effects of excess water. In medicinal plants that are prone to root diseases, rain-shelter facilities can effectively reduce the direct impact of rainfall on soil, lower soil moisture and root rot incidence, and increase soil enzyme activity and beneficial microbial populations, sometimes performing even better than fertilization measures (Abd El-Hafez et al., 2020).

5.4 Technical measures to prevent fruit cracking

Preventing fruit cracking requires careful control of fruit water relations, especially during the rapid fruit expansion and ripening stages. In many fleshy fruits, heavy rainfall or excessive irrigation before harvest can cause a sudden increase in soil or fruit water content, leading to a large water gradient between the peel and the flesh. Applying mild deficit irrigation (80%-100% of full irrigation) at appropriate stages can maintain or slightly increase yield while improving water productivity. This approach works well around the flowering period but is not suitable during the late fruit expansion stage (Wen et al., 2023).

6 Fruit Quality Improvement Techniques

6.1 Measures to improve fruit size, color, and sugar content

Compared with open-field cultivation, greenhouse cultivation significantly increases single fruit weight, fruit diameter, soluble solids content, and the sugar–acid ratio of bayberry. This is mainly due to enhanced sucrose accumulation and increased activity of related enzymes, indicating that optimizing the microclimate and carbohydrate metabolism is a key way to improve fruit size and sweetness (Wu et al., 2021). In Chinese bayberry, the use of insect-proof and rain-proof nets can increase fruit diameter and weight by 22.6% and 82.4%, respectively, with the proportion of high-grade fruit exceeding 91%. At the same time, soluble solids and sucrose content are increased while titratable acidity is reduced. This shows that isolating fruit from rainwater and pests not only protects the fruit but also promotes sugar accumulation and flavor balance (Yu et al., 2021) (Figure 1). Under controlled light conditions, supplementing with LED light can significantly increase fruit weight, fruit diameter, soluble solids, and vitamin C content in the ‘Black Charcoal’ bayberry cultivar, while reducing organic acid content. This again highlights the key role of light quality and intensity in determining fruit size and sweetness (Tang et al., 2025).

6.2 Nutrient management during fruit expansion stage

Nutrient management during the fruit expansion stage should meet the high demand for carbohydrates, nitrogen, and mineral elements, while avoiding excessive promotion of vegetative growth. The soluble solids content and sugar–acid ratio of greenhouse-grown bayberry are higher than those in open-field cultivation, which is closely related to the increased activities of sucrose phosphate synthase and acid invertase. This suggests that maintaining leaf photosynthesis and the activity of sugar metabolism enzymes during the fruit expansion stage can directly improve fruit sweetness and flavor (Wu et al., 2021). Insect-proof and rain-proof nets not only protect bayberry fruits from pests and cracking, but also alter the microbial community structure on the fruit surface, which is beneficial for carbon and nitrogen metabolism and mineral transport. In other fruit trees, a balanced supply of nitrogen and potassium (often combined with biofertilizers) can promote fruit enlargement and increase soluble solids and vitamin content. However, excessive nitrogen in the later growth stage may delay coloration, dilute sugar content, and increase the risk of diseases (Kumar et al., 2022; Zahid et al., 2022).

7 Integrated Pest and Disease Management Measures

7.1 Identification of major pests and diseases in waxberry orchards

Waxberry is seriously threatened by twig blight, mainly caused by Pestalotiopsis versicolor and P. microspora. These pathogens have been confirmed as the key agents responsible for large-scale branch dieback in major production areas. In recent years, several other fungi have also been identified as important causal agents of twig blight (Ren et al., 2013; Li et al., 2020; Chen et al., 2021). Meanwhile, new leaf diseases continue to emerge. For example, leaf spot caused by Nigrospora aurantiaca shows a relatively high incidence and damage level in commercial orchards, especially on young leaves. This indicates that the disease spectrum of waxberry is expanding, and accurate diagnosis of newly emerging pathogens is critical for timely control (Fu et al., 2025).