A second lesson is methodological. Regional case studies that treat frequency together with root-zone environment, nutrient supply, and plant status are more informative than studies that vary only seasonal water amount. This is why the Zhejiang greenhouse trial, the Shanghai phenotyping model, the northwestern pulsed-irrigation study, and the Taiwan plant-based RDI framework are especially useful references for a modern review. They move the discussion from "how much water?" to "how should the plant experience water over time?" (Chang et al., 2019; Yue et al., 2023; Sun et al., 2024; Fang et al., 2026).

7 Sustainable Irrigation Strategies for Improving Growth and Fruit Quality

7.1 Drip irrigation and water-saving technologies

Drip irrigation remains the most important base technology for melon water management because it allows both amount and frequency to be controlled accurately. The literature generally shows that drip systems outperform furrow or less localized methods in water use efficiency and often in yield when managed well. A recent northeastern/northern China study reported that plastic-mulched drip irrigation produced the highest greenhouse melon yield and sharply reduced water consumption relative to furrow-based control treatments. This confirms that the irrigation method itself conditions how frequency affects the crop (Liu et al., 2024).

Additional water-saving technologies refine this basic system. Subsurface drip can reshape the wetting pattern and reduce evaporation, but root-zone aeration may be needed to avoid oxygen limitations. Mulching reduces surface evaporation and stabilizes temperature, which often allows fewer or smaller irrigations without stronger plant stress. Reviews of greenhouse irrigation therefore emphasize that "efficient irrigation" is rarely a single device; it is a package that combines localized delivery, evaporation control, and scheduling logic (Nikolaou et al., 2019; Li et al., 2020).

7.2 Precision irrigation and smart agriculture

Precision irrigation is the natural next step because melon responds so strongly to stage and water status. Recent studies offer three promising routes. The first uses soil or substrate sensors to regulate irrigation based on allowable depletion, as in the Murcia studies that reduced water use and leaching while preserving yield. The second uses plant phenotyping or image-based information, as shown in the Shanghai muskmelon forecasting study. The third uses direct plant-based thresholds and crop coefficient calculations, as demonstrated by Fang and colleagues in Taiwan (Chang et al., 2019; Zapata-García et al., 2023; Fang et al., 2026).

These systems are attractive because they convert irrigation frequency from a calendar habit into a crop-response decision. Still, most are not yet effortless for commercial use. Plant-based monitoring can be expensive, image acquisition can be sensitive to greenhouse conditions, and some models still require manual or highly standardized measurements. Even so, the direction is clear: the future of melon irrigation lies in adaptive rather than fixed scheduling (Chang et al., 2019; Fang et al., 2026).

7.3 Integration of irrigation and nutrient management

For melon, irrigation frequency should rarely be discussed without nutrient management. Frequent irrigation changes nutrient residence time, fertigation uniformity, and leaching risk, while nutrient level changes the crop's ability to convert water into biomass and fruit. The Zhejiang greenhouse case showed that water and nitrogen had to be optimized together, not separately. Likewise, the northwestern high-EC study identified the optimum only when irrigation amount, nutrient-solution EC, and irrigation frequency were evaluated jointly (Yue et al., 2023; Sun et al., 2024).

The same principle appears in commercial-scale precision irrigation. Zapata-García and colleagues demonstrated that sensor-guided irrigation reduced water use while improving both water and nitrogen productivity, meaning that the gain was not simply "less water," but a better synchronization of water, root-zone retention, and nutrient availability. Biological complements may also help. In melon grown under deficit irrigation, AMF inoculation improved some quality traits and water-use indicators, which suggests that sustainable irrigation strategies can include microbial support as well as digital control (Miceli et al., 2023; Zapata-García et al., 2023).