Bioscience Evidence 2026, Vol.16, No.2, 114-125
http://bioscipublisher.com/index.php/be

Feature Review Open Access

Effects of Pruning Systems on Fruit Yield and Quality in Loquat

Jinhua Cheng, Wei Wang
Institute of Life Sciences, Jiyang College of Zhejiang A&F University, Zhuji, 311800, Zhejiang, China
Corresponding author: wei.wang@jicat.org

Bioscience Evidence, 2026, Vol.16, No.2 doi: 10.5376/be.2026.16.0010
Received: 26 Feb., 2026
Accepted: 10 Apr., 2026
Published: 22 Apr., 2026

Preferred citation for this article:
Cheng J.H., and Wang W., 2026, Effects of pruning systems on fruit yield and quality in loquat, Bioscience Evidence, 16(2): 114-125 (doi: 10.5376/be.2026.16.0010)

Abstract This study focuses on loquat (*Eriobotrya japonica* Lindl.) and systematically analyzes how different pruning systems affect yield and fruit quality. By examining the growth habits of loquat, its flowering and fruiting characteristics, and the relationship between canopy structure and yield, the effects of various pruning methods—including light, moderate, heavy, and seasonal pruning—were compared under practical production conditions. Pruning regulates canopy structure, improves ventilation and light penetration, and optimizes the source–sink relationship, thereby significantly influencing flower bud differentiation, fruit set, and fruit development. Moderate pruning can maintain relatively high yield while improving fruit size, soluble solids content, and appearance quality. In contrast, overly light pruning tends to produce smaller fruits, whereas excessive pruning reduces yield. Intensive pruning methods such as double heading help promote the formation of high-quality fruiting branches, improving individual fruit weight and the proportion of premium fruits. Pruning should be coordinated with practices such as flower and fruit thinning, fertilization, irrigation, and planting density management to achieve a balance between yield and quality. A well-designed pruning system is a key technical approach for improving orchard productivity and economic returns, and it plays an important role in the refined management of modern orchards.

Keywords Loquat (*Eriobotrya japonica* Lindl.); Pruning methods; Yield regulation; Fruit quality; Comparative analysis

1 Introduction

Loquat (*Eriobotrya japonica* Lindl.) is an evergreen subtropical fruit tree belonging to the Rosaceae family and has become an increasingly important component of diversified fruit production systems worldwide. Major producing countries include China, Brazil, Spain, Italy, as well as some regions in the Middle East and South Asia. Loquat fruits mature from late spring to early summer, usually during a market window when other fresh fruits are not yet widely available. This allows loquat to "fill the market gap" and obtain relatively high market prices due to its early maturity and unique sensory qualities (Hueso et al., 2021). Loquat fruit is favored for its juicy texture and pleasant flavor, and it is rich in sugars, organic acids, carotenoids, phenolic compounds, vitamins, and mineral nutrients, showing high nutritional value and pharmacological potential (Cai et al., 2019; Tinebra et al., 2022). High-quality loquat for fresh consumption generally has large fruit size, attractive peel color, high soluble solids content, a good balance between sweetness and acidity, and a low incidence of physiological disorders (Deng et al., 2023). In addition to fresh consumption, loquat can be processed into juice, jam, dried slices, fruit wine, and canned products. Its leaves and seeds can also be used as raw materials for health products and functional foods, further increasing its economic value (Dhiman et al., 2022). However, despite its strong development potential, the commercial expansion of the loquat industry in many regions is still limited by relatively low and unstable yields and the difficulty of consistently achieving high fruit quality compared with other pome fruits such as apple and pear (Jing et al., 2023).

Loquat trees are vigorous and tend to form large and dense canopies. Without effective canopy management, trees often become too tall, with poor ventilation and light penetration, outward movement of fruiting positions, and increased susceptibility of flowers and fruits to adverse conditions such as low-temperature injury and sunburn. Proper pruning practices (usually combined with training systems) can help control tree height, improve canopy structure, reduce the occurrence of pests and diseases, and promote the formation of high-quality fruiting branches. Traditional pruning and training methods are mostly based on growers' experience. Because tree structural responses are irreversible and slow to show results, and are also influenced by environmental conditions and labor constraints, optimization is difficult. In the absence of systematic pruning models tailored to the growth habits and phenological characteristics of loquat, many orchards commonly show problems such as overly tall canopies, crowded branches, and poor internal structure. These conditions lead to insufficient light inside the canopy, outward movement of fruiting zones, and reduced overall production efficiency. In high-density planting systems or aging orchards, these issues become more severe, increasing the difficulty of pruning and harvesting, raising labor costs, and potentially aggravating physiological disorders and postharvest losses. In addition, pruning needs to be coordinated with practices such as flower and fruit thinning, regulated deficit irrigation, nutrient management, and pollination management, which further increases management complexity (Ahmad et al., 2021).

Given the high economic importance of fruit size, earliness, and eating quality in the loquat market, it is necessary to conduct systematic research on pruning systems. Agronomic practices such as flower and fruit thinning, canopy optimization, and new pruning methods can significantly regulate fruit load, cell division, and the light microenvironment, thereby affecting fruit size, sweetness, appearance quality, and overall production efficiency. At present, systematic comparative studies on different pruning systems in terms of yield, key quality indicators (such as fruit weight, soluble solids, titratable acidity, and color), and operational feasibility are still limited. This study evaluates the effects of different pruning systems on canopy structure, fruiting characteristics, and physicochemical properties of fruits through field experiments, aiming to provide a theoretical basis for the optimized design and scientific management of loquat orchards.

2 Growth Characteristics of Loquat Related to Pruning

2.1 Growth habit and canopy structure of loquat trees

Loquat (*Eriobotrya japonica* Lindl.) is an evergreen fruit tree with strong vigor, and its growth habit and canopy structure largely determine how it responds to pruning. Under natural conditions, loquat trees tend to grow tall with vigorous vegetative growth. Without training and pruning, the canopy becomes too high, and the inner canopy is very dense, causing fruiting sites to shift toward the outer canopy. In this situation, flowers and fruits on the exposed outer layer are more likely to suffer from frost damage and sunburn, while the shaded inner canopy receives insufficient light, resulting in lower yield and poorer fruit quality. Loquat usually shows weak lateral branching ability, with long fruiting shoots and mainly terminal flower buds. This limits the number and uniform distribution of fruiting sites within a given canopy volume, making its productivity relatively lower compared with other pome fruit trees (Li et al., 2025). Differences among cultivars in shoot length, leaf–branch angle, and lateral branch number are closely related to hormone signaling pathways such as abscisic acid and strigolactones.

2.2 Flowering and fruiting characteristics

Loquat shows a unique flowering and fruiting pattern within the Rosaceae family. After a juvenile phase of about 4~6 years, the plant enters the adult reproductive stage, during which flower bud differentiation and flowering occur in autumn and winter, while fruit development continues throughout winter and fruits mature from early to mid-spring (Peng et al., 2022). The extended standardized BBCH scale divides its growth process into 7 main stages and 31 secondary stages, covering bud, leaf and shoot development, inflorescence formation, flowering, fruit development, and fruit ripening. There are significant differences among cultivars in phenological traits, including the onset and duration of flowering, the time from full bloom to maturity, and harvest time. Under Mediterranean or subtropical climates, some genotypes mature in early April, while others mature in late April or even later (Kaur, 2018; Kizil and Durgac, 2023). Loquat has large panicle inflorescences with many flowers and a naturally high fruit set rate. To obtain fruits that meet commercial size standards, thinning of flowers or fruits is usually required. Reducing the number of flower buds per inflorescence can increase fruit set, fruit size, and sweetness of the remaining fruits, mainly by reducing competition among sinks and improving the source–sink relationship of the tree. Flowering and fruit set are also affected by canopy orientation; under field conditions, the south side of the canopy usually shows higher flowering and final fruit set rates (Polat, 2015). Flowering time and floral initiation are regulated by at least two FT homologous genes (*EjFT1* and *EjFT2*), which respond to photoperiod and gibberellin signals; meanwhile, RAV transcription factors can delay flowering and extend the juvenile phase (Jiang et al., 2025).

2.3 Relationship between canopy structure and yield

Canopy structure determines the distribution of photosynthetically active radiation within the canopy, affects water transport and transpiration, and ultimately influences carbon acquisition and allocation. When trees are tall, unpruned, and have overly dense canopies, severe shading occurs inside the canopy, fruiting sites concentrate on the outer layer, and reproductive organs are more exposed to low temperature and sunburn, leading to reduced yield. In contrast, proper training and pruning that reduce tree height, open the canopy, and control branch number can improve light penetration and ventilation, and reduce the occurrence of pests and diseases. Vegetative growth parameters such as trunk cross-sectional area, shoot length, leaf area, and inflorescence size are significantly positively correlated with yield per tree and fruit size. This indicates that an optimal balance between vegetative growth and reproductive growth must be maintained by regulating canopy vigor and structure (Lin et al., 2025).

2.4 Sensitivity of loquat to pruning intensity and timing

In most production areas, loquat is usually pruned after harvest, generally from April to May. The summer shoots that emerge afterward complete flower bud differentiation and form flower buds by late summer or early autumn (Su et al., 2024). If pruning is too light, many weak shoots will participate in flowering, leading to excessive fruit set and smaller fruits. In contrast, overly heavy pruning may remove too many potential fruiting branches, reducing inflorescence number and overall yield. Removing about half of the vigorous summer shoots can effectively control inflorescence number, while promoting the remaining shoots to develop more leaves, thicker branches, and larger floral organs, ultimately improving fruit size. Regulation of vigorous shoots promotes cell division during floral organ development, and most fruit cell layers are formed before flowering. Therefore, any disturbance to shoot vigor or pruning timing before flowering can have a long-term effect on potential fruit size. Since loquat flowering and fruit development occur during cool or even cold seasons, any pruning or canopy-opening practice that changes the microclimate, light conditions, or temperature around the buds may affect the expression of key flowering regulatory genes such as *EjFT*s and *EjRAV*s, thereby influencing floral initiation, re-flowering ability, and fruit set (Peng et al., 2021).

3 Common Pruning Systems in Loquat Cultivation

3.1 Light pruning and its management characteristics

Loquat growers adopt various pruning systems, which differ in pruning intensity, timing, and objectives of canopy structure regulation, and these differences significantly affect subsequent fruit yield and quality. Light pruning is generally applied to mature trees whose canopy structure has already been established and whose production performance is stable. This method mainly involves removing dead branches, diseased branches, pest-damaged branches, crossing branches, and overly dense vegetative shoots, while retaining fruiting branch groups and the existing canopy framework as much as possible. By moderately opening up the canopy and improving internal light penetration and ventilation, light pruning helps maintain fruit quality and reduce disease occurrence without significantly reducing the number of inflorescences or overall yield (Li et al., 2005).

3.2 Moderate pruning and its application scenarios

Moderate pruning aims to more actively regulate shoot vigor, inflorescence density, and the balance between vegetative and reproductive growth, and thus has a more direct relationship with yield and quality optimization. In loquat production, a common moderate pruning practice is heading back fruiting shoots shortly after spring harvest. This heading treatment removes the terminal part of shoots that have just fruited, stimulating the emergence of strong summer shoots and limiting the total number of future inflorescences. These new shoots usually form flower buds in late summer or autumn and have a more appropriate leaf-to-fruit ratio, providing sufficient carbohydrate supply for fruit development. Moderate pruning is particularly suitable for trees with excessive flowering and small fruit size, or for orchards targeting high-end markets where large fruit size and high sugar content are prioritized over simply maximizing yield.

3.3 Heavy pruning and renewal strategies

Heavy pruning and renewal strategies are mainly applied when loquat trees become too tall, overly dense, or structurally aged. In unpruned or poorly managed orchards, the canopy is often large and crowded, with fruits concentrated on the outer parts, making them more susceptible to low-temperature damage and sunburn, while yield declines. Renewal pruning usually involves cutting back large upper branches or even main scaffold branches to reduce tree height and stimulate vigorous new shoot growth, thereby rebuilding the fruiting structure over several years. Although this relatively severe pruning reduces yield in the short term, it improves light distribution and canopy manageability. Once a new system of strong fruiting branches is established, it helps increase single fruit weight and enhances long-term yield stability.

3.4 Seasonal pruning methods (dormant period and growing season)

Due to the unique phenological characteristics of loquat (flowering in autumn–winter and maturing in late spring), the seasonal timing of pruning is critical. In many regions, the main pruning operations are carried out after harvest (April-May in subtropical East Asia), where fruiting shoots are headed back to promote summer shoot growth and induce flower bud formation later in the same year (Huang, 2025). This post-harvest pruning belongs to growing-season pruning and directly affects the number and vigor of flowering shoots. In contrast, pruning during the dormant period in late autumn or winter is usually lighter, mainly removing damaged or poorly positioned branches to optimize tree structure while avoiding disturbance to already differentiated inflorescences. In recent years, more intensive growing-season pruning systems have been developed, such as the annual "double heading" system: the first heading is performed after harvest on fruiting shoots, followed by a second heading in late summer or early autumn when small flower clusters just appear at the shoot tips. Although this seasonal pruning combination reduces the number of inflorescences, it promotes thicker shoots, more leaves, and larger inflorescences.

3.5 Structural pruning for canopy training

In the early stage of orchard establishment, structural training mainly involves key parameters such as planting density, trunk height, number and distribution of primary scaffold branches, and branch angles. Studies based on three-dimensional canopy models of loquat indicate that the angle between secondary scaffold branches and the trunk is about 15°, while the angle between adjacent secondary scaffold branches is 60°~90° (Tang et al., 2019) (Figure 1). In production practice, corresponding technical systems have been developed. A patented method in China specifies a trunk height of 60 cm and a planting spacing of 4 m × 4 m; in the first year, every fourth axillary bud is selected as a primary branch; in the second year, ropes are used to pull the primary branches outward; in the third year, the primary branches are fixed to bamboo poles to form an angle of about 77° with the trunk; in the fourth year, after flowering and fruit set, the central leader is removed, and excessive vegetative shoots are thinned at a certain ratio to form a low, open canopy with evenly distributed fruiting branches. Compared with untrained control trees, optimized structures such as the hierarchical central leader or low-canopy system not only advance the bearing period and increase fruit set rate by about 5%~6%, but also increase fruit weight by 35%-61% and improve soluble solid content (Li et al., 2005).

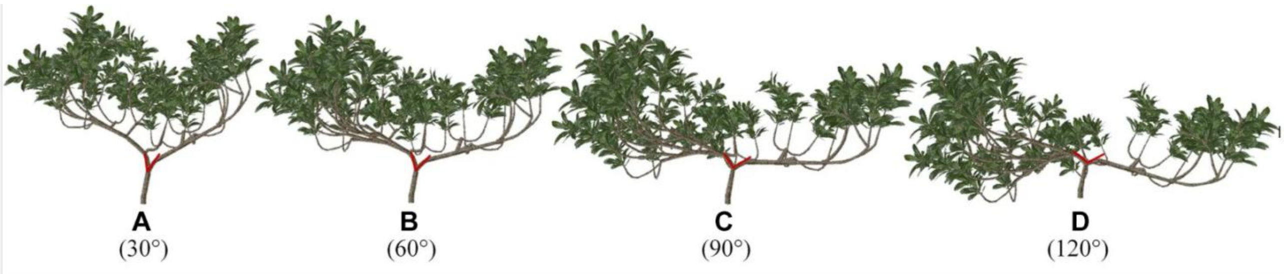

Figure 1 (A-D) Virtual representation of loquat morphology for different angles. The angle of the red line represents the angle below, that is, the angle of the level 2 scaffold branch in the three-dimensional space. The model was generated by the fast shaping and pruning function. The model information is the same for all scenarios, except for the angle (Adopted from Tang et al., 2019)

4 Effects of Pruning Methods on Vegetative Growth

4.1 Effects on shoot growth and branching

At the shoot level, post-harvest heading pruning can promote the sprouting of latent buds and the formation of new summer shoots, increasing the number of branches and leaf area on retained shoots. In recent years, a "double heading" pruning method has been developed. This involves one heading cut on fruiting shoots after harvest, followed by a second heading when small inflorescences form at the shoot tips in late summer. This approach can produce more vigorous new shoots. These shoots are usually thicker and have darker green leaves, indicating stronger photosynthetic capacity and higher vegetative vigor. Compared with the traditional single heading method, the effect is more obvious. The pruning intensity on a single shoot can regulate the total number of new shoots, shoot length, and leaf size. A moderate pruning level (removal of about 0.79~1.07 cm of woody tissue) is most favorable for new shoot formation and leaf development. Too light pruning cannot effectively stimulate renewal, while too heavy pruning may suppress inflorescence formation and reduce subsequent yield (Liu et al., 2008). For weakened or declining trees, heavy heading of large branches can reduce tree height and induce strong shoot regeneration. However, this vigorous vegetative growth may also divert nutrients in the short term and suppress reproductive growth.

4.2 Effects on canopy density and light distribution

Pruning also reshapes canopy density and internal light conditions by changing the number, length, and spatial distribution of branches. Branch angle and branch number are key factors determining light interception within the canopy. Without pruning, loquat trees often become too tall and overly dense, with leaves concentrated in the upper outer canopy. This leads to poor ventilation and insufficient light inside the canopy, resulting in low fruit set and higher disease risk. Through structural pruning and branch training (widening branch angles), a lower and more open canopy structure can be maintained. This reduces canopy volume and porosity gradients and improves light use efficiency both on the canopy surface and inside. Studies on other evergreen fruit trees support this pattern: although heavy pruning can quickly stimulate vegetative recovery, moderate pruning combined with proper pruning position is more beneficial for maintaining a compact canopy with good ventilation and light penetration in the long term (Jiménez-Brenes et al., 2017; Lodolini et al., 2023).

4.3 Regulation of the balance between vegetative and reproductive growth

Loquat fruit develops over a long period, from flowering in autumn–winter to harvest in late spring. The fruit clusters act as strong sinks and can suppress bud sprouting and limit shoot elongation. Comparisons between fruiting and defruited trees show that the presence of fruit significantly reduces bud sprouting in winter and early spring and shortens shoot length. In contrast, removing inflorescences or fruits promotes earlier bud sprouting and enhances vegetative growth across different seasons (Reig et al., 2014). This "sink effect" is partly mediated by hormonal changes. In fruiting trees, buds have higher levels of indole-3-acetic acid (IAA) and lower levels of zeatin, leading to a higher IAA/zeatin ratio, which is associated with suppressed bud growth. When the sink is removed, this ratio decreases, which favors the activation of vegetative buds. Excessive pruning may push the tree toward overly vigorous vegetative growth, delaying or reducing flower bud differentiation.

In loquat, genes such as *EjTFL1* and *EjRAV1/2* promote vegetative growth and branching while inhibiting flowering integrators (EjFTs and EjSOC1s). High expression of these genes can extend the juvenile phase or delay flowering transition (Jiang et al., 2020; Peng et al., 2021). By adjusting pruning intensity and timing (such as post-harvest heading and late-summer secondary heading), and by controlling shoot vigor and crop load, pruning systems can indirectly influence the expression window of these regulatory networks. This helps maintain a functional balance in the tree, ensuring both adequate vegetative renewal and stable reproductive capacity.

5 Effects of Pruning Systems on Fruit Yield

5.1 Effects on flower bud formation

The pruning system of loquat mainly regulates fruit production by controlling flower bud formation, fruit set and retention, and the final balance between fruit number and size. Heading-back pruning and its timing determine the vigor and leaf area of fruiting shoots (inflorescence-bearing shoots), thereby affecting the differentiation and development of flower buds. Strong shoots produced under an annual double-heading pruning system usually have thicker stems, more leaves, and significantly larger inflorescences compared with those under traditional single heading-back pruning. This indicates that enhanced cell division and floral organ growth during the flower bud stage are key driving factors for later fruit enlargement. Regulation of inflorescence "sink strength" also influences flowering dynamics at the whole-tree level: removing the main inflorescence can induce re-flowering, but the secondary inflorescences have fewer flower buds and branch axes, resulting in lower fruiting potential per inflorescence, while effectively extending the flowering and fruiting period by 2~4 months (Peng et al., 2022).

5.2 Fruit set and fruit retention performance

Experiments on manual thinning of loquat flower buds during the full bloom stage showed that retaining 4 flower buds per inflorescence, compared with retaining 12 buds, increased the fruit set rate per cluster by about 15%. This may be due to reduced competition for assimilates within the cluster and improved early source-sink relationships (Nordi et al., 2025). Studies combining flower and fruit thinning with bagging treatments indicate that reducing flower number can increase fruit set rate by up to 49%. Pruning strategies that create a moderate inflorescence load-either by reducing the number of fruiting shoots (such as double-heading) or by fine-scale thinning within inflorescences—can improve fruit set efficiency and reduce early fruit drop. In contrast, excessive flower density may suppress effective fruit set when the initial flower number is too high.

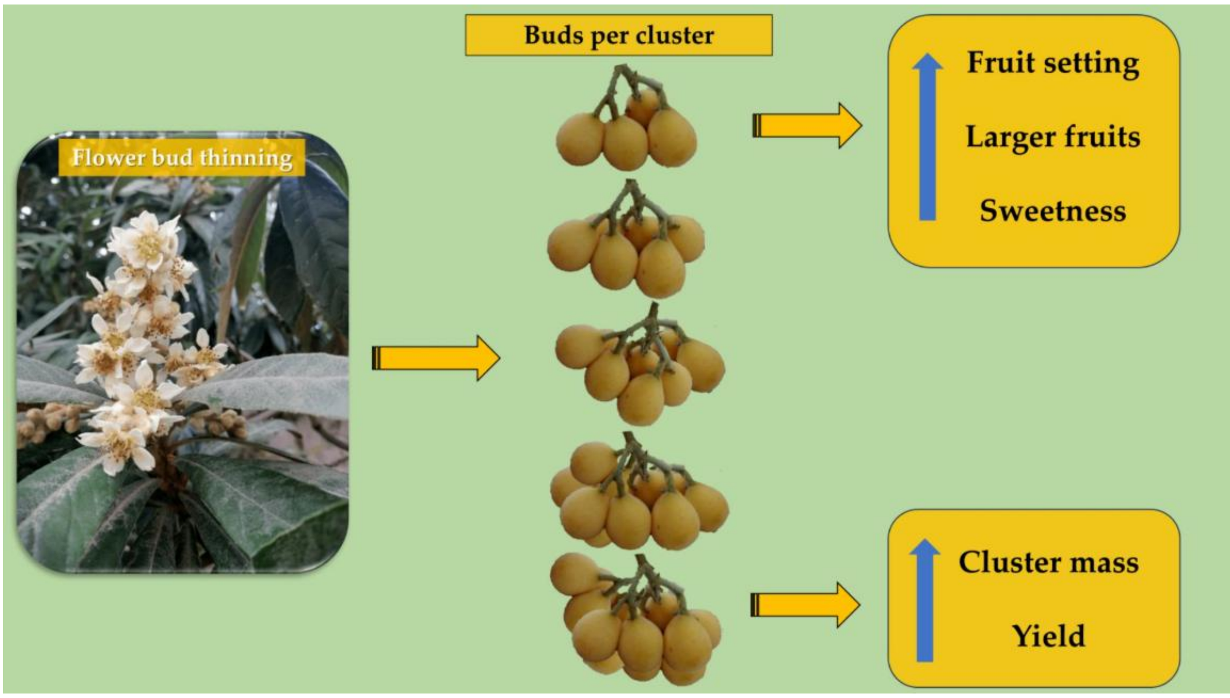

Figure 2 Effect of flower bud thinning on fruit set, fruit size, sweetness, and yield in clustered fruits (Adapted from Nordi et al., 2025)

5.3 Changes in fruit number and size

Loquat fruits show a single S-shaped growth curve under both heavy thinning and no-thinning conditions, but the growth curve under thinning is steeper, resulting in larger final fruit size, indicating stronger sink strength of individual fruits. Seed number and seed size are the main factors determining final fruit size, while leaf area per shoot shows only a weak correlation with fruit size. This highlights the importance of regulating fruit load based on the inherent sink capacity of fruits (Cuevas et al., 2003). At the shoot level, double-heading shows a similar pattern: this strong pruning method reduces the number of flowering shoots but produces larger flowers and significantly larger fruits. This is associated with enhanced cell division during early fruit development and downregulation of fruit weight-related genes (EjFWL1/2) (Su et al., 2024).

5.4 Overall yield performance under different pruning systems

At the cluster level, retaining more flowers can maximize yield per cluster, but this is often accompanied by smaller fruits and lower market value. At the whole-tree level, pruning methods that moderately reduce fruit number while significantly increasing average fruit weight and quality can improve the proportion of premium fruits and economic returns, even if total fruit number decreases. Double-heading can increase single fruit weight by about 35%, cluster weight by 32%, and the proportion of premium fruits (>65 g) to over 75%, resulting in more than a 60% increase in yield value per unit area compared with conventional pruning (Xu et al., 2013). For declining trees, heavy heading-back pruning can increase single fruit weight and gradually restore yield as the canopy is renewed. When these findings in loquat are combined with evidence from citrus (for example, increasing pruning intensity-removing up to 75% of main branches—can raise yield per tree by nearly 20% and improve fruit size and internal quality) (Al-Saif et al., 2023), a consistent pattern emerges: well-designed pruning systems regulate canopy vigor and fruit load, combined with flower and fruit thinning, shifting production from “many small fruits” to “fewer large, high-value fruits.” Even if the absolute number of fruits decreases, economic yield usually increases.

6 Effects of Pruning Systems on Fruit Quality

6.1 External fruit characteristics (size, uniformity, color)

Compared with retaining 10~12 flower buds per panicle, keeping only 4 buds can produce loquat fruits with greater single-fruit weight as well as larger longitudinal and transverse diameters, mainly because competition among “sinks” is reduced (Nordi et al., 2025). Consumers generally prefer fruits that are larger, have a higher flesh proportion, and contain smaller seeds, which confirms the commercial importance of pruning and thinning practices that reduce crop load to increase fruit size. Double-heading pruning promotes the formation of strong fruiting shoots with thicker branches and more leaves, which supports the development of larger floral organs and further increases fruit size, reflecting enhanced cell division during the early stages of fruit development. After thinning, fruit bagging can improve external quality by enhancing peel color and reducing surface defects. Aluminum-polyethylene composite bags increased fruit weight, length, and width to 1.37, 1.18, and 1.13 times those of the control, respectively, while also increasing peel thickness and edible rate, and significantly reducing sunburn, black spots, and damage from insects and birds (Zhi et al., 2021).

6.2 Internal quality (soluble solids, acidity, flavor balance)

Pruning, by regulating crop load and canopy microclimate, also affects internal fruit quality traits such as soluble solid content, titratable acidity, and their ratio, which together determine flavor balance. In flower bud thinning experiments, retaining 4 buds per panicle significantly increased soluble solids content and maturity index compared with higher crop load treatments, indicating sweeter fruits and a more balanced sugar-acid ratio at harvest. This improvement is mainly due to a more favorable source-sink relationship, allowing more carbohydrates to be allocated to each fruit. Although mineral nutrition is an important factor influencing internal quality-for example, Ca, Mg, Fe, and N levels in leaves and soil can significantly affect fruit weight, soluble solids, and titratable acidity-pruning systems can indirectly interact with these factors by adjusting leaf area per fruit and improving assimilate use efficiency (Huang et al., 2021). Fruits treated with paper bags showed the highest soluble sugar content and the lowest titratable acidity, with a sugar-acid ratio nearly twice that of unbagged fruits. Aluminum bags and aluminum-polyethylene composite bags slightly increased titratable acidity and some amino acids, but still improved the overall sugar–acid balance and enhanced fruit firmness.

6.3 Nutritional quality and market value

Larger fruits with a higher flesh proportion can increase economic returns, as buyers are more willing to pay a premium for loquats that are large, have small seeds, and show good appearance. Double-heading pruning, by promoting vigorous shoot growth and larger fruits, can indirectly enhance nutrient accumulation, mainly due to the increase in the edible portion of each fruit. Bagging treatments significantly improve the “health” level of fruit-that is, the proportion of undamaged, marketable fruits-by reducing sunburn, decay, black spots, and insect or bird damage. The proportion of healthy fruits increases by 75%~144% compared with unbagged controls, depending on the type of bag (Zhi et al., 2021). Aluminum-polyethylene bags are associated with higher carotenoid content and various amino acids, while paper and aluminum bags show positive relationships with phenolic compounds and proline, suggesting that microenvironment regulation can also influence bioactive compounds related to antioxidant capacity and nutritional value. Since fruit quality (size, flavor, and nutritional composition) directly determines grading and commercial value, pruning strategies that promote effective thinning and facilitate bagging can significantly increase overall market value per unit area, even when total fruit number is reduced.

7 Comparative Evaluation of Pruning Systems

7.1 Trade-off between yield and fruit quality

Comparative evaluation of loquat pruning systems clearly shows that yield, fruit quality, labor efficiency, and long-term orchard performance are jointly determined by how pruning regulates crop load, canopy structure, and vegetative vigor. Flower thinning in loquat reflects a typical "yield-quality" continuum: when 12 flower buds are retained per panicle, cluster weight and yield per tree reach their maximum; reducing to 4 buds per panicle lowers total yield but significantly increases individual fruit weight, fruit size, and sweetness. This indicates that stronger crop load regulation shifts production from yield-oriented to high-quality fruit production (Nordi et al., 2025). The double heading-back pruning system produces more vigorous fruiting shoots with more leaves and thicker branches. By concentrating resources on fewer but more efficient fruiting units, this system not only enlarges fruit size but also improves yield, and to some extent alleviates the traditional trade-off between fruit size and yield by enhancing early cell division.

7.2 Suitability of pruning systems under different orchard conditions

In high-density orchards of olive, apple, and similar species, combining winter structural pruning with summer pinching or hedging can control tree size and improve the balance between vegetative and reproductive growth, while maintaining or even increasing yield. However, if mechanical pruning is too frequent or too severe, yield or fruit size may decrease under limited light conditions. In high-density or overly vigorous loquat orchards, a pruning system with periodic heavy heading-back or partial renewal, combined with mechanized operations and manual fine adjustments, is more suitable for maintaining canopy openness, controlling tree height, and achieving uniform high-quality production. In contrast, in low-density orchards or those with weak vigor, a simpler and lighter pruning approach can be adopted.

7.3 Effects of tree age and vigor on pruning outcomes

The double heading-back pruning system in loquat has been developed in mature commercial orchards. By conducting summer pruning and a second heading-back in late summer or autumn, strong new shoots are induced, which can form larger inflorescences and fruits in subsequent years. In older citrus and apricot trees, strong renewal pruning combined with adequate nutrient supply can restore canopy growth, improve fruit set, and rebuild productivity. However, in young or weak trees, excessive pruning may have negative effects, delaying fruiting and reducing yield (Sharma et al., 2025). Experiments in high-density olive cultivation show that staged pruning (winter plus summer) is particularly effective in young and vigorous trees, helping to stabilize yield and maintain a compact canopy structure (Lodolini et al., 2023).

8 Practical Applications in Loquat Orchard Management

8.1 Pruning strategy recommendations for high-yield production

Under high-yield production conditions, pruning should prioritize maintaining a sufficient number of fruiting shoots and a stable source-sink relationship, rather than simply pursuing larger individual fruit size. In traditional cultivation systems, post-harvest pruning from spring to early summer promotes the formation of summer shoots, which undergo flower bud differentiation in late summer. Under this system, usually only about half of the inflorescences are retained for commercial production. Double-heading refers to the first heading after harvest, followed by a second pruning of the resulting summer shoots, removing about half of the branches. This method produces fewer but stronger fruiting shoots with thicker branches and higher leaf chlorophyll index, thereby enhancing carbohydrate supply. Compared with single heading, it can improve both fruit size and overall yield. For orchards where yield is the main goal, moderate control of inflorescence number helps increase cluster weight and yield per plant, although the average fruit size may decrease. Combined with a reasonable nitrogen-potassium fertilization ratio, it can promote vigorous shoot growth while avoiding excessive vegetative growth and shading.

8.2 Pruning strategies for improving fruit quality

When high-quality fruit production is the main objective, pruning and load regulation should be adjusted toward "fewer but better," producing fewer fruits that are larger, sweeter, and more uniform. During full bloom, thinning flower buds to retain only a few per cluster can consistently result in larger fruit, higher soluble solids content, and better appearance quality, although total yield will be lower compared with treatments retaining more buds. Double-heading promotes strong branch growth, enhances early cell division, and downregulates the expression of cell division inhibitors EjFWL1/2 in flower buds, significantly increasing single fruit weight and the proportion of premium-grade fruit. In practice, combining these measures (such as cultivating strong fruiting shoots through annual double-heading pruning and applying moderate flower thinning) can significantly improve average fruit weight and the proportion of high-quality fruit. Pruning also improves canopy ventilation and light penetration (by removing diseased, weak, crossing, and inner canopy branches and maintaining proper spacing of fruiting shoots), which promotes fruit coloration, reduces disease incidence, and enhances fruit uniformity—critical for meeting the high standards of the fresh fruit market. In addition, bagging fruit clusters with breathable paper or plastic bags can be used; studies have shown that this practice significantly improves fruit firmness, soluble solids content, and peel color (Hussain et al., 2024).

8.3 Integration with other management practices (fertilization, irrigation, planting density)

Effective pruning must be integrated with fertilization, irrigation, and planting design to achieve synergistic effects and avoid management imbalance. There is a significant interaction between autumn pruning and nitrogen-potassium management: maintaining an appropriate N-K ratio after pruning helps promote shoot growth, flower bud differentiation, cell division, and fruit enlargement, thereby improving yield and quality in the next season. Excessive nitrogen supply combined with insufficient pruning can lead to excessive vegetative growth, canopy shading, and reduced fruit quality. In contrast, combining light to moderate pruning with optimized nitrogen application can significantly improve tree vigor, fruit set, and productivity in older apricot trees (Sharma et al., 2025). Post-harvest and pre- plus post-harvest deficit irrigation strategies can advance flowering and harvest time, save about 18%~30% of irrigation water, and in some cases increase early yield; when drought periods are properly scheduled, fruit size is little affected or not negatively affected (Hueso et al., 2021). In semi-arid regions, combining such deficit irrigation with canopy size control through pruning is particularly important, as water resources must be allocated among multiple crops. Planting density and canopy structure determine the intensity and timing of pruning: high-density orchards require more frequent topping and lateral pruning to control tree height and maintain good light conditions. In high-density olive and mango systems, staged pruning has been shown to improve yield and water use efficiency (Hahn et al., 2022).

8.4 Common mistakes and optimization strategies

Common problems in loquat pruning include: excessive retention of inflorescences and flower buds, resulting in small fruit and low sugar content; improper or overly intense structural pruning, causing tree stress and reduced short-term yield; and neglect of canopy structure management, leading to overly tall trees, dense inner canopies, and outward migration of fruiting sites. Poor coordination between pruning and fertilization may result in either poor recovery of heavily pruned trees due to insufficient nutrients, or excessive vegetative growth and suppressed fruiting under excessive nitrogen supply. In regions using deficit irrigation, failure to adjust pruning intensity accordingly may cause excessive pruning to exacerbate water stress and hinder tree recovery.

Optimization strategies include: adopting standardized and easily applicable pruning systems, such as renewal pruning or double-heading techniques, to systematically update fruiting branches and improve scaffold branch quality; adjusting flower thinning intensity based on market goals (e.g., retaining four flower buds per cluster for high-quality production, or increasing slightly for higher yield); using digital or empirical canopy light assessment methods to guide branch angle and density adjustments; and dynamically adjusting nitrogen–potassium ratios and irrigation regimes according to pruning intensity to support vigorous and balanced regrowth (Ballester et al., 2018). In addition, strengthening training for pruning personnel and implementing a phased approach—testing new techniques in small orchard areas before wider application—can help reduce risks while continuously optimizing pruning systems suited to local varieties and ecological conditions.

9 Conclusion and Prospects

Loquat shows a high response to pruning, and a well-designed pruning system is one of the key factors determining fruit yield and quality. Pruning mainly works by regulating canopy structure, light distribution, and the balance between vegetative and reproductive growth. Light and moderate pruning are generally beneficial for maintaining a stable balance between shoot renewal and flower bud formation. Although heavy pruning and renewal pruning may reduce yield in the short term, they can rejuvenate the tree, improve canopy ventilation, and restore long-term productivity. The timing of pruning, as well as its coordination with other orchard management practices, has a significant impact on both fruit appearance and internal quality.

From a practical perspective, growers should avoid adopting a single, rigid pruning pattern. Instead, pruning strategies should be flexibly adjusted according to tree age, tree vigor, cultivar, and planting density. For young trees, training pruning should be the main focus, aiming to establish a well-structured and evenly distributed framework, and to form an open and moderately dense canopy that allows sufficient light penetration. During the full bearing period, moderate annual pruning should be applied, mainly removing overly vigorous branches, crowded branches, and crossing branches, in order to maintain good ventilation and light conditions and promote the formation of fruiting shoots on well-exposed branches. At the same time, appropriate flower and fruit thinning should be combined to regulate crop load and improve fruit size and uniformity. In old or declining orchards, heavy pruning or renewal pruning can be implemented in stages, renewing part of the canopy to stimulate new shoot growth while maintaining a basic level of yield. Throughout the whole growth cycle, pruning should also be coordinated with fertilization, irrigation, pest and disease control, and harvest scheduling, so as to reduce plant stress and avoid excessive vegetative growth.

Looking ahead, improving pruning efficiency and orchard productivity in loquat requires integrating physiological understanding, technological innovation, and precision management. Future research should further clarify the quantitative relationships among pruning intensity, canopy light environment, and source–sink relationships, so as to establish more predictive models for yield and quality responses. The application of remote sensing, digital canopy imaging, and three-dimensional modeling is expected to enable objective evaluation of canopy structure and provide a scientific basis for precision pruning. Mechanized or semi-mechanized pruning tools adapted to loquat canopy characteristics can help reduce labor costs and improve operational consistency. In addition, decision support systems that integrate meteorological data, tree vigor indicators, and historical yield records can assist growers in optimizing pruning timing and intensity under changing climate conditions. By combining these technological advances with improved cultivar breeding, high-density planting systems, and sustainable soil and water management, loquat orchards are expected to achieve higher productivity, better fruit quality, and stronger adaptability to environmental and market changes in the future.

Reference

Ahmad S., Khalofah A., Khan S., Khan K., Jilani M., Hussain T., Skalický M., Ghramh H., and Ahmad Z., 2021, Effects of native pollinator communities on the physiological and chemical parameters of loquat tree (*Eriobotrya japonica*) under open field condition, Saudi Journal of Biological Sciences, 28(6): 3235-3241.

Al-Saif A.M., Abdel-Aziz H.F., Khalifa S.M., Elnaggar I.A., Abd El-wahed A.E.W.N., Farouk M.H., and Hamdy A.E., 2023, Pruning boosts growth, yield, and fruit quality of old Valencia orange trees: A field study, Agriculture, 13(9): 1720.
https://doi.org/10.3390/agriculture13091720

Ballester C., Buesa I., Soler E., Besada C., Salvador A., Bonet L., and Intrigliolo D.S., 2018, Postharvest regulated deficit irrigation in early- and intermediate-maturing loquat trees, Agricultural Water Management, 205: 1-8.
https://doi.org/10.1016/j.agwat.2018.04.030

Cai J., Chen T., Zhang Z., Li B., Qin G., and Tian S., 2019, Metabolic dynamics during loquat fruit ripening and postharvest technologies, Frontiers in Plant Science, 10: 619.
https://doi.org/10.3389/fpls.2019.00619

Cuevas J., Salvador-Sola F.J., Gavilán J., Lorente N., Hueso J.J., and González-Padierna C.M., 2003, Loquat fruit sink strength and growth pattern, Scientia Horticulturae, 98(2): 131-137.
https://doi.org/10.1016/S0304-4238(02)00217-0

Deng H., Li X., Wang Y., Zeng Y., Xiang Y., Chen M., Zhang H., Xia H., Liang D., Lv X., Wang J., and Deng Q., 2023, Organic acid accumulation and associated dynamic changes in enzyme activity and gene expression during fruit development and ripening of common loquat and its interspecific hybrid, Foods, 12(5): 911.
https://doi.org/10.3390/foods12050911

Dhiman A., Suhag R., Thakur D., Gupta V., and Prabhakar P.K., 2022, Current status of Loquat (*Eriobotrya japonica* Lindl.): Bioactive functions, preservation approaches, and processed products, Food Reviews International, 38(sup1): 286-316.
https://doi.org/10.1080/87559129.2020.1866007

Hahn F., Valle S., and Navarro-Gómez C., 2022, Pruning and water saving management effects on mango high-density and mature orchards, Agronomy, 12(11): 2623.
https://doi.org/10.3390/agronomy12112623

Huang W., 2025, Impact of autumn pruning and N-K ratio regulation on yield performance of loquat in the following year, Tree Genetics and Molecular Breeding, 15: 17.
https://doi.org/10.5376/tgmb.2025.15.0017

Huang X., Wang H., Qu S., Luo W., and Gao Z., 2021, Using artificial neural network in predicting the key fruit quality of loquat, Food Science & Nutrition, 9(3): 1780-1791.
https://doi.org/10.1002/fsn3.2166

Hueso J.J., Alonso F., Cañete M.L., González M., Pinillos V., Chiamolera F.M., and Cuevas J., 2021, The effects of combined pre and postharvest deficit irrigation on loquat yield, fruit quality and handling aptitude, Agronomy, 11(2): 201.
https://doi.org/10.3390/agronomy11020201

Hussain T., Ali I., Ahmad I., Liaquat M., Akram M., Anwar A., Rahim G., Asghar S., Naseem W., Manzoor A., Khadija F., Naveed M., and Ali I., 2024, Evaluation of fruit bunch bagging techniques for improvement of loquat fruit quality, Journal of Applied Research in Plant Sciences, 5(01): 79-85.
https://doi.org/10.38211/joarps.2024.05.212

Jiang Y., Zhu Y., Peng Z., Su W., Peng J., Yuan Y., Zhang L., Zhang Z., Yang X., Gao Y., Lin S., and Ma C., 2025, Two FT genes synergistically regulate the reproductive transition of loquat, Horticultural Plant Journal, 11(2): 548-563.
https://doi.org/10.1016/j.hpj.2023.08.003

Jiang Y., Zhu Y., Zhang L., Su W., Peng J., Yang X., Song H., Gao Y., and Lin S., 2020, EjTFL1 genes promote growth but inhibit flower bud differentiation in loquat, Frontiers in Plant Science, 11: 576.
https://doi.org/10.3389/fpls.2020.00576

Jiménez-Brenes F.M., López-Granados F., De Castro A.I., Torres-Sánchez J., Serrano N., and Peña J.M., 2017, Quantifying pruning impacts on olive tree architecture and annual canopy growth by using UAV-based 3D modelling, Plant Methods, 13(1): 55.
https://doi.org/10.1186/s13007-017-0205-3

Jing D., Liu X., He Q., Dang J., Hu R., Xia Y., Wu D., Wang S., Zhang Y., Xia Q., Zhang C., Yu Y., Guo Q., and Liang G., 2023, Genome assembly of wild loquat (*Eriobotrya japonica*) and resequencing provide new insights into the genomic evolution and fruit domestication in loquat, Horticulture Research, 10(2): uhac265.
https://doi.org/10.1093/hr/uhac265

Kaur S., 2018, Evaluation of vegetative and floral characteristics of loquat genotypes under submontaneous conditions of Punjab, Chemical Science Review and Letters, 7(25): 290-294.

Kızıl M., and Durgac C., 2023, Phenological and pomological characterization of promising loquat (*Eriobotrya japonica*) cultivars suitable for the Mediterranean climate, Mediterranean Agricultural Sciences, 36(2): 59-64.
https://doi.org/10.29136/mediterranean.1233047

Li W.H., Zhang Z.L., Wei L.Y., Cheng Y.F., and Shen L.P., 2005, Studies of shaping and pruning technique on *Eriobotrya japonica*, Journal of Northwest Forestry College, 20(1): 92-93.

Li X., Feng C., Su R., Song P., Peng X., Zhou J., Li Y., and Deng Q., 2025, Transcriptomics and hormone-targeted metabolomics reveal the mechanisms underlying special branching in loquat, Agronomy, 16(1): 37.
https://doi.org/10.3390/agronomy16010037

Lin S., Wu B., Xiong Y., Huang L., Lin D., Lin J., Lin S., and Wu J., 2025, Integrated endogenous hormones and transcriptome analysis contribute to fruit development related gene mining in *Eriobotrya japonica*, Scientific Reports, 15(1): 14794.
https://doi.org/10.1038/s41598-025-96870-2

Liu Y.J., Xu J.H., Zhang Z.H., Jiang J.M., Yu D., and Zheng S.Q., 2008, Effects of the cutting width of loquat branches on the new branch growth, blossom and fruit of loquats, Journal of Yunnan Agricultural University, 23(5): 705-708.

Lodolini E.M., Polverigiani S., Giorgi V., Famiani F., and Neri D., 2023, Time and type of pruning affect tree growth and yield in high-density olive orchards, Scientia Horticulturae, 311: 111831.
https://doi.org/10.1016/j.scienta.2023.111831

Nordi N., Coelho L., Leonel S., Silva M., Putti F., Leonel M., Furlan M., and Tecchio M., 2025, Yield and fruit quality of loquat trees as a result of flower bud thinning, Horticulturae, 11(3): 270.
https://doi.org/10.3390/horticulturae11030270

Peng J., Li W., Yuan Y., Han Z., Cao Y., Shahid M., Zhang Z., Gao Y., Lin S., and Jiang Y., 2022, Removal of the main inflorescence to induce reflowering of loquat, Horticultural Plant Journal, 8(1): 35-43.
https://doi.org/10.1016/j.hpj.2021.03.009

Peng Z., Wang M., Zhang L., Jiang Y., Zhao C., Shahid M., Bai Y., Hao J., Peng J., Gao Y., Su W., and Yang X., 2021, EjRAV1/2 delay flowering through transcriptional repression of EjFTs and EjSOC1s in loquat, Frontiers in Plant Science, 12: 816086.
https://doi.org/10.3389/fpls.2021.816086

Polat A., 2015, Effect of canopy orientation on flowering time and fruit set in loquat, Acta Horticulturae, 1092: 205-210.
https://doi.org/10.17660/ActaHortic.2015.1092.30

Reig C., Farina V., Mesejo C., Martínez-Fuentes A., Barone F., and Agustí M., 2014, Fruit regulates bud sprouting and vegetative growth in field-grown loquat trees (*Eriobotrya japonica* Lindl.): Nutritional and hormonal changes, Journal of Plant Growth Regulation, 33(2): 222-232.
https://doi.org/10.1007/s00344-013-9364-2

Sharma D.P., Thokchom R., and Thakur K.K., 2025, Pruning and nitrogen fertilization interactions on growth and productivity of New Castle apricot (*Prunus armeniaca* L.) trees, Journal of Animal and Plant Sciences, 35(2): 341-353.
https://doi.org/10.36899/japs.2025.2.0028

Su W., Deng C., Wei W., Chen X., Lin H., Chen Y., Xu Q., Tong Z., Zheng S., and Jiang J., 2024, Double-heading produces larger fruit via inhibiting EjFWLs expression and promoting cell division, Horticulturae, 10(8): 793.
https://doi.org/10.3390/horticulturae10080793

Tang L., Yin D., Chen C., Yu D., and Han W., 2019, Optimal design of plant canopy based on light interception: A case study with loquat, Frontiers in Plant Science, 10: 364.
https://doi.org/10.3389/fpls.2019.00364

Tinebra I., Passafiume R., Scuderi D., Pirrone A., Gaglio R., Palazzolo E., and Farina V., 2022, Effects of tray-drying on the physicochemical, microbiological, proximate, and sensory properties of white- and red-fleshed loquat (*Eriobotrya japonica* Lindl.) fruit, Agronomy, 12(2): 540.
https://doi.org/10.3390/agronomy12020540

Xu Q.Z., Jiang J.M., Lin M.H., Deng C.J., Zheng S.Q., and Xu X.D., 2013, The influence on fruiting cane and fruit quality of loquat by twice cutting back pruning, Chinese Journal of Tropical Crops, 34(1): 87-91.

Zhi C., Ali M.M., Zhang J., Shi M., Ma S., and Chen F., 2021, Effect of paper and aluminum bagging on fruit quality of loquat (*Eriobotrya japonica* Lindl.), Plants, 10(12): 2704.
https://doi.org/10.3390/plants10122704