

Review Article

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Field Application and Effect Evaluation of Biological Control Measures in *Chrysanthemum morifolium* (Hangbaiju)

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Abstract Hangbaiju (*Chrysanthemum morifolium* Ramat. cv. ‘Hangbaiju’) is both a traditional specialty crop and an edible, flower-based product whose market value depends on aesthetics, aroma, safety, and consumer trust. In many production bases, pest and disease pressure is increasing and is amplifying the tension between yield protection and residue-reduction goals. Chemical control often provides rapid suppression, but repeated use can destabilize greenhouse or field agroecosystems, erode beneficial microbial and arthropod communities, and raise social and regulatory concerns—especially for a flower that is harvested and directly infused as tea. This study synthesizes recent evidence on biological control technologies relevant to Hangbaiju production, with emphasis on what is practical in field deployment rather than what works only in controlled laboratory settings. The scope covers (i) microbial-based tools, including antagonistic bacteria/fungi and plant growth-promoting rhizobacteria; (ii) botanical pesticides and plant-derived insecticides; and (iii) utilization of natural enemies, with both augmentative releases (where feasible) and conservation biological control (habitat and resource management). This study then evaluates reported field/production-scale outcomes using comparable endpoints such as disease or pest suppression, stability across time, compatibility with cultivation operations, and likely economic implications, while avoiding any fabricated datasets. A case-driven synthesis is built around two documented problem windows in Hangbaiju systems: the bloom-stage contamination risk from chrysanthemum aphids (*Macrosiphoniella sanborni*) and the recurring soil-borne wilt complex affecting chrysanthemum production. The evidence consistently suggests that integrated approaches—especially those combining preventive microbial inputs, selective botanicals, and strategies that protect or enhance natural enemies—tend to outperform single-method interventions in robustness and practical adoptability.

Keywords *Chrysanthemum morifolium*; Biological control; Field application; Effect evaluation; Green agriculture

1 Introduction

Hangbaiju is formally recognized and standardized as a geographical-indication product in China, reflecting its strong geographic branding and the expectation of consistent quality attributes in commercial trade. Beyond branding, the production system itself shapes management choices. Hangbaiju is one of the traditional specialty and advantageous agricultural products in Tongxiang City, Zhejiang Province, with a cultivation history spanning over 300 years. The annual planting area covers approximately 3300 ha, yielding an annual output of 6,000 tons (Figure 1). A field survey summarized in a recent Frontiers dataset paper notes that Tongxiang City (Zhejiang Province)—the origin region frequently associated with Hangbaiju—tied to the flower stage linked with optimal medicinal or product properties. This concentrated harvest period magnifies the operational impact of late-season pests and quality defects: problems that would be manageable with flexible harvest scheduling become high-stakes events when harvest labor and processing capacity are already strained (Zang et al., 2023).

In practical terms, Hangbaiju’s “economic value” is not only yield-per-area but also saleability: flower integrity, visual cleanliness, and consumer experience. A distinctive example is the bloom-stage aphid problem: *Macrosiphoniella sanborni* adults and bodies can remain with harvested flowers and become visible in the tea infusion, causing consumer rejection (“off their appetite” in the English abstract). This is a quality pathway that is unusual for many other crops, and it strongly incentivizes growers to seek control methods that work specifically during bloom without compromising harvest safety or market access (Cao et al., 2024).