

4 Irrigation Strategies for Peach Yield Improvement

4.1 Water requirement at different growth stages

During flowering and young fruit development, avoiding severe water stress is essential for canopy growth, carbon acquisition and early yield formation. In humid subtropical conditions, daily evapotranspiration of young peach trees peaks during active shoot development, and accurate crop coefficients allow scheduling to avoid both stress and over-irrigation (Zambrano-Vaca et al., 2020).

Field studies show that non-irrigated trees under drought have markedly reduced canopy volume, trunk growth, leaf water potential and photosynthesis, with lower commercial yields than irrigated trees, highlighting the importance of supplying adequate water from establishment through early cropping (Casamali et al., 2021b). Water requirements and sensitivity change as fruits enlarge and mature. Soil-water-potential thresholds for triggering irrigation differ among stages: stem and fruit growth become progressively less sensitive to deficits from stage I to III, and irrigation at moderate soil water potentials (around -10 to -17 kPa) promotes both fruit growth and assimilate allocation to fruit (Lou et al., 2024).

Studies imposing water shortage at specific growth stages report that deficits from flowering to early growth (stage I) cause the largest yield reductions, whereas moderate deficits during stone hardening or mid-season can save 25%-50% of water with limited effects on yield and improved color and soluble solids (AboOgiela, 2021).

4.2 Irrigation methods in peach orchards

Modern orchards commonly use drip or micro-sprinkler irrigation. In young trees under variable rainfall, irrigation-regardless of method-improves water status, growth, and early yield compared with rainfed conditions, while drip uses substantially less water than micro-sprinklers. A related study on nitrogen partitioning likewise found higher cumulative N removal (reflecting greater growth) in irrigated than in non-irrigated trees, and ~38% water savings with drip versus micro-sprinkler irrigation (Casamali et al., 2021b).

Long-term comparisons including furrow (flood-type) irrigation indicate that drip and micro-sprinkler systems can match yields with less water and fewer quality penalties. Over 10 years, postharvest deficit irrigation under furrow, drip, or micro-sprinkler saved up to 40% water without significant reductions in yield or key quality attributes; surface drip in particular maintained soil water better than furrow and micro-spray under deficit conditions (Zhang et al., 2017; Wang et al., 2020). Broader meta-analysis across crops confirms that drip typically produces higher yields and water-use efficiency than flood, border, furrow, sprinkler, and even micro-sprinkler irrigation, especially under water shortage (Yang et al., 2023).

4.3 Deficit irrigation and water-saving approaches

Regulated deficit irrigation (RDI) and related strategies deliberately apply less than full crop evapotranspiration during periods when trees are less sensitive, aiming to balance yield and quality. In semi-arid Spain, sustained deficit ($\approx 62.5\%$ of full) and RDI (50% during stone hardening) often produced fruit yields similar to full irrigation, with only modest reductions in average fruit weight but higher soluble solids and sugar/acid ratios, suggesting improved commercial quality with water savings (Faci et al., 2014).

In Morocco, RDI at 75% ET_c during slowdown stages allowed water savings of up to 25% in peach without yield loss, while 50% ET_c reduced yield and size but enhanced sugar/acid ratio and polyphenols (Razouk et al., 2020). RDI scheduled by stem-water-potential thresholds (-1.5 to -1.8 MPa) cut water use by 43%-65% without affecting fruit size or yield and even slightly improved quality (Mirás-Avalos et al., 2016). A broader review and case study in Morocco reported that sustained deficit irrigation of peach reduced water use by 20% without affecting yield or quality and increased water productivity by 33% (Laita et al., 2024).

Partial root-zone drying (PRD), through alternating irrigation on both sides of the root system, can further improve water-saving efficiency and enhance fruit quality. In arid regions of Tunisia, deficit irrigation and partial root-zone drying at 50% ET_c increased fruit dry matter content, firmness, soluble solids, phenolic compounds, and mineral element concentrations, thereby enhancing market value while reducing water use by half (Toumi et