plays a key role in determining fruit wetness duration, microclimate conditions, and ultimately the occurrence of cherry cracking and overall fruit quality.

4 Effects of Canopy on Rain Exposure and Cherry Fruit Cracking

4.1 Rainfall interception characteristics under different canopy structures

In open and sparse canopies, more rainfall can pass directly through the leaf layer, so exposed fruit clusters receive stronger direct impact from raindrops, and a larger proportion of the fruit surface becomes wetted. In dense canopies, the upper leaves intercept a considerable amount of rainfall. This water then drips or flows along branches and pedicels, forming localized high-frequency dripping zones around the lower fruits, and even small areas of water accumulation at the pedicel cavity and stylar end. In both situations, when fruit clusters extend beyond the leaf layer or hang below drip points, their effective wetted area increases, making them high-risk sites for fruit cracking (Balbontín et al., 2013).

4.2 Duration of surface wetness on cherry fruit

Besides the amount of intercepted water, the duration of surface wetness is a key factor determining fruit cracking: the longer the wetness lasts and the larger the wetted area, the higher the cracking frequency (Ranjan et al., 2022). Canopy ventilation (driven by wind penetration and airflow within the canopy) directly affects the evaporation rate of free water on the fruit surface or in the pedicel cavity. Dense canopies with poor ventilation tend to maintain high humidity and slow down the drying process, which can even promote dew formation and extend wetness duration under no-rain conditions. In contrast, more open or well-ventilated canopies usually allow faster drying and shorter wetness duration, reducing the risk of cracking. However, if fruits are directly exposed to rainfall, this advantage may be offset.

4.3 Fruit position within the canopy and cracking sensitivity

The spatial position of fruits within the canopy creates different microclimates and rain exposure patterns. Fruits located in the outer and upper parts of the canopy are more likely to be affected by direct rainfall and wind-driven raindrops. They tend to have a larger wetted area and, even though they dry faster, may still show higher cracking rates (Winkler et al., 2020). In contrast, fruits in the inner and lower canopy are more shaded and experience higher relative humidity. Dripping from upper leaves and weaker air movement prolong their wetness duration, and after rainfall, dew or condensed water may remain as a local water film around the pedicel cavity or stylar end. This spatial variation leads to clear heterogeneity in cracking distribution within the tree: in some cases, cracking is concentrated in outer regions directly exposed to rain, while in others it is more common in lower, high-humidity zones, depending on the balance among rainfall exposure, interception patterns, and drying conditions (Balbontín et al., 2013).

5 Effects of Canopy on Light Distribution and Cherry Fruit Quality

5.1 Light conditions and peel coloration formation

The synthesis of anthocyanins in cherry peel is highly dependent on light. Fruits exposed to good light conditions, or those with enhanced light through ground reflective films or supplemental lighting, show significantly higher red coloration intensity and anthocyanin content than shaded fruits (Muñoz-Alarcón et al., 2025) (Figure 1). Shading or low-light stress can significantly inhibit anthocyanin accumulation by downregulating key structural genes in the anthocyanin biosynthesis pathway, resulting in lighter fruit color and reduced market quality.

Within the same canopy, fruit coloration varies clearly at different positions. Cherries located in the lower or inner shaded areas usually have poorer coloration, while fruits in the upper canopy with sufficient light show better color. This difference becomes more obvious under plastic rain-shelter coverings where incident light is further reduced (Palacios-Peralta et al., 2022).

5.2 Effects on sugar accumulation

Light conditions not only affect leaf photosynthesis but are also directly related to carbon metabolism in the fruit. Low-light stress reduces photosynthetic capacity, carbon assimilation efficiency, and nutrient accumulation, leading to lower soluble sugar content and higher acidity at fruit maturity (Tang et al., 2023).