UNIVERSITY OF FLORIDA | Cooperative Extension Service
Institute of Food and Agricultural Sciences

PACKINGHOUSE NEWSLETTER

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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).

Update on Postharvest Pitting and Its Control

Huating Dou, Florida Department of Citrus, Lake Alfred

Postharvest Pitting (PP) is a physiological disorder of citrus that continues to be an economic problem in Florida. Since 1998, when Petracek and Dou first published the symptoms, causes, and control of PP, new information has become available. In this article, we review and report on our current knowledge concerning this important physiological disorder.

Fig 1. Symptoms of postharvest pitting on grapefruit.

Symptoms of Postharvest Pitting. In grapefruit, symptoms of PP begin with the collapse of individual oil glands that form clusters of 4-30 glands (Fig. 1). Clusters become brown and decay develops in these areas over time. Surrounding tissue remains healthy and does not discolor. In 'Fallglo' tangerines, 100 or more collapsed oil glands often form large clusters that may connect with each other. The pitted areas become black with accelerated decay.

Susceptible Cultivars. PP develops most severely in 'Marsh' grapefruit, 'Fallglo' tangerines, and Navel and temple oranges. PP occasionally develops in Valencia and Hamlin oranges. This past season, PP also developed in colored grapefruit.

Maturity and fruit size. PP is most severe in early and late season grapefruit. Immature 'Fallglo' tangerines are more susceptible to PP development than more mature fruit. In all cases, large fruit are more susceptible to PP development than smaller fruit. Canopy position before harvest does not significantly affect susceptibility of fruit to PP.

Occurrence. PP can develop on waxed citrus when they are held at temperatures above 50 ^{o}F; the warmer the temperature, the more severe the PP that develops. PP symptoms usually develop 2 to 4 days after packing with the severity of symptoms depending on the cultivar, storage temperature, and type of wax. PP is most severe on fruit coated with shellac or resin wax. These usually produce the best shine, but greatly reduce oxygen (O_2) and carbon dioxide (CO_2) diffusion into and out of the fruit. It appears that development of PP symptoms is completed within about two weeks of packing.

Control. Besides reducing decay, water loss, and the respiration rate of the fruit, lower temperatures are also the most effective means of reducing the development of PP. Rapid precooling of citrus is the first defense against PP; a 24 hour delay in cooling can enhance the possibility of developing PP compared to fruit cooled within 6 hours. Storage and shipping temperatures higher than 50 ^{o}F may cause PP development in waxed fruit. Although low temperatures (below 50 ^{o}F) reduce the risk of PP development, these low temperatures can also cause chilling injury in grapefruit. However, Florida Department of Citrus studies show that storage of waxed, mid-season grapefruit at 45 ^{o}F greatly reduces the development of PP while minimizing the risk of developing chilling injury.

The choice of wax also greatly influences susceptibility of citrus to PP. Application of waxes to citrus fruit can rapidly reduce O_2 and increase CO_2 concentrations within the fruit; internal O_2 can drop from ~20%, to less than 4% in only 4 to 12 hours after coating with shellac wax. The severity of PP becomes worse with lower internal O_2 concentrations. Fruit internal O_2 concentrations should always be higher than 12% in order to avoid PP development.

Use of carnauba or polyethylene waxes often results in less shine, but allows greater O_2 and CO_2 gas exchange than shellac wax and therefore reduces the potential for PP development. In overseas markets, shellac wax is widely requested because of its high shine. Some shellac formulations contain a percentage of carnauba wax that we found resulted in the same shine, but with greatly reduced PP compared to shellac alone.

Relative humidity during storage and procedures or materials used during drenching, degreening, and washing do not significantly influence PP development in Florida citrus. However, in laboratory experiments, PP development was significantly reduced by dipping grapefruit in a variety of food grade oils (e.g. Canola, soybean, or sunflower oil) before waxing. This could prove commercially useful if food oils could be incorporated into the wax. Other postharvest chemicals (including squalene) have not reduced PP.

During citrus production, extremely wet or dry soil conditions increase the incidence of PP. Four years of studies in Florida have shown that fertilization with high N and low K tends to increase the occurrence of PP in citrus. In California, fruit developing PP contained less ammonium-N, phosphorus, and potassium but results were not consistent from year to year. Nitrate concentration in fruits did not influence PP incidence. Recent studies in Florida indicate that foliar-applied nitrogen and potassium do not affect PP development. Preharvest treatment with gibberellic acid (GA) can reduce PP development, but may risk GA phytotoxicity. In addition, the greater need for degreening of early season fruit makes this practice unsuitable for routine use in most commercial cases.

In summary, the most effective means to minimize the development of PP in Florida citrus is to:

1) Hold waxed fruit at their lowest, “safe” temperature. A good temperature compromise between PP and chilling injury for grapefruit coated with shellac wax is often 45 ^{o}F, and 34 to 40 ^{o}F for oranges and tangerines.

2) Choose a wax that satisfies the customer’s desire for shine, but also provides the best gas exchange to help maintain high internal O_2 levels.

3) Follow IFAS irrigation and nutrition recommendations.

References:

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Control of Green Mold on Florida Citrus

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Green mold is one of the leading causes of citrus decay worldwide and is also important in Florida. Spores of this fungus are present practically everywhere (from the field to the marketplace) and green spores developing on a single fruit can discolor neighboring healthy fruit in the same carton. If effective control measures are not consistently used, this disease can cause significant product loss before the fruit arrives at destination markets.

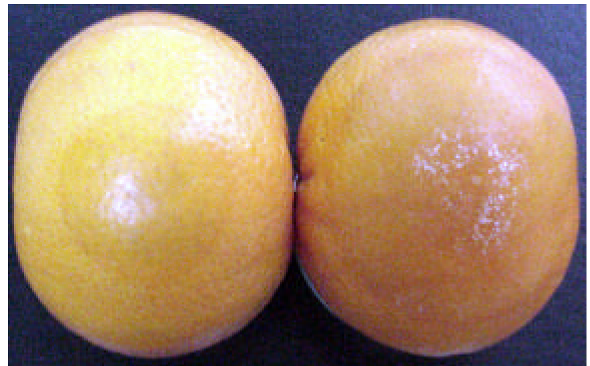

Fig 2. Green mold ("clear rot") symptoms on orange.

Symptoms of Green Mold: Initial symptoms of green mold (*Penicillium digitatum*) are similar to those of sour rot and blue mold. Decay starts at the site of injury and initially appears as a soft, watery spot and is sometimes called "clear rot" because of this (Fig. 2). As the lesion grows, white mycelia appear at the center of the lesion with green spores forming later from the center outwards (Fig. 2 and 3). The fungus produces enzymes that break down the cell walls and macerate the tissue as the mycelia grow through it. The entire fruit can quickly become covered with green spores as an unpleasant odor develops.

Fig 3. Development of green mold symptoms on orange.

How green mold infects citrus: Spores present in the field are carried by wind to the surface of fruit in the canopy. During harvest and postharvest handling, the spores germinate when nutrients and moisture are released at sites of injury on the fruit (e.g. punctures, scrapes, plugs, etc.). Green mold only infects citrus fruit through wounds in the peel; even injuries penetrating only a few oil glands are enough to result in infection. The fungus produces large numbers of spores that easily contaminate packinghouse equipment, recirculated water systems, shipping containers, and degreening and storage rooms. Such spores can then infect other fruit through injuries. With the large number of spores produced, the fungus also has the potential to develop resistance to different postharvest fungicides. Resistance to thiabendazole (TBZ) and Imazalil has been reported in California and other locations. The optimum temperature for growth of green mold and production of spores is about 75 ^{o}F. Since Florida degreening conditions are at 85 ^{o}F (with 90 to 96%

relative humidity) these conditions actually retard green mold growth and promote fruit healing from injuries sustained during harvest.

Control of Green Mold: To control this disease, an integrated control strategy is needed that includes:

1) Careful harvesting and handling of fruit to minimize fruit injuries.

2) Drenching fruit after harvest with an Imazalil (1,000 ppm) or thiabendazole (TBZ, 1,000 ppm) solution. Imazalil systems must use heat and TBZ systems must use free chlorine (50 to 150 ppm at pH ~7) to prevent the buildup of resistant pathogens (e.g. *Geotrichum candidum* that causes sour rot) in the solutions. (See Packinghouse Newsletter #192 for more information on the use of chlorine).

3) Daily cleaning and sanitizing (e.g. with chlorine or quaternary ammonium) of fruit bins, packinghouse equipment, etc. Degreening and storage rooms should be cleaned and sanitized when fruit with green mold are observed.

4) Washing of fruit with sodium orthophenylphenate (SOPP, 2%) and application of TBZ and/or Imazalil as aqueous (1,000 ppm) treatments or mixed in with the wax (2,000 ppm).

5) Promptly removing any infected fruit from the packinghouse and not repacking cartons containing decaying fruit in the packinghouse.

6) Quickly cooling fruit and maintaining cold temperatures throughout storage, transport and marketing. Optimum storage temperature depends on the citrus cultivar, growing location, and postharvest treatments used.

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Brown, G. E. and Eckert, J.W. 2000. Green mold, p. 41-42. In: L.W. Timmer, S.M. Garnsey, and J.H. Graham (eds.). Compendium of Citrus Diseases. APS Press, St. Paul, MN.

Forty-First Annual Citrus Packinghouse Day

Thursday, August 29, 2002
Citrus Research and Education Center
700 Experiment Station Road, Lake Alfred, FL 33850

Mark your calendar for this year's Citrus Packinghouse Day on August 29th. Registration opens at 8:30 AM and the program begins at 9:30 AM. Our keynote speaker this year is Dr. Joseph Smilanick from the USDA in Parlier, California who will present the latest information on citrus decay control, including information on new fungicides and the use of heat and alternative compounds such as sodium bicarbonate to reduce decay. Other speakers will cover:

- Preharvest-applied fungicides that reduce postharvest decay
- Food security issues for citrus packinghouses
- The latest on the importation of Spanish Clementines
- Information about a new USDA-FDACS good handling practices (GHPs) and good agricultural practices (GAPs) third-party auditing program
- The latest information on non-destructive, internal quality sensing
- Citrus postharvest resources available on the Internet

Lunch is again free this year to the first 200 people to register at the door. We will also again be giving out $250 in door prizes. Representatives from more than 30 leading companies will be on hand to provide valuable information for your business. We look forward to seeing you at this important event!

New Address for Dr. Steven Pao

Dr. Steven Pao, previously an active scientist with the Florida Department of Citrus, has accepted a new Associate Professor position with Virginia State University. His new contact information is: Agricultural Research Station, P.O. Box 9061, Petersburg, VA 23806, Tel: (804) 524-6715, e-mail: spao@vsu.edu.

Fall Postharvest Course Offered At a UF IFAS Research Center Near You

The University of Florida course, "Maintaining Fruit & Vegetable Quality After Harvest" (VEC 4932) will be offered this fall via videotape. During the course, participants will obtain a solid understanding of how harvested commodities respond to their postharvest environments and how to maintain maximum quality throughout the postharvest life of the commodity.

Students will meet weekly in Gainesville or at one of the UF IFAS Research and Education Centers. Instructors will deliver the course from Gainesville and the Indian River Research and Education Center (Ft. Pierce) to other locations via videotape. A coordinator will be available to assist students at each site and an instructor will visit students at each site. Classes begin Aug. 26, 2002 and end Dec. 11. Non-degree participants are encouraged to register. Participants completing the course will receive three UF credits and a "Certificate of Completion." Qualified students at Ft. Pierce and Gainesville may take an expanded course (HOS 5085C) for graduate credit (includes a laboratory project). Topics will include:

- Respiration & temperature - impacts on shelf life
- Role of plant hormones (especially ethylene & ripening/degreening)
- Food safety
- Decay prevention

- Reducing commodity water loss
- Maturity and quality standards
- Harvesting and handling systems
- Physiological disorders such as chilling injury
- Cooling & cold storage
- Modified & controlled atmospheres
- Transportation issues

And much, much more.

For more information, call the Indian River Research and Education Center at (772) 468-3922 ext. 167, or e-mail Mark Ritenour at mritenour@mail.ifas.ufl.edu. One can also visit the IFAS Distance Education website (http://disted.ifas.ufl.edu) for more information.