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Institute of Food and Agricultural Sciences

PACKINGHOUSE NEWSLETTER

Mark Ritenour
Indian River REC
2199 South Rock Road
Ft. Pierce, FL 34945-3138
Phone: (561) 468-3922
FAX: (561) 468-5668
Email: mritenour@mail.ifas.ufl.edu

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All previous and present Packinghouse Newsletters (PHNL) are available on the Internet at the University of Florida's postharvest web site (http://postharvest.ifas.ufl.edu) and can also be accessed through our citrus resources web site (http://flcitrus.ifas.ufl.edu). Those who signed up to receive the PHNL via e-mail should have already received a copy electronically. Please contact me if you wish to sign up for electronic delivery or if you did not receive your electronic copy.

Chilling Injury of Grapefruit and its Control

Huating Dou, Florida Department of Citrus, CREC, Lake Alfred
Mark A. Ritenour, Indian River REC, Ft. Pierce
Greg T. McCollum, USDA, Ft. Pierce

Chilling injury (CI) is a physiological disorder that is occasionally reported on fresh citrus shipments from Florida. It is most often characterized by areas of the peel that collapse and darken to form pits (Fig. 1). Pitting is not targeted to the oil glands. Less severe symptoms may show up as circular or arched areas of discoloration or scalding. Symptoms of CI are typically more pronounced after fruit are warmed to room temperature following exposure to the chilling temperature. CI symptoms generally require at least 3 to 6 weeks to develop at low (e.g. 40 ^{o}F) shipping and storage temperatures. Chilled fruit are also more susceptible to decay than are non-chilled fruit. CI is often confused with another physiological disorder called postharvest pitting (PP) that is caused by low-oxygen concentrations (< 9%) within waxed fruit and is visible as collapsed oil glands. PP requires only 2 to 4 days for symptom development after waxing and appears in fruit held at warm (> 50 ^{o}F) temperatures.

Fig. 1. Symptoms of CI

Packers and shippers should keep in mind several factors that influence if and to what degree grapefruit develop CI.

Temperature effects on CI: Depending on other predisposing factors, grapefruit storage and shipment below 50 ^{o}F can cause severe CI. Studies at the Florida Department of Citrus show that CI is most severe when fruit are stored at temperatures from 38 to 40 ^{o}F compared with storage at higher or lower temperatures. There was no difference in CI incidence between fruit cooled immediately and fruit held at room temperature 24 to 48 hours before cooling. Though holding fruit at temperatures above 50 ^{o}F greatly reduces the potential for CI, it can also lead to the development of severe PP in waxed fruit. Thus, storage of waxed grapefruit at 45 ^{o}F may often represent the best compromise to minimize the occurrence of both disorders. Preconditioning fruit for 7 days at 60 ^{o}F has been reported to reduce CI, but this may promote severe PP if fruit are preconditioned after the wax application.

Time of season: In Florida's climate, fruits are most susceptible to CI early (October-December) and late (March-May) in the season. The fruit usually become more resistant to CI during mid-season (December-March), but the specific time of year when the fruit become resistant fluctuates from season to season.

Intermittent warming: Though intermittent warming (e.g. warming fruit to room temperature 1 day a week) has been reported to reduce CI development, it is usually not practical with large quantities of fruit under commercial conditions.

Relative humidity: High relative humidities (e.g. $\geq$ 95%) reduce the development of CI symptoms by reducing water loss from the fruit. Water loss dehydrates the cells resulting in their collapse and the development of pitting associated with CI.

Waxing and Modified atmospheres: Storing citrus fruit in low O_2 (possibly not effective for grapefruit) or very high CO_2 concentrations (e.g. 10%) reduces CI. Increased CO_2 generated by the use of semipermeable film packages sometimes reduce CI, but the effect disappears on grapefruit harvested after the trees bloom. Waxing reduces CI, but the effect appears to depend on the gas permeability of the wax and the CO_2 buildup within the fruit. Waxes that restrict gas exchange (e.g. shellac) reduce CI more than do waxes that "breathe" (e.g. carnauba). However, too little gas exchange leads to off flavors (anaerobic respiration) and increased PP. Waxing also reduces water loss, which contributes to the development of CI symptoms.

Fungicide: Fungicides such as thiabendazole (TBZ), benomyl, and imazalil have been reported to reduce CI in citrus fruit. These generally have less of an effect on reducing CI development than waxing or use of modified atmospheres.

Canopy position and sun exposure: Fruit from the sun-exposed, exterior canopy are more susceptible to CI than the shaded fruit from inside the canopy. Even the sun-exposed side of exterior fruit is more susceptible to CI than the shaded side of the same fruit.

***Heat treatments**:* Heat treatments, such as dips or sprays in hot water, have been shown to reduce CI. A range of treatments involving longer exposure to relatively cooler temperatures (e.g. 2 minutes at 127 ^{o}F) or shorter exposure to higher temperatures (e.g. 15 seconds at 140 ^{o}F) have been tested. However, fruit response to heat treatments (e.g. temperatures resulting in injury vs. CI resistance) has not yet been determined under Florida conditions.

What packers can do to reduce CI:

- Do not hold fruit at chilling temperatures. However, when PP is a potential problem on waxed fruit, storage and shipping temperatures of 45 ^{o}F should be considered as a compromise to minimize the occurrence of both CI and PP.
- Be particularly cautious of holding grapefruit at low temperatures early and late in the season when grapefruit are most sensitive to CI.
- Remember that use of more "breathable" waxes (e.g. carnauba) may reduce the CI protection commonly observed when using less gas-permeable waxes (e.g. shellac). On the other hand, use of waxes with lower gas permeability may result in the development of PP.
- Be more cautious of holding organic or "chem-free" fruit at low temperatures because potential CI protection from TBZ and/or imazalil will be absent.
- Maintain relative humidity at 85 to 90%. At relative humidities above 90%, fiberboard cartons deteriorate. If fruit are stored in plastic or wood bins, maintain relative humidity between 90 and 98%.

Stem-End Rind Breakdown of Citrus

Mark A. Ritenour, Indian River REC, Ft. Pierce
Huating Dou, Florida Department of Citrus, Lake Alfred

Sporadic reports of stem-end rind breakdown (SERB) occur each season. SERB is most severe on oranges and Temples, but it may also occur on tangelos and grapefruit. Although there is still much that needs to be learned about the development and prevention of SERB, there are some principles that can be applied to help reduce SERB development in your fruit.

Symptoms of SERB: SERB symptoms involve the collapse of rind tissue around the stem end of fruit (Fig. 2). The affected area is irregular in shape and becomes dark and sunken. A 2 to 5 mm ring of unaffected tissue immediately around the stem (button) is a distinctive symptom of SERB; that area contains no stomata and has a thick layer of natural wax on the cuticle. Symptoms usually develop after harvest and during storage within two to seven days after packing. SERB is more common and severe on small fruit and on well-colored fruit. Thinner-skinned fruit grown in humid growing environments tend to be more prone to SERB than thicker-skinned fruit from arid environments. Fruit with SERB are more prone to decay.

Fig. 2. Symptoms of SERB

How SERB is caused: SERB is primarily associated with drying conditions, particularly between harvest and the application of wax. These drying conditions arise from factors such as delays in packing, holding the fruit under low humidities and high temperatures, and excessive air

movement around the fruit. While not causing SERB (unless temperatures are too high), color-add dye will stain injured areas, making them more visible. Excessive brushing during packing increases water loss and enhances SERB development.

Preharvest conditions no doubt have a critical impact on susceptibility to SERB, but specific factors have been difficult to identify. In some cases, SERB has been reported to be more severe when fruit are harvested from water-stressed trees compared to non-stressed trees. However, in preliminary research conducted last spring on Valencia orange, fruit harvested from water stressed trees did not have significantly greater levels of SERB. Researchers in other countries have also found that nutritional imbalances involving nitrogen and potassium may predispose fruit to SERB. Under Florida conditions, however, significant relationships between potassium, nitrogen and SERB development have not been shown. There are currently no nutritional recommendations to reduce the potential for SERB development in Florida. There have been some reports that fruit from heavily bearing trees may develop more SERB. Preliminary work on rootstock effects conducted last spring indicates some significant differences, but this work needs to be repeated and expanded.

How to reduce or prevent SERB: To reduce fruit desiccation (and SERB), minimize the time between harvest and waxing, especially during hot, dry or windy weather. Harvested fruit should be shaded in the grove and at the packinghouse. If delays in packing are unavoidable (including degreening if required), maintain high relative humidity (>90%) and as low a temperature as possible without injuring the fruit or interfering with degreening. Avoid warm temperatures because even with the same relative humidity, warmer air dries fruit faster. During degreening, continuously exchange the air (~ 2% of total air volume per minute) instead of periodically opening the rooms for airing; the latter practice enhances fruit water loss. During packing, avoid excessive brushing that increases water loss and increases SERB development. Keep brush speeds below 100 rpm and use automatic wipeouts to prevent fruit from sitting idle on the brushes. Other than what is required for cooling and maintaining air circulation for degreening, reduce air speeds around the fruit. Apply a good, even coat of wax before packing while avoiding excessive wax application that may promote the development of off-flavors. Cool the fruit if possible after packing. Our research continues to show that Valencia fruit held at 38 ^{o}F develop SERB much more slowly than when stored at 70 ^{o}F.

Florida Postharvest Horticulture Industry Tour

March 4 - 7, 2002

The Florida Postharvest Horticulture Industry Tour will provide an opportunity to experience first-hand the latest technologies for the harvest, packing, cooling and shipping of subtropical and tropical fruits, warm and cool season vegetable and ornamental crops. Visits are planned to the following areas: Dover/Plant City (strawberry), southwest coast (vegetable, citrus harvest, packing & cooling; protected vegetable production) and Tampa (port facilities, a regional produce distribution warehouse and a major supermarket produce department). Tour enrollment will be limited to 30 participants. For more information, contact Ms. Abbie Fox, Institute Facilitator at 352-392-1928, ext. 235 or by e-mail at ajfox@mail.ifas.ufl.edu. A brochure and registration form can be found at http://postharvest.ifas.ufl.edu under the “Events” section.