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Reducing Flesh Browning in Apples

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Predictors of flesh browning in apples

Flesh browning

Many modern apple cultivars are known for their excellent fruit quality. However, depending on their parentage, orchard management and growing conditions, some of these cultivars are prone to flesh browning (FB).

Flesh browning is a devastating and highly erratic physiological disorder which compromises fruit quality and long-term storage potential, leading to severe economic losses to the apple industry. The development of FB involves compromised structural integrity and functional stability of the cells making up the fruit flesh.

Types of flesh browning

Flesh browning can be broadly categorised into chilling injury, CO_2 injury and radial browning depending on the cause (Figure 1).

Chilling injury is browning of flesh generally showing defined margins between damaged and healthy flesh.

CO_2 injury is characterised by brown portions throughout the fruit flesh with small to large lens-shaped cavities in the cortex tissue.

Radial browning shows typical radial patterns of browning extending outwards from the vascular bundles, but there is no defined margin between affected and unaffected tissue.

Tasmanian trials

In this three-year study, over 10,000 individual apples were assessed for FB and potential predictors. The trials were established in 11 different orchard trial blocks across five commercial orchards in the Huon Valley region of Southern Tasmania.

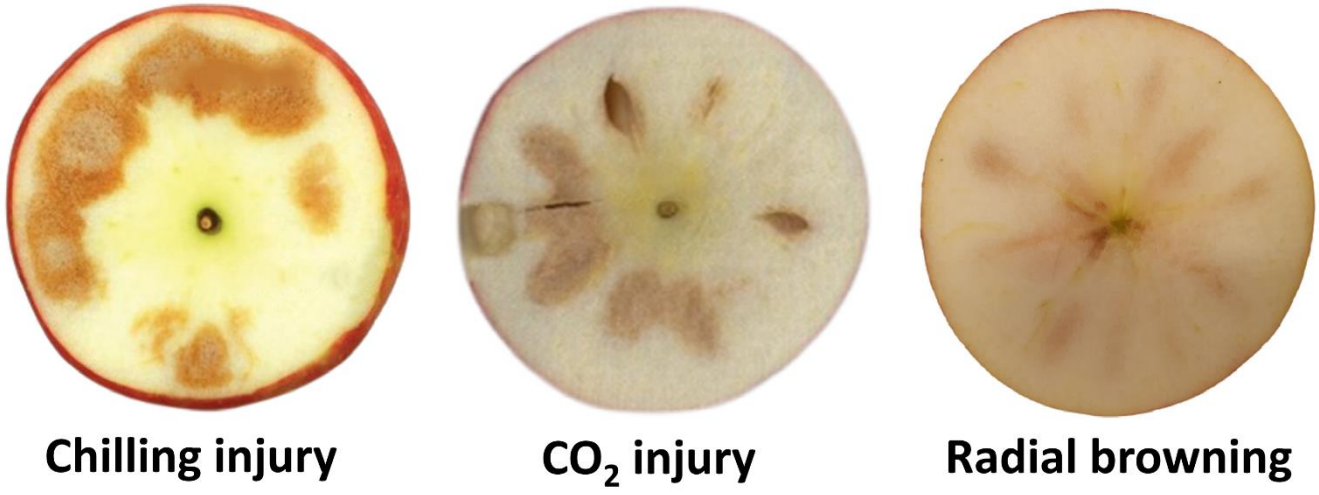

Figure 1 : *Images of three different broad categories of flesh browning found in apple fruit; chilling injury, CO_2 injury and radial browning.*

Predictors of flesh browning in apples

The incidence of FB was calculated in terms of percentage of total symptomatic fruit per block or site. There was considerable variation within and among the orchard sites, blocks and seasons.

The incidence of FB across the three seasons ranged from no browning at all through to 51 % of the crop being symptomatic. (Figure 2). The major seasonal variation was seen in blocks with greatest variation in crop load.

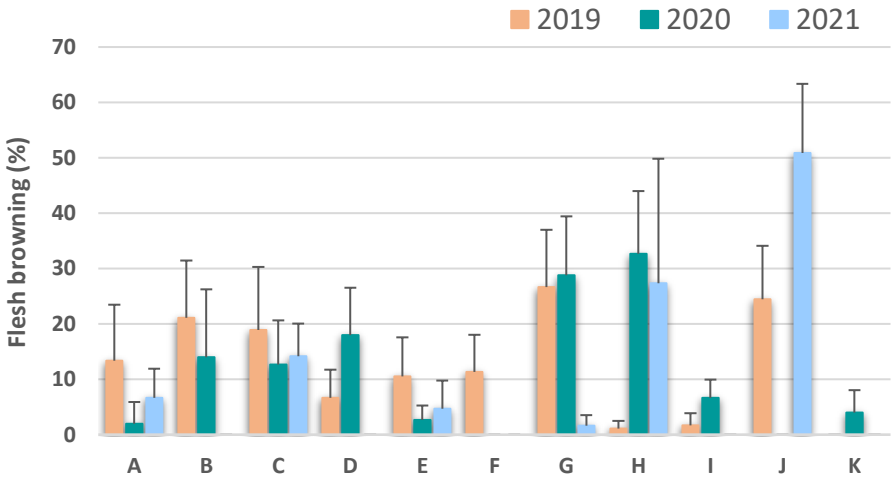

Figure 2: *Incidence of flesh browning (FB), expressed as a percentage of total symptomatic fruit per block or site (irrespective of FB type). Error bars represent 95% confidence interval.*

Crop load & fruit quality

FB showed a negative correlation with crop load and a positive correlation with fruit weight, flesh firmness and dry matter content (Figure 3).

This means higher crop loads reduce the risk of FB, while greater fruit weight, flesh firmness and dry matter content increase the risk of FB.

Fruit from lighter crop load (off-year) trees are larger, firmer and denser and are more prone to FB because these fruit tend to be low in Ca and experience poor diffusion of gases due to the dense flesh.

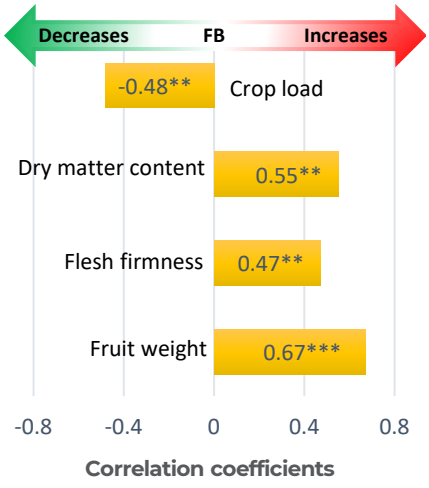

Figure 3: *Crop load and fruit quality parameters as predictors of flesh browning (FB) in apples. Spearman's correlation coefficients (* p < 0.05, ** p < 0.01, *** p < 0.001).*

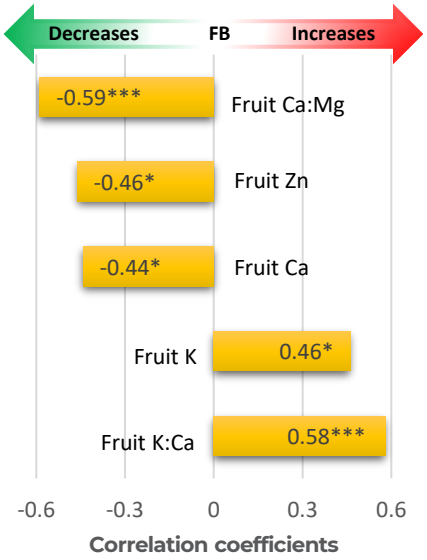

Figure 4: *Fruit mineral nutrients as predictors of flesh browning (FB) in apples. Spearman's correlation coefficients (* p < 0.05, ** p < 0.01, *** p < 0.001).*

Mineral nutrients

Comparing fruit and leaf mineral nutrients, fruit nutrients were found to be better predictors of FB than leaf nutrients.

FB was positively correlated with fruit K and K:Ca and but had a negative relationship with fruit Ca, Zn and Ca:Mg (Figure 4).

This means that higher fruit K and K:Ca can increase the risk of FB while higher fruit Ca, Zn and Ca:Mg can reduce the risk of FB and vice versa.

Calcium in fruit plays essential role in imparting structural and functional stability to fruit cells, but excessive K and Mg can induce Ca deficiency due to their antagonistic relationship with Ca. Zinc is known to complement fruit Ca uptake (to a certain limit), hence can it play a role in reducing FB.

KEY POINTS

- Fruit from lighter crop load (off-year) trees tend to be larger, firmer and denser, making them more prone to FB.
- Optimising crop load to avoid biennial bearing can mitigate the risk of FB.
- Managing crop load to ~6 fruit per cm^2 trunk cross-sectional area can prevent biennial bearing and reduce FB.
- Incidence of FB is lower in fruit weighing <200 grams.
- Higher fruit K and Mg and lower Ca, Mn, Zn can increase risk of FB.
- Balancing mineral nutrition, particularly fruit Ca, is critical.

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