 'Flavorcrest', 'Elegant Lady', 'O'Henry', 'Parade', 'Fairtime', 'Carnival', 'Last Chance', 'Autumn Gem', 'Autumn Lady', and 'Autumn Rose' peaches; 'Summer Grand' and 'September Red' nectarines; and 'Fortune' plum. However, decay development may be a problem. Delayed cooling at 20^{o}C must be carried out with fruit protected with fungicide and wax for the shortest possible, but still effective, length of time to limit IB. The temperature and the length of this pre-ripening treatment, and the presence or absence of ethylene during the delayed cooling is cultivar dependent. Thus, specific pre-ripening conditions must be developed for each cultivar.

HortScience - June 1997, 32(3):497
Abstract 416 - Conference of the American Society of Horticultural Science

Evaluation of the Influence of Packhard on 'Ross' Cling Peaches during Postharvest Storage

Laurence A. Sistrunk, Dan Shapman,* and *J. Benton Storey;* Dept. of Horticultural Sciences, Texas A&M University, College Station, TX 77843-2133

The Packhard treatment included Packhard7 Caenise at 3 qt/A rate applied at four equally spaced intervals beginning on 1 May 1996 and continuing until harvest on 29 July 1996. After harvest, treated and nontreated peaches were stored at 1^{o}C, 95% RH. For up to 42 days, after which they were allowed to ripen for 6 days at 18^{o}C. Fruit from 5-day storage intervals and 2-day ripening intervals were then evaluated for firmness, color, brown rot lesions, soluble solids, titratable acidity, starch, pectin, total Ca, and fruit epidermis thickness. Packhard protected the fruit in cold storage for 42 days from brown rot compared to the control, which began to breakdown in 26 days. The ripening studies have given mixed results suggesting that there is no difference in the degree of brown rot contamination between Packhard-treated fruit and control fruit after removal from storage. Fruit firmness was increased by Packhard in the majority of the storage periods. Sucrose content seemed to have been reduced in the Packhard-treated fruit compared to the controls, possibly due to increased respiration. The Packhard-treated fruit retained more moisture than the control fruit, which indicates that Ca^{2+} from Packhard may have increased the integrity of the plasma membranes of treated fruit. In general, the Packhard-treated fruit held up much better in cold storage than the control fruit but was not different in brown rot infection during ripening. Packhard increased fruit firmness and allowed the fruit to retain more moisture than the control fruit. Sucrose content decreased in Packhard-treated fruit compared to the controls.

International Controlled Atmosphere Conference
July 1997 - Davis. Page 45

Development of High Concentration Carbon Dioxide Modified Atmosphere Packaging Systems to Maintain Peach Quality

Juan Pablo Zoffoli[1], *Jessica Rodriguez*[2], *Paulina Aldunce*[2] and *Carlos H. Crisosto*[3]; [1]Facultad de Agronomía, Pontificia Universidad Católica de Chile 306-22, Santiago, Chile, [2]Exportadora Chiquita Ltda., [3]Pomology Department, University of California, Davis, CA 95616

Evaluation of different modified atmosphere packaging (MAP) systems were studied in 'Elegant Lady' and 'O'Henry' peach cultivars. Different carbon dioxide (CO_2) and oxygen (O_2) concentrations were attained by using bag box liners made with different film permeabilities to enhance CO_2 accumulation. Internal box CO_2 and O_2 atmospheric composition was monitored during a 22-day storage period (0°C). Fruit quality, with an emphasis on evaluation for flesh browning and mealiness incidence, was measured after cold storage on ripe fruit. CO_2 levels varied from 10 to 25% O_2 levels from 1.5 to 10%. A reduction in flesh browning and mealiness was measured on the MAP treatment with the highest CO_2 levels. As a followup to this screening test, the best MAP treatments in maintaining peach quality were tested in a semi-commercial scale shipment from Valparaíso (Chile) to Los Angeles (USA). After 30 days fruit firmness, decay incidence, soluble solids concentration, flesh browning and mealiness incidence were measured on ripe 'O'Henry' peaches. The rate of fruit softening was slow and flesh browning was educed on all of the high CO_2-MAP treatments. Mealiness was reduced only in the high CO_2 and low oxygen MAP treatments, but high ethanol formation produced off flavors in 'O'Henry' peach. This work suggest that more detailed work on the development of MAP with high CO_2 and low O_2 concentration should be pursued.

International Controlled Atmosphere Conference
July 1997 - Davis. Page 47

Controlled Atmosphere Storage of South African Plums

A. B. Truter[1] and *J. C. Combrink*[2]; [1]TransFRESH Africa (Pty) Limited, P. O. Box 87, Howard Place 7450, Republic of South Africa, [2]Agricultural Research Council, Private Bag X5013, Stellenbosch 7600, Republic of South Africa

Three plum cultivars were stored at 0°C for different periods under four different conditions. Shelf life simulation was done at 10°C.

Promising results were obtained. 'Laetitia' plums could be stored for 8 weeks at 0°C followed by 7 days at 10°C. Pre-storage conditioning, CA storage at 3% O_2 + 5% CO_2 and partial CA storage were the best treatments for this cultivar. 'Casselman' could also be stored for 8 weeks at 0°C plus a further 7 days at 10°C. The two best treatments for this cultivar were CA storage at 3% O_2 + 5% CO_2 and partial CA storage. The best treatment for 'Songold' plums was CA storage at 3% O_2 + 5% CO_2 and the maximum storage time was 7 weeks at 0°C followed by 7 days at 10°C.

The incidence of decay was low in all cultivars and treatments, but wilting, although slight, was too high after 8 weeks. Shorter storage periods resulted in less wilting.

International Controlled Atmosphere Conference
July 1997 - Davis. Page 96

Predicting Market Life for 'O'Henry' and 'Elegant Lady' Peaches Under Controlled Atmosphere Conditions

C. H. Crisosto[1]*, D. T. Garner*[1],and *L. Cid*[2]; [1]Pomology Department, University of California, Davis, CA 95616, [2]Department of Statistics, University of Concepcion, Chile

During the 1995 season, large (~275 g), medium (~175 g), and small (~125 g) 'O'Henry' peaches were stored in either air, 5% CO_2 + 2% O_2, or 17% CO_2 + 6% O_2 at 3.3°C (38°F). The onset of the internal breakdown (I.B.) symptoms was related to both fruit size and storage atmosphere. Large size fruit developed mealiness and flesh browning symptoms earlier than medium and small size fruit. Large size fruit benefitted most from the 17% CO_2 + 6% O_2 treatment which increased their market life 10 days beyond that of the other storage atmosphere treatments. In all of the cases, mealiness was observed before the development of flesh browning. Thus, market life was dependent on the incidence of mealiness rather than flesh browning.

During the 1996 season, large, medium, and small 'Elegant Lady' and 'O'Henry' peaches were stored in either air or 17% CO_2 + 6% O_2 at either 0°C (32°F) or 3.3°C (38°F). Fruit size, storage atmosphere, and temperature all had significant effects on market life. Small 'Elegant Lady' peaches stored in air at 0°C (32°F) had 14 days more market life than large fruit. At 0°C (32°F) large size 'Elegant Lady' fruit had a market life of 19 days under CA and 9 days in air storage. At 3.3°C (38°F), market life for all treatments was reduced. At this temperature, large size 'Elegant Lady' fruit had 7 more days of market life under CA than in air storage. However, at 3.3°C (38°F), small size 'Elegant Lady' fruit in CA had a shorter market life than air stored fruit. This suggests that 17% CO_2 + 6% O_2 may be inducing problems in small size fruit. A computer program was developed to predict the performance of these two peaches under different storage conditions. International Peach Symposium
June 1997 - France

Development of an objective and non-destructive harvest maturity index for peaches and nectarines.

L. E. Luchsinger[1] and *C. S. Walsh*[2]; [1]Centro de Estudios Postcosecha CEPOC, University of Chile, Casilla 1004, Santiago, Chile; [2]Department of Horticulture and Landscape Architecture, University of Maryland, College Park, MD 20742

The objectives of this study were to develop an objective and non-destructive harvest maturity index based on ground color for two peach and two nectarine cultivars, and to evaluate statistical models to predict the maturity stage measured as ethylene evolution rate (EER).

After fruit set, fruit were tagged in order to follow maturation and ripening on the tree. Before, during and after commercial harvest, 48 fruits of similar diameter and tree position were harvested every 2-4 days. The fruit were kept at 20°C in order to measure ethylene evolution rate, fresh weight, ground and cover color (L*, a*, b*, c* and Hue value). Firmness at several fruit points, TSS, pH and TA were measured on 24 fruit, and the rest were held for 7 days at 20°C to measure all the same parameters mentioned above after ripening.

Pearson correlation coefficients were determined between variables to explore possible relations with the log of the EER. The Stepwise procedure was used for model building. The log of the EER was used as the dependent variable. To test the validity of criteria used in the model and significance of coefficients of independent variables the Regression Procedure of SAS was performed.

<u>Quadratic models used to predict EER produced varying results, but the best fit was found for ground color based on the CIELAB a* value.</u> Nevertheless, ground color values are specific for each cultivar.

International Peach Symposium
June 1997 - France; Poster No. 34

Locality effect on some fruit quality parameters in peaches and nectarines

M. E. Salvador[1,2], *L. A. Lizana*[1], *E. Alonso*[3], *E. Loyola*[1], and *E. Luchsinger*[1]; [1]Centro de Estudios Postcosecha CEPOC, University of Chile, Casilla 1004, Santiago, Chile; [2]CONICOR Bv. Chacabuco N1127, 5000 Cordoba, Argentina; [3]Universidad Iberoamericana de Ciencias y Tecnologia, Moneda 1490, Santiago, Chile

In order to determine the variation of quality parameters attribute to locality and climatic causes, peaches *Prunus persica* (L.) Batsch cv. Elegant Lady and nectarines cv. Fantasia, grown under similar management conditions in Mendoza (Argentina) and Metropolitan Region (Chile) were studied.

The Mendoza area (warmer and sunnier) presented fruit with larger polar diameter, tip, greater red cover color, pulp color grade, soluble solids/titratable acidity ratio and sorbitol percentage. Nevertheless, the Metropolitan Region (greater thermal amplitude) presented fruit with larger sutural diameter, greater sutural deformation, titratable acidity and sucrose percentage.

<u>The variation observed in fruit pH, firmness, soluble solids and sugar content could be explained by the fact that ground color, used as harvest index, was affected by locality and climatic conditions, and therefore the fruit was at different maturity stages at harvest.</u> There was no difference in equatorial diameter and total phenols.

International Peach Symposium
June 1997 - France; Poster 35

Storage life and quality of peach fruit harvested at different stages of maturity.

R. E. Murray, G. H. Valentini, A. K. Yommi, and *F. Tonelli*; Estacion Experimental Agropecuaria San Pedro, INTA C.C. 43, 2930 San Pedro, Buenos Aires, Argentina.

Internal breakdown related to chilling injury is one of the main restriction to maritime transportation of peaches from Argentina to the Northern Hemisphere. Some authors indicated that the stage of maturity at harvest may have a role on the development of the disorder when the fruits are stored. Information about stage of maturity and quality evolution is also important for the local market. This experiment was to evaluate the relationship among the stage of maturity at harvest, development of internal breakdown and evolution of maturity and quality after harvest.

'Flordaking' and 'Dixiland' peach fruits, were harvested at four dates each. The fruits of each harvest date were washed and sorted in three increasing maturity stages (S1, S2 and S3) based on ground color. Fruits were stored at 0°C for up to 35 days. Evolution of maturity (ethylene production), internal disorder and quality (firmness, L*a*b* color, TSS and acidity) were assessed after 0, 7, 14, 21, 28 and 35 days of storage on the day of withdrawal and after 3 days at 20°C.

The more proper harvest maturity stage was different depending on cultivar. The results indicated that 'Flordaking' for prompt consumption should be harvested at the medium stage (S2). For delayed consumption, as in the case of exports by maritime transportation to long distance markets, the fruits should be harvested close to S1 in order to diminish internal disorder. 'Dixiland' showed best flavor development and less internal breakdown development when the fruits were harvested at S3 although because of the low firmness fruits should be handled with extra care.

International Peach Symposium
June 1997 - France; Poster 36

Postharvest Physiology of Peach and Nectarine Slices

F. Mencarelli[1], *F. Garosi*[2], and *P. Tonutti*[3]; [1]Istituto di Industrie Agrarie, Universita di Pisa, Via S. Michele 4, 56124 Pisa, Italia, [2]Istituto di Tecnologie Agroalimentari, Universita di Viterbo, Via De Lellis, 01100 Viterbo, Italia, [3]Dipartimento di Agronomia Ambientale e Produzioni Vegetali, Universita di Padova, Via Romea 16, 35020 Legnano, Padova, Italia Freestone peaches (cf Royal Glory) and nectarines (cf SuperCrimson Gold) were harvested at the commercial ripening stage (9.3 °Brix and 9.5 °Brix, respectively), washed with sodium hypochloride, and then sliced after removal of the pit as minimally processed fruit product. Slices were immediately stored at 2°C in an atmosphere of air (control), nitrogen (99.9%) or 2% O_2 in nitrogen up to 3 days. In control slices, ethylene biosynthesis increased within 1 and 2 days in peach and nectarines, respectively, and showed an increasing trend throughout the experimental period. Slices maintained in low oxygen displayed a reduced rate of ethylene evolution. Complete inhibition of ethylene production was observed in slices of both nectarines and peaches kept in nitrogene. A similar pattern was detected when respiration was monitored.

Commercial quality of sliced fruit was also defined by colorimetric parameters. Hue angle was unaffected by treatments in nectarines whereas, in peaches, it declined in control slices but not in nitrogen and low oxygen-treated samples. Chroma and L (lightness) values decreased in nectarines air-treated slices but not in peaches air-treated slices. Nitrogen and low oxygen atmospheres were strongly effective in controlling the reduction of both parameters in nectarines.

Slice firmness measured by Instron did not show any significant change among treatments.
In conclusion, these preliminary data indicate that cv Royal Glory appears to be more suitable for minimally processed preparation than Super Crimson Gold in which the maintenance of high quality standard of the slices requires the application of specific treatments.

International Peach Symposium
June 1997 - France; Poster 37

Comparing pulsated ultra violet light and postharvest fungicide for fruit decay control

C. H. Crisosto[1], *Ximena Seguel*[1] and *T. Michailides*[2]; [1]Pomology Department, University of California, Davis, 9240 South Riverbend Avenue, Parlier, CA 93648, [2]Plant Pathology Department, University of California, Davis, 9240 South Riverbend Avenue, Parlier, CA 93648

Decay control comparison between pulsated ultraviolet light (PUV) and postharvest fungicide was evaluated on commercially packed peaches, nectarines, plums, and apples, <u>PUV (1J/cm^2) treated fruit had earlier and more severe *Botrytis cinerea* and *Monilinia fructicola* decay development than the commercially postharvest fungicide treated fruit.</u> The same situation occurred on wounded and not wounded inoculated fruit. Furthermore, the PUV treatment reduced fungicide performance on wounded and not wounded inoculated fruit.

Fruit quality measured at harvest and after simulated shipment was not affected by any of the treatments. However, a blemish developed on the surface of the peach, nectarine and apple fruit as a consequence.

International Peach Symposium
June 1997 - France; Poster 40

Chemical and organoleptic description of white flesh nectarines and peaches

Gayle M. Crisosto[1], *C. H. Crisosto*[1], and *Marilynn Watkins*[2]; [1]Pomology Department, University of California, Davis, 9240 South Riverbend Avenue, Parlier, CA 93648, [2]California Tree Fruit Agreement, P. O. Box 968, Reedley, CA 93654

<u>A large variability in soluble solids concentration (SSC), titratable acidity (TA), SSC/TA, market life and impact bruising susceptibility was found on 15 white flesh peach and 11 white flesh nectarine cultivars growing under San Joaquin Valley conditions.</u> In general, white flesh nectarines were more flavorful, sweeter and more sour than white flesh peaches. During ripening, white flesh peaches and nectarines did not increase SSC nor decrease acidity, thus the SSC/TA remained the same. Trained judges were able to detect differences in sweetness, sourness and peach or nectarine flavor intensity perception among cultivars. In general, a longer market life (at least 5 weeks), based on mealiness susceptibility, was measured on white flesh nectarine than on white flesh peach cultivars. Although in both cases, market life was longer than for most of the yellow flesh peach and nectarine cultivars. Impact bruising susceptibility measured at three bruising intensities indicated different susceptibilities among white flesh cultivars.