Crop Regulation Approaches to Improve Yield and Quality in *Gypsophila* Cultivation

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ABSTRACT

Gypsophila, known commonly as showy baby's breath, is an ornamental plant highly regarded for its elegant appearance in cut flower arrangements, bedding, and potted settings. This plant is native to regions spanning from Southern Ukraine to Northern Iran and includes both annual and perennial species that are widely cultivated worldwide. Among these, G. paniculata and G. elegans hold significant commercial value. This review examines the physiological, genetic, and cultural factors influencing flowering and crop management in Gypsophila. Favourable night temperatures and extended daylight hours are crucial for initiating and developing flowers, while plant growth regulators such as GA_3 and BA promote shoot elongation, extend the flowering period, and improve vase life. Effective nutrient management, particularly concerning nitrogen, phosphorus, and potassium, is vital for maximizing both yield and quality. On a genetic level, the COL and FT homologs in G. paniculata highlight how photoperiodic flowering reactions are regulated at a molecular scale. Agricultural practices like pinching can encourage the growth of lateral shoots and prolong the flowering phase, while maintaining optimal plant density improves the balance between resource competition and floral output. The use of floral preservatives, such as cobalt chloride, greatly enhances the post-harvest vase life by facilitating water uptake, reducing microbial growth, and extending the duration of the flowers in a vase. By integrating physiological, agronomic, and genetic strategies, a comprehensive approach emerges for enhancing Gypsophila production to ensure sustainability and profitability in the floriculture industry.

Keywords: Gypsophila, Flowering, Growth regulators, Post-harvest

INTRODUCTION

Gypsophila, commonly referred to as showy baby's breath, is a short-lived annual plant native to Southern Ukraine, Eastern Turkey, and Northern Iran. It is part of the Caryophyllaceae family and includes approximately 125 species of annual, biennial, and perennial plants. Annual varieties like *G. muralis* and *G. elegans* are often used in seasonal floral arrangements, while perennials such as *G. guastiondes*, *G. perflita*, *G. oldhamiana*, *G. repens*, and *G. paniculata* are valued for their ornamental qualities in gardens and as cut flowers. Additionally, Gypsophila can serve as a rock garden plant.

This species is cultivated globally as a commercial filler in bouquets, bedding plants, and pots. Gypsophila elegans is classified as a long-day plant, requiring approximately 10 hours of light for bolting (Takeda 1996).

Uses of gypsophila

G. paniculata is utilized both as a fresh and dried cut flower, and it stands out as one of the essential components in floral arrangements and bouquets within the domestic market (İnan, 2006; Korkmaz, 2007).

1. Dual-purpose species: *Gypsophila sphaerocephala* and *G. perfoliata* serve both aesthetic and ecological purposes.
2. Boron hyperaccumulators: Capable of growing in very high concentrations of boron (up to 8900 mg/kg), especially accumulating it in their seeds and leaves.
3. Phytoremediation potential: Demonstrated to be highly effective in cleaning boron-contaminated soils, offering a natural solution for the restoration of agricultural land.
4. Environmental sustainability: Enables environmentally friendly land restoration where excessive fertilizer application has resulted in toxicity (Korkmaz et al. 2011).

Need for Effective Crop Regulation

Effective crop regulation is important in flower crop production for a variety of reasons, all having a direct bearing on yield, quality, profitability, and market timing:

- ***Synchronization of Flowering and Market Demand***

Flower time regulation allows growers to force blooms during off-seasons or periods of high demand, a process referred to as "forcing." This provides steady supply and peaks profits by aiming at high market prices (Swati et al. 2024).

- ***Increased Yield and Quality***

Crop regulation methods, including the application of growth regulators, pruning, and accurate nutrient management, aid in maximizing the number and quality of flowers per plant. For instance, in Gypsophila, effective fertilizer management significantly enhanced flower yield and quality, resulting in increased economic returns (Quddus et al. 2021).

- ***Stress Mitigation and Adaptation***

Effective regulation of flowering time is an important characteristic for alleviating the effects of environmental stresses such as heat and drought. Through the regulation of the timing of plant flowering, farmers can escape unfavourable conditions, achieving improved reproductive success and crop fitness (Naik et al. 2025).

- ***Genetic and Molecular Optimization***

Genomic and molecular advances enable specific interventions in flowering time control. This enhances productivity but also aligns crops with fluctuating climates and varying environments, ensuring sustainable floriculture (Naik et al. 2025).

- ***Resource Optimization***

Effective regulation of crops ensures the optimal utilization of inputs like fertilizers, water, and labour to minimize waste and production cost (Quddus et al. 2021).

Varieties

Bright Rose, Covent Garden, Red Cloud, Bristol Fairy, Fratensis, Furusato, Grandtastic, Million Stars, Xlence, White Elegans.

Physiology of Flowering in Gypsophila

1. Role of photoperiod and temperature

Temperature and photoperiod influence the growth and flowering of *Gypsophila paniculata* cv. 'Bristol Fairy'. The plants were cultivated in a phytotron under short (10 hours) and long (24 hours) day conditions, with varying night temperatures of 12, 18, and 24°C. Under short day conditions, the plants remained in a vegetative state and developed rosette-like forms at higher night temperatures (18 or 24°C). However, at 12°C, all plants flowered, although the emergence of visible flower buds and fully open flowers was delayed by 28 and 38 days, respectively, compared to long day conditions. Long days and elevated night temperatures promoted flower initiation (characterized by the fewest leaves beneath the apical buds), flower differentiation, and the development of flower buds. Higher night temperatures were associated with reduced plant height and fewer flower stems per plant. Long day conditions are essential for both the initiation and development of flowers. Additionally, exposing young vegetative plants to low temperatures (12°C) for several weeks stimulated lateral branching and increased flower yield.

Hormonal influence on growth and flowering

According to Patra et al. (2015), the application of plant growth regulators in agriculture promotes flowering, leading to optimal yields. These organic chemical substances, when applied in small amounts, influence and regulate physiological processes within plants. They are rapidly absorbed and distributed throughout plant tissues. Research has shown that growth regulators significantly enhance overall plant development, flowering duration, flower production, and the quality of cut blooms. Previous studies indicated that GA3 (Gibberellic acid) positively impacts growth metrics such as shoot and internodal lengths, as well as flowering characteristics including early blooming, longer stalks, extended flowering periods, increased yield per area, and prolonged vase life. Additionally, BA (Benzyladenine) was found to improve the number of basal shoots, flower count, flower longevity, and vase life.

Nutrient management

Gypsophila is known to be highly demanding and responsive to inorganic fertilizers such as nitrogen, phosphorus, potassium, and sulfur. The use of fertilizers is essential for maximizing crop yields (Dass and Mandal, 2016). Properly balanced applications of inorganic fertilizers enhance the quality of flowers, growth performance, and overall yield of various ornamental plants (Ahmed et al., 2017). Also, the application of putrescine has been shown to enhance the production of beneficial bioactive compounds that positively influence plant growth and development, with cationic charge and aliphatic carbon chains between amino groups believed to contribute to polyamine aggregation (Antony 2003).

Genetic regulation of flowering

Kanayama et al. (2007) has revealed that at least four COL genes (GpCOL1 to GpCOL4) are expressed in *G. paniculate*. Each GpCOL gene features a CCT domain located near its carboxyl terminus. This conserved region may harbor a nuclear localization sequence, indicating that GpCOL1, GpCOL2, GpCOL3, and GpCOL4 belong to the COL gene family, which is categorized into three groups *(Griffiths et al., 2003)*. Phylogenetic analysis of the amino acid sequences of the CCT domain demonstrates that the four GpCOLs are classified within Group I, characterized by the presence of two zinc finger B-boxes and involvement with CO. Importantly, the expression patterns of two GpCOLs exhibit daily fluctuations, implying a connection between these genes and flowering in G. paniculata *(Kanayama et al., 2007)*. It is anticipated that Gypsophila possesses an FT homolog that operates downstream of the Gypsophila CO homolog. Through RT-PCR with degenerate primers, two cDNAs corresponding to potential Gypsophila FT homologs (GpFT1 and GpFT2) were successfully cloned from *G. paniculata* plants that underwent flowering induction under long-day conditions. The predicted amino acid sequences of GpFT1 and GpFT2 exhibit significant homology with FT.

Cultural practices for Crop regulation

Effect of Pinching

Pinching has an effect on the flowering period of gypsophila by delaying the initiation of flowering but increasing the overall flowering period. Specifically, Cheong Dong Chun et al. (2002) found that pinching promoted the number of flowering branches per plant, leading to a longer and more staggered bloom period.

Key Effects of Pinching

1. Enhanced Flower Stalk Length and Yield: Pinching in Gypsophila increases the length of flower stalks and boosts cut flower production, making it a standard practice for improving both yield and quality in commercial cultivation.
2. Promotion of Lateral Branching: By removing the apical dominance, pinching encourages the development of axillary (side) branches. This results in bushier plants with more flowering sites, ultimately leading to a higher number of marketable stems per plant (Kedar et al. 2021).

Density

Plant density plays a crucial role in determining the yield and growth characteristics of crops like *Gypsophila*, as it affects canopy structure, light interception, and dry matter production (Singh et al., 2015; Khenizy et al., 2014). This can lead to increased flower production and improved overall plant vigor.

1. High planting density can result in competition for resources such as water and nutrients, potentially leading to stunted growth and reduced flowering in Gypsophila. Therefore, understanding the balance of density is essential for maximizing yield and quality (Quddus et al. 2022).
2. Conversely, low density may lead to underutilization of space and resources, resulting in lower overall productivity. Thus, finding the right density is critical for achieving the desired aesthetic and commercial value of Gypsophila in horticultural practices.

Post-Harvest Regulation of Gypsophila

1. Maintaining optimal vase life is crucial for Gypsophila, with treatments such as Cobalt chloride at 100 ppm significantly extending vase life to 13.33 days, compared to control treatments which only lasted 5.10 days
2. The use of floral preservatives like Aluminium sulphate and Cobalt chloride not only enhances vase life but also improves water uptake and reduces microbial activity in the vase solution, leading to better overall flower quality

3. Regular monitoring of microbial counts in vase solutions is essential, as lower counts were observed with Cobalt chloride treatments, indicating its effectiveness in preventing microbial growth that can shorten vase life
4. Fresh weight change is a critical indicator of flower health; treatments with Cobalt chloride showed the highest fresh weight change, suggesting that effective post-harvest treatments can maintain flower vitality over time
5. Physiological loss in weight (PLW) should be minimized through the use of appropriate floral preservatives, as lower PLW values were recorded with Cobalt chloride, indicating better water retention and overall flower health.
6. Implementing these post-harvest regulations can lead to enhanced marketability and economic returns for growers, ensuring that Gypsophila remains a viable cut flower option in the floral industry.

Star World

Crystal Diamond

Table: Scheduling gypsophila for different seasons

Planting	Making bush	Pinching	Elongation (Artificial lighting)	Induction	Flowering	Harvesting
1st week	------	5th week	6th to 9th week	10th to 12th week	13th week	14th to 17th week (Summer)
18th to 19th week (dry period and pruning)	20th to 22nd week	-----	23rd to 26th week	27th to 29th week	30th week	31st to 34th week (Rainy)
35th to 36th (Dry period and pruning)	37th to 39th week	------	40th to 43rd week	44th to 46th week	47th week	48th to 51st week (Winter)

CONCLUSION

Gypsophila flourishes under suitable photoperiod, temperature, growth regulators, and nutrient management, enhancing flowering, quality, and yield. Methods like pinching and ensuring ideal density boost output, while after-harvest processes extend vase longevity. Its genetic flexibility and capacity for phytoremediation make it a vital crop for sustainable, high-quality ornamental and ecological applications.

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