

beyond a threshold (midday stem water potential around -1.5 MPa), daily net carbon gain becomes negative, indicating that carbon assimilation no longer meets the respiratory and growth demands of shoots and fruits.

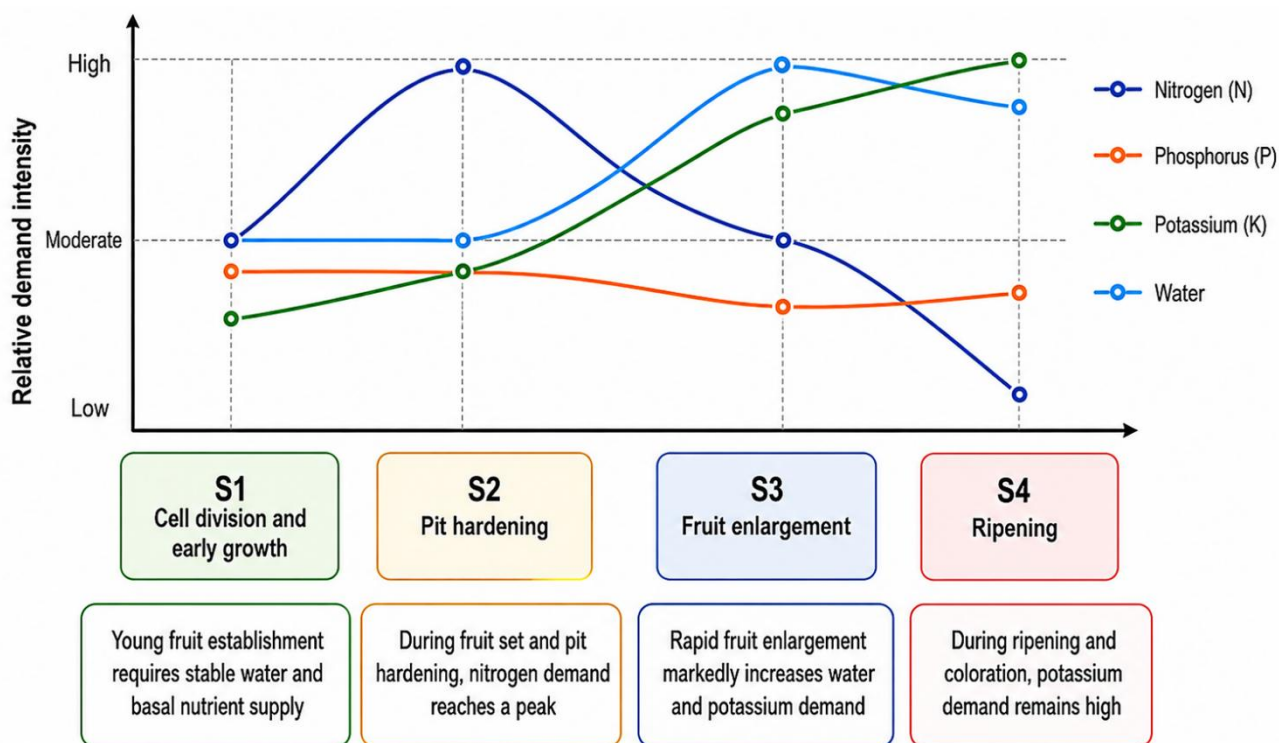


Figure 1 Changes in water and nutrient demand across peach fruit developmental stages (S1-S4)

Image caption: Peach trees show stage-dependent water and nutrient requirements, with nitrogen peaking at flowering and fruit set, while water and potassium demand increase markedly during fruit enlargement and ripening stages

2.2 Source–sink relationship in peach trees

Leaf photosynthesis provides the primary carbohydrate source for developing fruits. N is central to leaf development and photosynthetic capacity in stone fruits, supporting sugar and carbohydrate formation for fruit growth (Chawla and Sharma, 2025). Water deficit reduces leaf photosynthesis by decreasing stomatal conductance and by reducing total leaf area, thereby lowering whole-tree carbon assimilation (Rahmati et al., 2015). Altering the source-sink ratio through thinning (reducing fruit number per leaf area) can transiently decrease photosynthesis and cause sugar accumulation in leaves, indicating feedback limitation when sink demand is low (Andrade et al., 2019). Application of 5-aminolevulinic acid (ALA) can enhance leaf photosynthetic gas exchange capacity for at least one month and enlarge “source” volume, increasing carbon fixation in leaves (Liang et al., 2023). Fruit sink strength—its capacity to import and utilize assimilates—depends on both sink size and activity. A realistic estimate of sink strength is the sum of carbon gained as dry weight plus carbon lost through respiration, with net sink strength determined by the product of sink size and sink activity (Bianco and Rieger, 2002).

In peach, both sorbitol and sucrose are major forms of translocated carbon, and their contents in fruit correlate positively with growth rate; enzyme activities involved in their metabolism are closely associated with sink strength across developmental stages (Bianco and Rieger, 2002). Under conditions of high crop load or limited assimilate availability, acid invertase activity and hexose:sucrose ratios increase, which can enhance fruit sink strength by raising hexose concentrations (Morandi et al., 2008). ALA treatments further strengthen fruit sink competition by increasing the proportion of radiolabeled carbon transported from leaves to fruits and reducing allocation to young leaves (Liang et al., 2023).