

that low sink demand reduced net photosynthetic rate, closely linked to lower stomatal conductance and accompanied by damage to PSII-related components. Comparable work in olive showed that high leaf-to-fruit ratios increased leaf saccharide content and depressed photosynthesis through feedback inhibition, especially when assimilate export was constrained. These results suggest that in loquat, the quality benefit of thinning is more likely to come from optimizing, rather than maximizing, leaf carbon supply to fruit.

5.2 Effects of fruit thinning on hormonal regulation networks

Fruit thinning also acts through hormonal regulation networks because fruit set, early fruit growth, and later maturation are all under strong phytohormone control. Across fleshy fruits, auxin and gibberellin are the core signals promoting fruit set and early growth, while cytokinin supports early cell proliferation and final fruit size (Zhang et al., 2026). More broadly, fruit development proceeds through coordinated crosstalk among auxin, gibberellin, cytokinin, ABA, and ethylene, rather than through any single hormone acting alone. Since thinning changes sink number and developmental competition among fruit, it likely shifts this hormonal balance by altering which fruits maintain growth-promoting signals and which enter arrest or abscission.

The mechanistic basis for this view is supported by studies showing that hormone pathways directly regulate fruit enlargement through cell division and expansion. Auxin and GA act together to promote these processes after fertilization, and their interaction is mediated by ARF/IAA and DELLA signaling modules. Cytokinin is also mechanistically linked to fruit size, because lowering endogenous CK reduced pericarp thickness, cell division, and single-fruit weight while repressing auxin- and GA-related genes. In a broader fruit-size framework, thinning is recognized as a cultivation practice that interacts with hormonal and environmental regulation of final fruit phenotype. For loquat, this implies that thinning improves quality not only by reallocating assimilates, but also by favoring hormonal states that sustain retained fruit growth and maturation.

5.3 Effects of fruit thinning on carbon and nitrogen metabolism and resource allocation

The clearest metabolic effect of thinning is on carbon allocation. Fruit biomass accumulation and metabolite formation depend on photosynthesis and carbon export from source leaves, and thinning increases carbon supply per retained fruit by reducing competition among sinks (Paz Covarrubias et al., 2021). Early developmental stages appear especially sensitive: in nectarine, thinning mainly altered fruit metabolic composition early in development, and early sugar, organic acid, and phenylpropanoid intermediates could distinguish fruits exposed to different source-sink conditions. Peach studies reached a similar conclusion, showing that adequate thinning created early metabolic shifts that later translated into superior fruit quality, consistent with a metabolic priming effect.

Nitrogen metabolism and whole-tree resource allocation also respond to crop-load manipulation, but the response is more complex than for carbon alone. Source-sink manipulation can trigger redistribution of both photosynthate and nitrogen in perennial crops, and stored C and N reserves help buffer temporary imbalances between assimilate supply and sink demand. In pistachio, late-season declines in photosynthesis under high sink demand were associated with lower leaf N, suggesting N remobilization toward kernels (Marino et al., 2023), whereas in kiwifruit a low-crop-load “feast” treatment increased fruit nitrogen concentration relative to a high-crop-load “famine” treatment. However, carbon sufficiency does not automatically improve every metabolic trait: severe sink reduction in grape caused large plant-level losses of sugars, organic acids, and aroma precursors without improving their balance in ripe fruit. In loquat, the most plausible interpretation is therefore that thinning improves quality when it creates a balanced redistribution of carbon and nitrogen to retained fruit, rather than an extreme reduction in sink demand. Overall, the physiological basis of fruit thinning in loquat is a coordinated adjustment of photosynthetic supply, hormonal signaling, and carbon-nitrogen partitioning. The evidence supports moderate, developmentally timed thinning as a way to improve fruit quality by strengthening retained fruit without inducing the metabolic inefficiencies that can follow excessive sink removal.

6 Different Fruit Thinning Strategies and Their Integrated Effects on Loquat Cultivation

6.1 Characteristics and applications of manual fruit thinning techniques

Manual fruit thinning remains the most direct and controllable crop-load regulation method in loquat. Commercial loquat trees often set excessively, so thinning is required to obtain marketable fruit size rather than relying on