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Optimization of Perennial Cultivation Models and Continuous Production Management Strategies for *Paeonia lactiflora*

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Abstract *Paeonia lactiflora* Pall. is an important perennial medicinal and ornamental plant. However, its industrial development is constrained by a long propagation cycle, continuous cropping obstacles, limited ecological adaptability, and insufficient standardization of production management. This review systematically synthesizes the growth characteristics, cultivation models, and key management technologies of perennial *P. lactiflora*, and explores strategies for optimizing continuous production systems. The reviewed literature indicates that traditional open-field cultivation has advantages of strong adaptability and low production costs but is vulnerable to environmental fluctuations and soil-related problems. Large-scale standardized cultivation improves production stability through tissue culture, elite seedling propagation, and precision management, whereas ecological and green cultivation enhances quality improvement through soil health maintenance, rhizosphere microbiome regulation, and biological control. Future production should focus on establishing a collaborative optimization model integrating cultivar selection, environmental adaptation, and cultivation management, while developing continuous production systems covering seedling propagation, soil regulation, growth-stage management, and post-harvest processing. Furthermore, the integration of digital agricultural technologies will promote precision and intelligent management, providing technical support for the sustainable development of the *P. lactiflora* industry.

Keywords *Paeonia lactiflora*; Perennial cultivation; Continuous production management; Continuous cropping obstacles; Precision cultivation

1 Introduction

Paeonia lactiflora Pall., a perennial herbaceous species in the family Paeoniaceae, has been used medicinally for over two millennia, with its processed root products-Paeoniae Radix Alba and Paeoniae Radix Rubra-occupying a central role in traditional Chinese medicine (Cai et al., 2026). The species is also globally renowned as an ornamental, cherished for its large, colorful, and fragrant flowers, and is widely cultivated as a landscape, potted, and cut-flower plant across European, North American, and Asian countries (Li et al., 2023). Over 200 bioactive compounds have been identified from *P. lactiflora*, including monoterpene glycosides, flavonoids, and polysaccharides, with paeoniflorin as the principal pharmacologically active constituent underpinning its anti-inflammatory, antioxidant, hepatoprotective, and neuroprotective effects. Given its dual medicinal and ornamental value, *P. lactiflora* serves as both an agricultural cash crop and a traditional famous flower, and market demand for high-quality seedlings and cut flowers has increased considerably in recent years.

In Japan alone, annual peony root consumption reached approximately 1 712 tons in fiscal year 2020, with roughly 98% of supply imported from China, underscoring strong international demand. China possesses rich germplasm resources across five main producing areas-Anhui, Zhejiang, Sichuan, Shandong, and Hunan-where 12 medicinal cultivars have been documented, including eight monopetalous red-flower types. Since 1900, over 2 200 new horticultural *Paeonia* cultivars have been created worldwide through the discovery and breeding of wild species, reflecting rapid industrialization (Yang et al., 2020).

However, the species is naturally distributed in temperate regions (hardiness zones 3~7), and expanding cultivation into lower-latitude subtropical and tropical zones remains a significant horticultural objective constrained by hot-humid climates (Zhang et al., 2019a). Climate modeling projects a 25~45% expansion of total suitable habitat under future warming scenarios, accompanied by a northeastward centroid shift, suggesting both