Introduction

Every year, sunburn causes some damage to fruit growing commercially in northern Victoria. Sunburnt fruit can be used for producing juice, but this often does not cover the picking and grading costs and damaged fruit is often dumped. Orchardists in the Goulburn Valley estimate fruit losses can vary from 6 to 30 per cent, depending on the season and the type of fruit. Losses in susceptible varieties like Granny Smith and Gala apples have been as high as 40 to 50 per cent.

What causes sunburn in apples?

The energy of sunlight can cause sunburn on the sun-exposed surface of apples. The heating effect of sunlight, combined with the damaging effects of ultra-violet (UV) light are the main causes of sunburn in apples, plus the sudden movement of fruit from shade to direct sunlight can also cause sunburn, even at lower temperatures.

Types of sunburn

Sunburn in apples has been studied in detail and three types of sunburn have been found.

1. Sunburn necrosis

This appears as a sunken dark brown or black dead or necrotic patch on the side of fruit exposed to the sun. It is usually caused by heat generated in fruit by direct sunlight, when the fruit surface temperature of an apple reaches $52^\circ\pm1^\circ\text{C}$ for 10 minutes.
2. Sunburn browning

This appears as a yellow, brown or dark, tan patch on the side of the apple exposed to the sun. Cells do not die and damage initially appears superficial, although deeper layers may show more damage after cool storage. This is caused by less intense sunlight at lower surface temperatures on the fruit. Sunburn browning in apples normally begins to appear when fruit surface temperatures rise to 46º to 49ºC for one hour, depending on different varieties.

3. Photo-oxidative sunburn

This initially appears as white, bleached skin in a patch on the side of apples exposed to the sun, that later becomes brown and sometimes also necrotic. It can occur at relatively low air temperatures and with lower surface temperatures of fruit (less than 45ºC). It is associated more with a sudden increase in direct, visible light intensity, such as when a branch moves suddenly under the increased weight of the growing fruit to expose fruit that was previously shaded.

Sunburn Risk

Fruit surface temperature will increase with increased duration and intensity of exposure to sunlight and this provides the best indicator of sunburn risk. However air temperature is normally the most convenient indicator of sunburn risk. Orchardists should be aware that the Bureau of Meteorology air temperature measurements are always taken in shade and sun-exposed fruit surface temperatures are normally 10º to 18ºC higher than the official, measured air temperature.

Shaded air temperature as an indicator of sunburn risk:

- Greater than 40ºC = High risk of a necrotic patch
- Greater than 35ºC = High risk of browning damage
- 30º to 35ºC = Damage is variable, depending on wind, sunlight intensity (cloud cover), humidity and level of fruit acclimatisation to sunlight

Other factors that increase sunburn risk are:

- Sudden movement of fruit from shade to direct sunlight
- Modern orchards with dwarfing rootstocks and good light penetration
- Fruit positioned with a westerly aspect
- Water stress on hot days (evidence from grower experience)

Sun Protection Options

1. Best management practices for sun protection

- Use more heat tolerant fruit varieties. For example: Pink Lady® and Sundowner® are more tolerant than Granny Smith and Gala
- Schedule irrigations to avoid tree water stress
- Train fruit trees to develop an appropriate canopy. For example: scaffold branches that do not move and less fruit at the end of branches
- Avoid early and excessive summer pruning and leaf stripping to enhance colour
Protect picked fruit in the bin from unnecessarily extended periods of direct sunlight exposure
Avoid bare inter-row spaces that reflect solar radiation
Improve air movement through the fruit block

2. Spray-on products
Leaves and fruit of agricultural crops can be sprayed with suspensions of tiny, white, mineral particles (clay or calcium carbonate) or with wax emulsions to create a film that provides some protection from the damaging effects of sunlight.

The clay products are made from processed kaolin clay and research in the United States has shown, under high application rates, they can reduce fruit surface temperatures. Under summer conditions, when sunlight levels are high, the film may promote photosynthesis by lowering heat stress on trees and by creating better distribution of light to lower parts of the canopy.

More recently, spray-on products manufactured from calcium carbonate have become available. They appear to be similar to the clay-based products, but form a lighter film on treated trees and are more rainfast.

The wax-based product is almost completely transparent. Unlike the other products it does not require complete removal from the fruit before being packed for market. It works mainly by filtering out a significant proportion of UV light and is more effective at preventing sunburn browning than sunburn necrosis. It is also more rainfast than the other products.

3. Shade netting

Traditionally, netting has been used to protect orchards from birds and hail, but recently it has been used primarily to provide sun protection for fruit. Shade netting is usually designed to reduce mid-day, solar radiation by about 20 per cent to reduce the heat load and the damaging effects of UV light on trees and fruit. The netting normally has only a small influence on air temperature.

Permanent shade netting should last for at least 10 years and the supporting structures for at least 40 years. Orchard management under shade netting should be modified to allow for slightly more vegetative growth, humidity and soil wetness.

4. Over-tree sprinkler cooling systems

Over-tree sprinkler, cooling systems are designed to reduce sunburn by delivering misted or sprinkled water over the orchard canopy to cool fruit during the hottest part of the day.

The effectiveness of misting in reducing fruit surface temperature is variable due to the influence of moving air or wind. Water running over fruit is likely to cause soil waterlogging if it is not carefully coordinated with irrigation and rainfall. Evaporation from the surfaces of leaves and fruit is the most efficient way to reduce sunburn with sprinklers.
The aim is to keep the fruit wet during the hottest part of the day and to minimise the amount of water running through to the orchard floor.

Over-tree sprinklers could be positioned at the top of tall risers or they could be attached to poly pipes, stretched along wires supported by tall trellis or net supporting posts.

Water could be delivered by the existing irrigation system or by a separate sprinkler system. To save water and to allow a greater area to be cooled in heat-wave conditions, water delivery could be pulsed, with water turned off for a period and then, turned on again before all water has evaporated from the surface of leaves and fruit. To achieve this efficiently it is essential to have a well-designed system.

An additional benefit of over-tree sprinkler cooling is that it can increase colour development in red-blush apples. Colouring with maturing apples is directly proportional to the time the fruit is at, or close to, 20ºC. To achieve this, cooling could be applied for about one hour just after sunrise and for about one hour around sunset.

**Further References**


**Contact / Services available from DPI**

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