Fruit Skin Problems: Russet, Sunburn, Poor Color, and Lenticel Breakdown

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Problems arising from abnormal fruit skin development can have a significant negative impact on the value of fresh market apple fruit. This presentation discusses the probable causes and describes some possible control measures for three pre-harvest (russet, sunburn and poor fruit color) and one postharvest (lenticel breakdown) fruit skin problems in apple.

Russet

Russet may be caused by different stimuli including fungi or yeasts on the fruit surface, insect feeding, frost around the time of bloom, high humidity and precipitation, particularly during the period from 15-20 days after bloom, or various crop protection sprays. It is likely that these factors interact to alter the final russet severity. To illustrate the interaction between environmental conditions and a chemical spray, the data in Figure 1 shows the incidence of russet on 'Gala' apples from two different climatic regions of New Zealand as affected by multiple applications of lime sulfur as a bloom thinning spray. Lime sulfur increased the incidence of russet by approx. two-fold in both regions. However, the overall incidence of russet was much lower in the region with a drier, more continental climate (Otago) compared to the region with a wetter, more humid climate (Hawke's Bay).

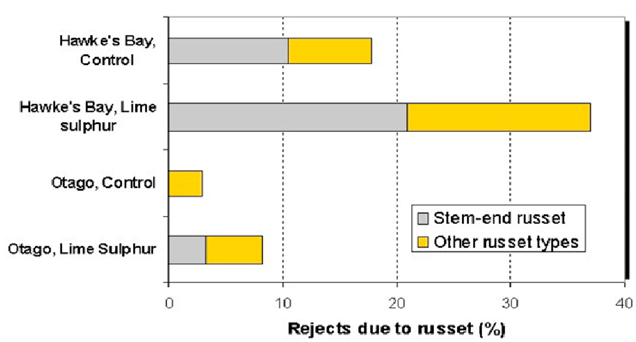

Figure 1

Effects of lime sulfur thinning sprays on russet of 'Gala' in two different climatic regions of New Zealand. Hawke's Bay is a more humid region than Otago. Data are averages from five different orchards in each region. Liquid lime sulfur was applied three times during bloom as a dilute spray at a concentration 2%.

Russet in 'Golden Delicious' is related to abnormal development of the cuticle which is the layer of waxy material that covers the epidermal cells in the skin of the fruit. Non-russeted portions of 'Golden Delicious' fruit have either a thicker, more convoluted cuticle or a double layer of cuticle compared to russeted portions. Russet can be observed on 'Golden Delicious' as early as 35-45 days after full bloom, coincident with a rapid increase in the width of epidermal cell. Epidermal cells of russeted fruit increase in width more rapidly than epidermal cells in non-russeted fruit. Russet in 'Golden Delicious' is caused by a weakness in cuticle formation that leads to micro-cracks developing in the cuticle: these micro-cracks expand further with fruit enlargement. Exposure of the hypodermal cells beneath micro-cracks to air results in formation of a cork cambium that is known as russet.

Multiple sprays of GA_{4+7} (Valent USA Provide; Fine Americas Novagib) can be applied at 7-10 day intervals during the first month after bloom to reduce the incidence and severity of russet. Three or four applications of a proprietary mixture of 15-20 $mg \cdot L^{-1}$ GA_{4+7} beginning at PF are recommended to reduce russet severity on susceptible cultivars. GA_{4+7} sprays for russet control were recently shown to increase the density of epidermal cells. Somewhat paradoxically, the gibberellin inhibitor Apogee (prohexadione-calcium) can also reduce russet and increase the efficacy of GA_{4+7} sprays for russet control (Table 1). A single application of Apogee, tank mixed with the first of four GA_{4+7} sprays, has consistently increased the control of russet compared to a program of GA_{4+7} only in our studies in the Southeastern US.

Table 1. Effects of Apogee (prohexadione calcium) and Provide (GA_{4+7}) on the proportion of 'Golden Delicious' fruit with a low incidence russet (20% or less of the surface affected). Apogee was applied once only in each experiment at a concentration of 150 $mg.L^{-1}$, in combination with the first Provide application in a standard program of four sprays. Means within each column followed by different letters are significantly different (*P*<0.05).

Treatment	Fruit with < 20% surface russet (%)	
	Experiment 1	Experiment 2
Control	88 a	16 a
Apogee	92 b	33 b
Provide	99 c	65 c
Apogee + Provide	98 c	76 d

Sunburn ('Fuji')

Sunburn browning occurs when the fruit surface temperature (FST) reaches 115-120°F (46-49°C) (Schrader, 2009). The exact temperature at which sunburn browning occurs is variety dependent. High levels of UV-B light (315-280 nm) are also involved in sunburn browning. Since FST can range from 9-32°F higher than ambient air temperatures (Schrader, 2009), and FST's typically average 22°F higher, then the risk of sunburn browning increases any time that air temperatures are above 90°F. Products such as Surround WP, Raynox Plus and Purshade reduce sunburn browning by reducing the FST and the amount of damaging UV-B radiation reaching the epidermal cells. Surround WP (kaolin clay) and Purshade (calcium carbonate) reduce fruit surface temperature by reflecting ultraviolet and infrared radiation. Raynox Plus is a combination of carnauba wax and bentonite clay that both absorbs and reflects ultraviolet radiation (Schrader, 2011). In 2011 we found that only 43% of the fruit in a block of Fuji/M.9 trees in Henderson County exhibited no sunburn, whereas the proportion of fruit with no sunburn was increased to 67% following a program of four sprays of Raynox Plus. We have not compared the effects of Purshade and Raynox Plus on the control of sunburn.

Red Color ('Pink Lady')

The development of red color in the skin of apples is due to formation of anthocyanin pigments and their accumulation in the vacuole of epidermal cells. Anthocyanin formation is promoted by high light conditions that favor photosynthesis and cool night time temperatures. Direction absorption of light by the fruit itself is required for anthocyanin formation. However, anthocyanin formation is reduced by high temperatures and excessive tree vigor which limits light penetration into the canopy. In 2011 we compared the effects of three spray materials (Blush, Oxidate, and ABA) and a reflective plastic film (Global Packaging Solutions Inc.) on red color formation in a block of mature Pink Lady/M.7 apple trees in an orchard with rows oriented in an east-west direction. The reflective film was the only treatment to increase red color coverage in this study. The proportion of fruit with >80% red color coverage in the control trees was only 47%. In comparison, laying a 100 inch wide reflective film in the orchard rows four weeks before harvest increased the proportion of high colored fruit to 75%. Putting the film out in the orchard only two weeks before harvest was equally as effective, increasing the proportion of high colored fruit to 70%. Reflective films such as this will have greatest effect in more vigorous orchards where the dense foliage results in excessive shading within the canopy. The positive effect of reflective film on red color formation was observed throughout the tree canopy (Fig. 2).

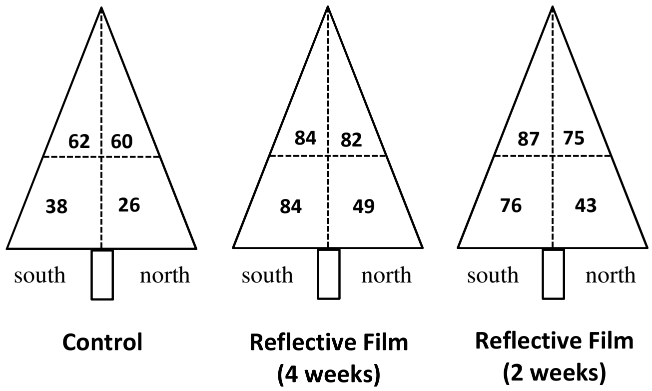

Figure 2

Effects of a reflective plastic film on the proportion of high-colored fruit in different parts of the canopy of mature 'Pink Lady'/M.7 trees. Orchard rows were oriented in an east-west direction. Data indicate the percent of fruit with more than 80% red color coverage. Reflective film was put in the orchard for four weeks (center) or two week (right) prior to harvest.

Lenticel Breakdown ('Gala')

Lenticel breakdown is a postharvest skin disorder predominantly affecting 'Gala' that can significantly reduce crop value in some years. The incidence of lenticel breakdown varies between orchards and years for reasons that are not well understood. The incidence of lenticel breakdown in 'Gala' is reduced if fruit are harvested before they are too mature, if foliar calcium sprays are applied during the summer, if the time delay between harvest and cooling is kept to a minimum, if the temperature difference between the fruit and the water dump is minimized, and if soaps/detergents are avoided in the packing line.

If lenticel breakdown is related to fruit maturity then we might expect that postharvest SmartFresh treatments might reduce its incidence. Data from a three year study in Washington State however showed that SmartFresh had no effect on lenticel breakdown in two out of three years, but actually increased the incidence of fruit with lenticel breakdown in the third year of the study.

In 2011 we investigated the effects of harvest date and SmartFresh treatment on the incidence of lenticel breakdown in 'Gala' fruit after 60 d cold storage. Fruit were harvested at 3-4 day intervals during the normal harvest period. At the first harvest date the fruit firmness was 19.3 lbf and the starch index was 3.9 according to the Cornel Starch Chart. At the final harvest date the fruit firmness had declined to 16.3 lbf and the starch index increased to 7.6, indicative of very advanced fruit maturity. The incidence of fruit with lenticel breakdown after 60 d in cold storage tended to increase with harvest date (Figure 3). We found that SmartFresh reduced the incidence of fruit with lenticel breakdown at all harvest dates except the initial harvest (Figure 3). We will be repeating this study in 2012 to establish if the positive effect of SmartFresh on the incidence of lenticel breakdown in 'Gala' is consistent across years.

Figure 3

Effects of SmartFresh treatment and harvest date on the incidence of lenticel breakdown in 'Gala' fruit after 60 days cold storage in 2011. Vertical bars represent the standard error of the mean.