CENTRAL VALLEY POSTHARVEST NEWSLETTER

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

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GOOD NEWS FROM TAIWAN

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California Tree Fruit Agreement
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AGREED MINUTES BETWEEN THE TAIPEI ECONOMIC AND CULTURAL REPRESENTATIVE OFFICE AND THE AMERICAN INSTITUTE IN TAIWAN

Recognizing the need for the authorities represented by Taipei Economic and Cultural Representative Office in the U.S. (TECRO) to adopt and enforce measures necessary to protect human, animal or plant life or health in a manner consistent with international rules and practice, representatives of TECRO and the American institute in Taiwan (AIT) met to discuss issues related to adoption and enforcement of maximum residue limits (MRLs) for pesticides.

As the result of these discussions, TECRO and AIT have agreed that the following provisions would apply.

Adoption of MRLs: Provisional MRLs

1. Where the authorities represented by TECRO have not adopted a MRL, but a Codex Alimentarius Commission (CODEX) MRL exists, the authorities represented by TECRO will apply the CODEX MRL.

2. Where the authorities represented by TECRO have not adopted a MRL and no CODEX MRL exists, Taiwan will adopt a MRL based on the residue standards of Taiwan's major trading partners and based on scientific principles and sufficient scientific evidence. The authorities represented by AIT will supply a preliminary list of MRLs adopted in the United States, as soon as possible, and will update that list on a regular basis.

3. Where the authorities represented by TECRO have adopted a MRL significantly stricter than the MRL adopted in the United States, the authorities represented by TECRO will apply the CODEX MRL until a report, based on scientific principles and with

sufficient scientific evidence to justify adoption of the stricter MRL, is completed and reviewed. Similarly, where the MRL adopted in Taiwan is significantly stricter than the MRL adopted in the United States, but no CODEX MRL exists, the authorities represented by TECRO will adopt a new MRL that takes into account the residue standards of Taiwan's major trading partners and based on scientific principles and sufficient scientific evidence, until a report, based on scientific principles and scientific evidence justifying adoption of a more stringent MRL, in completed and reviewed. The authorities represented by TECRO and AIT will complete a joint review of any of the reports referred to above, within 4-6 months after both sides receive such a report.

Permanent MRLs

4. The authorities represented by TECRO will endeavor to adopt permanent MRLs on July 16, 2000. Companies in the United States will begin applying for pesticide tolerances at the earliest opportunity. The authorities represented by TECRO will provide the authorities represented by AIT with information regarding the application process and specific data required to apply for a pesticide tolerance and establish a MRL in Taiwan. The authorities represented by TECRO will continue to apply provisional MRLs to product with applications already in the review process until permanent MRLs are adopted. After July 16, 2000, the authorities represented by TECRO will continue to apply provisional MRLs only for products with applications already filed before this date with the authorities represented by TECRO.

Enforcement of MRLs

5. From July 16, 1999 to December 31, 1999, the authorities represented by TECRO will inspect and test imported products to observe when problems may occur with inspection and testing procedures. No actions will be taken against U.S. products during this period, unless the test results on a sample exceed the MRL adopted in the United States. In such cases, the authorities represented by TECRO can reject that shipment. During this period, the authorities represented by TECRO will inspect and test imported products from other major trading partners.

6. The authorities represented by TECRO will immediately sample and release shipments that are randomly selected in the normal course of testing. Testing will be completed within three working days. If a sample is found to have pesticide residues that exceed the relevant MRL, the importer will be required to make a good faith effort to recall the product in that shipment that has not yet been consumed. The next five shipments from the same origin, i.e., the same brand name/exporter, will be subject to testing. These shipments will not be released until testing is completed. Test results on samples from these shipment will also be completed and returned within three working days.

7. All shipments on the water by December 31, 1999, as documented by a Bill of Lading, will be subject to the provisions of paragraphs 5 and 6. After December 31, 1999, all shipments will be subject to the provisions of paragraphs 1, 2, 3, 4, and 6.

Consultations

8. The authorities represented by TECRO and AIT agree to consult at the request of either party to address any matter relating to the operation or implementation of this system for

adoption and enforcement of MRLs.

<u>POSTHARVEST DECAY MANAGEMENT OF STONE FRUIT CROPS WITH FUNGICIDES IN THE SUMMER OF 1999 -</u>
Decay management with fludioxonil, thiophanate-methyl, dicloran, or iprodione

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The Section 18 emergency registration of fludioxonil (Medallion or Scholar 50WP) on stone fruit crops was renewed for a second year in 1999. The US-EPA approved the request made by the California Grape and Tree Fruit League earlier this spring. Thus, the compound can be used for postharvest management of brown rot, gray mold, and Rhizopus rot of peach, plum, nectarine, and apricot. IR-4, the federal program for minor crop registration of pesticides, and Novartis, the manufacturer of fludioxonil, have also indicated that all residue studies have been completed and submitted to EPA for a Section 3 registration. Because Scholar is a “reduced-risk” pesticide, the fungicide is expected to be fully registered for postharvest use on stone fruit for the 2000 growing season.

To briefly recap the recent history of postharvest fungicide use on stone fruit crops, all of the postharvest fungicide registrations for brown rot control including iprodione (Rovral 50WP) were canceled by the mid 1990s. Old-labeled materials are still allowed for use until supplies are exhausted. Research by the first author identified the new fungicide fludioxonil and successfully helped re-registering thiophanate-methyl (Topsin-M 50WP) in California (Section 24c). Thus, with old labeled Rovral in short supply, decay management will depend on more of these later fungicides. Several concerns about using Topsin and Scholar, however, exist. For Topsin, concerns are mostly that inconsistencies in efficacy will occur. This is a valid issue because resistant populations of the brown rot pathogen to the benzimidazole fungicide already occur in California orchards. Thus, Topsin will not prevent fruit decay from orchards with resistant populations to this class of fungicide. Still, not all populations of the fungus are resistant and the fungicide does have international residue tolerances (except for Taiwan). Furthermore, being an older compound that has been used before, packers and service companies already know how to use the material in conjunction with other fungicides like dichloran (Allisan) and wax treatments.

With the introduction of any new fungicide, concerns also exist for using Scholar as a replacement for current fungicide treatments. These concerns include: 1) Efficacy under commercial conditions as compared to older compounds; 2) Potential incompatibilities with other postharvest treatments that might result in fruit staining; 3) Cost of use; 4) Concerns about culls for juice or animal feed); and 5) Lack of established international tolerances (e.g., the fungicide has not been approved for some international markets). These concerns are summarized in Table 1. Our research indicates that Scholar is a broad-spectrum fungicide that is highly effective as a wound protection or preventative treatment. In experimental packing line tests that have been conducted at the postharvest lab at the Kearney Ag Center in the last three years, nearly 100% control was obtained with Scholar for brown rot, gray mold, and Rhizopus rot. Many of the postharvest waxes (e.g., Decco 251, 255, Brogdex 522M) at concentrations of 20-50% were evaluated and were shown to be completely compatible with Scholar. No fruit staining has been associated with the fungicide treatment. Although not every variety has been tested, Red Diamond and

Summer Bright nectarine, Elegant Lady, Diamond Princess, and Fairtime peach, and Casselman and Fortune plum have been evaluated. The compound also belongs to a new class of fungicide that is not related to any other material previously registered. With only one postharvest application of Scholar, the potential for resistance developing in any target population of decay pathogen is at an absolute minimum. This translates for "real world" use by packers and service companies that Scholar can be used with or without Allisan for Rhizopus rot management. Thus, a cost analysis should be comparable between Scholar and Topsin+Allisan or Rovral+Allisan treatments.

Table 1. A comparative summary of fungicide treatments available for treating stone fruit.

		Fungicide Program			
Concern^	**Category**	**Topsin***	**Rovral**	**Allisan**	**Scholar**
Efficacy	Brown Rot	+	+	-	+
	Gray Mold	+	+	+/-	+
	Rhizopus Rot	-	+	+	+
Residues	Working	1-1.5 ppm	1.5-2.0ppm	1-2 ppm	0.5-1 ppm
	Tolerance	10 ppm	20 ppm	20 ppm	5 ppm
Tolerance	Domestic	+	+	+	+
	International**	+/-	+/-	+/-	+/- (pending)
Culls	Juice	+	+	+	+
	Animal Feed	+	+	+	+
Compatibility	Waxes	+	+	+	+
	Fungicides	+	+	+	+
	Fruit Staining***	-	-	- (color changes)	-

^ - Note that cost was excluded from the table because of the variability between pricing from retail or wholesale sources (see comments in text).

* - Resistant populations of *Monilinia fructicola* occur in California stone fruit orchards.

** - Not all international markets accept iprodione, thiophanate-methyl, or dichloran. Taiwan will defer to US-EPA residue limits for fludioxonil and other fungicides (see Table 2).

*** - Ratings based on fruit that are pre-washed prior to postharvest application of fungicides.

As already mentioned Scholar is a “reduced risk” pesticide with a Class E rating by EPA. Reduced-risk fungicides are compounds with a “reasonable certainty of no harm” to humans or the environment. Again this means that Scholar is the safest fungicide currently registered among the fungicides labeled for postharvest use on stone fruit crops. The fungicide is also highly active against postharvest decays mentioned previously and this means lower rates are needed. The registered rate is 8 oz/200,000 lb of fruit. This indicates that working residues of 0.5 to 1 ppm on fruit is all that is needed for decay control and this is well below the 5 ppm tolerance established by EPA. Furthermore, culls can be used for juice or feed just as any previous postharvest fungicide treated fruit. Thus, Scholar is the safest residual fungicide ever developed for postharvest use on any crop and it has the lowest residues needed for decay control of any of the fungicides previously or currently registered on stone fruit.

In respect to international markets, Novartis and the California Grape and Tree Fruit League are working toward getting fludioxonil accepted worldwide. We may need help from other US government agencies but every effort is being made to establish several international markets such as Canada, Mexico, and Taiwan. From a historical perspective, most international tolerances for Rovral (i.e., iprodione) were not established for many years after the domestic postharvest registration. Not all of the fruit produced in California, however, goes to international markets. Thus, during this transitional period, there are several ways to address shipping fruit to international markets. The main concept is to save and use those fungicides currently registered for an international market (e.g., Canada) for the specific crop being exported. As indicated in Table 2, Taiwan will accept fungicides that do not have maximum residue levels set by their country as long as international standards (CODEX) or US-EPA established tolerances exist for the fungicide used. In large packinghouses, one packing line could be dedicated for an international market and thus, Rovral could be reserved only for this treatment line. This would result in extending existing supplies. Similarly, smaller packinghouses could treat using Rovral/Allisan for one day per week and the rest of the time with Scholar. Another strategy is not to use Rovral during the early portion of the season when postharvest decays are at a lower incidence in most years. Unfortunately, we may need to micromanage fungicide usage until tolerance issues are resolved. Thus, not all of these concerns can be answered definitively. Hopefully, we have provided ideas for a better understanding of some of the major concerns for postharvest decay management with fungicides in the summer of 1999 and beyond.

Table 2. Status of fungicides with maximum residue levels (MRL or tolerances) established in Taiwan and the USA.

		Established MRL	
Status in Taiwan	Fungicide	USA	Taiwan
Registered on Stone Fruit	Allisan (Botran)	+	+
	Funginex**	+	+
	Rovral	+	+
	Rally	+	+
Registered on Another Crop*	Break	+	+
	Elite	+	+
	Ronilan**	+	?
	Bravo**	+	?
Not Registered Currently on any Crop*	Scholar	+	+
	Benlate	+	+
	Topsin-M	+	+
	Manex**	+	-
	Ziram**	+	-
	Captan	+	Banned

* - The multi-agency task force within the USDA has indicated that in the absence of MRL or Codex standards, Taiwan will acceptance tolerances established by the US-EPA for fungicides registered in the United States.

** - Fungicides not registered for preharvest cover sprays on fruit of stone fruit crops in the United States. Tolerances, however, are established at low levels because of blossom treatments.

DECAY OUTBREAKS - SOUR ROT

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Sour rot caused by the fungus *Geotrichum candidum* occasionally causes fruit decay and crop losses during transport and market display. Symptoms include a watery, soft decay with a thin layer of white mycelial growth on the fruit surface. Rotted fruit have a characteristic yeasty to vinegary odor (other odors may develop with bacterial contamination that commonly develops in the watery decay). The fungus is a wound pathogen that decays fruit after spores are deposited into injuries. The organism is commonly found in soil and is carried on dust or dirt onto the fruit surface.

Epidemiology and Control Measures:

The fungus is widespread on organic material in the soil. Spores of the fungus may spread by vinegar flies from decayed fruits to cracks or bruises in healthy fruit. The spores may also be spread in picking boxes and handling equipment. During harvest micro-wounds occur on the fruit and these injuries may function as infection sites. When the fruit is washed, the wash water may carry the spores of the fungus into the wounds. Thus, proper sanitation practices are critical for effective decay control. Fruit should not be harvested from the orchard floor, and should be carefully sorted at the packingline. Care in handling should be taken to prevent injuries and fruit should be washed using a disinfectant such as chlorinated water. To be effective, chlorinated washes need to be monitored and maintained at 50-100 ppm free chlorine (hypochlorous acid) at a pH of 7.5-8. Furthermore, the decay can be managed with proper temperature management.

The minimum temperature for spore germination, growth of the fungus, and infection is about 36 F (2 C), the optimum 77-80 F (25-27 C), and the maximum 101 F (38 C). At above 60 F (15.5 C), the rot spreads very rapidly in ripe peaches. Decay will essentially stop developing if fruit is maintained below 41 F (5 C), however, if the fruit was inoculated the decay develops quickly once the fruit are stored at higher temperatures. Rapid cooling of the fruit and refrigeration at low temperature will reduce losses from sour rot.

Previously, registered pre- and postharvest fungicides were not effective against this decay pathogen. The new fungicides tebuconazole (Elite 45WP) and propiconazole (Break 3.6EC) are effective against this fungus and they are registered for preharvest but not for postharvest use on stone fruit crops. Preharvest applications of these fungicides should probably be effective in reducing the incidence of decay. Although specific usage of these fungicides for management of this decay on stone fruit has not been well studied.

Three aspects of sour rot make it potentially a serious decay problem:

- Incipient infections cannot be easily observed by graders and infected fruit become packed with healthy fruit.
- Sour rot spreads rapidly at temperatures above 5 C; and
- The disease is not controlled by any postharvest fungicide treatment and requires proper harvesting and handling to minimize wounds and soil contamination. Additionally, sanitation rinses that prevent additional spread of inoculum and inoculation of fruit during postharvest cleaning and low-temperature storage (<41 F or 5 C) are required for effective control.

CONTAINER SO_2 FUMIGATION

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Materials and Methods

Container loading. A 2,377 ft^3 Cho Yang container was loaded for export at cold storage in Reedley, CA. Twenty metric pallets (40" x 48") were pinwheeled into the container. Each pallet was comprised of 72 sixteen-pound Styrofoam boxes (12 tiers, 6 boxes per tier), plus an additional tier of boxes was added to the top to bring the load to within six inches of the limit line. The pinwheeled loading pattern left not more than one inch of clearance between pallets or between the pallets and sidewalls. There was approximately 10" of uncovered floor at the rear of the container. The container drain holes and air exchange vent were closed for this trial.

Test pallets. Fumigation penetration was measured by placing passive dosimeter tubes in the front (second row from bulkhead), middle (fourth row from bulkhead), and rear (eighth row from bulkhead, third from rear doors) of the load. Five tubes were used for each position. One Gastec 5DH tube (10-600 ppm-h) was placed on the top of each pallet to measure the container dose. One Gastec 5D (0-100 ppm-h) and one 5DH tube were also placed in both the third and ninth center box from the top of each pallet (including the addition top box). These tubes were placed within the cluster bags that contained the fruit. The cluster bags themselves were enclosed in microperforated box liners.

In addition to the passive dosimeters, container SO_2 concentration was measured by withdrawing air samples from plastic tubing placed at the top rear pallet position, then fed out under the rear door seal. These samples were analyzed using a Kitagawa pump and SO_2 detector tubes.

Fumigation. One pound of "Fruit Doctor" SO_2 was introduced into the container through a plastic tube inserted through the rear door bottom seal.

Results

The concentration of SO_2 measured in the container was 1,500 ppm (0.15%) one minute after gas introduction. This concentration decreased to 250 ppm after one hour and 35 minutes (Fig. 1). At this time the container vent was opened as well as the rear door. It was observed that the Styrofoam ends of three of the bottom rear boxes had been melted due to SO_2 contact during injection. After the SO_2 was exhausted, the container was unloaded and the passive dosimeters recovered. At all of the sampling positions the Gastec 5D (0-100 ppm-h) tubes were completely saturated (+150 CT). With the exception of the rear top and rear bottom pallet positions, the Gastec 5DH tube (10-600 ppm-h) measured 600+ ppm-h (Table 1). The rear top and rear bottom pallet positions measured 400 and 350 ppm-h, respectively. Low penetration at these positions may be due to leaving the small portion of floor near the rear doors uncovered.

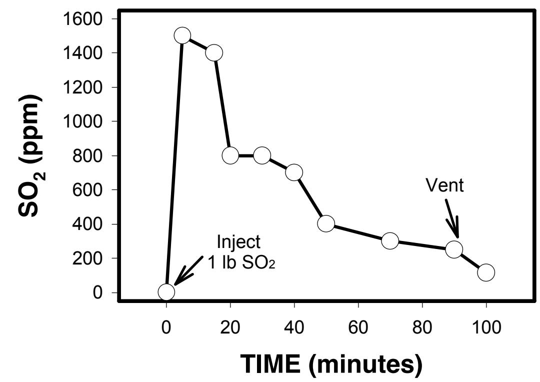

Fig. 1. Sulfur dioxide concentrations measured with Kitagawa tubes in a 2.377 ft^3 marine container after fumigation with one pound of gas.

Table 1. Sulfur dioxide penetration, measured as C x T (ppm-h), into pallets of Styrofoam boxes (perforated box liners plus cluster bags) loaded into a marine container and fumigated with one pound of gas.

Pallet Position	Box Position	Dose (ppm-h)[z]
Rear	Air	600+
Rear	Top	400
Rear	Bottom	350
Center	Air	600+
Center	Top	600+
Center	Bottom	600+
Front	Air	600+
Front	Top	600+
Front	Bottom	600+

[z] Measured using Gastec 5DH passive dosimeters.

Final Comments

- Approximately 1,000 ppm x hour was obtained after container fumigation with one pound of SO_2.
- One pound SO_2 fumigation was more than adequate. It may induce bleaching in susceptible cultivars. More tests will

be carried out with red color cultivars.

- Multiple SO_2 gassing at more than 600 ppm x hour should be avoided to prevent potential residue accumulation.
- High SO_2 residues can became a problem on grapes stored for 8-10 weeks prior to this 1,000 ppm x hour container fumigation.
- We recommend forced air fumigation at low temperature (force air tunnel) before loading the container rather than fumigating in the container.

PRODUCE FACTS PEACHES AND NECTARINES

Recommendations for Maintaining Postharvest Quality

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Maturity Indices:

- In California, harvest date is determined by skin ground color changes from green to yellow in most cultivars. A color chip guide is used to determine maturity of each cultivar except for white flesh varieties.
- A two tier maturity system is used in California: 1) US Mature (minimum maturity); 2) Well-Mature and/or 3) Tree Ripe. Well-Mature and Tree Ripe are equal based on definition. Tree Ripe has become a marking with no relationship to the maturity in the box. There are some packers who do pack a higher maturity fruit for tree ripe.
- Measurement of fruit firmness is recommended in cultivars where skin ground color is masked by full red color development before maturation. Maximum maturity: The flesh firmness at which fruits can be handled without bruising damage is measured with a penetrometer with an 8 mm- (5/16") tip. Bruising susceptibility varies among cultivars.

Quality Indices:

- High consumer acceptance is attained on fruit with high soluble solids content (SSC). Fruit acidity, SSC/acidity ratio and phenolic content are also important factors in consumer acceptance. There is no established minimum quality standard for peaches and nectarines.
- Fruit with 2-3 pounds-force flesh firmness is considered "ready to eat." Fruit below 6-8 pounds-force measured on the cheek are more acceptable to the consumer.

Optimum Temperature:

-1 to 0°C (30.5-32°F)
Freezing point varies depending on SSC from -3 to -2.5°C (26.5 to 29.5°F)

Optimum Relative Humidity:

90-95% R.H.; an air velocity of approximately 50 CFM is suggested during storage.

Rates of Respiration:

- 2-3 ml/kg hr at 0°C (32°F), 8-12 ml/kg hr at 10°C (50°F), and 32-55 ml/ kg hr at 20°C (68°F).
- To calculate heat production multiply ml CO_2/kg hr by 440 to get Btu/ton/ day or by 122 to get kcal/metric ton/day.

Rates of Ethylene Production:

0.01-5 µl/kg hr (range)* at 0°C (32°F), 0.02-10 µl/kg hr at 5°C (41°F), 0.05-50 µl/kg hr at 10°C (50°F) and 0.1-160 µl/kg hr at 20°C (68°F)

*The lower end of this range is for mature but unripe fruit; higher values are for ripe fruit.

Responses to Ethylene:

In general peaches and nectarines harvested at Well Mature (higher than US-Mature) will ripen properly without exogenous ethylene application. Ethylene application to fruit harvested at the US-

Mature maturity will only ripen the fruit more uniformly without speeding up the rate of ripening. A few cultivars may need to be exposed to ethylene to ripen properly.

Responses to Controlled Atmospheres(CA):

The major benefits of CA during storage/ shipment are retention of fruit firmness and ground color. Decay incidence has not been reduced by using CA 1-2%O_2 + 3-5 %CO_2. CA conditions of 6% O_2 + 17% CO_2 are suggested for reduction of internal breakdown during shipments, but the efficacy is related to cultivar, preharvest factors, temperature, market life and shipping time period.

Effects of Genotype and Cultural Practices on Postharvest Life:

There are approximately 350 peach and nectarine cultivars in California. Market life varies among them and it is strongly affected by temperature management. Maximum market life is obtained when fruit is stored at approximately 0^{o}C (32^{o}F). Maximum market life varies from 1-7 weeks for nectarine cultivars and from 1-5 weeks for peach cultivars. Because internal breakdown is the main limitation to market life, minimum postharvest life occurs when fruit is stored at 5^{o}C (41^{o}F). Cultural practices have an important role in determining fruit quality and storage potential. Leaf nitrogen content between 2.6-3.0% is advised to obtain high red color development and maximum storage performance. Small size fruit grown in the outside canopy position have a longer market life than large size fruit grown in the inside position.

Physiological Disorders:

- **Internal Breakdown or Chilling Injury:**
  This physiological problem is characterized by flesh internal browning, flesh mealiness, flesh bleeding, failure to ripen and flavor loss. These symptoms develop during ripening after a cold storage period, thus, are usually detected by consumers. Fruit stored within the 2.2-7.6 ^{o}C (36-46 ^{o}F) temperature range are more susceptible to this disorder.
- **Inking(black staining):**
  It is a cosmetic problem affecting only the skin of peaches and nectarines. It is characterized by black or brown spots or stripes. These symptoms appear generally 24-48 hours after harvest. Inking occurs as a result of abrasion damage in combination with heavy metals (iron, copper and aluminum) contamination. This occurs usually during the harvesting and hauling operations, although it may occur in other steps during postharvest handling. Gentle fruit handling, short hauling, avoiding any foliar nutrient sprays within 15 days before harvest, and following the suggested preharvest fungicide spray interval guidelines are our recommendations to reduce inking in California.

Pathological Disorders:

- **Brown Rot:**
  Caused by *Monilia fructicola* is the most important postharvest disease of stone fruits. Infection begins during flowering and fruit rot may occur before harvest but often occurs postharvest. Orchard sanitation to minimize infection sources, preharvest fungicide application, and prompt cooling after harvest are among the control strategies. Also, postharvest fungicide treatment may be used.
- **Gray Mold:**
  Caused by *Boyrytis cinerea* can be serious during wet spring weather. It can occur during storage if the fruit has been contaminated through harvest and handling wounds. Avoiding mechanical injuries and good temperature management are effective control measures.

- **Rhizopus Rot:**
  Caused by *Rhizopus stolonifer* can occur in ripe or near ripe stone fruits kept at 20 to 25°C (68 to 77°F). Cooling the fruits and keeping them below 5°C (41°F) is very effective against this fungus.

PRODUCE FACTS

PLUMS

Recommendations for Maintaining Postharvest Quality

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Maturity Indices:

- In some of the cultivars growing in California, harvest date is determined by skin color changes that are described for each cultivar. A color chip guide has been designed to determine maturity for each cultivar.
- A two tier maturity system is used in California: 1) US Mature (minimum maturity); 2) Well-Mature and/or 3) Tree Ripe. Well-Mature and Tree Ripe are equal based on definition. Tree Ripe has become a marking with no relationship to the maturity in the box. There are some packers who do pack a higher maturity fruit for tree ripe.
- Measurement of fruit firmness is recommended for cultivars where skin ground color is masked by full red or dark color development before maturation.

Maximum maturity:

Flesh firmness, measured with a penetrometer with an 8 mm-tip, can be used to determine a maximum maturity index, which is the stage at which fruit can be harvested without suffering bruising damage during postharvest handling.

- Plums are less susceptible to bruising than most peach and nectarine cultivars at comparable firmness.

Quality Indices:

High consumer acceptance is attained on fruit with high soluble solids content (SSC). Fruit acidity, SSC/acidity ratio, and phenolic content are also important factors in consumer acceptance. There is no established minimum quality standard based on these factors. Plums with 2-3 pounds-force flesh firmness are considered "ready to eat".

Optimum Temperatures:

-1.0 to 0°C (30.5-32°F)
Freezing point varies depending on SSC.

Optimum Relative Humidity:

90-95% R.H.; an air velocity of approximately 50 CFM is suggested.

Rates of Respiration:

1-1.5 ml/kg hr at 0°C (32°F), 4-6 ml/kg hr at 10°C (50°F), and 8-12 ml/kg hr at 20°C (68°F).

- To calculate heat production multiply ml CO_2/kg.hr by 440 to get BTU/ton/day or by 122 to get kcal/metric ton/day.

Rates of Ethylene:

0.01-5 µl/kg hr (range)* at 0°C (32°F), 0.02-15 µl/kg hr at 5°C (41°F), 0.04-60 µl/kg hr at 10°C (50°F) and 0.1-200 µl/kg hr at 20°C (68°F).

* The lower end of this range is for mature but unripe fruit; higher values are for ripe fruit.

Responses to Ethylene:

Most of the plums harvested at the California Well-Mature stage (higher than US-Mature) will ripen properly without exogenous ethylene application. Ethylene application to fruit harvested at the US-Mature maturity will only ripen the fruit more uniformly without speeding up the rate of ripening. However, for the slow ripening plum cultivars, exogenous application of ethylene (100 ppm for 1-3 days at 20°C (68°F) is needed for even ripening. These cultivars are Black Beaut, Casselman, Late Santa Rosa, Kelsey, Nubiana, Queen Ann, and Roysum.

Responses to Controlled Atmospheres(CA):

The major benefits of CA during storage/shipment are retention of fruit firmness and ground color. Decay incidence has not been reduced by CA of 1-2%O_2 + 3-5 %CO_2. CA conditions of 6% O_2+ 17%CO_2 are suggested for reduction of internal breakdown during shipment, but its effectiveness depends on cultivar, preharvest factors, market life and shipping time.

Effects of Genotype and Cultural Cultivars in California:

Market life varies among cultivars and it is strongly practices on affected by temperature management. Maximum market life is obtained when fruit are stored at approximately 0°C (32°F). Maximum market life varies from 1-8 weeks. Because internal breakdown is the main limitation to market life, minimum postharvest life occurs when fruit is stored at 5°C (41°F).

Physiological Disorders:

- **Internal Breakdown or Chilling Injury:**
  This physiological problem is characterized by flesh translucency, flesh internal browning, flesh mealiness, flesh bleeding, failure to ripen and flavor loss. These symptoms develop in plum and fresh prunes during ripening after a cold storage period. Thus, these symptoms are usually detected by consumers. Fruit stored within the "killing temperature range" 2-8°C (36-46°F) are more susceptible to this problem.

Pathological Disorders:

- **Brown rot:**
  Caused by *Monilia fructicola* is the most important postharvest disease of stone fruits. Infection begins during flowering and fruit rot may occur before harvest but often occurs postharvest. Orchard sanitation to minimize infection sources, preharvest fungicide application and prompt cooling after harvest are among the control strategies. Also, postharvest fungicide treatment may be used.
- **Gray Mold:**
  Caused by *Botrytis cinerea* can be serious during wet spring weather. It can occur during storage if the fruit has been contaminated through harvest and handling wounds. Avoiding mechanical injuries and good temperature management are effective control measures.
- **Rhizopus Rot:**
  Caused by *Rhizopus stolonifer* can occur in ripe or near ripe stone fruits kept at 20 to 25°C (68 to 77°F). Cooling the fruits and keeping them below 5°C (41°F) is very effective against this fungus.

PRODUCE FACTS
TABLE GRAPES

Recommendations for Maintaining Postharvest Quality

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Maturity Indices:

In California, harvest date is determined by Soluble Solids Concentration (SSC) of 14 to 17.5% depending on cultivar and production area. In early production areas, an SSC/TA ratio of 20 or higher is used to determine minimum maturity for cultivars that meet a low minimum SSC. For red and black colored cultivars, there is also a minimum color requirement.

Quality Indices:
High consumer acceptance is attained for fruit with high SSC or SSC/TA ratio. Berry firmness is also an important factor for consumer acceptance as are lack of defects such as decay, cracked berries, stem browning, shriveling, sunburned, dried berries, and insect damage.

Optimum Temperature:
Storage temperature of -1.0 to 0.0°C (30-32°F) is recommended for mature fruit. Freezing damage may occur in less mature grapes.

The highest freezing point for berries is -3.0°C (26°F), but freezing point varies depending on SSC. A -2.0°C (28°F) freezing point for stems has been reported for wine grapes. New table grape cultivars are more sensitive to stem freezing damage.

Optimum Relative Humidity:
90-95% RH and an air velocity of approximately 20-40 feet per minute (FPM) is suggested during storage.

Rates of Respiration: (of grape clusters, i.e. berries + stems)

Temperature	ml CO_2/kg× hr*
0°C (32°F)	1-2
5°C (41°F)	3-4
10°C (50°F)	5-8
20°C (68°F)	12-15

Stem respiration rate is approximately 15 times higher than berry respiration.

* To calculate heat production, multiply ml CO_2/kg.hr by 440 to get BTU/ton/day or by 122 to get kcal/metric ton/day.

Rates of Ethylene Production:
<0.1 µm l/kg × hr at 20°C (68°F).

Responses to Ethylene:
Table grapes are not very sensitive to ethylene. However, exposure to ethylene (>10 ppm) may be a secondary factor in shatter.

Responses to Controlled Atmospheres (CA):
CA (2-5% O_2 + 1-5% CO_2) during storage/ shipment is not currently recommended for table grapes because its benefit is slight and SO_2 used for decay control.

Effects of Genotype on Market Life:
Market life varies among table grape cultivars grown in California and is also strongly affected by temperature management and decay susceptibility.

Physiological Disorders:

- **Shatter:** (loss of berries from the cap stem)
  In general, shatter increases in severity with increasing maturity, i.e., the longer the fruit remains on the vine. Berries of seedless cultivars, are usually less well attached to the cap stem than seeded cultivars. Shatter varies considerably from season to season, and there is a large difference among varieties. Gibberellin applied at fruit set weakens berry attachment. Shatter occurs mainly due to rough handling during field packing with additional shatter occurring all the way to the final retail sale. Shatter incidence can be reduced by controlling pack depth and fruit packing density (cubic inches per pound), using cluster bagging, gentle handling, and maintaining recommended temperature and relative humidity. Cane girdling reduces shattering incidence.
- **Waterberry:** Waterberry is associated with fruit ripening and most often begins to develop shortly after veraison (berry softening). The earliest symptom is the

development of small (1-2 mm) dark spots on the cap stems (pedicles) and/or other parts of the cluster framework. These spots become necrotic, slightly sunken, and expand to affect more areas. The affected berries become watery, soft, and flabby when ripe. In California, this disorder has been associated with a high nitrogen status vine, canopy shading, or cool weather during veraison and fruit ripening. Avoid over fertilization with nitrogen. Foliar nutrient sprays of nitrogen should be avoided in waterberry-prone vineyards. Trimming off affected berries during harvest and packing is a common practice, although labor intensive.

Pathological Disorders:

- **Gray Mold:** (*Botrytis cinerea*)

  Gray mold is the most destructive of the postharvest diseases of table grapes, primarily because it develops at temperatures as low as 31°F (-0.5°C) and grows from berry to berry. Gray mold first turns berries brown, then loosens the skin of the berry, its white, thread-like hyphal filaments erupt through the berry surface, and finally masses of gray colored spores develop. Wounds near harvest also provide opportunities for infections. No wound is required for infection when wet conditions occur.

  Botrytis infection can be reduced by removing desiccated, infected grapes of the previous season from vines, leaf-removal canopy management, preharvest fungicides, trimming visibly infected, split, cracked, or otherwise damaged grapes before packing, prompt cooling and fumigation with sulfur dioxide (100 ppm for one hour) or use of slow release SO_2 pads.

FUTURE EVENTS

December 1, 1999
Winter Tree Fruit Meeting
Location: Dinuba Memorial Building, Dinuba
Time and Topics to be announced
For more information contact Harry Andris at 559-456-7285.

July 9-11, 2000
International Peach Symposium
Location: University of California, Davis
For more information contact Scott Johnson or Carlos Crisosto at 559-646-6500.