

Galar-Martínez et al., 2024; Lan, 2025). Mechanistically, greater light interception in the canopy and bud zone improves photosynthetic performance, carbohydrate status, and reproductive development. Shoot thinning increased inflorescence primordia number and size through changes in bud microclimate, shoot growth capacity, and carbohydrate content, and bud light interception was positively correlated with bud fruitfulness, indicating that canopy management can influence not only the current crop but also the following season's yield potential (Collins et al., 2020). At the berry level, contrasting high- and low-light canopy positions altered phenolic compounds, sugar-related metabolism, and transcription of genes associated with photosynthesis, carbohydrate metabolism, and photoprotection, showing that canopy light environment directly shapes fruit developmental physiology and composition (Yang et al., 2024).

Research progress over the last two decades shows that canopy management can deliver substantial agronomic value, but responses are strongly practice-, cultivar-, and climate-dependent. Reviews of summer pruning note that shoot positioning, shoot thinning, trimming, leaf removal, and cluster thinning are no longer viewed only as corrective operations, but as flexible tools for directing ripening and adapting vineyards to warming conditions. Leaf removal and shoot thinning can improve cluster exposure and hasten maturity, yet excessive exposure in warm climates can reduce the expected benefit for some quality traits and increase economic cost; in Cabernet Sauvignon, shoot thinning raised soluble solids by about 2.5 °Brix but also halved yield and increased labor cost markedly (Torres et al., 2020). Likewise, modern warm-climate viticulture increasingly applies leaf removal and shoot thinning more cautiously because clusters often need protection from overheating and sunburn (Poni et al., 2023). Training-system effects are also prominent. In North Dakota, leaf removal had no significant effect on 'Frontenac' fruit quality, whereas the Geneva Double Curtain increased cluster number and yield without reducing soluble solids or acidity (Olson et al., 2021). In a rainy region of China, the single-curtain system improved cluster-zone light, photosynthetic capacity, assimilate allocation to fruit, and reduced vegetative growth (Du et al., 2023). Canopy division has also doubled yield relative to dense vertical systems in vigorous vineyards, while open canopies increased photon flux, photosynthetic rate, soluble solids, and phenols in berries (Hernández-Ordoñez et al., 2024). In table grape cultivars, preharvest canopy-related applications improved red coloration and consumer acceptability in 'Crimson Seedless' under warming conditions, while summer pruning in 'Alphonse Lavallée' increased cluster and berry size, soluble solids, maturity index, phenolics, antioxidant activity, and berry mechanical resistance important for transportability (Petoumenou and Patris, 2021; Doğan, 2025). Yet not all interventions are consistently beneficial: in 'Sugraone', lateral-shoot formation increased yield with limited effects on standard quality traits, whereas in 'MidSouth' grapes early pruning, leaf removal, and shoot thinning often reduced yield and did not sufficiently improve fruit quality, underscoring the need for locally calibrated management (Leão and Lima, 2018; Williams et al., 2023).

This review examines the effects of canopy management practices on fruit development and yield stability in table grapes. Existing studies indicate that canopy management plays an important role in regulating the grapevine growing environment, improving fruit quality, and enhancing production stability. However, substantial differences exist among grape cultivars, training systems, ecological conditions, and combinations of management practices, and the precise matching of cultivar characteristics with canopy regulation strategies still requires further investigation. Using 'Shine Muscat' grape (*Vitis vinifera* 'Shine Muscat') as a representative case, this review synthesizes evidence on how optimized canopy management influences vine growth, fruit development, and yield formation. Particular attention will be given to the effects of different canopy regulation practices on vine growth, canopy structure, photosynthetic characteristics, fruit quality, and yield stability, while also summarizing the application effects of shoot control, training-system optimization, inflorescence thinning, cluster regulation, and light-environment management. This review provides a theoretical basis for optimizing canopy architecture in table grapes, improving the stability of fruit quality and yield performance in commercial production, and providing a reference for the precise, efficient, and sustainable development of the grape industry under climate change.