



Commercial Postharvest Practices Used to Handle Fresh Citrus Fruit with Canker Symptoms

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To assist in developing best postharvest practices for handling fruit with canker lesions, a survey was distributed in summers of 2008 and 2009 to better understand current practices. Approximately 60% of the surveys were returned each year, representing about 55% of total fresh fruit shipments. As expected, the percentage of fruit received from blocks certified canker free declined from 2008 to 2009 as canker spread within the state. Sodium o-phenylphenate was the fruit disinfestation sanitizer most used by 52% of the packers to decontaminate fruit in 2008, but its use declined to 47% in 2009. Use of peroxyacetic acid increased from 21% to 33% over the same period, while chlorine use dropped from 27% to 20%. Most (~50%) of the sanitizers were applied as the fruit were first wetted, but managers were switching more to applying as the fruit were washed or afterwards. For both years, an average of 22 human graders were stationed at different points on the packingline to evaluate each load, with most (83%) increasing to 27 graders when fruit was known to come from a block with canker infection. All but one respondent reported that electronic graders were not useful for removing fruit with canker symptoms. In 2009, packers estimated that 34% of the citrus crop normally packed for the European Union market was disqualified because of canker and that 12% of the product packed for the domestic or Japanese markets was either disqualified, or contained sufficient canker infection to make unprofitable to pack for the fresh market.

The establishment of citrus canker (caused by *Xanthomonas axonopodis* pv. *citri*) in Florida, the end of the eradication program in Jan. 2006, the Aug. 2006 interim canker rule, the Nov. 2007 canker rule, and the latest changes to the canker rule in Oct. 2009 have resulted in dramatic changes in the way Florida's \$400 million fresh fruit industry grows, packs, and ships fruit (Ritenour et al., 2008; USDA APHIS, 2009b). When citrus canker became established in Florida, research and extension programs were expanded to help the industry manage the disease and maintain market access. Intense postharvest research was initiated to evaluate the perceived threat of fruit serving as a vector for this disease (Gottwald et al., 2009), to identify compounds to kill the bacteria on fruit and plant tissues (Graham et al., 2006; Narciso, 2005), and to improve packinghouse grading practices and the ability to detect even small canker lesions (Qin et al., 2009). Extension programs focused on providing resources (disease identification posters, sheets, etc.) and training workshops for packinghouse personnel in how to correctly identify citrus canker lesions on

fruit so that no symptomatic fruit were shipped from Florida and to minimize the number of healthy fruit inadvertently removed because of misidentification.

Fortunately, the 2009 canker rule now allows even fruit with canker lesions to be shipped to domestic markets, including citrus-producing states, as long as they do not substantially affect the visual quality of the fruit. However, over 40% of all fresh Florida citrus is exported outside the United States and those shipments are governed by the receiving country, many of which still require the fruit to be inspected and found free of canker before shipment. For example, about 34% of Florida's exported citrus was sent to countries of the European Union (EU) during the 2007–08 season (Florida Department of Citrus, 2010), and all of these countries still require the groves to be inspected and found free of canker before harvest, and postharvest fruit treatments and inspection to verify the fruit is free of canker before shipping. If a single canker lesion is found on a fruit, the entire production block is disqualified for EU shipment. While the canker Pest Risk Assessment (USDA APHIS, 2009a) that supported the latest U.S. canker rule is being used to argue for relaxing the canker regulations in restrictive export markets, only Japan has so far changed its regulations to now accept fruit with canker lesions.

During the midst of changing canker regulations and intense

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research and extension activities, a survey was developed and distributed to Florida packinghouse owners and managers during the summers of 2008 and 2009 to better understand industry needs, opportunities for improvement as our knowledge of citrus canker increased, and better evaluate the potential costs and disruption to current packinghouse operations if new regulations or recommendations arise.

Materials and Methods

A survey was developed and distributed during the summers of 2008 and 2009 and sent to fresh citrus packinghouse owners and managers requesting comment on their experiences and handling practices related to citrus canker the previous season. The survey also asked them to comment about their anticipated practices for the upcoming season. Each survey consisted of 13 questions, with the same questions asked each season.

Results and Discussion

SURVEY RESPONSE. In 2008, out of 28 surveys sent out, 17 packinghouse owners (61%) returned completed surveys. These shippers represented approximately 21.1 million 4/5 bushel boxes of fresh citrus, or 57% of total fresh citrus shipments in the 2007–08 season. In 2009, out of 24 surveys sent out, 14 packinghouse owners (58%) returned completed surveys. These shippers represented approximately 19.5 million 4/5 bushel boxes of fresh citrus, or 55% of total fresh citrus shipments in the 2008–09 season.

PERCENTAGE OF FRESH FRUIT RECEIVED AT PACKINGHOUSES FROM CITRUS BLOCKS CERTIFIED CANCER-FREE. Citrus canker continued to spread within fresh citrus groves between the 2007–08 and 2008–09 seasons as seen in the declining percentage of grapefruit, oranges, and tangerines received at Florida packinghouses from blocks certified canker-free (Fig. 1). Citrus canker disqualified substantially more fresh grapefruit blocks than orange or tangerine blocks during the two seasons. However, shippers estimated the

percentage of grapefruit and oranges from certified blocks would be approximately equal in the upcoming 2009–10 season. It is unknown if this estimate held true after the season was completed. Citrus canker apparently spread faster than anticipated in all three varieties, because substantially fewer blocks were actually certified canker-free during the 2008–09 season than were anticipated in the 2008 survey.

CHOICE OF FRUIT DISINFECTION PRODUCTS. USDA canker rules require that all fresh citrus to be shipped out of Florida be run through packinghouses operating under a signed APHIS Packinghouse Compliance Agreement, and the fruit disinfected with one of three approved sanitizers (USDA APHIS, 2009b; USDA PPQ, 2010). The approved disinfection treatments include use of 200 ppm sodium hypochlorite (pH 6 to 7.5) for at least 2 min, 85 ppm peroxyacetic acid (PAA) for at least 1 min, or 1.86% to 2.00% sodium o-phenylphenate (SOPP) for 45 s with detergent, or 1 min without detergent. Figure 2 shows that SOPP was used most often during both the 2007–08 and 2008–09 seasons to satisfy USDA fruit disinfection requirements, though usage declined between the two seasons. Chlorine usage also declined during this time, but PAA usage increased substantially to exceed that of chlorine the second season. The reasons for these changes were not addressed in the survey, but the shorter contact time required of PAA compared to chlorine was a potential consideration.

TIMING OF FRUIT DISINFECTION SANITIZER APPLICATION WITHIN THE PACKINGHOUSE. Fruit disinfection can occur anywhere on the packingline. The vast majority of surveyed packinghouse managers applied sanitizer to satisfy disinfection requirements soon after dumping onto the packingline: either during initial fruit wetting or as the fruit were washed (Fig. 3). The percentage of packinghouse owners that disinfected the fruit during initial wetting rose from 52% during the 2007–08 season to 60% in 2008–09, while those disinfecting the fruit while washing declined from 39% in 2007–08 to 33% in 2008–09. After both seasons, some packinghouse owners anticipated disinfecting the fruit after washing, but the percentage who actually disinfected after washing dropped slightly from 9% or 7% between the two seasons.

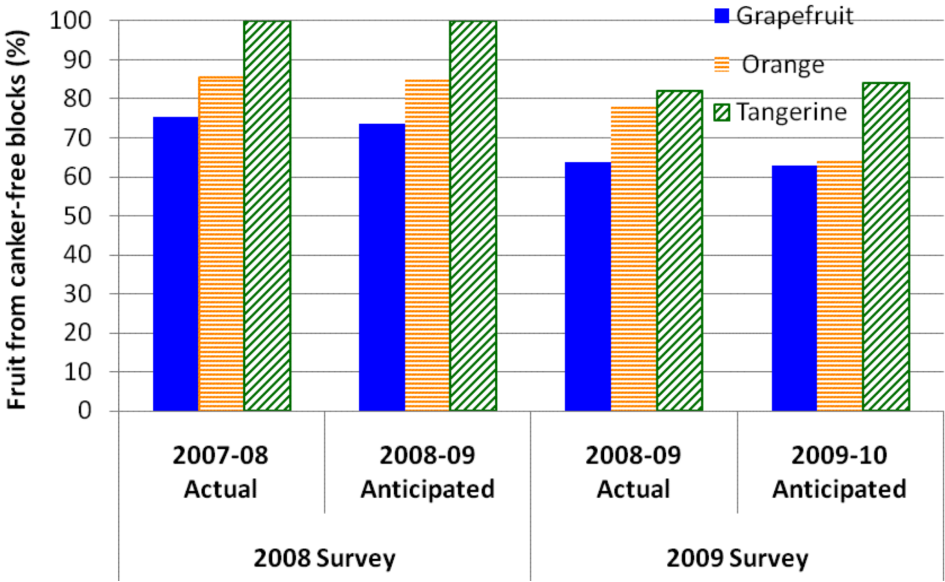


Fig. 1. Estimated percentage of fruit received at Florida packinghouses from blocks certified free of canker. Data are from two surveys with each concerning the preceding season and an estimate for the upcoming season.

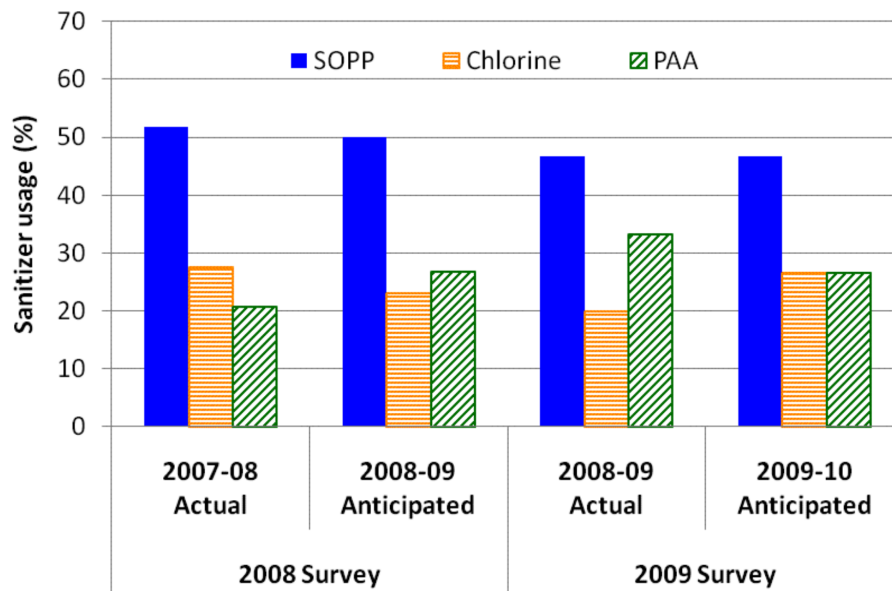


Fig. 2. Choice of sanitizer used in Florida citrus packinghouses to satisfy USDA fruit disinfection requirements. Approved sanitizers include sodium o-phenylphenate (SOPP), sodium hypochlorite (chlorine), and peroxyacetic acid (PAA).

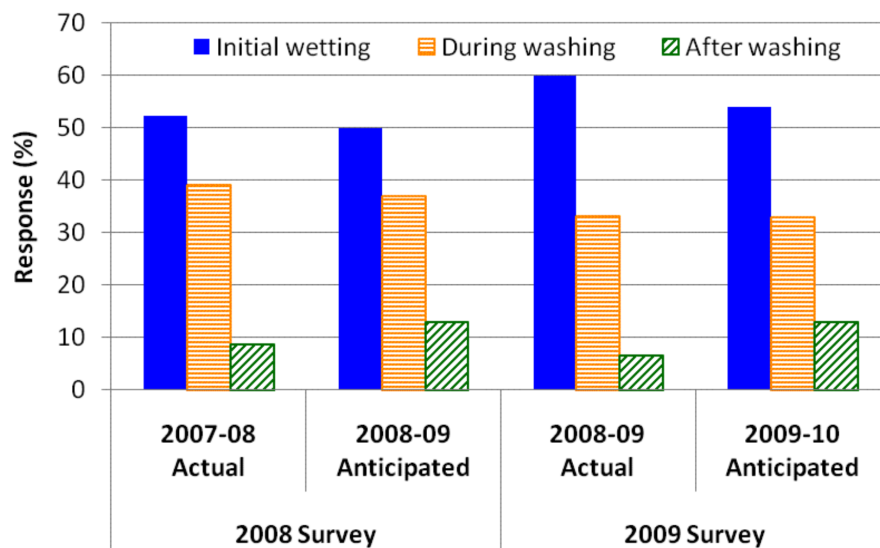


Fig. 3. Percentage of respondents who applied the fruit disinfection sanitizer with the initial fruit wetting, during the washing process, or after the fruit were washed.

USE OF HUMAN GRADERS ON THE PACKINGLINE. Survey respondents reported that an average of 22 human graders were stationed at different points on the packingline during both the 2007–08 and 2008–09 seasons to evaluate the fruit before it was packed. When fruit from production blocks known to contain citrus canker were run over the packingline, 62% of respondents increased the number of graders during the 2007–08 season. Those who added graders, added an average of five graders to the packingline both seasons.

USE OF ELECTRONIC (OPTICAL) GRADING EQUIPMENT. Pre-grading evaluates and eliminates unmarketable fruit before they are washed and waxed. Fruit eliminated at this stage are usually more obviously defected because dirt and sooty mold obscures smaller or less obvious defects. Thus, most grading of Florida citrus is accomplished after washing the fruit. During the 2007–08

season, 35% of respondents used electronic grading equipment that utilizes cameras to photograph the fruit surface to detect blemishes. Of these, only one respondent thought such devices were useful for removing fruit with canker symptoms at the pre-grade, and none thought it was useful at the final grade. During the following season, use of electronic pre-grading equipment increased to 58%, and 25% reported using them as part of the final grade. However, none believed the devices were useful for removing fruit with canker symptoms.

LOSSES IN MARKETABLE FRUIT DUE TO CITRUS CANKER. Respondents estimated that 24% of the 2007–08 citrus crop, and 34% of the 2008–09 crop normally shipped for the EU market was disqualified because of canker. They also estimated for both seasons that about 12% of the citrus normally shipped to domestic or

Japanese markets was either disqualified or contained sufficient canker infection to make it unprofitable to pack for the fresh market.

PREVENTING SHIPMENT OF FRUIT WITH CANKER SYMPTOMS. In 2008, respondents believed that the most important practices to prevent fruit with canker symptoms from being shipped were thorough preharvest grove inspections so that fruit are harvested from canker-free blocks, and well trained packinghouse graders to effectively identify and remove symptomatic fruit before packing and shipping. In 2009, after canker continued to spread in the field, the top practices were control of the disease in the field, effective sanitizing operations in the field and packinghouse, and effective grading in the packinghouse to remove fruit with canker symptoms.

RESEARCH AND EXTENSION NEEDS RELATED TO CITRUS CANKER IN FLORIDA. As previously mentioned, after canker became established in Florida, research and extension needs of the industry expanded. In both years, the most important research needs listed by respondents were development of resistant citrus trees, chemical treatments that kill the bacteria in the field and on the fruit, and research showing that fruit with canker symptoms will not spread the disease. While research continues to address these concerns, great progress was made in 2009 when two independent, refereed publications demonstrated that even citrus fruit with canker symptoms are highly unlikely to transmit the disease to other regions (Gottwald et al., 2009; Shiotani et al., 2009). Based on these, the latest Pest Risk Assessment and canker rule was published in 2009 that allows fruit to be shipped with canker lesions as long as they do not affect the visual marketing quality of the fruit. In addition, such fruit can now be shipped to all domestic states, even those that produce citrus. However, export markets are governed by the receiving country and many of these (i.e., the EU) still require fruit to be inspected for the absence of canker lesions before shipment. Industry and diplomatic representatives continue to argue for increased access to these markets using the latest research.

In terms of extension training programs, respondents reported in 2008 that packinghouse personnel needed more training to accurately identify fruit with canker symptoms so that symptomatic fruit were eliminated without mistakenly eliminating healthy fruit from the marketing channel; both of which would be costly mistakes. Additional posters, identification cards, etc. were requested to further aid in detection. While the 2009 survey contained many of the same statements, some respondents commented that they believed their employees were now adequately trained in canker

identification, suggesting that joint UF/IFAS and FDACS DPI training programs were successful. Given that no loads of fresh citrus with canker symptoms have ever been shipped from Florida over the years when regulations prohibited it, Florida growers and shippers, working with federal and state regulators and inspectors, have a good track record for effectively adhering to regulations for any other diseases, such as citrus black spot (*Guignardia citricarpa*), that might arrive in Florida.

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