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Effects of Water Deficit Irrigation on Quality of Pear

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Abstract This study focuses on the effects of moderate deficit irrigation on pear fruit quality and provides a systematic analysis. Based on a review of global pear orchard irrigation patterns and technological developments, it summarizes the implementation methods and outcomes of deficit irrigation under different climatic conditions, cultivar types, and cultivation management practices. Applying moderate water deficit at appropriate growth stages of fruit trees can not only effectively save water resources, but also improve, to some extent, the soluble solid content, sugar–acid ratio, and flavor quality of the fruit, while enhancing storage performance. Deficit irrigation regulates fruit physical traits, chemical composition, and aroma compound formation, and its effects are jointly influenced by multiple factors such as cultivar, rootstock, soil type, and climate conditions. The study proposes suitable irrigation regulation strategies and simple, farmer-friendly technical approaches, emphasizing the importance of coordinated water–fertilizer management and low-cost monitoring methods. Moderate deficit irrigation is a practical technique that balances water saving and quality improvement, and it is of great significance for enhancing resource use efficiency and promoting sustainable development in the pear industry.
Keywords Pear (*Pyrus* spp.); Deficit irrigation; Fruit quality; Water use efficiency; Sustainable agriculture

1 Introduction

Pear (*Pyrus* spp.) is one of the most widely cultivated temperate fruit trees in the world, playing an important role in horticultural production and rural economies in regions such as Europe, China, and South America. As consumers increasingly demand better sensory and nutritional quality, pear growers are not only under pressure to maintain stable yields, but also to improve fruit appearance, texture, flavor, and storage performance. Climate change, more frequent droughts, and competition for limited freshwater resources are making traditional irrigation methods harder to sustain. Agriculture accounts for about 70% of global freshwater withdrawals, and fruit trees are usually irrigated to avoid water stress, especially in semi-arid and arid regions where rainfall is insufficient or unstable (Vélez-Sánchez et al., 2023).

In many major pear-producing areas, current irrigation management mainly relies on supplying all or nearly all crop evapotranspiration (ETc) through surface or subsurface drip irrigation, micro-sprinkler irrigation, furrow irrigation, or flood irrigation. Full irrigation at 100% ETc or maintaining relatively high soil moisture thresholds (such as 80% of field capacity) is commonly used as a reference or “safe” strategy when comparing deficit irrigation treatments (Zhang et al., 2022). The rapid development of pressurized irrigation systems, especially drip irrigation, has greatly improved the precision of water supply. However, in practice, it often leads to “insurance irrigation,” where excessive water is applied to avoid potential yield loss (Vandermaesen et al., 2021). Under conventional management, irrigation amounts are often close to or even exceed ETc in order to maintain vigorous vegetative growth and larger fruit size.

Deficit irrigation refers to the intentional application of water below crop water requirements without causing unacceptable reductions in yield or quality. Regulated deficit irrigation (RDI) is one of the most commonly used approaches in fruit trees. It applies moderate water deficit during phenological stages that are less sensitive to water stress, while maintaining near-full irrigation during critical periods such as rapid fruit enlargement. In pear production, moderate deficit irrigation is usually implemented as applying 50%-80% ETc at specific growth stages, or maintaining soil moisture at about 60%~70% of field capacity, rather than applying it throughout the entire