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Effects of Different Pinching Treatments on Branch Formation and Flower Yield of *Chrysanthemum morifolium*

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Abstract Topping is an important cultivation practice for regulating plant architecture, branching development, and flower production in chrysanthemum. However, the effects of different topping methods on branch formation and flower yield in Hangbaiju (*Chrysanthemum morifolium* Ramat.) remain insufficiently understood. This review systematically examines the effects of topping timing, intensity, and frequency on vegetative growth, axillary bud development, canopy structure, photosynthetic performance, flower bud differentiation, and yield formation in Hangbaiju. Topping can alleviate apical dominance and stimulate axillary bud outgrowth, thereby increasing the number and complexity of primary and secondary branches. Appropriate topping may improve canopy architecture, enhance light interception and photosynthetic productivity, and promote assimilate accumulation and allocation toward reproductive organs. In contrast, excessive or improperly timed topping may delay plant development, reduce photosynthetic source capacity, and adversely affect flower bud formation and final yield. A representative case study framework is proposed to evaluate different topping treatments based on plant morphology, branching characteristics, flowering traits, and yield components. Integrating physiological responses with yield-related indicators can facilitate the identification of optimal topping strategies. Overall, moderate and appropriately timed topping is expected to provide an effective approach for coordinating branching, canopy development, and flower production, offering a theoretical basis for precision cultivation and standardized production of Hangbaiju.

Keywords Hangbaiju; Topping methods; Branch formation; Flower yield; Plant architecture

1 Introduction

Hangbaiju, a cultivated form of *Chrysanthemum morifolium*, has production value that extends beyond ornamental use because it is widely cultivated and economically important in China, while even its leaf residues contain recoverable polyphenols with antioxidant potential and value-added processing prospects (Yuan et al., 2025). More broadly, chrysanthemum has become an important commercial floricultural crop because of its uses as a pot plant, loose flower, cut flower, and landscape species, and this multifunctionality has supported rapid expansion of its production and trade in diverse regions. The commercial importance of chrysanthemum also means that cultivation is judged not only by whether plants flower, but by whether they produce the branching pattern, flower number, flower size, and harvest timing required by different markets. In practical production, this creates a need for cultivation strategies that can coordinate vegetative architecture with reproductive output, especially in forms grown for numerous harvestable capitula rather than a few large blooms (Kumar et al., 2024). For Hangbaiju, whose harvested flower heads determine much of its direct economic return, management practices that increase productive shoots and stabilize inflorescence yield are therefore closely tied to industrial development and grower profitability.

Among such practices, topping or pinching is especially important because it directly alters apical dominance and redistributes growth toward lateral buds. Chrysanthemum studies consistently show that unpinched plants tend to be taller and earlier flowering, whereas pinched plants usually become shorter, wider, and more branched (Kathad et al., 2024). The basic mechanism has been described similarly across experiments: removal of the terminal growing point suppresses apical dominance, promotes axillary bud outgrowth, and redirects assimilates toward side shoots, thereby increasing branch number and canopy spread. This architectural shift is important because flower number in chrysanthemum is strongly linked to the number of productive lateral shoots, so treatments that