



Figure 2 Overview of key orchard factors that influence preharvest peach tree and fruit physiology and affect harvest quality (Adapted from Anthony and Minas, 2021)

Temperature is another key factor regulating fruit growth and metabolic processes. Suitable temperatures and appropriate diurnal temperature variation favor sugar accumulation, acid balance, and aroma formation, thereby improving flavor quality. In general, a larger day-night temperature difference enhances the sugar-acid ratio and results in a more balanced taste. However, both extreme heat and insufficient heat accumulation can negatively affect quality (Shin et al., 2023). Controlled-environment studies indicate that high temperatures (e.g., 30 °C) accelerate early fruit growth and shorten the development period, advancing harvest by 2-3 weeks, but may reduce final fruit size and SSC, despite improving red skin coloration (Shin et al., 2023). In contrast, insufficient winter chilling can impair dormancy release, reduce fruit set and yield, and indirectly affect fruit quality (Babintseva, 2024).

Water conditions also have a profound impact on peach quality. Adequate water supply supports cell turgor, fruit expansion, and external quality, whereas excessive irrigation can dilute SSC, reduce firmness, weaken flavor, and increase the risk of cracking, diseases, and physiological disorders (Zhen et al., 2025). In contrast, moderate deficit irrigation strategies, such as deficit irrigation (DI) or partial root-zone drying (PRD), can increase DMC, firmness, SSC, glucose, and polyphenol content while reducing certain organic acids, thereby enhancing flavor intensity and antioxidant capacity. However, excessive water stress can limit fruit growth, reduce yield, and negatively affect the accumulation of some nutrients such as carotenoids. Therefore, irrigation management should be optimized according to developmental stages and regional conditions to balance yield and quality.

3.2 Cultivation practices

Cultivation practices serve as key regulatory tools linking environmental conditions to fruit quality formation. They influence tree nutritional status, canopy structure, light distribution, and source-sink relationships, thereby affecting external, internal, and nutritional quality traits (Figure 3). Fertilization management, particularly nitrogen (N), phosphorus (P), and potassium (K), plays a crucial role. Appropriate NPK application can improve yield, fruit size, SSC, total sugar, sugar-acid ratio, firmness, and vitamin C content while reducing titratable acidity (Babintseva, 2024). However, excessive nitrogen promotes vegetative growth, leading to poor coloration, lower SSC, and reduced flavor intensity. In contrast, potassium enhances sugar transport and coloration, whereas imbalanced phosphorus supply may negatively affect sugar accumulation. Since peach trees are perennial and