

FRUIT SKIN DISORDERS

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INTRODUCTION

Numerous skin disorders lower the quality of apples and increase cullage. Many disorders are induced by environmental stress such as high temperatures and solar radiation. Other skin disorders are induced by chemical treatments and by pathogens. The skin disorders discussed in this paper are those induced by environmental stress.

Our research, which has been heavily supported by the Washington Tree Fruit Research Commission over the past several years, has characterized several skin disorders and their causes. We have identified or developed remedies for some of these disorders. These topics are addressed in this paper.

HEAT AND/OR LIGHT STRESS AND SKIN DISORDERS

Heat and/or light stress induce several skin disorders. These disorders frequently cause fruit on the packing line to either be rejected to cullage or to be downgraded. These disorders cost growers tens of millions of dollars annually.

Heat and/or light induce or enhance the following disorders: sunburn, Fuji stain, lenticel marking, “sunburn scald” in Granny Smith, cracking/splitting, bitter pit, and watercore. Some of these disorders appear before harvest and some appear later (e.g., Fuji stain).

Sunburn

Sunburn of apples is normally the major source of cullage, and averages 8 to 12% in most years. In 2003, sunburn was more severe in many orchards in Washington State. Frequently, assessors at the packinghouse underestimate sunburn damage. Brunner et al. recently reported (<http://postharvest.tfrec.wsu.edu/PC2003B.pdf>) to the Research Commission that apples in cullage have an average of 2.5 defects per apple. Most packinghouses, however, report or score only one defect per apple. The assessor normally reports the most obvious defect, or the one the assessor is most confident in identifying. Consequently, the cullage report provided to a grower normally underreports the amount of damage due to sunburn. Even if sunburn damages only 10% of the crop, total cost to Washington State growers surpasses \$100 million per year.

Our research has shown that apples that are sunburned frequently develop other skin disorders as well. Some disorders appear before harvest and some appear later. Thus, a high priority should be given to reducing sunburn in the orchard, especially since we have shown that several other skin disorders are enhanced in fruit that has more severe sunburn.

Our research has established that three types of sunburn are caused by heat and/or light stress (Figure 1). Sunburn necrosis occurs when the fruit surface temperature (FST) reaches 126 °F for only 10 minutes. At this FST, thermal death occurs on the skin. The most prevalent type of sunburn (sunburn browning) is induced when the FST reaches 114 to 120 °F for 1 hour. Apple

varieties differ in their tolerance to temperature stress (i.e., some sunburn at a lower FST than others). Damaging ultraviolet-B (UV-B) radiation also contributes to sunburn browning. The third type of sunburn (Type 3) occurs on “non-acclimated” apples that are suddenly exposed to full sunlight (e.g., after thinning or shifting of a branch as fruit load increases). Type 3 sunburn can occur at much lower air and fruit surface temperatures, and does not appear to require UV-B. Initial damage is seen within 24 hours as bleaching or whitening of the sun-exposed apple skin surface. With continued exposure to sunlight, the bleached area turns brown (Figure 1).



Figure 1. Three types of sunburn in apple. Left to right: Sunburn necrosis, sunburn browning, and Type 3 sunburn.

Fuji Stain

Most Fuji stain appears on the sun-exposed side of sunburned apples after a period of cold storage. Stain typically appears around the edges (in the halo) of a sunburned area (Figure 2). The incidence of Fuji stain is usually very low in non-sunburned apples even after 4 months of cold storage. As the severity of sunburn increases on fruit, the incidence of stain generally increases significantly. The amount of stain also increases as the time in cold storage increases (Figure 3). Three applications of RAYNOX, a new sunburn protectant, during the season as recommended on its label significantly decreased ($P < 0.01$) the appearance of stain after 2, 3, and 4 months of cold storage (Figure 3).



Figure 2. Fuji stain after 3 months of in regular atmosphere cold storage.

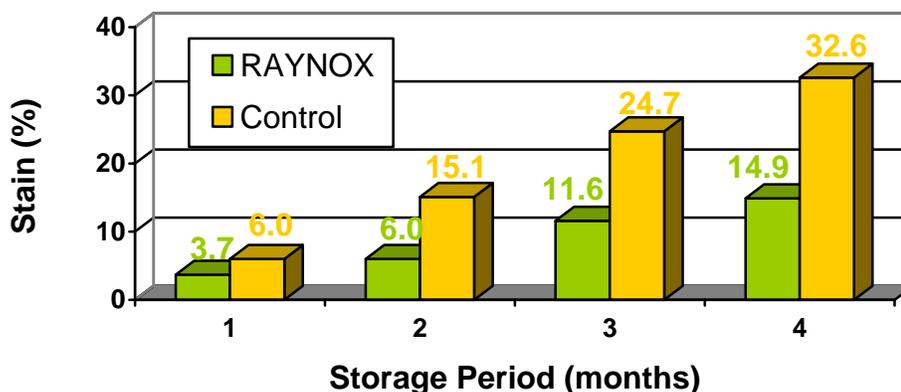


Figure 3. Fuji stain evaluated monthly after 1 to 4 months in regular atmosphere cold storage. Half the fruit were from trees that had been sprayed with three applications of RAYNOX according to its label for sunburn protection. The other fruit were from untreated controls.

Lenticel Marking

This skin disorder also appears on the sun-exposed side and its incidence also increases with increasing severity of sunburn. It therefore appears to be another skin disorder that is induced by heat and/or light. Microscopic observations have shown that lenticels lose their integrity as the severity of sunburn and lenticel marking increase (Figure 4, lower right figure). These open and damaged lenticels predispose the apples to additional damage (e.g. lenticel breakdown) when the apples are subjected to detergents, finishing waxes etc. before packing. Lenticel breakdown commonly appears after the apples are returned to cold storage.

SKIN DISORDERS INDUCED BY FACTORS OTHER THAN HEAT AND LIGHT

Fuji Flecking

The causes of this skin disorder are not well established yet. It is thought that the disorder is induced during rapid expansion of the fruit during its first few weeks of development. We have established that the severity of this disorder is enhanced by conditions that cause high relative humidity around the fruit. These conditions include overhead irrigation that keeps the fruit wet for long periods of time. Evaporative cooling can also enhance appearance of flecking. Apples in trees with dense canopies are more prone to developing flecking than those in open canopies. The apple shown in Figure 5 has a high incidence of flecking.

Cracking/Splitting of Apples

The causes of this disorder are being investigated. Our preliminary research suggests that splitting is frequently initiated on or near a lenticel. Often, the crack or split develops between two or more lenticels. Fruit that have been sunburned are more vulnerable to cracking than non-sunburned fruit. This is due to a higher incidence of lenticel marking and damage in sunburned fruit, as discussed earlier.

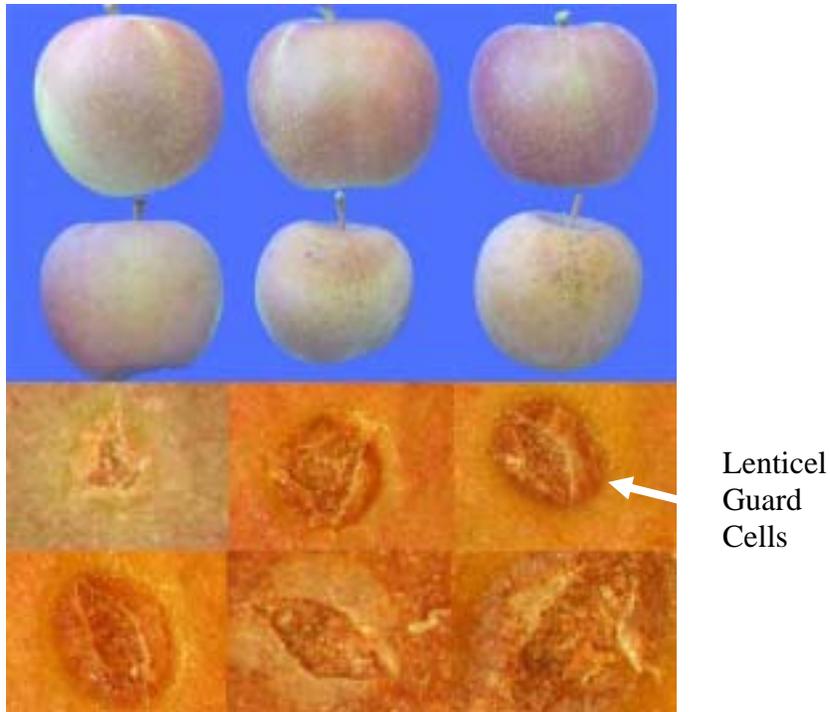


Figure 4. Upper figure (from upper left to lower right) shows increasing severity of sunburn and lenticel marking. Lower photomicrographs show that integrity of guard cells around the lenticel is lost (lower right corner)



Figure 5. Fuji flecking

ACKNOWLEDGMENTS

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