

7 Conclusion

Moderate deficit irrigation, achieved through fine control of soil moisture at specific phenological stages, can improve multiple quality indicators, including soluble solids content, flavor, nutritional composition, and storage performance, while having limited or acceptable effects on yield. Compared with conventional full irrigation, deficit irrigation helps achieve the dual goals of producing high-quality fruit and improving water use efficiency, which is particularly important in regions facing increasing water scarcity and more frequent droughts due to climate change.

Moderate deficit irrigation generally increases soluble solids content and sugar concentration, improves the sugar–acid ratio, and enhances flavor and aroma. Fruits under deficit treatment often show higher firmness and better texture, lower incidence of physiological disorders, and in many cases higher levels of vitamin C, phenolic compounds, and antioxidant capacity. Although fruit size and total yield may decrease slightly, these losses are usually compensated by better appearance quality, more uniform fruit within the marketable size range, and improved storage and transport tolerance.

Moderate deficit irrigation is a practical water-saving technique that can be integrated into existing orchard management systems with relatively low additional cost. By adjusting irrigation schedules based on soil moisture conditions, evapotranspiration, or plant water status indicators, growers can reduce irrigation water use without reducing, and sometimes even improving, fruit quality. Deficit irrigation can also be combined with optimized fertilization, canopy management, and pruning practices to improve light distribution and source-sink relationships. At the regional scale, promoting deficit irrigation in pear orchards can contribute to sustainable water use, reduce energy consumption for pumping, and lessen environmental impacts caused by over-irrigation and nutrient leaching.

To promote wider application, several recommendations are proposed. First, the level and timing of deficit irrigation should be scientifically determined based on cultivar characteristics, local climate, soil water-holding capacity, and orchard structure, and severe water stress should be avoided during highly sensitive stages such as early fruit development and cell division. Moderate deficit is generally recommended during the middle to late stages of fruit enlargement and, in some cases, the pre-harvest maturation stage, with quantitative thresholds set using soil moisture, stem water potential, or other reliable indicators. Second, simple and low-cost monitoring tools and decision-making methods should be promoted so that deficit irrigation can be applied by both smallholders and large-scale growers. Third, more demonstration orchards and field trials should be established to validate and optimize deficit irrigation strategies under different production conditions, forming region-specific technical guidelines and training materials. Finally, future research should focus on the long-term effects of continuous deficit irrigation on tree vigor, alternate bearing, root development, and soil health, and explore its integration with precision agriculture technologies, so as to fully realize the water-saving and quality-improving potential of moderate deficit irrigation in pear production and support its wider adoption.

Author Contributions

The authors appreciate Dr Fang from the Hainan Institution of Biotechnology for her assistance in references collection and discussion for this work completion.

Conflict of Interest Disclosure

The authors affirm that this research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

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