

C13-norisoprenoid contents, and sensory scores, showing that source-sink optimization is a major route by which canopy-related management improves ‘Shine Muscat’ quality (Li et al., 2023).

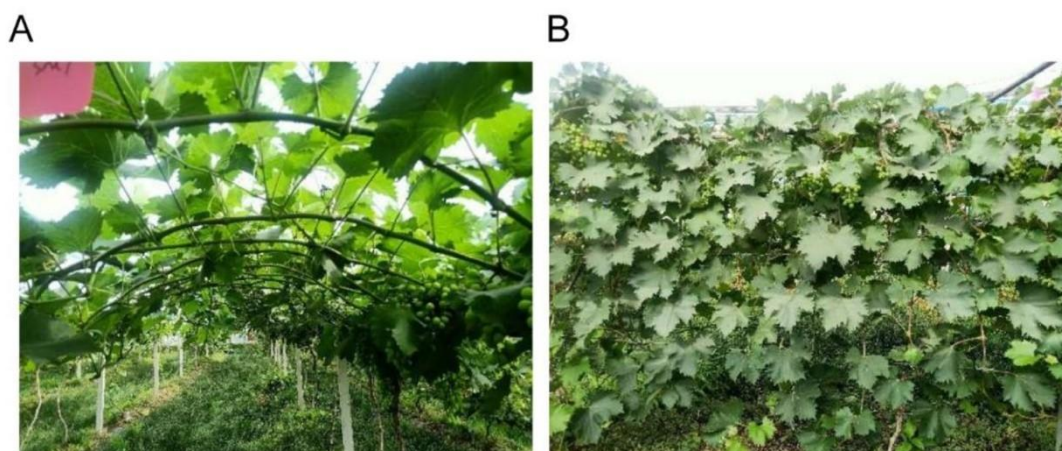


Figure 2 PER (pergola) (A) and SCT (single-curtain training system) (B) of ‘Miguang’ grape (Adopted from Du et al., 2023)

Berry-quality formation also responds to canopy-regulated light, temperature, and hormonal conditions. Supplementary light under facility cultivation reduced green hue, lowered organic acids, increased soluble solids, glucose, and fructose, and enhanced monoterpene accumulation and floral-fruity sensory quality, with blue light giving the best overall quality improvement (Li et al., 2025). Reflective ground film likewise improved sugar-acid ratio and aroma composition in protected ‘Shine Muscat’ (Yuan et al., 2024). PGR combinations produced strong but differentiated berry responses: GA₃+TDZ and GA₃+CPPU achieved nearly or fully 100% seedlessness, CPPU and TDZ increased berry weight and size through cortical expansion, GA₃ increased berry weight but also promoted rachis thickening and lowered TSS, and EBR at higher concentrations inhibited berry growth (Yang et al., 2025). At the cellular level, GA₃ promoted berry longitudinal elongation by enlarging cells and reducing cell density, whereas CPPU promoted transverse expansion by increasing both cell number and cell dimensions, explaining why different management combinations can improve berry size while also altering berry shape and commercial appearance (Chen et al., 2025).

5 Case Analysis: Effects of Canopy Optimization on Yield Stability of ‘Shine Muscat’ Grapes

5.1 Effects on yield components and marketable fruit rate

Canopy optimization changes yield stability first through its effects on the immediate components of yield, including fruit set, bunch number, bunch weight, berry number, and berry weight. In grapevine, fruit weight per node is determined by shoots per node, bunches per shoot, bunch weight, berries per bunch, and berry weight, so canopy practices can stabilize total output only if they improve several of these components together rather than enlarging one at the expense of another. In ‘Shine Muscat’, combined GA₃ and CPPU treatments significantly improved fruit set, cluster density, the percentage of seedless berries, and overall yield stability, while also increasing single-berry mass, cluster mass, soluble solids, and fruit hardness. Floral cluster thinning also changed the balance between cluster compactness and individual berry growth: a 4 cm thinning standard promoted fruit growth and maintained a better sugar-acid ratio, whereas 5 cm thinning produced more berries per cluster but smaller berries and a lower sugar-acid ratio (Figure 3) (Choi et al., 2023).

The marketable fruit rate in ‘Shine Muscat’ depends not only on total yield but also on maintaining berry size, appearance, firmness, sugar accumulation, and peel eating quality within commercial ranges. PGR treatments combining GA₃ with TDZ produced the largest cluster weight, berry weight, and berry diameter, while CPPU-based treatments better preserved fruit skin and flesh firmness and the positive residual feel of the edible peel, both of which are relevant to market acceptance (Choi et al., 2023). Yield control studies further showed that raising production to 24 000 kg/ha did not reduce fruit size, but it lowered soluble solids, worsened coloration, increased acidity and hardness, and retained more chlorophyll, whereas keeping yield at or below 21 000 kg/ha better balanced productivity and fruit quality (Kim et al., 2019). More generally, early canopy interventions can