

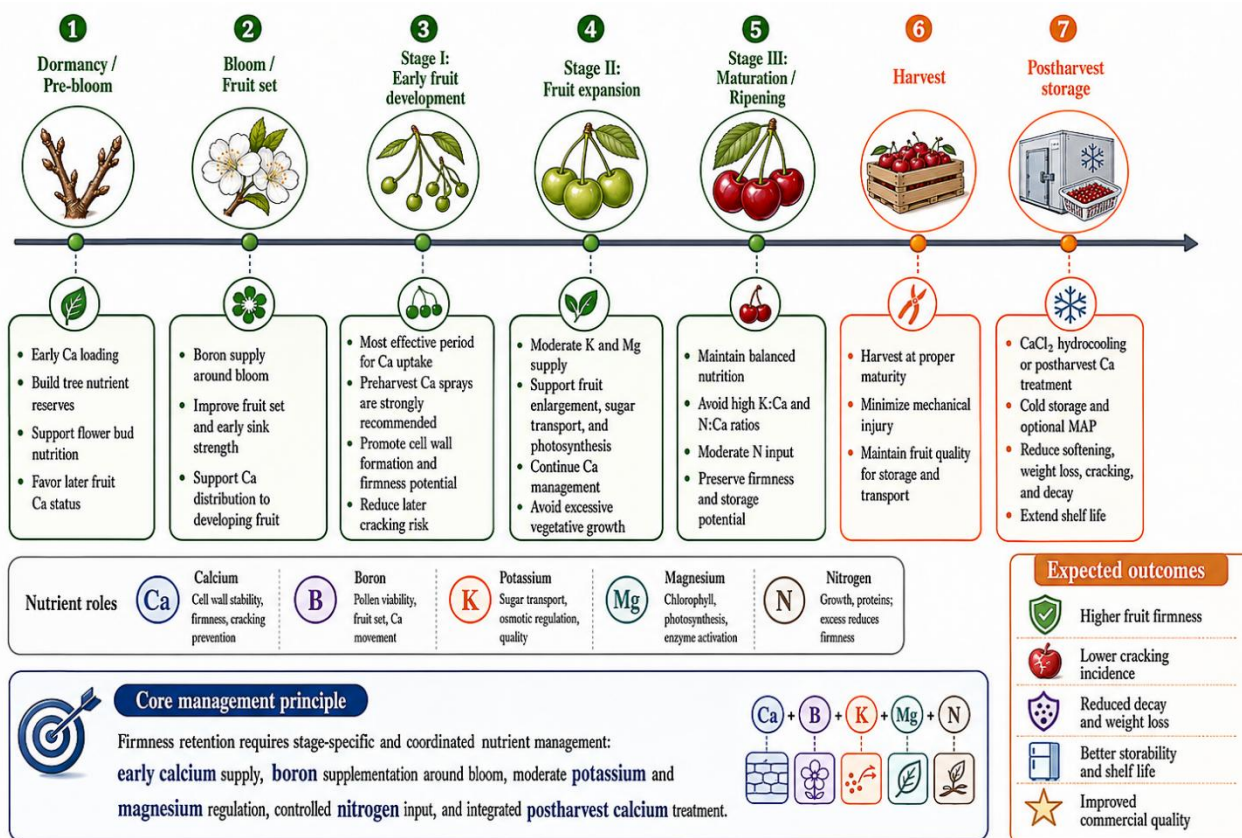


Figure 2 Stage-specific nutrient management strategy for enhancing sweet cherry firmness and shelf life

Image caption: Early calcium supply during dormancy, bloom, and Stage I fruit development is emphasized because calcium import into fruit declines as xylem function weakens. Boron should be supplied around flowering, while potassium and magnesium should be moderately regulated during fruit enlargement and maturation. Postharvest calcium treatment and cold storage technologies can further delay firmness loss

4.2 Fruit expansion and maturation-stage nutrition

During fruit enlargement, nutrient management must support cell expansion and sugar accumulation without allowing calcium dilution, nutrient imbalance, or excessive vegetative growth to weaken firmness (Matteo et al., 2022; Ateş et al., 2022; He et al., 2025). This stage is where the benefits of potassium become clear, but also where antagonism between potassium and calcium becomes a major management concern (Ateş et al., 2022; He et al., 2025).

Potassium is strongly associated with cherry fruit quality and can increase fruit size, weight, soluble solids, and firmness when adequately supplied (Ateş et al., 2022; Santos et al., 2024). In sweet cherry, soil K application before full bloom increased fruit length by 9%, fruit weight by 23%, flesh firmness by 24%, and water-soluble dry matter by 20% (Ateş et al., 2022). However, potassium can also decrease fruit calcium and magnesium concentrations, and increasing the K:Ca ratio can hinder calcium uptake and weaken the mineral balance associated with firm fruit (Ateş et al., 2022; He et al., 2025). This balance matters because fruit calcium concentrations naturally decline during development through reduced import and dilution by growth, so late enlargement strategies should combine potassium support with continued calcium management rather than emphasizing K alone (Matteo et al., 2022; Winkler et al., 2020).

Balanced fertilization is essential because sweet cherry fruit compete with vegetative sinks for both carbohydrates and nutrients during their short development period (Matteo et al., 2022; Santos et al., 2024). Nitrogen supports canopy development and photosynthesis, but excess nitrogen promotes excessive vegetative growth at the expense of fruit formation and maturation and is associated with fruit softening (Varaldo and Giacalone, 2025; Varaldo et