

Research Insight

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Effects of Canopy Management Practices on Fruit Development and Yield Stability of Fresh Table Grapes

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Abstract Canopy structure plays an important role in regulating plant growth, fruit development, and yield stability during fresh table grape production. Appropriate canopy management can improve fruit quality and production stability by regulating light distribution, microenvironmental conditions, source-sink relationships, and nutrient allocation. However, grape cultivars, cultivation systems, and ecological environments show different responses to canopy management practices, and the establishment of suitable precision management systems remains an important challenge in current production. This review used ‘Shine Muscat’ (*Vitis vinifera* ‘Shine Muscat’) as a representative case to synthesize the mechanisms by which canopy optimization management affects growth, fruit development, and yield formation in fresh table grapes. The effects of canopy structure regulation, light environment optimization, and microenvironment improvement on vegetative growth, photosynthetic efficiency, and fruit quality formation were summarized. Based on the production practice of ‘Shine Muscat’ grape, the effects of shoot control, trellis optimization, inflorescence thinning, cluster regulation, and light environment management on plant growth, berry enlargement, fruit maturation, and marketable fruit rate were analyzed. Furthermore, the regulatory roles of canopy management in source-sink balance, nutrient allocation, and yield stability under different environmental conditions were discussed. It is suggested that canopy management in fresh table grapes should shift from single-factor regulation toward an integrated management system based on cultivar characteristics, water-fertilizer supply, and crop load optimization. In addition, the integration of remote sensing, intelligent sensing, and artificial intelligence technologies will promote the development of precision canopy management. This review provides theoretical references and practical approaches for high-quality, efficient, and stable production of fresh table grapes.

Keywords Canopy management; Fresh table grapes; ‘Shine Muscat’; Fruit development; Yield stability

1 Introduction

Fresh table grape production depends on achieving high marketable yield together with stable berry size, color, firmness, soluble solids, and cluster uniformity under increasingly variable seasonal conditions. Canopy management is central to this goal because it regulates canopy microclimate, light interception, air circulation, source-sink balance, and the spatial distribution of vegetative and reproductive organs, all of which affect fruit development and productivity (Collins et al., 2020; Du et al., 2023). In grapevine, the light environment within the canopy is especially important because shade reduces yield components, delays ripening, and lowers quality, whereas improved canopy microclimate can simultaneously enhance yield and fruit composition. This importance is becoming even greater under climate change, as longer growing seasons, faster ripening, overheating stress, sunburn, and more frequent extreme events are forcing renewed attention to training systems and in-season canopy manipulation as practical adaptation tools (Del Zozzo and Poni, 2024; Lan, 2025).

In fresh table grapes, canopy management has particular significance because commercial value depends not only on total yield, but on visible and textural traits that directly determine consumer acceptance. Seasonal fluctuations in environment can alter yield and berry composition, making the maintenance of high and consistent fruit quality a continuing challenge in table grape systems (Petoumenou and Patris, 2021). Studies across grape production systems show that canopy interventions such as shoot thinning, leaf removal, pruning intensity adjustment, shoot topping, cluster thinning, and training-system selection are used to optimize light distribution and vegetative growth, thereby influencing berry growth, ripening, disease risk, and harvest quality (Poni et al., 2023;