Results from 'Yali' pear show that under deep soil conditions, completely stopping irrigation (close to 0% ETc) from bud break to 25 days after flowering or during the last month before harvest is feasible, as long as the stress period is limited and followed by sufficient rewatering. These strategies improved WUE and late-stage quality without reducing yield (Cheng et al., 2012).

From a broader perspective, a meta-analysis of woody fruit trees (including pear) shows that mild deficit irrigation at 80%~100% of full irrigation maximizes yield and water productivity (WP). It is best applied during the first and second growth stages (bud break to leaf expansion, and flowering to fruit set), which can increase WP by about 2%~9% while reducing yield risk (Wen et al., 2023). More severe seasonal deficits (below 60% of full irrigation) increase the risk of yield reduction, but may still be reasonable when water resources are extremely limited or when fruit quality has a high price premium.

6 Differences in Cultivars and Growth Conditions

6.1 Differences in responses among common pear cultars

The European pear cultivar "Triunfo de Viena," grown in high-altitude tropical regions of Colombia, shows strong tolerance to regulated deficit irrigation (RDI) during the rapid fruit growth stage. Across different years, reducing irrigation to 74%~60% or even 48%~27% of ETc did not significantly affect fruit number, average weight, size distribution, yield, or key quality traits (firmness, sugars, organic acids, pigments, and phenolic compounds), while saving up to about 73% of water (Vélez-Sánchez et al., 2021). Even under more severe conditions (such as 25% ETc or no irrigation during rapid fruit growth), no significant differences in yield and quality were observed for this cultivar.

In contrast, the late-maturing European pear cultivar "Abbé Fetél" under Mediterranean climate conditions is more sensitive to seasonal water deficit. After storage, fruits on BA29 rootstock showed higher soluble solids at 60% ETc, while fruit firmness on SYDO rootstock was more sensitive to irrigation level. This indicates that tree vigor and scion–rootstock combinations play an important role in regulating stress resistance and fruit quality (Venturi et al., 2021).

Asian pear types show different response patterns. For white pear (*Pyrus* bretschneideri 'Sinkiangensis'), applying moderate deficit irrigation at 60% of pan evaporation (Ep) during the early cell division stage (Stage 1) or Stage 1+2 reduces fine root length density, but has no significant effect on final yield compared with full irrigation. This suggests that the whole plant still has strong recovery ability even when roots are temporarily restricted. More severe early stress (40% Ep) causes clear changes in root distribution and can even increase final yield when applied only in Stage 1, indicating a specific compensation mechanism when early vegetative growth is controlled (Wu et al., 2021) (Table 1).

Studies on other pear cultivars further show differences in water use and stress sensitivity. In South African orchards, seasonal transpiration of "Packham's Triumph" and "Forelle" was 539 mm and 733 mm, respectively. This is related to the higher leaf area index and longer growth period of "Forelle," reflecting differences in water demand among genotypes (Dzikiti et al., 2024).

6.2 Effects of soil conditions and climate

Soil profile and climate conditions largely determine the safe range of deficit irrigation. Water limitation is more obvious in semi-arid and arid climates, and plant responses are stronger. In the semi-arid middle São Francisco River region of Brazil, pear trees under both drip and microsprinkler irrigation were negatively affected by either insufficient or excessive water. This was shown by reduced gas exchange and abnormal synthesis and accumulation of carbohydrates, amino acids, and proteins in leaves. Yield reached its maximum at 91.8% ETc, indicating that under high evaporative demand and shallow or moderately deep soils, the room for deficit regulation is limited (Gomes et al., 2023).

Soil texture and water-holding capacity interact with climate to influence deficit irrigation effects. In coarse-textured or salinity-prone soils in desert or continental regions, deficit irrigation may lead to salt