

Review and Progress

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Evaluation of the Effects of Water and Fertilizer Management on Fruit Yield and Quality Formation in *Rubus chingii*

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Abstract This review evaluates the effects of water and fertilizer management on fruit yield and quality formation in *Rubus chingii* Hu, aiming to provide a theoretical basis for high-quality cultivation and industrial production of *R. chingii*. As an important medicinal and edible plant resource, *R. chingii* fruits contain abundant flavonoids, phenolic compounds, terpenoids, ellagic acid, kaempferol-3-O-rutinoside, and other bioactive constituents, exhibiting high medicinal value and development potential. However, current production still faces challenges including unstable yield, significant variation in fruit quality, and inconsistent accumulation of medicinal active compounds. This study systematically analyzed the effects of water supply, nitrogen-phosphorus-potassium nutrient management, and water-fertilizer coupling regulation on plant growth, fruit yield formation, fruit quality characteristics, and bioactive compound accumulation in *R. chingii*. Evidence from *R. chingii* and related fruit crops suggests that enhanced photosynthetic capacity and water-use efficiency, and provided sufficient material resources for fruit development. Balanced nitrogen, phosphorus, and potassium application optimized plant nutritional status, promoted biomass accumulation, and improved fruit-setting capacity and yield performance. Integrated water-fertilizer regulation coordinated yield and quality improvement by regulating carbon assimilation, nutrient uptake and transport, and secondary metabolic pathways. Meanwhile, water and fertilizer conditions played important roles in regulating fruit appearance quality, sugar-acid composition, nutritional quality, and the accumulation of medicinal active compounds such as flavonoids and phenolic compounds. Current research on *R. chingii* water-fertilizer management still faces limitations, including insufficient understanding of water and nutrient requirements at different growth stages, incomplete technical systems and production standards, and limited knowledge of the mechanisms underlying the coordinated improvement of yield and quality. Future studies should integrate cultivar characteristics, growth stages, and environmental conditions to establish precision water-fertilizer regulation models, promote integrated water-fertilizer technologies and smart agriculture approaches, and achieve coordinated improvements in yield, quality, and resource-use efficiency, thereby supporting standardized cultivation and sustainable industrial development of *R. chingii*.

Keywords *Rubus chingii*; Water and fertilizer management; Fruit yield; Quality formation; Precision regulation

1 Introduction

Rubus chingii Hu is a medicinal and edible plant with long-standing use in China and substantial potential for coordinated development of herbal medicine, functional foods, and fruit processing industries (Yu et al., 2019; He et al., 2023). Its dried unripe fruit is the official Rubi Fructus recorded in the Chinese Pharmacopoeia, while the ripe fruit is also consumed directly or processed into products such as juice, jam, wine, vinegar, beverages, and teas, reflecting its dual-use value in medicine and food (Liu et al., 2023; Xiong et al., 2024; Wu et al., 2024). Traditional records and modern reviews consistently describe *R. chingii* as useful for nourishing the kidney and liver, consolidating essence, reducing urination, and improving vision, and modern studies further attribute antioxidant, anti-inflammatory, antitumor, immunomodulatory, hypoglycemic, anti-aging, and neuroprotective activities to its diverse phytochemicals (Sheng et al., 2020). Chemically, the fruit is rich in terpenoids, flavonoids, phenolic compounds, organic acids, vitamins, amino acids, polysaccharides, and related secondary metabolites, with ellagic acid and kaempferol-3-O-rutinoside currently used as representative quality markers (Yu et al., 2019; Wu et al., 2024). Recent work also shows that the accumulation of these compounds varies markedly with genotype, tissue, origin, and fruit developmental stage, indicating that medicinal quality and edible quality are both dynamic traits rather than fixed characteristics (Li et al., 2025).