

Research on grape bagging has progressively moved from simple protection trials to more detailed analyses of berry microclimate, ripening physiology, and metabolite regulation. Earlier work showed that bagging can alter the temperature and humidity conditions surrounding grape clusters, increase day-night thermal differences, reduce fruit shrinkage, and in some systems improve carbohydrate assimilation, yield, and economic return, indicating that the bag acts not merely as a barrier but as a microenvironmental regulator. More recent studies have shown that the effects of bagging on grape quality are highly dependent on the light environment created inside the bag. Because different bag materials and colors transmit light differently, they can alter berry ripening, sugar accumulation, anthocyanin synthesis, phenolics, and aroma compounds in distinct ways, with some treatments improving sensory or compositional quality and others delaying maturation or suppressing coloration (Wang et al., 2022).

Current evidence therefore supports a nuanced view of fruit bagging in grapes: it can improve fruit protection, reduce pesticide residues, and in some cases enhance bunch weight, berry appearance, flavor-related compounds, or marketability, but it can also delay ripening or inhibit color development under low-light conditions. For example, bagging has been shown to reduce pesticide residues while improving some quality traits in white table grapes, yet other studies report lower soluble sugars and delayed anthocyanin accumulation in shaded berries unless bags are removed before harvest to restore light exposure (Luca et al., 2023). Against this background, the objective of the present paper is to examine how fruit bagging modifies the grape cluster microclimate and how those microclimatic changes translate into effects on berry development and final fruit quality. Particular attention is given to the interactions among bag type, light transmission, temperature and humidity conditions, and cultivar-specific berry responses, with the broader aim of clarifying how bagging can be optimized as a sustainable viticultural practice.

2 Characteristics of Fruit Bagging Microenvironment in Grape Production

2.1 Effects of bagging on temperature regulation around fruit clusters

Fruit bagging modifies the thermal environment around grape clusters, but the magnitude and direction of change depend strongly on bag material and local radiation load. In Mediterranean table grapes, air temperatures around unbagged clusters were slightly higher than those inside paper bags, while a broader review of grape bagging reported that temperatures inside paper bags were modestly lower during July to September, with only a slight reversal in October (Pisciotta et al., 2020; Ali et al., 2021). These results indicate that paper-based bagging does not necessarily create overheating; under field conditions, it can instead buffer fruit clusters from direct solar heating and smooth short-term thermal extremes.

Temperature effects are nonetheless not uniform across bag types, because plastic and highly enclosed systems can trap more heat than ventilated or paper-based coverings. In organic grape production, clear plastic bags advanced ripening relative to brown paper bags and also caused abnormal overgrowths and sunburn, whereas in colored polypropylene bagging systems, lower temperature inside the bag was proposed as one factor contributing to larger berry size under white bags (Kiran et al., 2020). Taken together, these findings suggest that temperature regulation by bagging is best understood as a balance between radiation interception and heat retention, with breathable paper or light-colored bags generally providing a milder thermal microclimate than transparent plastic enclosures.

2.2 Influence of bagging on humidity and gas exchange conditions

Bagging also changes the moisture environment around grape bunches, although humidity responses vary with bag permeability and ventilation design. In Cabernet Sauvignon, temperature inside bags was only slightly elevated while relative humidity was slightly decreased compared with the canopy environment, likely because the two-layer Kraft bags were fitted with ventilation support; by contrast, postharvest plastic-film bag studies in table grapes showed that non-perforated bags maintained the highest relative humidity and reduced weight loss most effectively (Amorim et al., 2020). This contrast shows that bag structure, especially whether it is ventilated or tightly sealed, determines whether the cluster microenvironment shifts toward moisture retention or toward a more balanced exchange with outside air.