International Journal of Research in Agronomy 2025; 8(10): 623-627

International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X

NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(10): 623-627
Received: 06-08-2025
Accepted: 08-09-2025

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Effect of biocides on postharvest vase life of Gypsophila cv. Star World

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DOI: https://www.doi.org/10.33545/2618060X.2025.v8.i10i.4037

Abstract
This study examined the impact of biocides on extending the postharvest vase life of Gypsophila cv. Star World. Given the significant postharvest losses (30%) and perishable nature of cut flowers, this research aimed to identify effective biocide treatments. The experiment consisted of 14 treatments, arranged in a Completely Randomized Design (CRD) with three replications. The results showed that T_9 treatment, comprising 2% sucrose and 200 ppm 8-HQS, recorded the best figures in majority of the parameters, including improved water uptake (27.42 g. flower^{-1}), reduced transpirational loss of water (22.22 g. flower^{-1}), extended vase life (15.5 days), maintained fresh weight (15.9 g. flower^{-1}), and lowest optical density of vase solution (0.045 nm). The T_9 treatment demonstrated a significant improvement in the postharvest vase life of gypsophila flowers, suggesting its potential to enhance the quality and longevity of cut flowers. The findings of this study provide valuable insights into the development of effective postharvest management strategies for gypsophila flowers, and highlight the importance of biocides in maintaining the quality and vase life of cut flowers. The results of this study have significant implications for the cut flower industry, and can be used to improve the postharvest handling and management of gypsophila flowers.

Keywords: Biocide, gypsophila, cut flower, vase life, optical density, and 8-HQS

Introduction
Gypsophila (*Gypsophila paniculata* L.) is a flowering plant native to Central and Eastern Europe, widely cultivated in Eurasia, Africa, Australia, Turkey, and Pacific Islands, with Turkey boasting around 35 endemic species. Valued for its ornamental and cut flower purposes, Gypsophila is often used as a filler in flower bouquets, adding volume and texture. The Star World cultivar is a hardy plant, growing up to 1-2 meters tall, producing medium-sized white panicles, and exhibiting resistance to pests and diseases. Additionally, Gypsophila is a popular choice for floral arrangements due to its delicate, airy blooms and long vase life, making it an ideal selection for weddings, events, and everyday bouquets. Its versatility and beauty have also made it a favourite among florists and gardeners alike.
Biocides are a crucial component in preservative solutions for cut flowers, controlling harmful bacteria and preventing bacterial embolism (Halevy and Mayak, 1981) [3]. Microbial blockage of xylem vessels is a primary cause of deterioration in cut flowers (Danaee *et al.*, 2011) [2]. To address this, floral preservatives often include biocides, such as 8-Hydroxyquinoline Sulfate (8-HQS), a widely used germicide in the floral industry (Nowak and Rudnicki, 1990) [10]. 8-HQS acts as an antimicrobial agent, enhancing water uptake and promoting extended vase life (Ketsa *et al.*, 1995; Reddy *et al.*, 1996) [5, 12].

Materials and Methods
This study was conducted in the Floriculture and Landscape Architecture laboratory, College of Horticulture, Rajendranagar, under Sri Konda Laxman Telangana Horticulture University, Hyderabad. The experiment employed a CRD design with three replications and 14 treatments.
Gypsophila cv. Star World flowers were obtained from the Floricultural Research Station, Rajendranagar, and harvested at a stage with 50% of overall flowers opened, after which leaves were removed. The flowers were then placed in 1000 ml beakers containing 14 different

preservative solutions. Flowers were continuously held in the preservative solutions, and postharvest parameters were evaluated every two days throughout the vase life period.

Treatment details

T_1: (Sucrose @ 2%),
T_2: (8HQS 100 @ ppm)
T_3: (8HQS 200 @ ppm)
T_4: [Sodium hypochlorite (SH) @ 25 ppm],
T_5: [Sodium hypochlorite (SH) @ 50 ppm],
T_6: [Calcium hypochlorite ($Ca(OCl)_2$) @ 25 ppm],
T_7: [Calcium hypochlorite ($Ca(OCl)_2$) @ 50 ppm],
T_8: (Sucrose @ 2% + 8HQS @ 100 ppm),
T_9: (Sucrose 2% + 8HQS @ 200 ppm),
T_{10}: (Sucrose 2% + SH @ 25 ppm),
T_{11}: (Sucrose 2% + SH @ 50 ppm)
T_{12}: (Sucrose 2% + $Ca(OCl)_2$ @ 25 ppm)
T_{13}: (Sucrose 2% + $Ca(OCl)_2$ @ 50 ppm)
T_{14}: [Control (Distilled water)]

1. Water uptake (WB) (g. flower^{-1})

Water uptake was measured by recording the difference in weight of the container plus solution (without flowers) at alternate-day intervals, and expressed as grams per flower, following the method described by Venkatarayappa *et al*., 1980 [15].

$$WB = \frac{\text{Initial weight of container Without flower spikes} - \text{Final weight of container without flower spikes}}{\text{Number of flower spikes in the bottle}}$$

2. Transpirational loss of water (TLW) (g. flower^{-1})

Transpirational loss of water was measured by recording the difference in weight of the container + solution + flowers at 2 days intervals, and expressed as grams per spike, following the method described by Venkatarayappa *et al*., 1980 [15].

$$TLW = \frac{\text{Initial weight of container with spikes} - \text{Final weight of container with spikes}}{\text{Number of flower spikes in the bottle}}$$

3. Optical density of vase solution (ODVS) (480 nm)

Optical density of the vase solution was measured using a spectrophotometer at a wavelength of 480 nm.

4. Vase life of flowers (days)

Vase life was recorded as the number of days taken for more than 50% of the flowers to wilt, and expressed in days.

5. Fresh weight (g. flower^{-1})

Fresh weight of the flower spike was measured using an electronic balance and expressed in grams.

Results and Discussion

The collected data were subjected to statistical analysis, and the results are presented and discussed under relevant headings

1. Water uptake (WU) (g. flower^{-1})

Significant differences were observed among biocide treatments for water uptake (WU) in Gypsophila cv. Star World. The highest WU was recorded in T_9 (27.42 g flower^{-1}), comprising 2% sucrose and 200 ppm 8-HQS, it was on par with T_8 and T_{11}, whereas the lowest WU was observed in the control treatment (T_{14}), with a value of 10.90 g flower^{-1} (Table 1).

The highest water uptake recorded in T_9 treatment can be attributed to the enhanced and continuous water uptake facilitated by this treatment, which likely delayed senescence. Sucrose, acting as a respiratory substrate, maintained water balance and delayed turgidity loss, as reported by Sven and Jose (2004) [13]. Additionally, 8-HQS improved mineral salt uptake by influencing metal ions, leading to maximum solution uptake, as suggested by Hwang and Kim (1995) [4]. This finding is consistent with Pruthi *et al*., 2001 [11], who observed enhanced solution uptake in Gladiolus at higher biocide concentrations.

Table 1: Effect of biocides on water uptake (g flower^{-1}) of Gypsophila cv. Star World

Treatments (T)	Days					
	1	3	5	7	9	Mean
T_1 Sucrose 2%	16.3	15.3	13.6	11.3	10.3	13.36 ^{bc}
T_2 8HQS 100 ppm	18.6	15.6	13.3	11.6	11.3	14.08 ^{b}
T_3 8HQS 200 ppm	17.3	14.3	13	12.3	11.6	13.70 ^{bc}
T_4 SH 25 ppm	14	13.3	12.3	11.3	10.3	12.24 ^{bc}
T_5 SH 50 ppm	16	15.6	14.3	12.6	10.6	13.82 ^{bc}
T_6 $Ca(OCl)_2$ 25 ppm	14	12	11.6	10.4	10	11.60 ^{bc}
T_7(C T_7 $Ca(OCl)_2$ 50 ppm	14.3	13.3	11.3	10.6	9.3	11.76 ^{bc}
T_8 Sucrose 2% + 8HQS 100 ppm	34.6	30.3	24.6	20	18.6	25.62 ^{a}
T_9 Sucrose 2% + 8HQS 200 ppm	36.3	30.6	25	23.6	21.6	27.42^{a}
T_{10} Sucrose 2% + SH 25 ppm	18.3	18	16.6	14.3	13	16.04 ^{b}
T_{11} Sucrose 2% + SH 50 ppm	23	21.6	19	18.3	16.6	19.70 ^{ab}
T_{12} Sucrose 2% + $Ca(OCl)_2$ 25 ppm	19.3	16.3	13.6	11	10.6	14.16 ^{b}
T_{13} Sucrose 2% + $Ca(OCl)_2$ 50 ppm	18.6	17.6	15	14.6	12.3	15.62 ^{b}
T_{14} Control (Distilled water)	13.6	11.6	10.6	9.4	9.3	10.90 ^{c}
S.Em±	2.05					
CD (p = 0.05)	5.76					

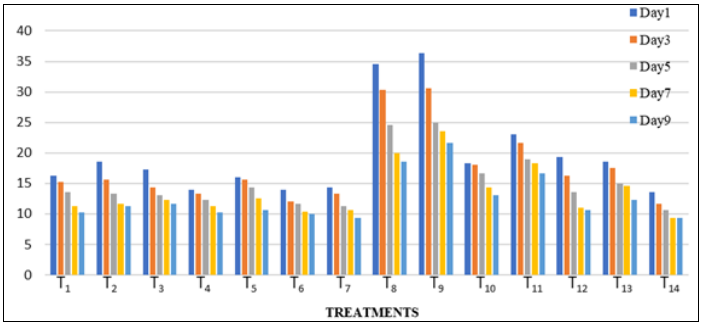

Fig 1: Effect of sucrose and biocides on water uptake (g flower^{-1}) of *Gypsophila* cv. Star World

2. Transpirational loss of water (TLW) (g. flower^{-1})

The data on changes in transpirational loss of water (TLW) during the vase life period of cut Gypsophila cv. Star World treated with biocides are presented in Table 2. Significant differences were observed among all biocide treatments with respect to TLW.

The highest transpirational loss of water (TLW) was recorded in T_9 treatment, comprising 2% sucrose and 200 ppm 8-HQS, with a value of 22.22 g flower^{-1}, it was on par with T_8, T_{11}, T_{10}, T_{13} and T_2, whereas the lowest TLW was observed in the control treatment (T_{14}), with a value of 10.52 g flower^{-1}. The combination of sucrose and 8-HQS likely reduced blockages in stem tissue, improving water balance and osmotic potential by maintaining turgidity, as reported by Bravdo *et al*. (1974) [1].

Table 2: Effect of biocides on transpirational loss of water (g. flower^{-1}) of Gypsophila cv. Star World

Treatments (T)	Days					
	1	3	5	7	9	Mean
T_1 Sucrose 2%	14	13.6	12.6	12.3	11	12.70 ^{c}
T_2 8HQS 100 ppm	18.3	16.6	15.3	14	13.3	15.50 ^{ab}
T_3 8HQS 200 ppm	14.6	14	13.6	12.3	11.3	13.16 ^{bc}
T_4 SH 25 ppm	15	14.4	12.6	11.3	10	12.66 ^{c}
T_5 SH 50 ppm	16.6	15.6	15.3	13.4	11.7	14.52 ^{b}
T_6 $Ca(OCl)_2$ 25 ppm	13.3	12.3	11	10.2	9.3	11.22 ^{d}
T_7(C T_7 $Ca(OCl)_2$ 50 ppm	14.7	13.4	11.6	10.3	10	12.00 ^{cd}
T_8 Sucrose 2% + 8HQS 100 ppm	24	22.6	20.3	18	16.3	20.24 ^{a}
T_9 Sucrose 2% + 8HQS 200 ppm	27	25.4	22	19.4	17.3	22.22 ^{a}
T_{10} Sucrose 2% + SH 25 ppm	24	19.4	17	16.3	13.7	18.08 ^{a}
T_{11} Sucrose 2% + SH 50 ppm	25	21.4	18	16.3	14.6	19.06 ^{a}
T_{12} Sucrose 2% + $Ca(OCl)_2$ 25 ppm	19.6	17.6	15.3	14.6	14	16.22 ^{ab}
T_{13} Sucrose 2% + $Ca(OCl)_2$ 50 ppm	24.6	20	17.6	14.3	12.3	17.76 ^{a}
T_{14} Control (Distilled water)	12.6	11.3	10.4	9.3	9	10.52 ^{d}
S.Em±	2.02					
CD (p = 0.05)	5.67					

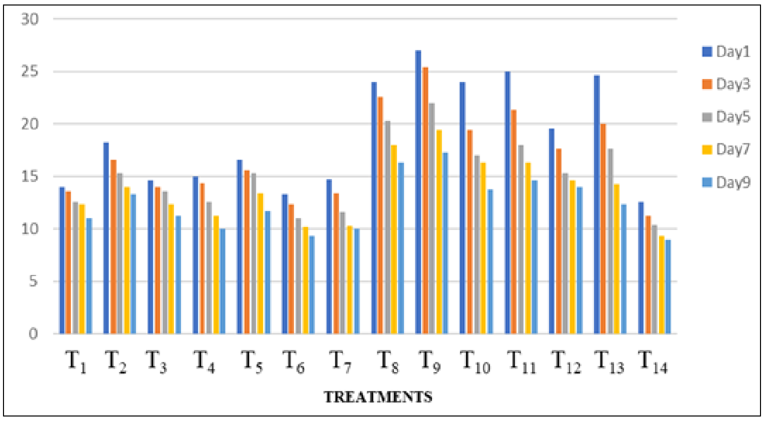

Fig 2: Effect of sucrose and biocides on transpirational loss of water (g flower^{-1}) of Gypsophila cv. Star World

3. Optical density of vase solution (ODVS) (nm)

The mean optical density of vase solution (ODVS) differed significantly among biocide treatments of Gypsophila cv. Star World. The lowest value of 0.045 nm was recorded in T_9 treatment (2% sucrose + 200 ppm 8-HQS), and was statistically at par with most other treatments. Conversely, the control treatment (T_{14}) showed the highest ODVS value of 0.173 nm (Table 3).

The lowest ODVS observed in T_9 treatment is likely attributed to the reduced bacterial count, as this treatment also exhibited the highest water uptake and transpirational loss of water, indicating a cleaner vase solution with minimal microbial growth.

Table 3: Effect of biocides on optical density of vase solution (480nm) of gypsophila cv. Star World

Treatments (T)	Days					
	1	3	5	7	9	Mean
T_1 Sucrose 2%	0.051	0.072	0.091	0.112	0.142	0.094 ^{a}
T_2 8HQS 100 ppm	0.049	0.061	0.083	0.095	0.103	0.078 ^{a}
T_3 8HQS 200 ppm	0.039	0.048	0.096	0.112	0.124	0.084 ^{a}
T_4 SH 25 ppm	0.074	0.113	0.128	0.151	0.164	0.126 ^{b}
T_5 SH 50 ppm	0.059	0.068	0.074	0.099	0.107	0.081 ^{a}
T_6 $Ca(OCl)_2$ 25 ppm	0.087	0.108	0.119	0.231	0.274	0.164 ^{cd}
T_7(C T_7 $Ca(OCl)_2$ 50 ppm	0.073	0.128	0.136	0.172	0.204	0.143 ^{c}
T_8 Sucrose 2% + 8HQS 100 ppm	0.039	0.044	0.057	0.062	0.079	0.056 ^{a}
T_9 Sucrose 2% + 8HQS 200 ppm	0.038	0.043	0.045	0.047	0.05	0.045 ^{a}
T_{10} Sucrose 2% + SH 25 ppm	0.055	0.063	0.064	0.072	0.087	0.070 ^{a}
T_{11} Sucrose 2% + SH 50 ppm	0.042	0.054	0.067	0.075	0.081	0.064 ^{a}
T_{12} Sucrose 2% + $Ca(OCl)_2$ 25 ppm	0.045	0.054	0.061	0.075	0.087	0.075 ^{a}
T_{13} Sucrose 2% + $Ca(OCl)_2$ 50 ppm	0.049	0.058	0.074	0.089	0.097	0.072 ^{a}
T_{14} Control (Distilled water)	0.096	0.138	0.171	0.205	0.256	0.173 ^{d}
S.Em±	0.021					
CD (p = 0.05)	0.059					

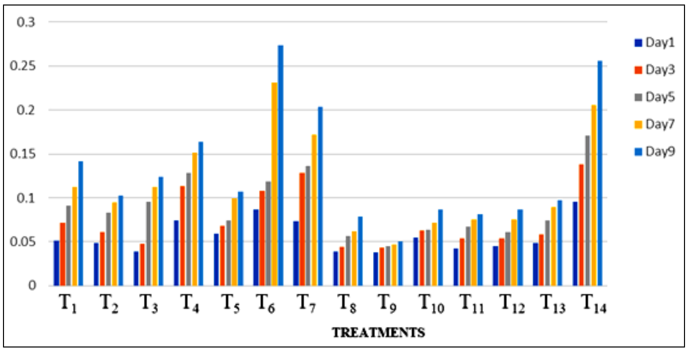

Fig 3: Effect of sucrose and biocides on optical density vase solution (nm) of Gypsophila cv. Star World

4. Vase life (days)

Significant differences were observed in Gypsophila cv. Star World about vase life among all biocide treatments. The longest vase life (15.5 days) was achieved with T_9 treatment (2% sucrose + 200 ppm 8-HQS), followed closely by T_8 (14 days) and T_{11} (13.5 days) treatments, which were statistically similar. In contrast, the control treatment (T_{14}) had the shortest vase life (8.8 days)

The data in Table 4 indicates that T_9 treatment was the most effective in extending vase life, likely due to its superior performance in enhancing water uptake (WU), transpirational loss of water (TLW), and minimizing optical density of vase solution (ODVS). These findings are consistent with Laksminarayana and Prashath (2020a) [8], who reported similar results in Gladiolus.

Table 4: Effect of biocides on vase life (days) of Gypsophila cv. Star World

Treatments (T)	Vase life (days)
T_1 Sucrose 2%	11.2 ^{cd}
T_2 8HQS 100 ppm	12 ^{bc}
T_3 8HQS 200 ppm	11.7 ^{c}
T_4 SH 25 ppm	11 ^{d}
T_5 SH 50 ppm	11.8 ^{c}
T_6 Ca(OCl)$_2$ 25 ppm	10.7 ^{ef}
T_7(C T_7 Ca(OCl)$_2$ 50 ppm	10.8 ^{e}
T_8 Sucrose 2% + 8HQS 100 ppm	14 ^{ab}
T_9 Sucrose 2% + 8HQS 200 ppm	15.5 ^{a}
T_{10} Sucrose 2% + SH 25 ppm	12.8 ^{b}
T_{11} Sucrose 2% + SH 50 ppm	13.5 ^{ab}
T_{12} Sucrose 2% + Ca(OCl)$_2$ 25 ppm	12.2 ^{bc}
T_{13} Sucrose 2% + Ca(OCl)$_2$ 50 ppm	12.5 ^{bc}
T_{14} Control (Distilled water)	8.8 ^{f}
S.Em±	0.41
CD (p = 0.05)	1.20

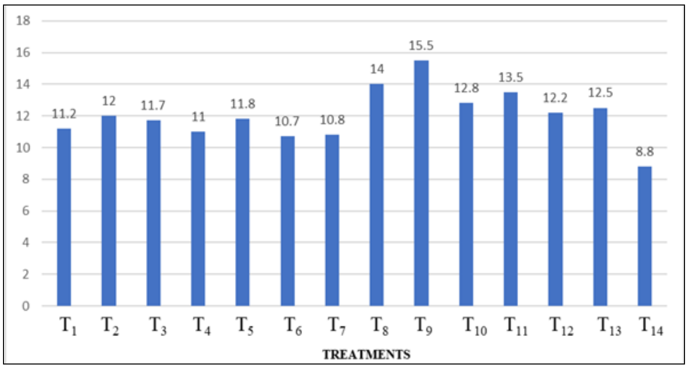

Fig 4: Effect of sucrose and biocides on vase life (days) of *Gypsophila* cv. Star World

5 Fresh weight (g. flower^{-1})

The impact of biocide treatments on flower fresh weight of Gypsophila cv. Star World was shown in Table 5. A significant difference in fresh weight was observed among treatments. T_9 treatment (2% sucrose + 200 ppm 8-HQS) achieved the highest fresh weight (15.9 g flower^{-1}), which was statistically at par with most other treatments except control. The control treatment (T_{14}) recorded the lowest fresh weight (11.07 g flower^{-1}).

The highest fresh weight observed in T_9 treatment can be attributed to its superior performance in water uptake, transpirational loss of water, and vase life compared to other treatments. The positive effect of 8-HQS on retaining fresh weight is likely due to enhanced water uptake, as reported by Uthaichay *et al*. (2007) [14]. Similar findings have been observed in rose by Martha *et al*. (2011) [9] and in Freesia by Kwon and Kim (2000) [7], supporting the notion that 8-HQS plays a crucial role in maintaining fresh weight by promoting water uptake.

Table 5: Effect of biocides on fresh weight (g flower^{-1}) of Gypsophila cv. Star World

Treatments (T)	Fresh weight (g)
T_1 Sucrose 2%	14.2 ^{a}
T_2 8HQS 100 ppm	14.6 ^{a}
T_3 8HQS 200 ppm	14.37 ^{a}
T_4 SH 25 ppm	14 ^{a}
T_5 SH 50 ppm	14.53 ^{a}
T_6 Ca(OCl)$_2$ 25 ppm	13.47 ^{ab}
T_7(C T_7 Ca(OCl)$_2$ 50 ppm	13.8 ^{a}
T_8 Sucrose 2% + 8HQS 100 ppm	15.8 ^{a}
T_9 Sucrose 2% + 8HQS 200 ppm	15.9 ^{a}
T_{10} Sucrose 2% + SH 25 ppm	15.27 ^{a}
T_{11} Sucrose 2% + SH 50 ppm	15.6 ^{a}
T_{12} Sucrose 2% + Ca(OCl)$_2$ 25 ppm	14.8 ^{a}
T_{13} Sucrose 2% + Ca(OCl)$_2$ 50 ppm	15 ^{a}
T_{14} Control (Distilled water)	11.07 ^{b}
S.Em±	0.85
CD (p = 0.05)	2.47

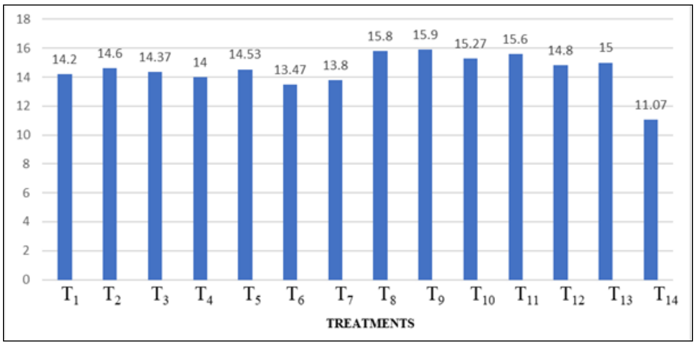

Fig 5: Effect of sucrose and biocides on fresh weight (g flower^{-1}) of *Gypsophila* cv. Star World

Conclusion

This study reveals that a solution combining 2% sucrose with 200 ppm 8-HQS (T_9) effectively improves the quality of Gypsophila cv. Star World cut flowers by prolonging vase life, enhancing water uptake, increasing fresh weight, and suppressing bacterial growth. Therefore, this (T_9) sucrose and 8-HQS combination shows promise as a preservative solution for maintaining the post-harvest quality and extending the vase life of Gypsophila cut flowers

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