

Simplified Cultivation Techniques and Their Application Effects in *Lonicera japonica* (Honeysuckle)

Jianhua Wang¹, Xiaoying Li^{2*} ✉¹ Niujiinsuiyue Agricultural Development (Songyang County) Co., Ltd, Songyang, 323406, Zhejiang, China² Songyang County Shuimoshicang Agricultural Products Co., Ltd, Songyang 323499, Zhejiang, China✉ Corresponding author: 2714489364@qq.comGenomics and Applied Biology, 2026, Vol.17, No.2 doi: [10.5376/gab.2026.17.0010](https://doi.org/10.5376/gab.2026.17.0010)

Received: 11 Mar., 2026

Accepted: 13 Apr., 2026

Published: 28 Apr., 2026

Copyright © 2026 Wang and Li, This is an open access article published under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Preferred citation for this article:

Wang J.H., and Li X.Y., 2026, Simplified cultivation techniques and their application effects in *Lonicera japonica* (Honeysuckle), Genomics and Applied Biology, 17(2): 107-121 (doi: [10.5376/gab.2026.17.0010](https://doi.org/10.5376/gab.2026.17.0010))

Abstract Simplified cultivation techniques have emerged as a practical approach to improving the efficiency, stability, and scalability of medicinal plant production. *Lonicera japonica* (honeysuckle), a widely used medicinal crop rich in phenolic acids and flavonoids, faces multiple challenges in current production systems, including labor-intensive harvesting, unstable quality, and region-specific variability. This review systematically summarizes simplified cultivation techniques for honeysuckle across four main aspects: planting, field management, pest and disease control, and mechanization. It further evaluates their application effects on plant growth, yield, quality, labor input, and economic performance. Evidence from agronomic experiments indicates that practices such as formula fertilization, standardized planting geometry, and controlled irrigation can significantly improve yield and stabilize production. Meanwhile, quality is closely related to ecological conditions, genetic background, and harvest timing, suggesting that simplified cultivation must be region-specific and quality-oriented. Mechanization studies demonstrate that harvesting robots, although not yet fully commercialized, provide measurable improvements in labor efficiency and highlight the importance of canopy standardization. Case analysis shows that model-based fertilization can increase yield by over 30% and improve economic returns. Overall, simplified cultivation is not equivalent to low-input agriculture but represents a structured reduction of unnecessary variability through standardized and repeatable practices. Future development should focus on integrating agronomic optimization with quality control systems and mechanization requirements, while strengthening farmer training and regional adaptability. These findings provide a practical framework for improving honeysuckle production under both smallholder and large-scale plantation systems.

Keywords Honeysuckle; Simplified cultivation; Yield and quality; Mechanization; GACP

1 Introduction

Honeysuckle is one of those medicinal crops whose “value” is not a single thing: it sits at the intersection of traditional medical use, modern quality control, and large-scale commodity supply. Contemporary reviews and pharmacology-oriented syntheses describe *Lonicerae japonicae flos* as rich in phenolic acids, notably chlorogenic acid, flavonoids, iridoid glycosides, and other constituents; these chemical classes anchor both traditional indications and many modern mechanistic studies (Li et al., 2020). A key reason cultivation matters so much for honeysuckle is that its “medicinal part” is typically the flower bud, while the open flower is often treated differently in commercial grading and utilization. A recent metabolomics and network-pharmacology study comparing buds and flowers used GC-MS and LC-MS to identify differential compounds between the two organs and argued for more rational utilization of flowers rather than discarding them as “non-medicinal” by default. That framing pushes cultivation research beyond yield alone: the crop’s value chain is increasingly about targeted harvesting, classification, and product routing (Tong et al., 2025). Market demand is not only driven by traditional formulas but also by heightened attention to respiratory and infectious disease contexts. For example, chemical pattern-recognition research has been used to differentiate *Lonicerae japonicae flos* from related *Lonicerae flos* and to evaluate anti-SARS-CoV-2 main protease activity in vitro, which shows why market expansion also raises stricter quality-control concerns (Gu et al., 2021). From a production perspective, demand translates into pressure on supply stability. Agronomic and microbiome work on continuously cultivated honeysuckle notes that annual

market demand can reach large volumes and high sales values, framing honeysuckle as a major economic crop in its primary regions and making cultivation constraints a practical bottleneck rather than an academic detail (Ma et al., 2024).

In many core producing areas, honeysuckle is still grown in open-field systems and harvested manually. This is not merely a “traditional” choice; it is tightly connected to flower-bud phenology. A recent study dissected the regulation of floral bud duration and emphasized that commercial harvest focuses on particular bud stages, with a short high-quality window. When this window is narrow, the field system becomes labor-hungry and time-sensitive (Li et al., 2025). Mechanization researchers describe the labor constraint in plain terms. In a 2025 IFAC-PapersOnLine study, honeysuckle harvesting was still described as mainly manual, while rising labor costs and shrinking labor availability were identified as factors threatening sustainable production. The study further presented a selective picking robot and reported field indicators such as maturity-detection precision, picking success rate, and damage rate, thereby turning “labor shortage” from a general production problem into a concrete engineering design issue (Rui et al., 2025). A related field evaluation of a straddle-frame honeysuckle harvesting robot reached a similar conclusion. The lack of modern mechanical harvesting methods keeps honeysuckle harvesting highly dependent on manual labor, and labor scarcity increases production costs. The reported performance indicators, including picking-point detection, harvest time per bud, and damage rate, are useful for cultivation specialists because they suggest that crop training, canopy structure, and bud exposure may directly affect the feasibility of robotic harvesting (Rui et al., 2025). Beyond labor, quality stability is also constrained by ecological conditions, soil history, and regional differences. A study combining HPLC analysis with the MaxEnt model showed that secondary metabolite contents, including chlorogenic acid and related compounds, vary with ecological factors, and that suitable habitat zones may shift across regions. In other words, the same honeysuckle variety may not show the same quality profile everywhere, so production planning should be region-aware rather than mechanically uniform (Cheng et al., 2024).

“Simplified cultivation” can be misunderstood if it is treated as a synonym for “low input.” For a medicinal crop, simplification is better defined as a deliberate reduction of unnecessary variability-fewer ad hoc decisions, fewer redundant operations, clearer timing rules, and more standardized protocols that can be taught, monitored, and scaled. In the herbal medicine context, this aligns naturally with Good Agricultural and Collection Practice (GACP) logic: quality assurance begins at cultivation and primary processing, and farmers/handlers need workable procedures rather than idealized checklists (World Health Organization, 2003). The WHO GACP guidelines emphasize that cultivation and collection techniques, recording, and documentation are foundational to quality assurance, while also noting the real-world difficulty of training farmers and implementing guidelines consistently. That tension-high standards, uneven implementation-is exactly where simplification has value: a simplified technical package is often the only way a guideline becomes everyday practice (World Health Organization, 2003). In Europe, the updated EMA/HMPC GACP guideline (Revision 1 adopted in July 2025) reinforces that plant production and primary processing directly influence herbal substance quality. It explicitly discusses outdoor, greenhouse, and indoor cultivation, and it highlights the need for appropriate quality assurance systems across cultivation, harvest, and primary processing, with additional provisions for indoor cultivation. These points matter for honeysuckle enterprises that aim to standardize supply for pharmaceutical-like value chains (European Medicines Agency, Committee on Herbal Medicinal Products, 2025). An interesting cross-domain bridge comes from robotics. A comprehensive review of fruit-harvesting robots in *Precision Agriculture* noted that success rates can improve when the environment is simplified; while this was discussed in the context of fruit crops, the principle generalizes to honeysuckle: when plant structure and field geometry are standardized, mechanical or semi-mechanical harvesting becomes more realistic (Zhou et al., 2022).

For individual farmers, simplification is attractive when it reduces peak-season labor dependence and avoids operations that do not reliably translate into income. The most fragile point is harvest: bud-stage timing and labor scheduling determine whether growers capture high-grade product or miss the window. Genetic and physiological work on bud duration makes it clear that small changes in flowering dynamics can create large differences in

harvest manageability, directly affecting labor planning (Li et al., 2025). For enterprises, the driver is often supply-chain reliability: stable procurement quality, traceable field records, and predictable output. GAP/GACP-oriented analyses in Chinese Herbal Medicines highlight that standardization and large-scale production are key for traditional herbal medicine trade under globalization, connecting cultivation practice to downstream safety, clinical expectations, and international market acceptance (Zhang et al., 2021). Mechanization research further clarifies the “enterprise logic.” A picking robot might not replace workers immediately, but field evaluation metrics, such as damage rate, cycle time, and orientation recognition accuracy, provide a concrete path to hybrid systems where partial automation covers peak labor shortages. Even a modest reduction in manual picking can shift the economics when labor is the binding constraint (Rui et al., 2025).

This review aims to (i) summarize simplified cultivation techniques applicable to honeysuckle production, grouped into planting, field management, pest/disease control, and mechanization; (ii) evaluate reported application effects on plant growth, yield, quality, labor/cost inputs, and economic outcomes; and (iii) translate the evidence into practical recommendations for open-field and large-scale plantation contexts. Core agronomic evidence includes formula fertilization modeling with measured yield and economic benefit per plant, ecological habitat-quality mapping, soil microbiome dynamics under continuous cultivation, and irrigation response studies. Mechanization evidence includes field performance data from honeysuckle-selective picking robots.

2 Overview of Traditional Cultivation Methods and Existing Problems

2.1 Traditional planting and management methods

Traditional honeysuckle cultivation varies by region, but many systems share a few recognizable features: vegetative propagation through cuttings, open-field planting, substantial hand weeding and branch management, and repeated manual harvesting during the flowering period. Even when a study is not directly focused on cultivation techniques, its experimental methods often reflect common production practices. For instance, a formula fertilization study conducted in the hilly and gully region of the Loess Plateau used 1.0 m × 1.0 m plant and row spacing and applied fertilizer once through pit or ditch placement around each plant, which reflects a practical plantation configuration used in field production (Jiang et al., 2025).

In gravel-mulched land systems, which represent a distinct regional cultivation mode, honeysuckle has been introduced as both an ecological and economic crop in arid gravel-sand areas. This mode combines agronomic management with regional land-use adaptation. Although gravel mulch is not a traditional practice in all production areas, it has become an established cultivation baseline in parts of northwest China (Wang et al., 2023).

Traditional pest and disease management often relies on chemical control after symptoms become visible. However, because honeysuckle is a medicinal crop, heavy chemical use is constrained by residue concerns and quality requirements. Disease guidance for honeysuckle powdery mildew emphasizes that cultural measures, such as proper spacing for air circulation and planting in full sunlight, should be used as basic preventive strategies, while fungicides are more effective when applied preventively rather than after disease has become severe (Pscheidt, 2025).

2.2 Problems in current production

Labor input is especially concentrated during harvesting, because honeysuckle flower buds must be picked repeatedly within a narrow harvest window. Recent robotics studies have repeatedly pointed out that honeysuckle harvesting remains largely manual and that rising labor costs and labor shortages are becoming important constraints on sustainable production. These studies also evaluate harvesting efficiency through indicators such as picking success rate, damage rate, and time required per bud, which shows that labor demand is not only an economic issue but also a technical bottleneck in production (Rui et al., 2025a; Rui et al., 2025b).

Complexity in honeysuckle production does not simply mean that many inputs are used. More often, it reflects uncertain timing, inconsistent decisions, and regional differences in ecological conditions. Studies on ecological suitability and quality mapping suggest that factors such as temperature, precipitation, elevation, and habitat

conditions affect both the distribution suitability of honeysuckle and the accumulation of bioactive compounds. This makes it difficult to apply one uniform management model across all production regions (Cheng et al., 2024). Complexity also appears in variety identification. A germplasm fingerprinting study reported that mixed varieties and non-standardized management have created difficulties for variety classification, breeding, promotion, and quality consistency (Li et al., 2023).

Unstable yield and quality may be caused by nutrient management, pruning intensity, continuous cultivation, and ecological mismatch. Pruning, for example, is commonly used to increase flowering and yield, but its effect on medicinal quality is not always straightforward. Research on pruning-induced changes in *Lonicera japonica* showed that pruning can affect yield, quality, related gene expression, and phytohormone changes, indicating that higher flower production does not necessarily mean better medicinal quality (Qin et al., 2019).

Soil and microbiome dynamics may also contribute to unstable production. A study on continuously cultivated honeysuckle showed that bacterial community structure changes under continuous cultivation and that antagonistic bacteria may play a role in suppressing plant pathogens. This suggests that soil biological degradation can become a hidden production risk if long-term field management is not properly adjusted (Ma et al., 2024).

2.3 Need for simplification and optimization

The need for simplification does not mean lowering production standards. Instead, it responds to the difficulty of consistently implementing complicated technical requirements under real farming conditions. The WHO guidelines on good agricultural and collection practices for medicinal plants emphasize that cultivation, collection, recording, and documentation are essential for quality assurance. At the same time, the guidelines also recognize the difficulty of training farmers and ensuring consistent field implementation, which supports the development of simpler and more teachable technical packages (World Health Organization, 2003).

The updated GACP guideline issued by the European Medicines Agency also treats cultivation and primary processing as key stages affecting the quality of herbal starting materials. It calls for appropriate quality assurance systems and recognizes different cultivation modes, including outdoor, greenhouse, and indoor cultivation. This indicates that controlled, standardized, and easier-to-implement production systems are becoming increasingly important for medicinal plant production (European Medicines Agency, Committee on Herbal Medicinal Products, 2025).

3 Simplified Cultivation Techniques

3.1 Simplified planting techniques

Seedling selection is the first “simplification lever” because it sets an upper bound on later management complexity. In practice, growers face two layers of risk: genetic or varietal inconsistency within *L. japonica*, and confusion or substitution with related *Lonicera* taxa. A germplasm SNP fingerprint study argued that mixed varieties and lack of unified standards hinder cataloging, preservation, and variety promotion; it also showed that SNP-based fingerprints can effectively distinguish multiple *Lonicera* varieties, which may reduce downstream production variability if applied to nursery certification (Li et al., 2023).

From a different angle, domestication research comparing wild and cultivated *L. japonica* populations documented differences in morphological traits, resistance traits, including powdery mildew infection traits, and biochemical traits. The study also discussed pharmacopoeia-oriented standards such as chlorogenic acid thresholds. This evidence supports a practical rule for simplified cultivation: growers should not treat “honeysuckle” as a single uniform material, but should select a small number of well-characterized cultivars suited to local disease pressure and quality targets (Hou et al., 2025).

At the enterprise level, seedling selection is also closely linked to quality control and prevention of adulteration. Chemical pattern-recognition research distinguishing *Lonicerae japonicae flos* from *Lonicerae flos* shows that correct botanical identity is not only a matter of naming. Chemical profiles and related bioactivities may differ, and medicinal product requirements may depend on such differences (Gu et al., 2021).

Spacing is a deceptively powerful simplification tool because it affects disease control, pruning demand, and mechanization feasibility at the same time. Disease guidance for honeysuckle powdery mildew recommends proper spacing to improve air circulation and planting in full sun as cultural control measures, making canopy ventilation a preventive technique rather than a secondary effect (Pscheidt, 2025).

In agronomic trials, 1.0 m × 1.0 m spacing has been used as a standardized plantation geometry, for example in a Loess Plateau formula fertilization experiment. Although this does not prove that this spacing is optimal in all regions, it provides a reproducible baseline for enterprises to begin with and adjust according to local conditions (Jiang et al., 2025).

For mechanization, spacing must also match machine requirements. Straddle-frame honeysuckle harvesting robot designs assume row-based movement, which means that row spacing, plant height management, and canopy accessibility are no longer purely horticultural choices, but part of an integrated production system (Rui et al., 2025).

3.2 Simplified field management

Water management can be simplified when it is converted into a limited set of decision rules based on measurable stress indicators rather than personal experience alone. In saline-alkali areas, a study in *Scientific Reports* tested the effects of brackish-water irrigation on biomass allocation and carbon/nitrogen stoichiometry in *L. japonica*. The study aimed to support water-saving irrigation and explore the agricultural use of saline-alkali land. Although this evidence is region-specific, it is valuable because it treats irrigation as a controlled management variable rather than an improvised field operation (Liu et al., 2025).

In gravel-sand mulched systems, local cultivation expansion suggests that management packages can be developed for areas with low rainfall and harsh environmental conditions. Even if gravel mulch is not suitable everywhere, the broader lesson is transferable: a soil-water strategy should be designed to reduce frequent manual interventions, such as repeated watering or soil surface disturbance, by stabilizing the field micro-environment (Wang et al., 2023).

Fertilization is often the field where simplification brings the most direct management benefit, because it can replace repeated subjective decisions with a clear formula.

A useful example is the *PLOS ONE* formula fertilization study conducted in the hilly and gully region of the Loess Plateau. Using a 3414 experimental design, the researchers built a fertilizer effect function, identified phosphorus as a primary limiting factor in the local soil, and provided practical recommended dosages of nitrogen, phosphorus, and potassium in grams per plant. They also reported measurable production outcomes, including yield improvement and increased economic benefit under recommended formula fertilization. For growers and enterprise managers, this is exactly what a simplified technique should be: evidence-based, clear, and economically meaningful (Jiang et al., 2025).

Micronutrient management can also be simplified when it becomes targeted rather than scattered. A study from Ningxia gravel-sand mulched fields focused on boron fertilizer and assessed its effects on yield and chlorogenic acid content. This shows that even small nutrient decisions can be turned into specific and testable interventions. For simplified systems, the practical point is to limit micronutrient use to interventions that have documented relevance in the target region (Bao et al., 2022).

Pruning is often used to increase flowering and improve harvest access, but its effects are not always simple. A study in *Industrial Crops and Products* investigated yield and quality changes after pruning at different harvest times and linked these changes with biosynthetic gene expression and phytohormone variation. The key message for simplified cultivation is not simply to prune more or less, but to prune predictably: timing, intensity, and target branch types should be defined according to the harvest schedule and quality goals (Qin et al., 2019).

Simplified pruning also needs to be compatible with mechanization. Robots are sensitive to canopy occlusion, bud orientation, and irregular branch structures. The more uniform the canopy, the more likely it is that detection and picking will succeed. Current robotics studies have not yet provided a complete agronomic pruning standard, but they clearly indicate that canopy standardization is part of the pathway toward labor-saving harvesting (Rui et al., 2025) (Figure 1).

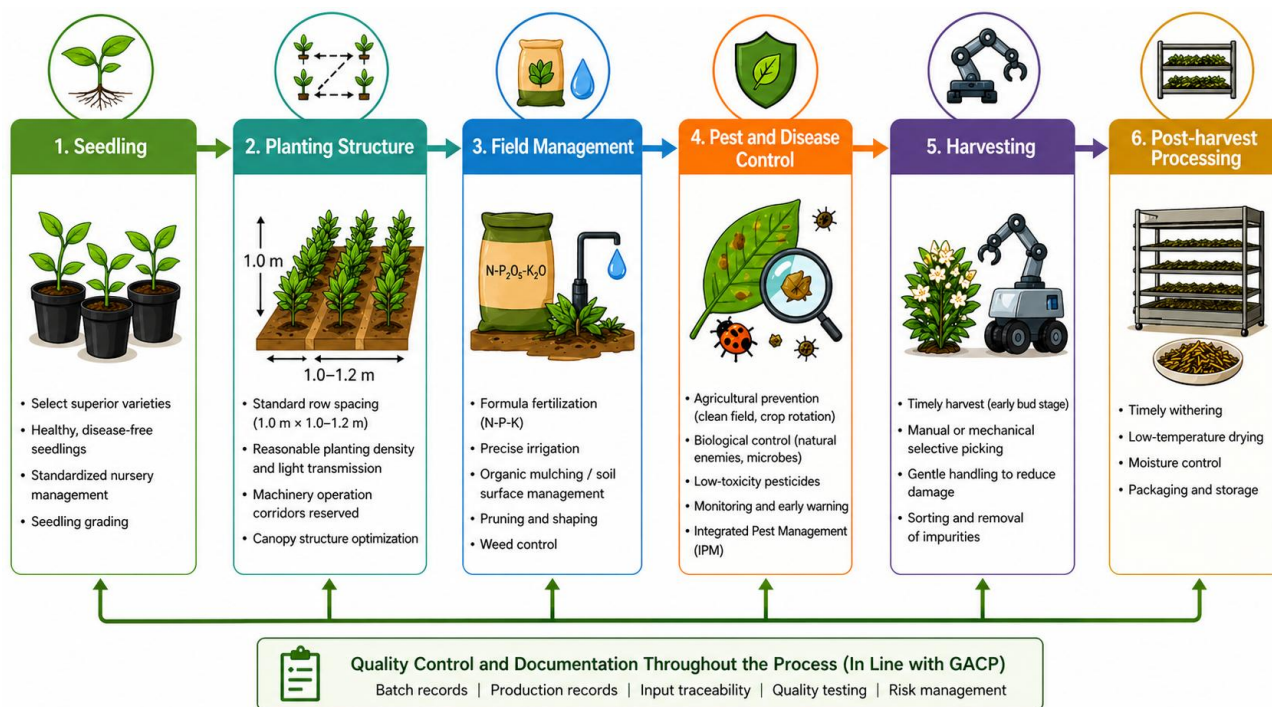


Figure 1 Flowchart of simplified cultivation techniques for *Lonicera japonica*

3.3 Simplified pest and disease control

3.3.1 Use of biological control or low-toxicity pesticides

For medicinal crops, pest and disease control must balance effectiveness with residue risk and consumer safety. EMA's updated GACP guideline highlights appropriate use of plant protection products, qualified personnel, and compliance with destination-market requirements. In this sense, pesticide selection is not only an agronomic decision, but also a quality-system issue (European Medicines Agency, 2025).

Powdery mildew is a common concern in honeysuckle production. Extension guidance describes the disease as favored by high humidity and dry leaf surfaces, and recommends cultural measures such as good air circulation and full sunlight. This makes preventive field design a simplified first-line control method (Pscheidt, 2025).

Biological control evidence is also emerging for honeysuckle. A *Biological Control* study on *Bacillus velezensis* HC-8 targeted honeysuckle powdery mildew caused by *Erysiphe lonicerae* var. *lonicerae*. The study provides a proof of concept that microbial antagonists can be developed for medicinal plant systems. Although field-scale use still depends on formulation, cost, and regulation, this evidence supports simplified IPM packages that rely less on repeated chemical spraying (He et al., 2022).

3.4 Integrated management approaches

Integrated management becomes simplified when it is transformed into a small number of consistent protocols: field design that reduces disease-favorable conditions, monitoring rules that determine when control measures are needed, and a limited toolbox of approved biological, cultural, and chemical options.

Soil biological health is also part of integrated management. Research on continuously cultivated honeysuckle analyzed bacterial community structure in the soil and screened antagonistic bacteria against plant pathogens. This

matters because some disease pressure may be built into soil history. Without soil-focused mitigation, growers may be forced to rely increasingly on chemical control (Ma et al., 2024).

3.5 Mechanization and labor-saving practices

Mechanization for honeysuckle is moving from concept to field-tested prototypes. The most important point for simplified cultivation is that machines require standardization. A robot cannot endlessly adapt to poorly structured canopies, irregular rows, and uncontrolled bud-stage variation.

A 2025 study in *IFAC-PapersOnLine* reported the design and field evaluation of a honeysuckle selective picking robot. In field tests involving 206 buds, the picking success rate reached 66.8%, the damage rate was 6.4%, and the average picking time was 4.9 seconds per bud. These figures are not yet proof of full commercial competitiveness, but they clearly show where agronomy must cooperate with engineering: reducing canopy occlusion and improving bud exposure to lower damage and improve picking efficiency (Rui et al., 2025).

A *Biosystems Engineering* study on a straddle-frame honeysuckle harvesting robot also reported field evaluation data, including detection performance, harvesting success rate, and damage rate. These results show that robustness under natural field conditions remains a key challenge. They also help growers think in practical terms: if a robot can successfully harvest about two-thirds of buds under current conditions, hybrid labor systems combining robots and human workers may already reduce peak-season labor pressure (Rui et al., 2025).

Labor-saving should not be understood as one machine replacing all workers. A more realistic near-term goal is partial automation that first reduces the most difficult constraints, such as peak labor demand, repetitive picking, and harvest scheduling pressure, while human workers handle exceptions. A review in *Precision Agriculture* emphasized that harvesting success rate, cycle time, and damage rate determine the commercial viability of harvesting robots. For honeysuckle, this supports an agronomy-to-robotics feedback loop: canopy and field layout should be simplified to narrow the gap between robotic performance and economic feasibility (Zhou et al., 2022).

Engineering literature has also explored multi-crop flower harvesting. A design and field experiment paper on a multi-species flower crop harvester described the use of YOLOv8s-seg for navigation and path segmentation, and emphasized low-damage harvesting for dense flower clusters in large-scale planting bases, including *Lonicerae japonicae*. This may be useful for enterprises with diversified flower-crop production, where shared machinery could improve economic efficiency (Deng et al., 2025).

4 Application Effects of Simplified Cultivation Techniques

4.1 Effects on plant growth

Plant growth responses are most clearly documented when simplification comes in the form of optimized water or nutrient rules. The Loess Plateau formula fertilization study reported that N, P, and K application significantly improved yield and identified phosphorus as a limiting factor; while “growth vigor” is not always directly measured, yield increase under nutrient optimization implies improved reproductive performance under those conditions (Jiang et al., 2025).

In water management, the brackish-water irrigation study framed its work as supporting water-saving irrigation and identifying a new agricultural use for saline-alkali land; it analyzed biomass allocation and C/N stoichiometry, which are directly relevant to stress physiology and plant vigor under constrained water quality (Liu et al., 2025).

Soil-mediated growth effects are also part of the picture. Gravel-mulched land research reported improvements in soil nutrient indicators and bacterial community diversity across cultivation years, which is consistent with the idea that soil biological health can support sustained plant performance. Continuous cropping microbiome work likewise highlights that shifts in bacterial communities can be linked to plant health and pathogen suppression potential (Wang et al., 2023; Ma et al., 2024).

4.2 Effects on yield and quality

Yield stability is difficult to prove without multi-year replicated data, but several studies provide pieces of the

stability argument by demonstrating that standardized interventions produce measurable yield effects. The Loess Plateau formula fertilization trial reported that formula fertilizer application increased yield by 38.18% compared with the control and increased economic benefit per plant, suggesting that a simplified nutrient recipe can reduce yield variability caused by under- or mis-fertilization (Jiang et al., 2025).

Regional cultivation mode studies also suggest that honeysuckle can be scaled when a workable production package exists. In gravel-mulched land, the introduction and expansion of honeysuckle cultivation is described alongside yield figures and economic outputs at scale, implying that the crop can perform reliably enough for enterprises and local governments to expand hectare coverage (Wang et al., 2023).

Quality discussions for honeysuckle tend to revolve around secondary metabolite content and correct botanical identity. A *Frontiers in Plant Science* study using HPLC and the MaxEnt model found significant variation in key compounds, including chlorogenic acid and related markers, across habitats and produced “quality zoning” maps that identify where high-quality honeysuckle tends to occur (Figure 2). This is crucial for simplified cultivation because it implies that quality management begins with region selection and site choice, not only with in-field inputs (Cheng et al., 2024).

Regional suitability and quality zoning of *Lonicera japonica* (Honeysuckle) in China
 (Based on MaxEnt modeling and HPLC quality analysis)

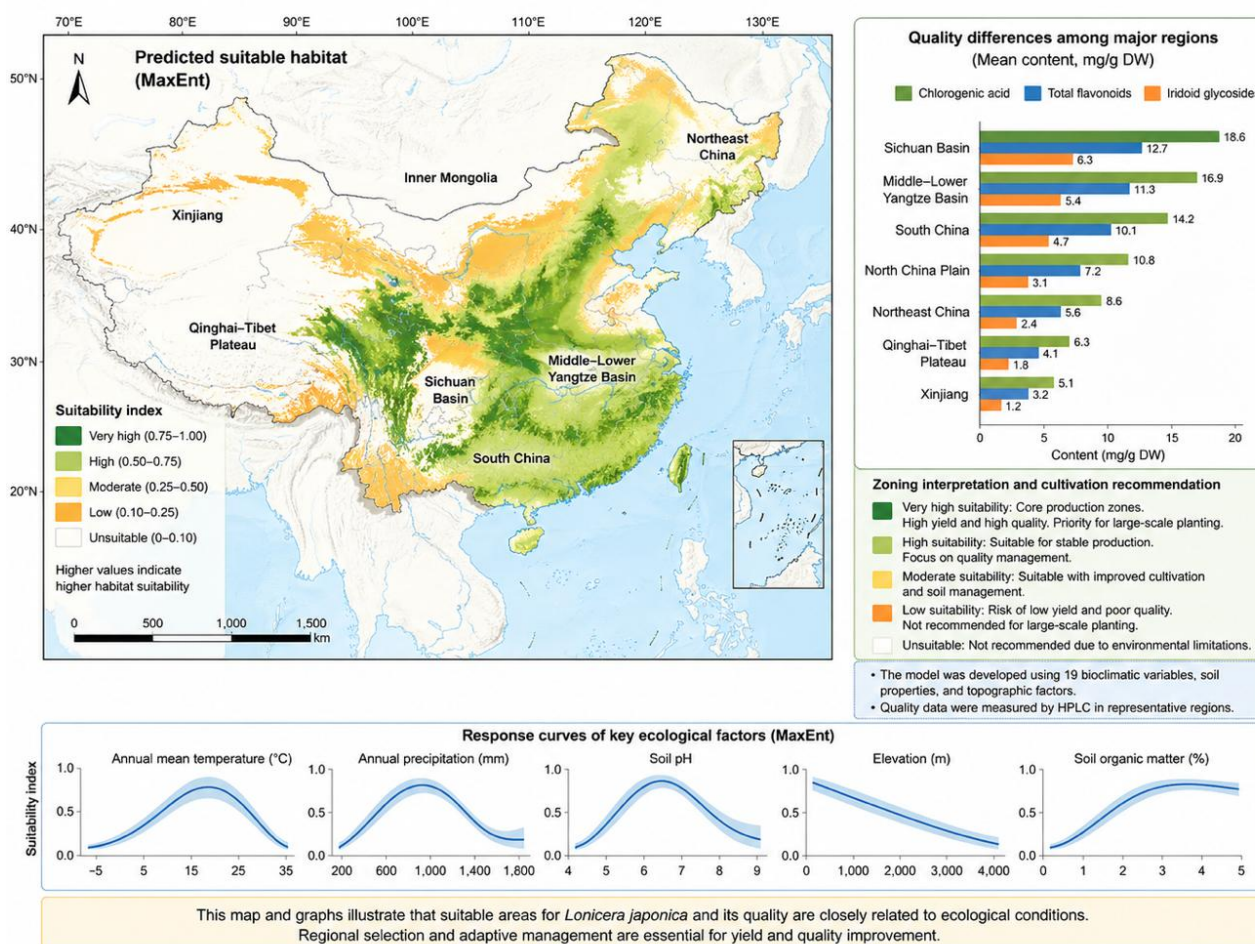


Figure 2 Regional suitability and quality zoning of *Lonicera japonica*

Quality is also linked to genetic background and domestication. Domestication comparisons between wild and cultivated populations documented biochemical differences and linked them to pharmacopoeia-related standards, making the case that “cultivated” should not simply mean “higher yield,” but “meeting consistent quality thresholds” (Hou et al., 2025).

Harvest timing and organ selection are additional quality levers. The *PLOS ONE* buds-versus-flowers study documented that flower buds and flowers have both shared and differential compound profiles and argued for rational utilization; for field systems, this supports simplified harvesting rules that separate products by intended use, such as medicinal buds and functional flower products, rather than forcing everything through one grading lens (Tong et al., 2025).

4.3 Labor and cost reduction

Direct head-to-head farm labor budgets are still relatively scarce in the open literature, but mechanization studies quantify the operational parameters that drive labor substitution. The IFAC selective picking robot study provided seconds-per-bud harvest time and damage/success rates in field testing; while this does not automatically convert to cost savings, it defines the “unit operation” costs and helps estimate how much human labor could be displaced under different adoption scenarios (Rui et al., 2025a).

Similarly, the *Biosystems Engineering* straddle-frame robot evaluation provides field metrics for detection and picking success and highlights damage risk depending on picking point, implying that canopy training and bud positioning, as agronomic choices, can directly affect the feasibility of labor-saving via robotics (Rui et al., 2025b).

Field simplification is not only about robots; it can also reduce manual operations such as repeated corrective pruning or repeated pest intervention. Cultural disease control guidance that emphasizes spacing and sun exposure effectively shifts labor from reactive spraying to preventive design, often reducing total intervention frequency (Pscheidt, 2025).

4.4 Economic benefits

Economic analysis becomes most persuasive when it is reported as part of a field trial rather than modeled hypothetically. In the Loess Plateau formula fertilization study, the authors computed economic benefits per plant and reported an additional USD 0.3729 per plant under formula fertilization along with yield increase. They also reported output-to-investment ratios for different fertilizer treatments, showing that maximizing yield is not always identical to maximizing economic ratio (Jiang et al., 2025).

Large-scale regional cultivation examples provide another kind of economic evidence: gravel-mulched land honeysuckle expansion was associated with reported large output values and yield levels at scale, including hectares and total output value, indicating that cultivation packages can translate into regional economic programs (Wang et al., 2023).

A simple, transparent way to connect agronomic change to economics-especially when farms have their own local price and labor conditions-is a partial budget equation:

Net benefit of simplification = $(\Delta\text{Yield} \times \text{Product price}) + (\Delta\text{Quality premium}) - (\Delta\text{Variable costs}) - (\Delta\text{Labor costs})$

This structure matches the logic used in agronomic papers that calculate economic benefit from yield and input data, and it can be implemented using farm-specific prices and wages without inventing new biological data (Jiang et al., 2025).

5 Application in Production Practice

5.1 Application in different cultivation modes

Open-field cultivation remains the dominant mode for honeysuckle in many regions, and it is the most relevant context for simplified cultivation packages. EMA’s GACP guideline notes that outdoor cultivation is the most common system for medicinal plants, while also acknowledging that greenhouse and indoor systems can offer more control over environmental factors. For honeysuckle, open-field simplification focuses on standardized planting geometry, predictable pruning, and formula-based fertilization that can be implemented without specialized infrastructure (European Medicines Agency, 2025).

Large-scale plantations face different “simplification priorities”: the aim is not only to reduce complexity for a single household farm, but to make practices repeatable across hundreds or thousands of hectares. The Loess Plateau study described a large planting base of 6,667 ha as part of poverty alleviation and development initiatives, illustrating how large-scale plantation contexts demand technical recipes that are easy to deploy and supervise (Jiang et al., 2025).

Mechanization becomes more plausible at scale because equipment utilization improves. Field-tested honeysuckle picking robots and multi-species flower harvesters are explicitly motivated by large-scale planting bases and dense flowering periods; these tools are less likely to be adopted where planting patterns are irregular and acreage is fragmented (Rui et al., 2025; Deng et al., 2025).

5.2 Adaptability in different regions

Honeysuckle production is highly regionalized, and simplification must be adapted rather than copied. Several recent studies offer region-specific evidence that can be treated as “modules” in a larger technical toolkit.

In the hilly and gully Loess Plateau of central Gansu, formula fertilization modeling produced per-plant nutrient recommendations and quantified yield and economic gains, providing a directly transferable “fertilization module” for similar soils and climates (Jiang et al., 2025).

In the Yellow River Delta saline-alkali context, brackish-water irrigation experiments aimed to support water-saving irrigation and explore new uses of marginal land. This represents a “water module” relevant to saline-alkali regions where water quality constraints limit cultivation (Liu et al., 2025).

In Ningxia gravel-sand mulched fields, both soil ecology research and nutrient-focused studies on boron fertilization reflect a third cultivation mode that integrates land-surface mulching with nutrient management. Together, these studies support a regionally tailored simplification approach rather than one national recipe (Wang et al., 2023; Bao et al., 2022).

Finally, habitat-quality mapping using MaxEnt and HPLC provides a macro-level tool for regional planning: it identifies where high-quality honeysuckle is likely to occur and how suitable areas may shift under future climate scenarios. This can help enterprises decide where to expand plantations, or where expansion would likely require additional management inputs to reach quality targets (Cheng et al., 2024).

5.3 Management considerations in practice

Real-world management is often where simplification succeeds or fails. Three considerations consistently emerge from authoritative guidance and research.

First, documentation and traceability are not optional for medicinal plant enterprises aiming for stable quality. WHO GACP emphasizes recording and documentation, while EMA’s guideline frames cultivation, harvest, and primary processing as quality-critical operations requiring quality assurance systems (World Health Organization, 2003; European Medicines Agency, 2025).

Second, training is a bottleneck. WHO guidance explicitly notes the difficulty of training farmers and other handlers, highlighting a gap between guidelines and implementation. A practical implication is that simplified protocols should be written as operational steps, such as what to do, when to do it, and how much input to apply, rather than as broad principles (World Health Organization, 2003).

Third, variety identity management is foundational. SNP fingerprinting work shows that mixed varieties and unclear genetic relationships create systemic problems. In practical terms, simplified cultivation at scale likely requires certified propagation material and clear variety naming or registration within the enterprise’s internal system (Li et al., 2023).

6 Case Study

6.1 Background of a production base

A documented example of simplified technique implementation comes from Tongwei County in central Gansu Province, located in the hilly and gully region of the Loess Plateau. A PLOS ONE study reported that a high-end *L. japonica* planting base spanning 6,667 ha had been established within Tongwei Qingliang Yuan Limited Liability Company as part of a poverty alleviation and development initiative in the honeysuckle industry (Figure 3) (Jiang et al., 2025).

Number	Treatment	N-coded value	P-coded value	K-coded value	Fertilization amount (g/plant)		
					N	P ₂ O ₅	K ₂ O
1	N ₀ P ₀ K ₀	0	0	0	0	0	0
2	N ₀ P ₂ K ₂	0	2	2	0	10	16
3	N ₁ P ₂ K ₂	1	2	2	15	10	16
4	N ₂ P ₀ K ₂	2	0	2	30	0	16
5	N ₂ P ₁ K ₂	2	1	2	30	5	16
6	N ₂ P ₂ K ₂	2	2	2	30	10	16
7	N ₂ P ₃ K ₂	2	3	2	30	15	16
8	N ₂ P ₂ K ₀	2	2	0	30	10	0
9	N ₂ P ₂ K ₁	2	2	1	30	10	8
10	N ₂ P ₂ K ₃	2	2	3	30	10	24
11	N ₃ P ₂ K ₂	3	2	2	45	10	16
12	N ₁ P ₁ K ₂	1	1	2	15	5	16
13	N ₁ P ₂ K ₁	1	2	1	15	10	8
14	N ₂ P ₁ K ₁	2	1	1	30	5	8

<https://doi.org/10.1371/journal.pone.0323828.t001>

Figure 3 Experimental design of ‘3414’ test (Adopted from Jiang et al., 2025)

6.2 Implementation of simplified techniques

The core “simplified” intervention in this case is formula fertilization based on a 3414 experimental design. The study applied N, P, and K fertilizers in a one-time manner before germination using ditch/pit application, with a small pit 30 cm deep around the root area, and maintained planting geometry at 1.0 m × 1.0 m. In this case, simplification is achieved by replacing ad hoc fertilization decisions with model-based nutrient combinations and recommended per-plant dosage ranges (Jiang et al., 2025).

6.3 Application results

The trial found that N, P, and K application significantly improved yield and that phosphorus was the primary limiting factor affecting yield in this soil context. Among treatments, the study reported yields and economic benefits per plant and identified high-performing fertilizer combinations. Most importantly for a “simplification” discussion, the study reported that formula fertilizer application resulted in a 38.18% yield improvement and an additional USD 0.3729 economic benefit per plant compared with the control (Jiang et al., 2025).

6.4 Economic benefit analysis

The study’s economic analysis included output-to-investment ratios for fertilizer treatments, showing that different nutrient combinations differ not only biologically but also economically. This is a practical reminder that simplified recommendations should be selected according to the farm’s objective, such as maximizing profit, improving yield, or reducing production risk, rather than yield alone. The reported additional economic benefit per plant under formula fertilization provides a direct and traceable indicator of profitability impact in that local context (Jiang et al., 2025).

6.5 Practical experience and promotion value

Two success factors stand out. The first is localization: the fertilization model and recommendations were developed under the region’s specific soil and climate conditions, which reduces the risk that a “standard recipe” fails under different constraints. The second is operational clarity: the study expresses recommended nutrient doses as ranges in grams per plant, which is a format that field managers can implement and supervise more easily (Jiang et al., 2025).

Replicability depends on whether other production bases can reproduce the key enabling conditions: stable planting geometry, consistent timing before germination, and the ability to apply fertilizers accurately at the per-plant level. While the model itself is region-specific, the broader approach-using experimental design to build a simple rule set tied to yield and profit-can be replicated elsewhere with local trials (Jiang et al., 2025).

7 Existing Problems and Limitations

7.1 Incomplete technical standardization

Even when strong evidence exists for a specific technique, standardization across regions and farms can still lag behind. Variety identity and naming are a clear example. Germplasm research has shown that mixed varieties and non-standardized management can become obstacles to breeding, germplasm conservation, and variety promotion, which means that technical packages cannot be truly standardized unless the planting material itself is standardized first (Li et al., 2023).

Similar standardization challenges also appear in quality control. Studies integrating chemical fingerprints and bioactivity evaluation, such as anti-SARS-CoV-2 Mpro inhibition, indicate that correct botanical identification and appropriate marker selection are important for distinguishing *Lonicerae japonicae flos* from related materials. However, the translation of laboratory-based marker systems into farm-level quality management remains uneven (Gu et al., 2021).

7.2 Differences in farmer adoption

Adoption is shaped by risk perception, labor availability, and access to training. WHO GACP guidance notes that training farmers and handlers is difficult and that a persistent gap often exists between technical knowledge and actual implementation. In honeysuckle production, where harvest timing is strict and labor demand is concentrated, farmers may hesitate to adopt new simplified practices if they worry that such changes could increase the risk of missing the best harvest window, even when the long-term benefits are reasonable (World Health Organization, 2003).

7.3 Regional adaptability issues

The evidence base shows clear regional effects. Habitat-quality modeling demonstrates that ecological variables influence both distribution suitability and metabolite accumulation, and it also predicts possible shifts in suitable production areas under future climate scenarios. Meanwhile, irrigation research under brackish-water conditions suggests that management packages for saline-alkali regions should differ from those used in conventional soils. Therefore, regional adaptability is not a secondary issue; it is central to whether simplified cultivation packages remain effective after being transferred to new production areas (Cheng et al., 2024; Liu et al., 2025).

7.4 Need for technical training

Training is the connective link between technical evidence and field outcomes. WHO guidance emphasizes that training is an important measure for ensuring the adoption of good agricultural and collection practices. The updated EMA guideline also stresses personnel competence, documentation, and quality management throughout cultivation and primary processing. For honeysuckle, training needs are especially important in three areas: recognizing flower bud stages and harvest timing, applying formula fertilization correctly, and identifying pests and pathogens early enough for preventive management (World Health Organization, 2003; European Medicines Agency, Committee on Herbal Medicinal Products, 2025; Li et al., 2025).

8 Optimization Strategies and Future Perspectives

8.1 Improvement of simplified techniques

A practical improvement strategy is to treat simplification as modular: refine each module, including variety selection, spacing and canopy structure, nutrient recipe, pest protocol, and harvest plan, and then recombine these modules according to region and production scale.

On the planting side, genetic identification tools such as streamlined SNP fingerprints can support certified nursery systems and reduce variety confusion. This is not merely academic; it is a direct response to documented

problems of mixed varieties and unclear genetic relationships in honeysuckle germplasm resources (Li et al., 2023).

On the nutrient side, formula fertilization approaches should be expanded beyond single-location trials. The success of a 3414-designed fertilization model in improving yield and economic benefit suggests that similar local models could be developed for other regions, such as gravel-mulched cultivation areas, instead of directly importing Loess Plateau recommendations without regional testing (Jiang et al., 2025).

8.2 Integration with modern agriculture

Modern agricultural integration includes both digital and biological approaches. On the digital side, habitat modeling that combines chemical data with ecological variables can guide plantation expansion and risk zoning. This approach can become part of enterprise decision-making, helping managers decide where to plant, what quality profile to expect, and what additional management measures may be required (Cheng et al., 2024).

On the biological side, biotechnology tools are increasingly relevant. A recent review on chlorogenic acid biosynthesis and tissue culture in *L. japonica* indicates that tissue culture can support rapid propagation, germplasm preservation, and secondary metabolite production. This suggests a possible route for producing disease-free and standardized planting materials, and may also support controlled production of key metabolites. Although tissue culture is not a “simplified” field technique for ordinary farmers, it can simplify the upstream supply of uniform seedlings for plantations (Cheng et al., 2025).

8.3 Promotion and extension strategies

Promotion strategies should focus on what farmers can repeat, not only on what researchers can optimize in one trial. In this respect, GACP guidance is still important. WHO emphasizes cultivation techniques, documentation, and farmer training, while EMA guidelines provide a structured quality-management framework that can be translated into enterprise standard operating procedures (World Health Organization, 2003; European Medicines Agency, 2025).

FAO training materials on GACP for medicinal plants also describe GACP as a practical guideline system that can create income opportunities for rural producers while meeting the quality requirements of herbal industries. This reinforces the point that extension work should be connected with market pathways and practical training, rather than remaining only at the level of agronomic theory (Food and Agriculture Organization of the United Nations, n.d.).

8.4 Future development trends

The next stage of honeysuckle simplification will likely be defined by compatibility: compatibility between agronomy and quality systems, and compatibility between plant structure and mechanization.

Mechanization is developing rapidly. Field-tested honeysuckle selective picking robots have already reported measurable success and damage rates, while multi-species flower harvesting machines are being designed to harvest dense flower clusters with low damage. Broader reviews on fruit-harvesting robots also emphasize that commercial viability depends on harvest success rate, working speed, damage rate, and the simplification of the field environment. For honeysuckle, this suggests that future canopy training and field geometry should be designed not only for plant growth, but also for machine vision and mechanical movement (Rui et al., 2025; Deng et al., 2025; Zhou et al., 2022).

At the same time, quality control will become more spatial and predictive. Habitat-quality modeling shows that suitable production areas may shift under future climate scenarios and identifies regions associated with high-quality profiles. This means that enterprises may increasingly integrate climate risk and quality zoning into planting decisions (Cheng et al., 2024).

Acknowledgments

We extend our sincere gratitude to the anonymous reviewers for their valuable and insightful comments, which have greatly strengthened this paper.

Conflict of Interest Disclosure

The authors affirm that this research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

References

- Bao Y.M., Liu H., Li M., and Ma B., 2022, Effects of boron fertilizer on the yield and chlorogenic acid content of *Lonicera japonica* Thunb. in Ningxia gravel-sand mulched field, Northern Horticulture, 15: 113-120.
- Cheng J., Chen Y., Guo F., Dong P., Zhou C., Liang W., and Wang H., 2025, Regulatory mechanisms and biosynthesis of chlorogenic acid in *Lonicera japonica*: Insights from tissue culture and inducer treatments, Frontiers in Plant Science, 16: 1567140.
<https://doi.org/10.3389/fpls.2025.1567140>
- Deng F., Li X., Cheng H., and Yu H., 2025, Design and field experiment of multi-species flower crops harvester, Journal of Agricultural Mechanization Research, 47(6): 39-45.
<https://doi.org/10.19998/j.cnki.2095-1795.202506039>
- European Medicines Agency, 2025, Guideline on Good Agricultural and Collection Practice (GACP) for starting materials of herbal origin (Final-Revision 1; EMA/HMPC/246816/2005), EMA Guideline, N/A: N/A.
- Food and Agriculture Organization of the United Nations, n.d., Trainers' manual on good agricultural and collection practices (GACP) for medicinal plants, FAO, N/A: N/A.
- Gu L., Xie X., Wang B., Jin Y., Wang L., Yin G., Wang J., Bi K., and Wang T., 2021, Chemical pattern recognition for quality analysis of *Lonicerae japonicae* flos and *Lonicerae flos* based on ultra-high performance liquid chromatography and anti-SARS-CoV2 main protease activity, Frontiers in Pharmacology, 12: 810748.
<https://doi.org/10.3389/fphar.2021.810748>
- He P., Cui W., and Peng L., 2022, Biocontrol efficacy of *Bacillus velezensis* HC-8 against powdery mildew of honeysuckle caused by *Erysiphe lonicerae* var. *Lonicerae*, Biological Control, 166: 104815.
<https://doi.org/10.1016/j.biocontrol.2021.104834>
- Hou C., Huang L., Li Z., Sun N., Yang S., Li J., and Liu Z., 2025, Domestication of medicinal plants (*Lonicera japonica* Thunb.) in China: Comparison of morphological, resistance and biochemical traits between wild and cultivated populations, Frontiers in Plant Science, 15: 1501396.
<https://doi.org/10.3389/fpls.2024.1501396>
- Jiang X., Guo J., Li S., Chen Y., Shi Z., Xu P., Zhang Y., Wang L., Zhao H., and Liu Q., 2025, Nitrogen, phosphorus and potassium formula fertilization model of *Lonicera japonica* Thunb in hilly and gully Loess Plateau of China, PLOS ONE, 20(6): e0323828.
<https://doi.org/10.1371/journal.pone.0323828>
- Li J., Chang X., Huang Q., Liu P., Zhao X., Li F., Wang Y., and Chang C., 2023, Construction of SNP fingerprint and population genetic analysis of honeysuckle germplasm resources in China, Frontiers in Plant Science, 14: 1080691.
<https://doi.org/10.3389/fpls.2023.1080691>
- Li Y., Gan Y., Qi G., Xu W., Xin T., Huang Y., Fu L., Hao L., Lou Q., Fu X., Wei X., Liu L., Liu C., and Song J., 2025, Transcription factor LjWRKY50 affects jasmonate-regulated floral bud duration in *Lonicera japonica*, Plants, 14(15): 2328.
<https://doi.org/10.3390/plants14152328>
- Liu X., Xie M., Wen S., He W., Li T., Zhang M., Wang X., and Zhang D., 2025, Effects of brackish water irrigation on biomass allocation and carbon, nitrogen stoichiometry in *Lonicera japonica*, Scientific Reports, 15: 23972.
<https://doi.org/10.1038/s41598-025-08769-7>
- Ma Q., Li L., Han X., Jiang X., Zhou Y., Wang T., Zhuang Y., and Ruan Z., 2024, Structural and functional analysis of the bacterial community in the soil of continuously cultivated *Lonicera japonica* Thunb. and screening antagonistic bacteria for plant pathogens, Agronomy, 14(2): 260.
<https://doi.org/10.3390/agronomy14020260>
- Pscheidt J.W., 2025, Honeysuckle (*Lonicera* spp.)-Powdery mildew, Pacific Northwest Pest Management Handbooks, N/A: N/A.
- Qin S., Chen X., Jiang C., Li M., Yuan Y., Yang J., and Wu Q., 2019, Pruning induced yield and quality variations and the correlated gene expression and phytohormone changes in *Lonicera japonica*, Industrial Crops and Products, 132: 386-395.
<https://doi.org/10.1016/j.indcrop.2019.02.048>
- Rui Z., Zhang Z., Hao C., Igathinathane C., Azizi A., Wu X., Zhang M., Abid F., and Javidan S.M., 2025, Development and field evaluation of a straddle-frame honeysuckle harvesting robot, Biosystems Engineering, 257: 104234.
<https://doi.org/10.1016/j.biosystemseng.2025.104234>
- Rui Z., Zhang Z., Jia Y., Zhang M., Li M., and Wang R., 2025, Design and field evaluation of a honeysuckle selective picking robot, IFAC-PapersOnLine, 59(23): 309-314.
<https://doi.org/10.1016/j.ifacol.2025.11.805>

- Tong K., Dai L., Rui W., Zhang Y., Fu J., Liao Y., Wang H., Li X., Chen Z., and Liu Q., 2025, GC-MS, LC-MS, and network pharmacology analysis to investigate the chemical profiles and potential pharmacological activities in flower buds and flowers of *Lonicera japonica* Thunb., PLOS ONE, 20(4): e0320293.
<https://doi.org/10.1371/journal.pone.0320293>
- Wang X., Ma B., Liu H., Bao Y., Li M., McLaughlin N.B., and Guo L., 2023, Improvement in gravel-mulched land soil nutrient and bacterial community diversity with *Lonicera japonica*, Frontiers in Microbiology, 14: 1225503.
<https://doi.org/10.3389/fmicb.2023.1225503>
- World Health Organization, 2003, WHO guidelines on good agricultural and collection practices (GACP) for medicinal plants, WHO Press, N/A: N/A.
- Zhang R., Zhang M.X., Chen Y., Wang C.C., Zhang C.H., Heuberger H., Li H.T., and Li M.H., 2021, Future development of good agricultural practice in China under globalization of traditional herbal medicine trade, Chinese Herbal Medicines, 13(4): 472-479.
<https://doi.org/10.1016/j.chmed.2021.09.010>
- Zhou H., Wang X., Au W., Kang H., and Chen C., 2022, Intelligent robots for fruit harvesting: Recent developments and future challenges, Precision Agriculture, 23: 1856-1907.
<https://doi.org/10.1007/s11119-022-09913-3>



Disclaimer/Publisher's Note

The statements, opinions, and data contained in all publications are solely those of the individual authors and contributors and do not represent the views of the publishing house and/or its editors. The publisher and/or its editors disclaim all responsibility for any harm or damage to persons or property that may result from the application of ideas, methods, instructions, or products discussed in the content. Publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.
