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

PACKINGHOUSE NEWSLETTER

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Packinghouse Newsletter No. 186
June 1, 1999

Key Index Words: Decay Control, Degreening, Harvesting, Sanitation

PRACTICES TO MINIMIZE DECAY IN FLORIDA FRESH CITRUS

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Introduction

Citrus fruit are relatively resistant to decay. Fruit carefully picked from the backyard tree may remain decay-free for several weeks in the home either under ambient or refrigerated conditions. Susceptibility to decay is enhanced during commercial handling when injuries occur to the rind surface and quiescent fungal infections on the button and fruit surface are activated by ethylene during degreening or develop during extended periods of storage. Some injuries and the need for degreening and storage are unavoidable under commercial conditions, but every effort must be made to minimize their impact on decay development.

Proper harvesting, handling, degreening, packaging and storage management combined with sanitation, effective fungicide application and control of fungicide resistance minimize decay losses resulting from commercial practices.

The purpose of this newsletter is to briefly review our commercial postharvest practices to identify those that have the potential to enhance the occurrence of postharvest diseases. Specific details of proper handling methods can be obtained from newsletters and publications available from the Citrus Research and Education Center, Lake Alfred.

Harvesting

Injuries associated with harvesting and the transporting of fruit to the packinghouse are sites of entry for fungi that cause green and blue mold and sour rot. Probability of infection by these fungi is directly related to the number and severity of injuries. Turgidity of the fruit is related to the time of day and moisture levels, and directly related to the occurrence of oleocellosis that results when peel oil released from injured oil glands causes rind damage. Even if fruit are clipped to minimize plugging, clipping must be done properly to prevent stems from puncturing adjacent fruit during handling. Contact with the ground must be minimized to prevent contamination from soil that contains the fungus causing sour rot and that may cause abrasive injury to the fruit.

Spot-picking or delayed harvest for better natural color development can help reduce the time or need of degreening. Do not overfill pallet boxes of harvested fruit and remove them carefully and immediately from the grove to minimize injuries and sunburn. Physical and heat damage will significantly enhance decay, respiration, and off-flavors. Harvested fruit should be kept undercover at high relative humidities and, if possible, at reduced temperatures, and processed as quickly as possible.

Fungicide applications before degreening

Delays in fungicide application of one day or more after harvest will cause a reduction in fungicide efficacy. Fungi that develop in injuries or from the button during degreening have an opportunity to progress during this period and more effectively escape fungicide activity. To prevent this, sprays of benomyl can be applied before harvest or fruit can be drenched with thiabendazole (TBZ) or imazalil after harvest before degreening. Since TBZ and imazalil do not control sour rot, brown rot, or fungicide resistant green mold that accumulate in the drencher, drench solutions must be treated with chlorine and/or heat. Chlorine must be added consistently to maintain the proper concentration (50-150 ppm free chlorine) and pH (6.5-7.5) in the drencher to effectively eradicate fungal contamination. TBZ is more effective for the control of stem-end rot than imazalil. However, if drench applications of imazalil are followed after degreening with packingline TBZ, control is normally comparable to the control with TBZ applied before and again after degreening.

Degreening

The degreening process, particularly for extended periods, can significantly enhance the occurrence of stem-end rot and anthracnose. Ethylene concentrations in excess of 5 ppm will also exacerbate these diseases. High relative humidities of 94-96% will prevent fruit desiccation and promote healing and resistance of minor injuries in the flavedo to green mold. Every effort should be made to minimize degreening time by maintaining proper conditions of air exchange, temperature, relative humidity, and ethylene concentration in the degreening room.

Dump and wash procedures

Upon dumping, the flow of fruit should be leveled out and long stems and trash removed as rapidly as possible to avoid fruit damage. Grading immediately to remove rotten fruit will prevent contamination of the washer brushes. An aqueous spray should be applied as soon as possible to

remove abrasive sand particles, and it may include chlorine to aid with fruit surface sanitation. The use of sodium-orthophenylphenate (SOPP) during washing provides control of green mold and sour rot, and helps maintain the washer brushes in a more sanitary condition to minimize contamination by decay pathogens. Remove non-packable fruit by extensive grading following washing to lower fungicide, wax, and drying costs, and to reduce fungicide residues in juice products.

Fungicide and wax applications

Imazalil and/or TBZ can be applied in water before waxing or in the wax. The eradicant activity of imazalil is significantly reduced when it is applied in wax. Treatment concentrations of both fungicides are twice the rate in wax than in water. Residues of imazalil (whole fruit) from either aqueous or wax applications should be 2 ppm to provide effective sporulation control of green mold. Effective wax applications retard fruit desiccation and enhance efficacy of fungicide treatments.

Sanitation

Sanitation practices help reduce inoculum of the fungi that cause green and blue mold and brown and sour rot. Complete removal of inoculum usually cannot be achieved, and is not necessary for a significant reduction in decay since a certain level of inoculum is required at an infection site to induce disease. Sanitation practices that keep inoculum below this level will greatly reduce the chances of infection.

Spores of the molds are airborne and contaminate equipment and building surfaces and water sources. Brown and sour rot fungi also can contaminate water and equipment surfaces. Populations of the molds are usually highest at the dump and primary grade areas where they are released from sporulating fruit during fruit dumping and handling. A significant reduction in decay has been noted when these areas are spatially separated from the rest of the packingline. Exhaust fans can be used to exhaust spores from the dump area, and the packingline can be designed so prevailing winds do not carry spores into the packing and storage areas.

Sanitizers, such as chlorine, quaternary ammonium, formaldehyde, or hot water (160°F) can be used to kill inoculum on pallets, packingline equipment, and building surfaces. Surfaces should be cleaned with water and detergent before applying chlorine or quaternary ammonium.

All fruit and trash should be removed daily to eliminate substrates for mold sporulation. Packed fruit with excessive green mold should be repacked in a remote area to prevent contamination of the packingline with fungicide resistant spores.

Fungicide resistance

A few biotypes of the green and blue mold fungi in the natural fungal population possess resistance to postharvest fungicides and can infect and sporulate on fungicide treated fruit. These strains can proliferate with continued use of the fungicides. Strains may be resistant to only one fungicide, but with continued exposure to all fungicides, such as in storage situations, one strain can develop resistance to the 3 postharvest fungicides, SOPP, TBZ, and imazalil.

By continually assessing the mold population in the packinghouse, development of resistance can be monitored and combatted by fungicide selection, effective sanitation, and use of broad-spectrum biocides, such as borax, soda ash, chlorine, quaternary ammonium, or formaldehyde. SOPP, TBZ, and imazalil, fungicides with specific modes of activity, are best utilized on the packingline for final treatment immediately before shipment.

Packaging

The package protects the fruit from mechanical damage and provides a microenvironment to maintain quality. With proper packing to prevent overfill, most of the weight in stacks of packed cartons of fruit is supported by the package. Fruit packed with flat orientation is more resistant to deformation, and tray and honey-comb packs provide additional protection against deformation, soilage, and the spread of decay.

Cartons stacked on pallets should be arranged to provide stability and adequate ventilation. Stacks wrapped with mesh, tape, or plastic, and strengthened with corner boards provide maximum protection and stability during long transit times.

Transit and storage conditions

Proper temperature and humidity management are critical for maintenance of fruit quality after packing. Cooling to 45°F immediately after packing controls pitting in grapefruit, and reduces decay, respiration, and production of off-flavors in all types of citrus. Desiccation, softening, shriveling, loss of attractiveness, and accelerated senescence develops if fruit are not maintained under high relative humidity conditions.

Conclusion

All aspects of fruit preparation, transit, and storage influence disease control. If any one process is neglected, quality is negatively impacted by decay. The postharvest efforts must be consistent and reliable to deliver the quality present at harvest to the consumer.

Retirement

Effective the end of May, I will retire from the Florida Department of Citrus after 34 years of conducting research on postharvest disease problems of Florida citrus. The years have gone quickly with a minimum of stress and illness. My wife and I will remain in the area after retirement. We have sand in our shoes and freeze when the temperature drops below 60°F!

I have thoroughly enjoyed my relationship with the Florida fresh fruit industry, and the opportunity to help develop products and procedures that have been useful to you in your packing operations. Many thanks for your support and cooperation. I may even drop by occasionally to see how the season is progressing.

Eldon Brown