

# Minimizing postharvest peel breakdown of fresh citrus

By Mark Ritenour

Fresh Florida citrus is well known for its excellent taste and juiciness. However, peel blemishes often develop to such a degree as to render the fruit unmarketable solely for cosmetic reasons.

Most blemishes are from pests (i.e., melanose and rust mite damage) or windscar that are graded out during the packing process when they exceed U.S. Department of Agriculture or export grade standards.

Other types of peel breakdown such as stem-end rind breakdown (Figure

1), peel pitting (Figure 2) and chilling injury (Figure 3) are due to the disruption of normal physiological processes and usually display symptoms only after harvest and sometimes after packing and shipping to destination markets. Such fruit are also more susceptible to decay than healthy fruit. These disorders can result in great economic losses due to rejected or discounted shipments and the loss of buyer confidence.

Preharvest factors such as weather conditions (e.g., temperatures and wind), fruit maturity and tree stress

(e.g., dehydration or diseases such as HLB) influence the fruit's susceptibility to such disorders, as do sub-optimal postharvest handling practices. Fortunately, there are both preharvest and postharvest practices that can help reduce development of such disorders.

## STEM-END RIND BREAKDOWN (SERB)

SERB symptoms involve the collapse of rind tissue around the stem end of citrus fruit (Figure 1). The affected area is irregular in shape and becomes dark and sunken. A 2 millimeter 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. It is more common on thinner-skinned fruit grown in humid environments such as Florida and on small fruit. The disorder is more common later in the season during dry months, especially when field temperatures start to increase and the trees start flushing and flowering.

While the causes of this disorder are not completely understood, it appears to be most related to the water status of the fruit. In the field, tree water stress from the lack of rain or insufficient irrigation before harvest can significantly increase SERB after harvest. Conversely, application of an antitranspirant (e.g., 1 percent or 2 percent Vapor Gard®) to the trees decreases water loss and can reduce SERB after harvest. In addition, a foliar application of mono-potassium phosphate (8 pounds of K<sub>2</sub>O per acre) can also reduce SERB, but the results are not as great or consistent as with the antitranspirant.

After harvest, SERB is promoted by drying conditions caused by delays in packing, exposure to low relative humidity (RH) and high temperature conditions, and excessive air movement around the fruit. Excessive brushing during packing also increases water loss and enhances SERB. Postharvest practices to reduce SERB include:

- Minimize the time between harvest, packing and cooling the fruit.
- Always hold fruit under high RH conditions (> 85 percent). At relative humidities above 90 percent, fiberboard cartons deteriorate. If fruit are stored in plastic or wood bins, maintain relative humidity between 90 percent and 98 percent.

- Avoid warm temperatures because even at the same RH, warmer air dries fruit faster.



Figure 1. Stem-end rind breakdown of grapefruit.



Figure 2. Peel pitting of grapefruit.



Figure 3. Chilling injury of grapefruit.

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- Avoid excessive brushing on the packingline by keeping brush speeds below 100 rpm and using automatic wipeouts to prevent fruit from sitting idle on the brushes.

- Cool the fruit as soon as possible and maintain low temperatures throughout storage, transport and marketing, but not so low as to cause chilling injury (see below).

### PEEL PITTING

Peel pitting (PP) (Figure 2) is a much more general symptom and may have multiple causes. It is most often associated with low RH conditions or low internal oxygen concentrations within fruit. In the first case, studies by Jacqueline Burns' group (University of Florida-IFAS) and others worldwide have shown that postharvest fruit exposure to low RH conditions (i.e., 30 percent) for as little as a few hours, followed by high RH (e.g., 90 percent) conditions induces the disorder. Even low RH conditions in the field at harvest can result in pitting of the fruit. In these cases, symptoms may first appear during the winter months, especially after cool and/or windy weather with low RH. Fortunately, the disorder usually disappears if harvest is delayed a week or two. Therefore, avoiding harvest during times of very low RH field conditions, and maintaining high RH during postharvest handling can greatly reduce the occurrence of this disorder.

To prevent pitting due to low internal oxygen concentrations, it is important to reduce fruit respiration (oxygen demand) by cooling the fruit soon after harvest, and to choose a wax coating with an adequate oxygen diffusion rate.

### CHILLING INJURY (CI)

CI of citrus is caused by exposure to low but non-freezing temperatures after harvest. CI symptoms are most characterized by areas of the peel that collapse and darken to form depressions or pits (Figure 3) and usually develop more rapidly after fruit are removed from the cold temperatures. The threshold temperature varies due to many factors such as variety (see Table 1, page 22), time-of-year and postharvest treatments. CI is best understood in grapefruit, and the main factors that influence its development are summarized below.

**Temperature effects on CI:** Studies show that CI is most severe when grapefruit are stored at temperatures from 38°F to 40°F compared with storage at higher or lower temperatures. Preconditioning fruit for seven days at 60°F before exposure to cold

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# Coordination of Research on Huanglongbing: Discussions Between CRDF and the California Citrus Research Board



By Harold Browning

During August of this year, members of the California Citrus Research Board (CRB) travelled to Florida to meet with CRDF board members and staff with the goal of exploring methods for cooperation in research related to huanglongbing (HLB). The day-long discussion focused on the two groups becoming more familiar with the processes used by each entity to solicit, review and fund projects of interest.

Particular emphasis was given to how timing of annual cycles might be synchronized to facilitate closer communication on research projects being considered. Currently the two groups are approximately six months apart in their timelines.

Participants discussed the current situation in California, with Asian citrus psyllid (ACP) populations expanding in some areas of Southern California and HLB detection to date being limited to dooryard citrus in the Los Angeles area. The group contrasted this status with Florida's situation, where ACP has been present since 1998 and HLB since 2005. This discussion demonstrated the different needs for growers in each region, and the possibilities that occur in California to apply research results to their early stage of experience with both the disease and the vector. Most importantly, it focused on the value of the wide range of research being pursued, from detection to integration of cultural practices into citrus management systems, and how this research will benefit each state.

Growers and research program managers from each state considered the research needs that are shared by both states and discussed how close communication will ensure that scientists supported by each program work in tandem to develop and field-test potential solutions. There are many examples where collaboration between scientists in California and Florida is being encouraged and can be further facilitated by close communication between CRDF and CRB. This also applies to research being conducted by scientists outside of these states.

While the status of the disease in Florida allows researchers to work with the disease and vector in laboratories and fields throughout the state, limitations imposed on working directly with ACP and the HLB pathogen in California and other states mean that partnerships are necessary to effectively develop solutions to HLB that will benefit all. CRDF has encouraged and enabled multi-state research teams since the first cycle of research supported by Florida citrus growers, and the continuation of this broad reach for solutions will be even more important as other states face the disease in their citrus groves, and develop on-site field research with the disease.

The discussions between CRDF and CRB also covered how research areas that are of interest to both states can be distinguished from research topics that are of greater interest to one state and less so to the other. The emphasis for cooperative projects should be those shared areas of research interest, leaving each state to address their unique priorities in their own ways.

Opportunities for joint funding of projects were discussed, as was the potential for cooperation to be applied to federal funding to support citrus disease research. While establishing collaborative partnerships will be vital to implementation of any federal program for support of citrus research, the benefits of interstate cooperation have already been experienced, and the meeting of CRB and CRDF reinforced that there remain many opportunities to advance this cooperation in discovering, testing and delivering solutions to HLB.

*Harold Browning is Chief Operations Officer of CRDF. The foundation is charged with funding citrus research and getting the results of that research to use in the grove.*



Column sponsored by the Citrus Research and Development Foundation

**Table 1. Lowest "safe" temperatures to avoid chilling injury (CI) of fresh Florida citrus fruit. Fruit may be successfully stored at lower temperatures depending on factors such as time of year and postharvest treatments (e.g., temperature conditioning, wax coatings, fungicides, etc.).**

Citrus type	Threshold temperatures for CI (°F)
Grapefruit, lemons, limes	50
Mandarin-type fruits	40
Oranges	32-34

conditions can greatly reduce CI. Though intermittent warming (e.g., warming fruit to room temperature one day a week) has been reported to reduce CI, it is usually not practical under commercial conditions. Heat treatments, such as dips or sprays in hot water, have also been shown to reduce CI.

**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 fruit become resistant fluctuates from season to season.

**Relative humidity:** High RH (e.g. > 95 percent) reduces 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:** Waxing reduces CI, but the effect appears to depend on the gas permeability of the wax and the CO<sub>2</sub> buildup within the fruit. Waxes that restrict gas exchange reduce CI more than do waxes with better gas transmission characteristics. However, too little gas exchange leads to off flavors (anaerobic respiration) and may result in a form of PP (see above). Waxing also reduces water loss, thus slowing the development of CI symptoms.

**Fungicide:** Fungicides such as thiabendazole and imazalil reduce CI in citrus fruit. These generally have less of an effect on reducing CI than waxing.

### Ways to reduce chilling injury of citrus:

- Do not hold fruit at chilling temperatures, especially early or late in the season when fruit are most sensitive to CI.
- Maintain high RH (> 85 percent).
- Wax fruit to elevate internal CO<sub>2</sub> and also reduce water loss and symptom development.
- Apply an approved fungicide.

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