Frost and chilling injuries in olives

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Nothing gets more discussion among olive growers than when to harvest. Fruit maturation depends, among other things, on olive variety, temperature, sunlight and irrigation. A hot autumn can cause fruit to ripen quickly, resulting in a narrow window for optimum picking. Some varieties will ripen faster than others, and olives may mature later in some parts of the orchard than in others. Some farmers are also forced to pick greener fruit than they want, to hedge against frost damage.

Frost is one of the most important weather-related hazards for the Australian olive industry and it has caused significant economic losses (Ravetti 2005, Smyth 2006, Guillaume *et al.* 2009). Its impact on oil quality was significant in 2006, with more than 20% of Australian oil that year being affected to some degree. Early frosts will normally affect the fruit, leading to significant changes in the chemical and organoleptic characteristics of the oils.

The aim of this research was to study the effect of freeze damage on the phenolic composition and quality parameters of oils from three different varieties: Frantoio, Barnea and Picual (Guillaume *et al.* 2009). Olive fruit that has been frozen produces oil with a distinctive defective quality. It is described as unpleasantly sweet and reminiscent of vanilla custard or stewed prunes.

Frost and chilling injuries are primarily disorders of crops of tropical and subtropical origin. Climatic conditions during the growing season affect the sensitivity of olives to injury. A number of Australian olive growing regions, particularly in New South Wales, South Australia and Victoria, can experience severe frosts.

Olive trees and fruit can suffer severe damage at temperature of -2°C to -9°C, however these temperatures are only temporary, with daytime temperatures usually reaching >10°C. Frost can seriously damage olive trees, especially young trees, young shoots and inflorescences, resulting in serious losses. Entire trees can die when exposed to temperatures of -7°C. In May, June and July 2006 minimum temperatures of -5°C and below on several mornings within a few days of each other, appear to have been responsible for progressive damage to olive trees (Smyth 2006).

The damage varies according to the specific temperature at ground level around the tree, the duration of the cold spell, the olive variety, the age of the tree, and whether the trees have had a chance to harden off. Frost occurs at inland sites on clear, cold nights without wind or at higher altitudes and is less likely to occur in costal areas.

Technically, the word "frost" refers to the formation of ice crystals on surfaces, either by freezing of dew or a phase change from vapour to ice. A frost occurs where the air has dropped below freezing but the ground has not. Frost is a local condition which occurs on a still night when the air temperature is less than or equal to 0°C" and it warms up again the next day.

Olive fruits with frost damage and chilling injuries were observed in New South Wales and Victoria in April 2010, when the temperature reached below + 5°C to -5°C. Fruit damagewith temperature -1.7°C frost

damage shows surface blisters and spots, indicating damage around the pit. Depending on the characteristics of the frost, the damaged fruit turns a brownish colour and remains with an aqueous consistency and drop, or dehydrates, remaining shrivelled until harvested.

Chilling injury is not the same as frost injury. The term 'chilling' has been used to describe periods in which plant tissue experiences temperatures below 12°C but above 0° (C. Bongi 1987). Variation in chilling sensitivity between cultivars was also found during storage, even at 10°C in Greece. It is known that these changes negatively affect table olive quality (A. Kiritsakis *et al*. 1998). Chilling stress and injury does not only occur in storage, but may also occur in the field. The sensitivity to chilling stress depends on several factors, with species, cultivar, plant part, and morphological and physiological condition at the time of exposure of critical importance.

The main chilling injury symptoms are internal browning around the pit, which progressively leads to external pitting and browning. Skin browning indicates an advanced stage and/or greater severity of chilling injury (exposure of fresh olives to temperatures below 5°C).

Detection and diagnosis of chilling injury is often difficult, but symptoms may occur when the produce is placed at higher temperatures. Symptoms which appear at higher temperatures may do so almost immediately, or may take several days to develop.

Symptoms also may not be visible externally. Internal browning begins in the flesh around the pit and radiates outward as time progresses. The internal flesh and pip may be blackened throughout the whole fruit or only at the apical end and secondary fungal rots, such as *Alternaria* species, commonly infect the damaged fruit. Injury occurs sooner and is more severe, the lower the temperature is below the threshold temperature. The degree of chilling and frost injuries depends on the duration of the cold temperatures and how fast the temperature dropped.

Frost and chilling injuries vary at different temperatures.

The internal flesh and pip may be affected and secondary fungal rots commonly infect the damaged fruit.

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