

4 Regulatory Effects of Cultivation Measures on Fruit Quality

4.1 Water and fertilizer management measures

Water and fertilizer management is an important cultivation practice affecting the formation of Chinese bayberry fruit quality and is directly related to fruit enlargement, sugar accumulation, sugar-acid balance, and yield stability. Rational fertilization provides the nutritional basis for tree growth and fruit development, among which nitrogen, phosphorus, and potassium have particularly significant effects on fruit quality. Appropriate nitrogen application promotes branch and leaf growth as well as photosynthesis; however, long-term excessive chemical fertilizer input, especially excessive nitrogen fertilization, can easily result in excessive tree vigor, decreased fruit sugar content, delayed ripening, intensified soil acidification, and organic carbon loss, which are unfavorable for the sustainable production of Chinese bayberry orchards (Hong et al., 2023). In contrast, moderately reducing nitrogen and phosphorus application can improve soil quality without significantly decreasing yield and fruit quality, indicating that balanced fertilization is more beneficial for stable production of high-quality Chinese bayberry than simply increasing fertilizer input (Chen et al., 2025).

Potassium fertilizer generally promotes sugar accumulation, peel coloration, and flavor formation, whereas phosphorus fertilizer is closely associated with root development and flower bud differentiation. Specialized compound fertilizers developed for Chinese bayberry can improve soil organic matter and nutrient content, increase leaf biomass and chlorophyll content, and enhance fruit total sugar, reducing sugar, and soluble solids contents. Among different application rates, approximately 8 kg per tree applied in two split applications showed favorable effects (Wu et al., 2021). Foliar nutrient regulation also has considerable application potential. Amino acid foliar fertilizer treatment on ‘Dingao’ Chinese bayberry significantly increased soluble solids, total sugars, sugar-acid ratio, and soluble solids/titratable acidity ratio, while reducing total acidity and improving postharvest water loss and decay rates, indicating its ability to simultaneously improve eating quality and storage tolerance.

Micronutrients and water management also influence Chinese bayberry fruit quality. Boron deficiency can cause small leaves, bud dieback, and reduced flowering and fruiting, whereas soil boron application or foliar boron spraying can improve fruit set, yield, single-fruit quality, and sugar-acid ratio. Combined application of boron fertilizer and paclobutrazol can also alleviate alternate bearing. In addition, intercropping ryegrass in Chinese bayberry orchards can improve rhizosphere soil properties and microbial environments, increase fruit sugar, vitamin C, and flavonoid contents, and reduce acidity, thereby providing a new technical approach for ecological water and fertilizer management (Li et al., 2023). Regarding water management, adequate water supply should be ensured during the fruit enlargement stage, whereas excessive rainfall or drastic soil moisture fluctuations during the ripening stage can easily lead to fruit cracking, sugar dilution, and increased decay. Therefore, precise irrigation and drainage management should be implemented according to different fruit developmental stages.

4.2 Tree, flower, and fruit management

Tree structure and flower-fruit management can influence Chinese bayberry fruit quality by regulating canopy microenvironment, source-sink relationships, and reproductive load. Proper training and pruning can improve canopy ventilation and light penetration, enhance leaf photosynthetic efficiency, and promote nutrient accumulation and uniform fruit coloration. Chinese bayberry trees generally have large canopies, and if not pruned for long periods, dense canopy closure can occur, resulting in insufficient inner-canopy light, increased pest and disease incidence, and uneven fruit coloration. Therefore, orchard management commonly includes thinning overly dense branches, vigorous shoots, and weak or diseased branches to optimize canopy structure and improve fruit commercial quality and ripening consistency.

Flower and fruit management is an important approach for regulating nutrient distribution and improving fruit quality. Excessive fruit load intensifies nutrient competition among fruits, leading to reduced single-fruit weight and insufficient sugar accumulation. Moderate flower and fruit thinning can reduce ineffective nutrient consumption and direct more assimilates toward retained fruits, thereby improving fruit size, coloration, soluble solids content, and sugar-acid ratio. The combined regulation of paclobutrazol and boron fertilizer has also been used to balance vegetative and reproductive growth. Spraying 100-200 mg·L⁻¹ paclobutrazol during the