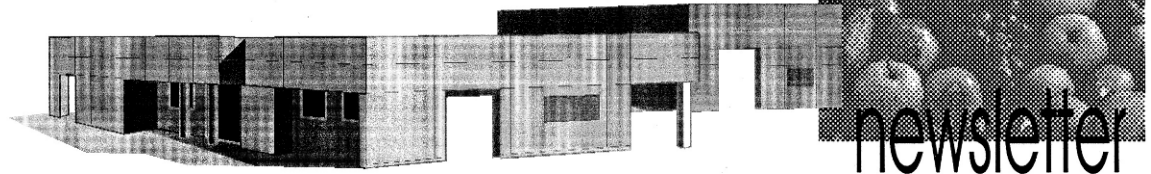




# Central Valley **POSTHARVEST**



newsletter

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COOPERATIVE EXTENSION  
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May 2008  
 Vol. 17, No. 2

Carlos H. Crisosto, Editor

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## ESTABLISHING A QUALITY CONTROL SYSTEM

**C.H. Crisosto**  
**Postharvest Physiologist**  
**Pomology Department, UC Davis**  
**Kearney Agricultural Center, Parlier, CA**

In recent years, the production and marketing of fresh stone fruits has increased rapidly, but consumption remains low at approximately 5.9 pounds per capita per year for nectarines and peaches, and 1.3 for fresh plums and prunes. Surveys to explain this low consumption indicate that consumers object to hard fruit and lack of flavor (Table 1). As the volume of

shipments is still increasing, greater attention must be given to the production and delivery of high quality stone fruits.

Table 1. Consumer satisfaction with peach purchases.

Consumer complaint	%
Little flavor	30
Too hard	21
Too soft	5
Mealy	13

Preliminary and limited studies associated high soluble solids concentration (SSC) with higher consumer acceptance. Unfortunately, there are

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more factors involved such as acidity, phenolics, volatiles, etc. in consumer acceptance than just the simple SSC value. Thus, since we do not know enough about consumer acceptance and stone fruit chemical composition during maturation/ripening, we are not able to propose any quality standards. Furthermore, the variability of the SSC among fruit from different orchards and within the individual tree is so large that it is impossible to set any minimum maturity standards.

The best way to ensure high quality produce is by using the right cultivars, training systems, pruning, thinning, good irrigation and fertilization practices, etc., in combination with late harvesting.

It also is essential to evaluate production processes by establishing a quality control system. It will help to identify, segregate and keep records of fruit quality. Also, it will help to evaluate the effect of changes in cultural practices on fruit quality and to identify cultivars with high SSC levels. Correct handling of the information will benefit growers and the California fruit industry's reputation.

## **MEASUREMENT OF pH AND TITRATABLE ACIDITY**

**D. Garner, C.H. Crisosto, P. Wiley,  
and G.M. Crisosto**

- I. Materials
  - A. Required: pH meter or phenolphthalein, burette, burette clamp and stand, gram scale, graduated cylinder, beakers, 0.1N NaOH solution.
  - B. Optional: magnetic stirrer & stir bar, automatic titrator.
- II. Procedure
  - A. Obtain at least 50 ml of clear juice by one of the following methods:
    1. Cut fruit, press with a hand press, and filter through cheesecloth, or

2. Cut fruit into a blender, homogenize, centrifuge slurry, and pour off clear liquid for analysis.

\*\* Sugar levels often vary within the fruit, being higher at the stem-end and lower at the calyx-end. For this reason, it is important to use longitudinal slices of fruit (from end to end) when sampling.

- B. Make sure samples are at room temperature before taking measurements.
- C. Measure the pH of the samples with a pH meter and record the value.
- D. For each sample, weigh out 6 grams of juice into a 100 ml beaker.
- E. To each sample, add 50 ml of water.
- F. Titrate each sample with 0.1 N NaOH to an end point of 8.2 (measured with the pH meter or phenolphthalein indicator) and record the milliliters (ml) of NaOH used.
- G. Calculate the titratable acidity using the following formula:

$$\% \text{ acid} = \frac{[\text{ml NaOH used}] \times [0.1 \text{ N NaOH}] \times [\text{milliequivalent factor}] \times [100]}{\text{grams of sample}}$$

<b>Commodity</b>	<b>Predominant Acid</b>	<b>Milliequivalent Factor</b>
Stone fruit, apples, kiwifruit	Malic Acid	0.067
Citrus	Citric Acid	0.064
Grapes	Tartaric Acid	0.075

## **MEASUREMENT OF FRUIT FIRMNESS**

**D. Garner, C.H. Crisosto, P. Wiley,  
and G.M. Crisosto**

- I. Materials
  - A. Effegi penetrometer or Magness-Taylor pressure tester, either hand-held or mounted on a stand for consistency.

## II. Procedure

- A. Make sure all fruits tested are comparable in temperature since warm fruits are usually softer than cold fruits.
- B. Make two puncture tests per fruit, one on each of the opposite cheeks, midway between the stem-end and calyx-end.
- C. Remove a disc (about 2 cm in diameter) of the skin with a stainless steel vegetable peeler or sharp knife.
- D. Use an appropriate tip (plunger) size for each commodity (5/16" for stone fruit and kiwifruit, D'Anjou pears, Bosc pears, Comice pears, Bartlett pears, and Winter Nellis pears; 7/16" for most apples).
- E. All determinations for a given lot should be made by one person to minimize variability.
- F. Hold the fruit against a stationary hard surface and force the tip into the fruit at a uniform speed (take 2 seconds).
- G. Depth of penetration should be consistent to the inscribed line on the tip.
- H. Record reading to the nearest 0.5 lb or 0.25 kg.
  1. The unit should be written as poundforce (lbf) or kilogramforce (kgf) in order to avoid confusion with the units of mass.

## III. Maintenance

- A. Before use on a given day, work the plunger in and out about 10 times to loosen up the springs inside the instrument.
- B. Clean the tips after use to prevent clogging with fruit juice.

## IV. Calibration:

- A. Hold the firmness tester in a vertical position and place the tip onto the pan of an accurate scale.
  1. Press down slowly on the firmness tester until the scale registers a given weight, then read the firmness tester. Repeat this comparison three to five times. If you find that the

instrument is properly calibrated, it is ready to use.

- B. If the instrument reading is not in agreement with the scale reading, find out the magnitude and direction of the difference and proceed as follows:

### 1. Effegi fruit penetrometer:

- a) Unscrew the chrome guide nut to remove the plunger assembly.
- b) To make the instrument read lower, insert washers between the spring and the stationary brass guide.
- c) To make the instrument read higher, insert washers between the chrome guide nut and the stationary brass guide on the plunger shaft.
- d) Reassemble and recheck for calibration.

### 2. Magness-Taylor Pressure Tester:

- a) Remove the plunger assembly from the barrel of the instrument and remove the bolt and washers from the end of the plunger assembly.
- b) Pull the plunger and spring out of the metal cylinder, then shake the washers out of the cylinder.
- c) To make the instrument read lower, move washers from inside to outside the metal cylinder.
- d) To make the instrument read higher, move washers from outside to inside the metal cylinder.
- e) Reassemble and recheck for calibration.

- C. If the indicator needle does not stop or does not release properly, clean the case in the area of the release button, remove the plunger assembly, and then lubricate the inside of the instrument with an aerosol lubricant.

## MEASUREMENT OF SOLUBLE SOLIDS CONTENT

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**D. Garner, C.H. Crisosto, P. Wiley,  
and G.M. Crisosto**

- I. Theory
  - A. Sugars are the major soluble solids in fruit juice. Other soluble materials include organic and amino acids, soluble pectins, etc. Soluble solids concentration (SSC%, °Brix) can be determined in a small sample of fruit juice using a hand held refractometer. This instrument measures the refractive index, which indicates how much a light beam is “bent” when it passes through the fruit juice.
  - B. Temperature of the juice is a very important factor in the accuracy of reading. All materials expand when heated and become less dense. For a sugar solution, the change is about 0.5% sugar for every 10°F. Good quality refractometers have a temperature compensation capability.
- II. Materials
  - A. 0-32% Brix temperature compensating refractometer, distilled water, Kimwipes, 5 or 10% sugar solution.
- III. Procedure
  - A. Extract clear juice from fruit to be sampled.
    1. Sugar levels often vary within the fruit, being higher at the stem-end and lower at the calyx-end. For this reason, it is important to use longitudinal slices of fruit (from end to end) when sampling.
  - B. Place a drop of juice on refractometer prism.
  - C. Lower cover plate and read.
    2. In juice samples with a high starch content, like unripe kiwi, it may be difficult to read the refractometer because the starch settles out on the prism. To remedy this, put your thumb on the cover plate, turn the

refractometer upside down, and re-read. This way the starch settles out on the cover plate and does not blur the reading.

- D. Rinse prism between samples with distilled water and dry with a soft, lint-free tissue (Kimwipe).
- IV. Refractometer maintenance and calibration
    - A. Clean the instrument after each use with distilled water. Dry with a soft tissue (Kimwipe).
    - B. Calibrate with a drop of distilled water. Adjust reading to 0°Brix if necessary with the small set-screw on the back. Verify accuracy with a drop of 5 or 10% sucrose solution (5 grams sugar in 100 ml of distilled water).
    - C. Do not submerge the refractometer when cleaning. If water gets into the instrument it will need to be sent out for repair and resealing.

## EFFECTS OF CONTROLLED ATMOSPHERE ON PLUMS

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**Carlos H. Crisosto and David Garner**

Recently the global production and consumption of plums (*Prunus salicina* Lindell) and prunes (*Prunus domestica* L.) have increased sharply and the need for longer storage periods is also increasing. Maintaining quality for a period of 5 weeks or even longer is needed for orderly overseas marketing. Incorporation of new cultivars has extended the harvest season from late spring through the summer months. Plums are climacteric fruit and undergo rapid deterioration after ripening, including softening, dehydration, and decay. Commercial storage conditions (0-5°C and 80-95% relative humidity) may delay the softening process, but may also lead to the development of storage disorders. Storage disorder symptoms include flesh browning, gel breakdown, mealiness, flesh translucency, red pigment accumulation (bleeding), overripening and loss of flavor. Postharvest life varies

among cultivars and it is strongly affected by temperature management. Most plum and fresh prune cultivars are susceptible to cold storage disorders when stored at 5°C more often than at 0°C. Market-life of 'Blackamber,' 'Fortune' and 'Angeleno' plums growing in California at 0°C was > 5 weeks. 'Showtime,' 'Friar,' and 'Howard Sun' plums developed chilling injury symptoms within 4 weeks, even when stored at 0°C. In all plum cultivars, a much longer market life was achieved when stored at 0°C rather than at 5°C (Table 2). Most plum cultivars when handled at temperatures very close to 0°C have a postharvest life that allow them to be marketed within 4 weeks without expressing cold storage disorders. However, other deterioration factors such as softening, skin color changes and decay may become important deterioration factors during after storage marketing that limit prolonged storage of plums.

For some cultivars, oxygen levels between 1-2 kPa delay ripening and carbon dioxide levels between 0-5 kPa suppress fruit softening. Oxygen levels below 1 kPa may induce failure to ripen and off flavors while carbon dioxide higher than 15 kPa has been associated with flesh browning. Thus, specific evaluation per cultivar should be carried out to conclude if any potential CA benefit can be used commercially. The major benefits of CA reported during storage and shipment have been delaying skin and flesh color changes. Flesh firmness retention immediately after cold storage removal has not normally been a benefit when fruit have been stored close to 0°C. However, in most of the cases when fruit were stored under cold storage temperatures higher than 0°C, CA treated fruit had higher firmness than air stored fruit. The same occurred in studies when fruit were stored at 7.5°C to avoid chilling damage. In this situation, CA treated fruit had a higher firmness than air stored fruit.

Currently, CA has a limited use for storage >4 weeks with some cultivars such as 'Angeleno',

'Casselmann', 'Santa Rosa', 'Laroda' and 'Queen Ann'. In California, success in plums has also been achieved with the long term storage temperature of 0.6°C and an atmosphere of 2 kPa O<sub>2</sub> + 5 kPa CO<sub>2</sub> with 8 weeks for 'Friar'; 12 weeks for 'Casselmann' and 16 weeks for 'Angeleno'. In South Africa, a period of 8 weeks postharvest life under CA storage at 3 kPa O<sub>2</sub> + 5 kPa CO<sub>2</sub> has been reported for 'Laetitia' and 'Casselmann'. For 'Songold' plums the best CA treatment was also 3 kPa O<sub>2</sub> + 5 kPa CO<sub>2</sub> but the maximum storage time was 7 weeks. During these studies, the incidence of slight overripening was high in all treatments. CA storage resulted in the lowest incidence of overripening and the highest firmness. Gel breakdown was low in fruit of all treatments and no decay developed in any of the fruit. Although the results indicate that air stored fruit also performed well, the taste of these fruit was totally unacceptable after 8 weeks storage and 7 days at 10°C.

Recently a detailed evaluation on different CO<sub>2</sub> and O<sub>2</sub> combinations (5 kPa CO<sub>2</sub> + 3 kPa O<sub>2</sub>, 10 kPa CO<sub>2</sub> + 5 kPa O<sub>2</sub>, or 15 kPa CO<sub>2</sub> + 10 kPa O<sub>2</sub>) was carried out using well-mature 'Blackamber', 'Flavorich', 'Fortune' and 'Friar' plums. Fruit were collected from packers in Fresno County, California, transported to the F. Gordon Mitchell Postharvest Laboratory at the Kearney Agricultural Center, and forced air-cooled overnight to a pulp temperature of approximately 0°C. After cooling, the fruit were stored at 0°C or 7.5°C in 338-liter sealed aluminum tanks under a continuous flow of either air or CA combinations. Flow rates and gas mixtures were established using a mixing board with micro-metering valves. Supply and exhaust gas O<sub>2</sub> and CO<sub>2</sub> composition was monitored using an Ametek paramagnetic oxygen analyzer (S-3A/II) and a Horiba infrared gas analyzer (VIA-510 for CO<sub>2</sub>). Plum quality was evaluated at receipt, then after 3 and 6 weeks cold storage.

**On 'Blackamber' plum** CA treatments did not affect fruit firmness changes as softening did not occur during this 3 week period at 0°C. However, CA delayed skin color changes from red to dark fruit during this 6 week period at 0°C. At this time, a higher proportion of red plums (~60%) stored in the 5 kPa CO<sub>2</sub> + 3 kPa O<sub>2</sub> and the 10 kPa CO<sub>2</sub> + 5 kPa O<sub>2</sub> CA treatments turned dark, while in the 15 kPa CO<sub>2</sub> + 10 kPa O<sub>2</sub> treatment only 27% of red plums turned dark. On fruit stored at 7.5°C, CA treatments still significantly reduced fruit softening and skin color changes from red to dark. By 4 weeks at 0°C, cold storage disorders such as gel breakdown, flesh browning, and mealiness were not observed in any of the treatments. Flesh bleeding incidence was lower in all of the three CA treatments than in air stored plums at 0°C.

**On 'Flavorich' plum** CA treatments did not affect fruit firmness changes as softening did not occur during the 6 week period at 0°C. However, CA delayed skin color changes from red to dark fruit during the 6 week period at 0°C. On fruit stored at 7.5°C, CA treatments still significantly reduced fruit softening and skin color changes from red to dark. At 7.5°C, 100% of the red fruit stored in air turned dark after 3 weeks storage, while 40% of CA stored fruit were still red after 6 weeks storage. Cold storage disorders such as gel breakdown, flesh browning, mealiness and flesh bleeding were not observed in any of the treatments within this 6 week period at 0°C. However, after 6 weeks storage at 7.5°C, high levels of gel breakdown were measured in CA stored fruit (both red and black) at 7.5°C indicating that low oxygen and/or high CO<sub>2</sub> toxicity may have occurred during this long period at 7.5°C and suggesting the importance of keeping fruit close to 0°C during storage to avoid any potential injury from the CA treatment.

**On 'Fortune' plum** CA treatments did not affect fruit firmness changes as softening did not occur during the 6 week period at 0°C. At 7.5°C, dark red fruit stored in CA remained

firmer than air stored fruit after 3 weeks. After 6 weeks storage, red plums stored in 10 or 15 kPa CO<sub>2</sub> were firmer than plums stored in air or 5 kPa CO<sub>2</sub>. In this cultivar, CA did not significantly affect skin color changes during this 6 week period at 0°C and 7.5°C. By 3 weeks at 0°C, cold storage disorders appeared and about 20% of plums had mealiness symptoms. Cold storage disorder incidence increased during cold storage at 0°C, reaching only about 20% of sound fruit on air stored compared with none on CA treated after 6 weeks. At 7.5°C, most plums were not marketable because of different cold storage disorder symptoms such as flesh browning, leathery texture and mealiness.

**On 'Friar' plum** CA treatments did not affect fruit firmness changes as softening did not occur during this 3 week period at 0°C. Fruit remained firm at 0°C under all storage atmospheres for 3 weeks. Some softening occurred after 6 weeks storage, but there was still no difference between storage atmospheres. At 7.5°C, fruit stored in CA remained firmer than air stored fruit after both storage intervals. In this cultivar which is dark at harvest time, CA did not delay skin color changes from dark to dark black fruit during the 6 week period at 0°C. In fact, plums turned dark black in cold storage, regardless of storage atmosphere or temperature. After 3 weeks storage at 0°C or 7.5°C, fruit stored in air had more flesh bleeding than CA stored fruit although onset of flesh browning symptoms were observed in fruit from all the treatments. At this time, fruit from all storage atmospheres remained juicy. At 7.5°C, both dark and dark black fruit from the 10 and 15 kPa CO<sub>2</sub> storage atmosphere treatments started to show some onset symptoms of gel breakdown. After 6 weeks storage, there were high levels of flesh browning and bleeding in all fruit. There was less flesh bleeding incidence in CA-stored fruit than air stored fruit. Fruit still remained juicy and CA treatments did not reduce the flesh browning problems.

## EFFECTS OF CONTROLLED ATMOSPHERE ON NECTARINES

**Carlos H. Crisosto, Celia M. Cantín  
and Gayle Crisosto**

In a recent detailed study testing four controlled atmosphere conditions (air; 2 kPa O<sub>2</sub> + 5 kPa CO<sub>2</sub>; 10 kPa CO<sub>2</sub> + 10 kPa; and 17 kPa CO<sub>2</sub> + 6 kPa for 5 and 6 weeks (simulated shipment) on 11 important nectarine cultivars grown in California, it was concluded that on 9 out of 11 cultivars CA was not necessary after 5 weeks storage at 0°C as chilling injury symptoms were not expressed and fruit remained firm. In these studies fruit were held in cold storage for a week before CA treatments were established simulating standard shipping practices. 'August Pearl' had high flesh browning incidence that was reduced by any of the three CA treatments. By 5 weeks of simulated shipment, 'August Fire' had high levels of mealiness in all the treatments (Table 1). On the other hand, by 6 weeks of simulated shipment at 0°C, only six cultivars out of the 11 did not show commercial chilling injury symptoms in any of the storage conditions (Table 2). 'Ruby Diamond' had near 80% flesh browning and absence of flesh mealiness on fruit under cold storage and FB was reduced in all the CA treatments. 'Honey Royale', 'Summer Bright', 'August Pearl', and 'August Fire' had mainly high incidence of flesh mealiness that were not reduced by using any of the CA treatments. Despite the lack of good control of flesh mealiness, the CA treatments did not damage fruit except for the 17 kPa CO<sub>2</sub> + 6 kPa O<sub>2</sub> at 1°C. A dull skin browning color (Fig. 1) and pitting (Fig. 8) was observed on 'August Pearl' and 'Honey Royale' fruit after 6 weeks cold storage under the 6 kPa O<sub>2</sub> + 17 kPa CO<sub>2</sub>.

Table 1. Influence of controlled atmosphere (CA) conditions on chilling injury development of ripe nectarines after 5 weeks of CA cold storage in addition to a previous one week of cold storage at 0°C.

Nectarine Cultivars	5 weeks			
	Air	2 kPa + 5 kPa	10 kPa + 10 kPa	6 kPa + 17 kPa
Ruby Diamond	0	0	0	0
Ruby Sweet	0	0	0	0
Spring Bright	0	0	0	0
Honey Royale	0	0	0	0
Fire Pearl	0	0	0	0
Summer Bright	0	0	0	0
Summer Fire	0	0	0	0
Zee Glo	0	0	0	0
August Pearl	100 <sup>FB</sup>	10 <sup>M</sup>	10 <sup>M</sup>	0 <sup>M</sup>
August Fire	20 <sup>M</sup>	60 <sup>M</sup>	30 <sup>M</sup>	50 <sup>M</sup>
Arctic Snow	0	0	0	0

<sup>z</sup> = Fruit showed external damage

<sup>M</sup> = Mealiness

<sup>FB</sup> = Flesh Browning

Table 2. Influence of controlled atmosphere (CA) conditions on chilling injury development of ripe nectarines after 6 weeks of CA cold storage in addition to a previous after one week of cold storage at 0°C.

Nectarine Cultivars	6 weeks			
	Air	2 kPa + 5 kPa	10 kPa + 10 kPa	6 kPa + 17 kPa
Ruby Diamond	80 <sup>FB</sup>	0	0	0
Ruby Sweet	0	0	0	0
Spring Bright	0	0	0	0
Honey Royale	40 <sup>M</sup>	40 <sup>M</sup>	30 <sup>M</sup>	70 <sup>M</sup>
Fire Pearl	20 <sup>M</sup>	0	0	0
Summer Bright	30 <sup>M</sup>	40 <sup>M</sup>	50 <sup>M</sup>	40 <sup>M</sup>
Summer Fire	20 <sup>FB</sup>	0	10 <sup>M</sup>	10 <sup>M</sup>
Zee Glo	10 <sup>FB</sup> -10 <sup>M</sup>	0	0	0
August Pearl	100 <sup>M</sup> -100 <sup>FB</sup>	40 <sup>FB</sup> -20 <sup>M</sup>	20 <sup>M</sup>	10 <sup>ZM</sup>
August Fire	30 <sup>M</sup>	100 <sup>M</sup>	40 <sup>M</sup>	80 <sup>M</sup>
Arctic Snow	10 <sup>FB</sup> -10 <sup>M</sup>	0	0	0

<sup>z</sup> = Fruit showed external damage

<sup>M</sup> = Mealiness

<sup>FB</sup> = Flesh Browning



Figure 1. A detailed view of external damage developed after prolonged storage (6 weeks) under 17 kPa CO<sub>2</sub> + 6 kPa O<sub>2</sub> at 0°C for Honey Royale nectarine.

## STONE FRUIT INTERNAL BREAKDOWN EVALUATION

**Carlos H. Crisosto, David Garner  
and Gayle M. Crisosto**

Symptoms of stone fruit internal breakdown (IB) or chilling injury (CI) include browning of the flesh, development of a mealy or leathery texture, accumulation of red pigment in the flesh, and development of off-flavors. These symptoms can be measured as follows:

**1. Flesh browning.** Measured qualitatively on a scale from 1-6.

Score	Description
1	None
2	Very slight browning in the pit cavity
3	Slight browning in the pit cavity and surrounding tissue
4	Moderate browning on less than 50% of the flesh
5	Severe browning on 50% to 75% of the flesh
6	Extreme browning covering most of the flesh

**2. Flesh texture.** Measured qualitatively on a scale from 1-3.

Score	Description
1	Juicy fruit
2	Moderately leathery or mealy fruit (small amount of juice released upon squeezing)
3	Severely leathery or mealy fruit (almost no juice released upon squeezing)

**3. Flesh bleeding.** Measured qualitatively on a scale from 1-3.

Score	Description
1	No bleeding
2	Moderate bleeding with red pigment covering less than 50% of the flesh
3	Severe bleeding with red pigment covering more than 50% of the flesh





Plate 1. Peach flesh browning (top), juicy fruit (bottom left), and mealy fruit (bottom right).

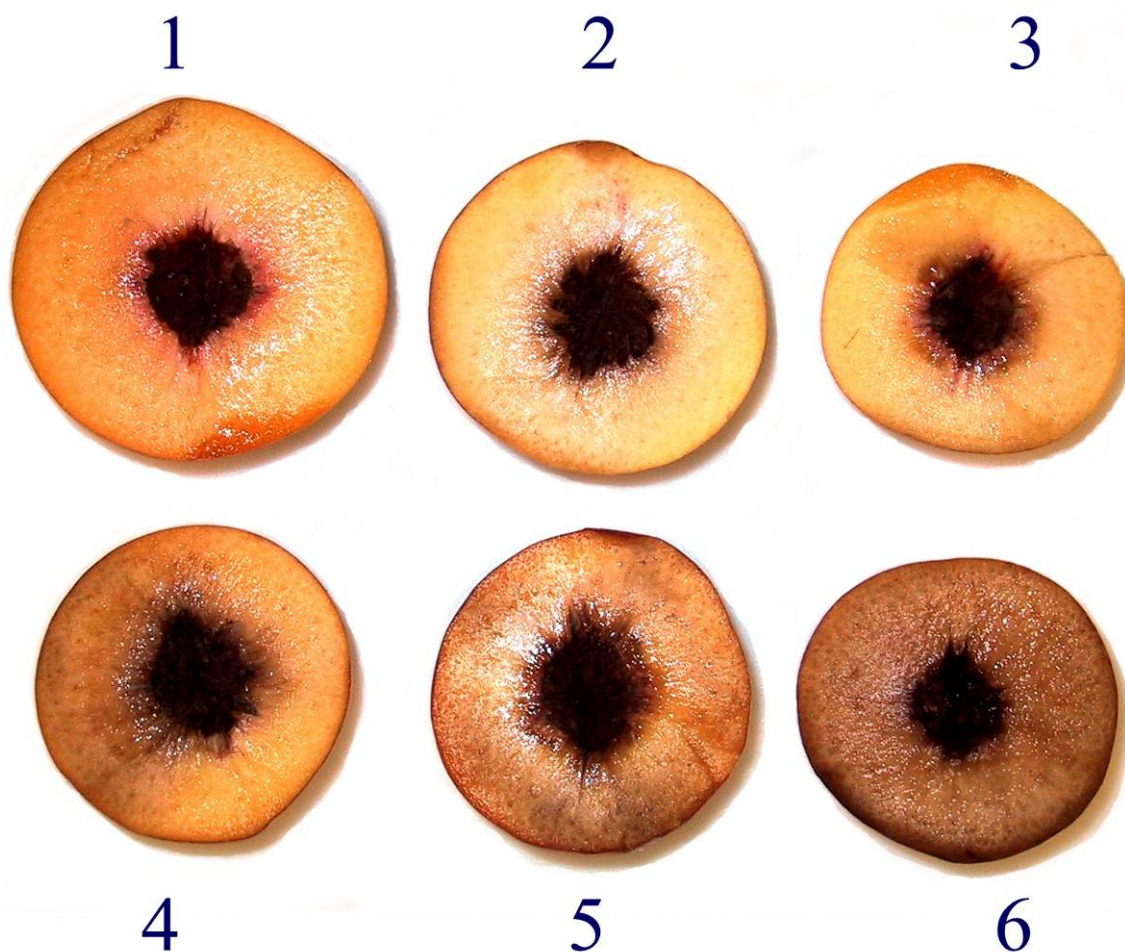


Plate 2. Peach flesh browning scale (1-6).

## FUTURE EVENTS

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**2008 Variety Displays and Research Update Seminars at the Kearney Agricultural Center, 9240 S. Riverbend Avenue, Parlier, CA.** Presented by University of California Cooperative Extension and the Kearney Agricultural Center.

8:00 – 9:00 a.m. Variety display by stone fruit nurseries, breeders and the USDA  
 9:00 – 10:00 a.m. Research Update Topic and discussion in the field

***Mark your calendars for these dates:***

- Friday, June 6 Stone Fruit Nutrition
- Friday, July 11 Fruit Quality
- Friday, August 22 Keeping Trees Short

For more information call: Scott Johnson (559) 646-6547; Kevin Day (559) 685-3309, Ext. 211; Brent Holtz (559) 675-7879, Ext. 209; or Bob Beede (559) 582-3211, Ext. 2737.

**Upcoming events are posted on the Postharvest Calendar at the ANR website at:**

<http://ucce.ucdavis.edu/calendar/calmain.cfm?calowner=5423&group=w5423&keyword=&ranger=3650&calcat=0&specific=&waste=yes>

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