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PACKINGHOUSE NEWSLETTER

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POSTHARVEST PITTING OF GRAPEFRUIT

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Summary: An apparently new peel disorder, a postharvest pitting of Marsh white and to a lesser extent pink and red grapefruit, has been characterized. This disorder is caused by the collapse of oil glands and is distinguished by the deep pits that form in the peel directly above the collapsed oil glands. The peel in the pitted region eventually becomes bronze in color. Clusters of two or more pits are often scattered over the surface of the fruit. This disorder develops during the first three weeks of storage and is stimulated by waxing of the fruit and storage at high temperatures. Postharvest pitting can be suppressed after 2 days storage at 70°F by reducing the storage temperature to 40°F or 50°F. However, the best control has been obtained by storing the fruit at 40°F immediately after packing. No preharvest pitting or other indicators of fruit susceptibility before packing have been observed.

In mid-February 1994 we received inquiries about the cause of pitting of exported white grapefruit. Although the fruit were reportedly not subjected to chilling temperatures, the pitting initially appeared to be similar to that caused by chilling injury. Preliminary studies showed that pitting occurred only on fruit stored at ambient temperature and thus confirmed that this disorder was not chilling injury. Subsequent studies on the effects of temperature and packinghouse treatments were performed at the Citrus Research and Education Center (CREC) during the 1993-94 and 1994-95 seasons on fruit packed at commercial packinghouses or at the CREC (Petracek et al., 1995).

Pitting of non-chilled fruit was characterized by clusters of collapsed oil glands scattered over the surface of the fruit. The disorder was first expressed as a slight depression of the peel in regions directly above oil glands. These regions often became bronze in color within 3 days after the initial depressions were noted. When two or more adjacent oil glands collapsed, the peel between the oil glands often became indented. In contrast, damage due to chilling injury tends to be more general rather than focused on oil glands and discoloration caused by chilling injury tends to be darker brown and more uniformly distributed between the oil glands.

The pits initially appeared from 2 to 28 days after packing. The rate of appearance was highest in the first week after packing (Fig. 1). Susceptibility of the fruit or specific regions on the fruit was not predictable by visual inspection of the fruit before pitting. Industry reports that pitting occurred in the field or appeared within hours after packing were not verified. Pitted areas consisted of an average of three oil glands per cluster (range: 1 to 27). The number of oil glands for a given cluster did not increase with time. The average number of clusters per fruit was 22. Clusters were evenly distributed over the fruit surface with two exceptions: (1) the stem end had about 60% fewer pits than other regions of the peel and (2) about a quarter of the midsection region of the peel had few or no pits.

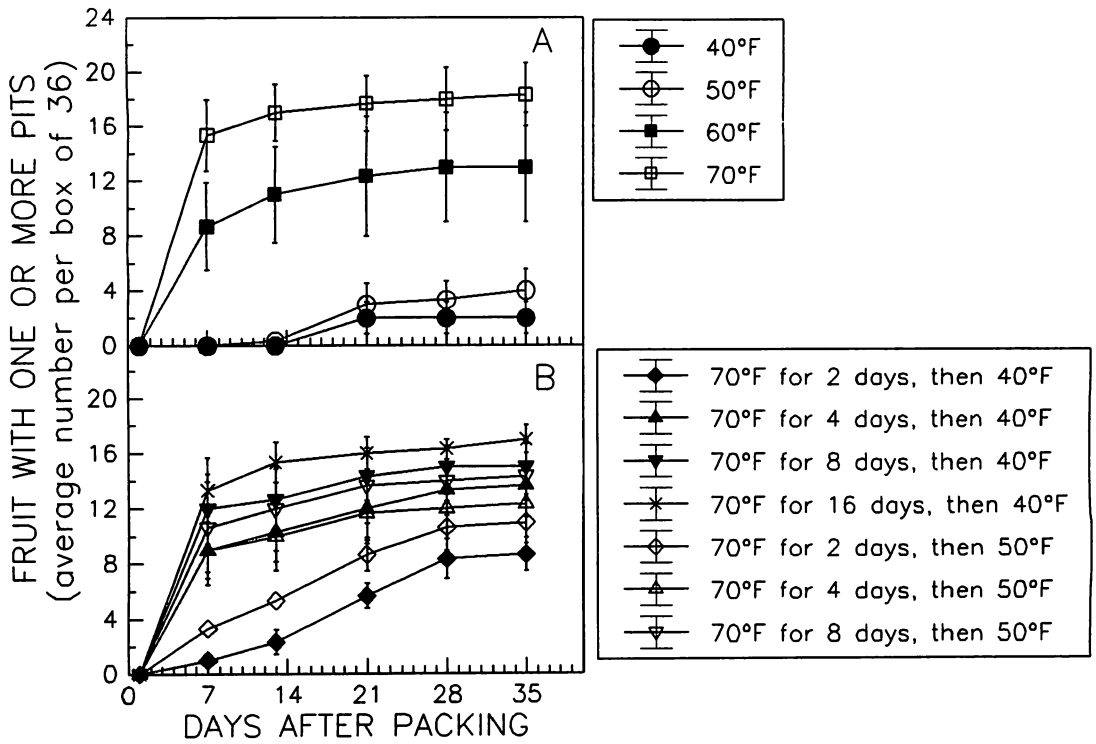

Figure 1. Effect of storage temperature on pitting of white grapefruit.

For all studies, postharvest pitting was absent on virtually all fruit that were stored at 40°F within several hours after packing, but was consistently observed at 70°F. Detailed evaluation of temperature effects revealed that the rate of appearance of pits (Fig. 1) and extent of pitting (Table 1) were most effectively controlled when fruit were stored at 40°F within 1 hour after packing. Storage at 50°F or transferring fruit from 70 to 40 or 50°F after 2 days also suppressed pitting, but to a lesser extent. Pitting observed for fruit stored at low temperature (40 or 50°F) within 1 hour after packing was due primarily to chilling injury. Pitting was not inhibited by transferring fruit to 40 or 50°F after 4 or more days storage at 70°F or by storage at 60°F.

Table 1. Effect of storage temperature on postharvest pitting of white grapefruit. Fruit were packed and stored for 35 days.

Storage temperature (°F)	% fruit with 10 or more pits
40°	0.0
50°	5.6
60°	16.7
70°	19.4
70° for 2 days, then 40°	5.6
70° for 4 days, then 40°	16.7
70° for 2 days, then 50°	7.4
70° for 4 days, then 50°	15.8

Exposure of the fruit to ethylene up to 68 hours before washing and waxing did not affect pitting (Table 2). Pitting was not significantly affected by washing with surfactant solution. However, pitting was present only on waxed fruit. Wild (1991) reported that peteca rind pitting of lemons was stimulated by waxing, but the exact cause of this stimulation was not determined. The pitting observed in our studies was unlikely to be due to a phytotoxic response or "burning" of citrus peel to wax. A phytotoxic response of the peel to wax is reportedly characterized by collapse over the entire peel within the first several days fter waxing. In contrast, the pitting we observed was characterized by scattered collapse of the patches of oil glands appearing, sometimes several weeks after wax application. We also noted that waxes used in our studies came from two companies and consisted of three formulations. Moreover, reports from packinghouses indicated that fruit treated with water emulsion waxes from other companies also pitted, which indicates that the problem is not associated strictly with one wax formulation.

Table 2. Effect of degreening, washing, and waxing on postharvest pitting of white grapefruit. Fruit were packed and stored for 35 days at 70°F.

	% fruit with 10 or more pits	
Treatment	Waxed	Not waxed
Degreened, washed	23	0
Degreened, not washed	19	0
Not degreened, washed	15	0
Not degreened, not washed	18	0

Personnel in the production, packing, and shipping industries were informally surveyed to determine whether additional factors contributed to the disorder. Although the reports were sometimes contradictory, some observations seemed consistent. Marsh white grapefruit was the cultivar most affected, although similar pitting was identified in pink and red grapefruit. The pitted uit came initially from groves in three counties of eastern Florida. Pitting was seen primarily on fruit shipped to Japan. Some pitting was reported on red grapefruit shipped to Europe, but was not reported for domestic fruit. However, we note that these observations are confounded by market preference, shipping mode, and shipping duration. Pitting was reported initially in mid-

February, 1994, was extensive throughout March and April, decreased in early May, but continued to the end of the season (early June). Pitting was reported again in the following season in late-December, 1994 and continued until mid-February, 1995.

No single preharvest treatment, such as spray application, nutrition or cultural practices, apparently are associated with the disorder. Fruit from some groves reportedly had excessive pitting. Rootstock, tree age, irrigation method, and fertilization strategies were suggested as playing roles, though no consistent trend accounted for differences in the incidence of the disorder. Several industry reports stated that fruit from adjacent rows or groves were alternately extensively pitted or virtually non-pitted, depending on the day they were harvested, the hour they were packed, and/or the mode by which they were shipped. While these reports have been unsubstantiated by experiment, they suggest that fruit susceptibility and postharvest stress may be involved.

We suspect that this disorder has been observed in previous seasons at lower rates of incidence and may have been cursorily diagnosed as chilling injury or physical damage. Pitting characterized in this article was distinguishable from chilling injury: (1) chilling injury requires low temperatures (<50°F) to develop whereas pitting develops at high temperatures (70°F). (2) chilling injury is reduced by waxing (Grierson, 1971) whereas pitting requires waxing. (3) chilling injury requires several weeks of storage to develop whereas pitting develops within the first week of storage. (4) chilling injury is general and typically develops a dark brown color whereas pitting is associated with oil glands and develop a bronze color.

Pitting is distinguishable from physical damage caused by sand abrasion, puncturing, or insect damage. Physical damage of the peel is often characterized by the presence of a wound periderm and of individual pits or isolated wound areas. Pitting was characterized by scattered clusters of pitted areas with no associated wound periderm. Moreover, physical damage is not always focused on oil glands and does not increase in frequency during storage as is characteristic of pitting.

Other sporadically occurring citrus peel disorders that involve the collapse of oil glands or surrounding areas include rumple or peteca of lemon, "nuxan" blemish of Shamouti orange, pitting of Pineapple and Valencia orange, aging, and stem end rind breakdown (Pantastico et al., 1975; Smoot et al., 1971). Further research is required to determine common causal factors between these disorders and the pitting observed for grapefruit. More extensive studies on the influence of storage temperature, wax composition, and changes in peel physiology may better explain this newly defined disorder.

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AVAILABLE PUBLICATIONS

Available from Dr. W. Wardowski, CREC, 700 Experiment Station Road, Lake Alfred, Florida 33850

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