

Melon fruit quality biology helps explain the stage effect. Integrated transcriptomic and metabolomic studies show that sucrose, glucose, organic-acid metabolism, and texture-related pathways all shift sharply across development and ripening. A review of melon firmness mechanisms similarly emphasizes that cell-wall remodeling during maturation is a major determinant of softening and storability. Therefore, when late irrigation frequency is reduced and fruit water influx becomes slightly more restricted, sugar concentration may rise and cracking pressure may fall, but if the stress is too strong, the fruit can lose mass and uniformity instead (Cheng et al., 2022; Gustani et al., 2024; Liu et al., 2024).

5 Effects of Irrigation Frequency on Fruit Quality

5.1 Soluble solids and sugar accumulation

Soluble solids concentration is the quality trait most consistently improved by mild water restriction in melon. This does not mean that drought “creates” sugar in a simple way. More often, reduced late-stage water supply limits further dilution and alters carbohydrate partitioning so that the concentration of sugars in the flesh becomes higher. In the Haining, Zhejiang greenhouse study, lower water treatments produced higher total soluble solids and vitamin C than the medium and high water treatments, even though they did not maximize yield. In the maturity-deficit study from China, mild deficit increased sugar-related quality and lowered cracking risk (Yue et al., 2023; Xue et al., 2025).

The pattern appears in other regions as well. Kuscü and Turhan reported that deficit treatments significantly affected soluble solids, total sugar, titratable acidity, vitamin C, and protein content, with quality traits generally improving under deficit irrigation. Miceli and colleagues similarly observed that moderate deficit combined with arbuscular mycorrhizal inoculation improved fruit soluble solids and the SSC/TA ratio. These results show why growers often accept slightly lower vegetative vigor or even a small yield penalty when the market strongly rewards sweetness (Figure 3) (Kuscü and Turhan, 2022; Miceli et al., 2023).

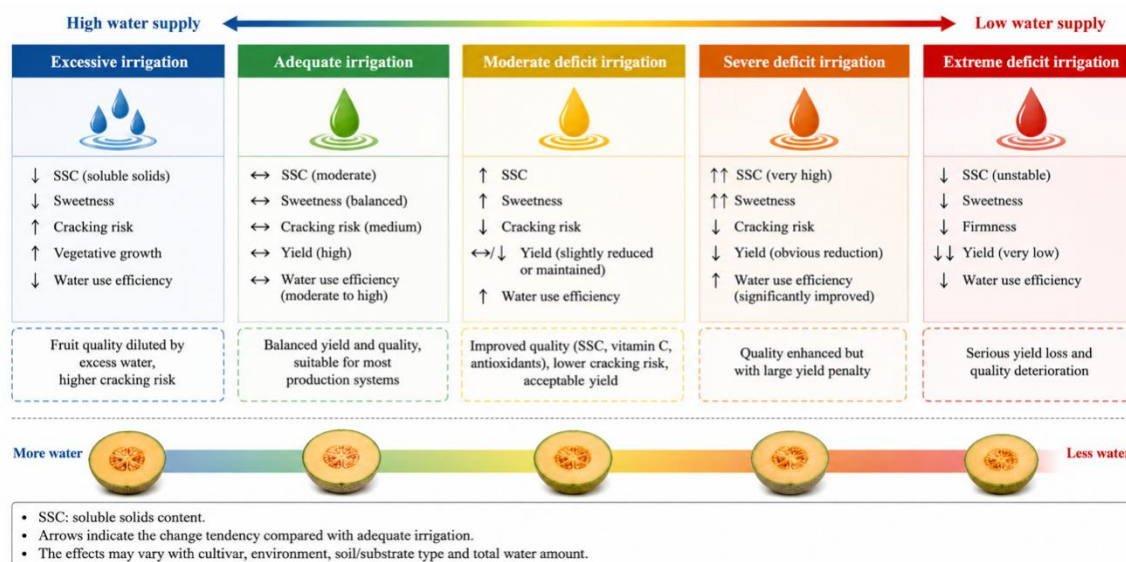


Figure 3 Quality formation of melon fruits under different water supply regimes

5.2 Organic acids and flavor formation

Flavor depends on more than sweetness. Organic acids help determine freshness, balance, and overall sensory character, and melon flavor is also shaped by volatile compounds that change across development and storage. Irrigation regime affects these traits by changing dilution, carbon metabolism, and ripening status. In a 2023 study of melon flesh and seeds under different irrigation regimes, sucrose, total sugar, titratable acidity, phenolic compounds, and antioxidant activity all responded significantly to how and when water was supplied. Notably, some deficit treatments improved phenolics and antioxidant activity while also shifting sugar composition (Ercan et al., 2023).