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Germicidal interventions to prolong vase life and quality of white friendship gladiolus cultivar

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Abstract
The study aimed to investigate the "Germicidal Interventions to Prolong Vase Life and Quality of White Friendship Gladiolus Cultivar". The research was conducted in the experimental laboratory of the Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar, during 2020-2021. The experiment employed a completely randomized design with nine treatments, each replicated thrice. The treatments included four preservative chemicals: Sodium dichloroisocyanurate dihydrate at 0.6 and 0.8 mg/l; 8-Hydroxy Quinoline Sulphate at 150 and 300 ppm; 8-Hydroxy Quinoline at 150 and 250 ppm; and silver nitrate at 50 and 100 ppm. All treatments contained 4% sucrose, along with a control group (distilled water). The results revealed that treatment T_6 (8-HQS at 300 ppm + 4% sucrose) exhibited the maximum water uptake (61.67 g/s), water balance (6.95 g/s), fresh weight change (149.33%), and vase life (11.19 days) compared to the control. Additionally, T_6 showed the least optical density of the vase solution (0.0207). Therefore, the findings lead to the conclusion that employing a vase solution formulated with 8-HQS at 300 ppm and 4% sucrose proved to be the most effective in extending the vase life and maintaining the quality of gladiolus spikes cv. White Friendship.

Keywords: Gladiolus (*Gladiolus grandiflorus* L.), sodium dichloroisocyanurate dihydrate, Hydroxyquinoline, Hydroxyquinoline sulphate, silver nitrate

Introduction
Gladiolus (*Gladiolus grandiflorus* L.), a member of the Iridaceae family, is a significant commercial flower crop that occupies a pivotal role as a cut flower in both domestic and global markets. Relatively straightforward to cultivate, gladiolus is well-adapted for ornamental bedding displays and exhibitions. Its floral spikes are extensively used in crafting floral arrangements, bouquets, and indoor decorative pieces [1]

In India, it is estimated that gladiolus cultivation spans approximately 1270 hectares, yielding around 127 million cut spikes annually [2]. However, major centers of commercial gladiolus production are concentrated within specific geographic regions of India, including Jammu and Kashmir, Darjeeling and Kalimpong districts of West Bengal, Chaubattia in New Delhi, Bangalore in Karnataka, Ooty in Tamil Nadu, Pune in Maharashtra, and Shimla in Himachal Pradesh. Under the climatic conditions of North India, the flowering period ranges from October to March in the plains and June to September in the hills, whereas in the Bangalore region, gladiolus can be planted throughout the year.

Since cut flowers are live tissues with a high metabolic activity, they senesce more quickly when separated from the mother plant because the water and nutrients that normally flow from the roots to the floral parts are disrupted [3]. Approximately 20% of postharvest losses in cut flowers result from insect damage, disease, or physical injuries sustained during postharvest handling practices [4]. Cut flowers are less marketable and less satisfying to customers because of their short vase life. Low internal sucrose concentrations, high rates of ethylene production, microbial growth, and unfavourable water relations are some of the factors that lead to limited postharvest lifespan. The vascular system at the cut end of the flower stem has air or microbial blockages that affect water relations. Furthermore, physiological disorders like peduncle bending, inhibition of flower bud opening, and wilting of leaves and flowers can

result from disturbances in water balance, which can ultimately affect vase life [5].

Gladiolus blossoms stay vibrant for 4 to 6 days when cut from the plant. Cut flowers typically go through two distinct life stages: first the buds unfurl into full blooms, then the flowers mature, age, and eventually wilt. An opportunity exists to develop techniques that encourage the flowers to open widely in the first stage while slowing down the aging process in the second stage, thereby lengthening the vase life of the cut flowers. After cutting the flower spike, preservative solutions inhibit the production of ethylene, a ripening hormone. An ideal preservative contains sugar as an energy source and antimicrobial agents that prevent microbial growth, ultimately helping the vascular tissues function better to keep the cut spike alive longer after harvest [6]. Researchers have made numerous efforts to study the impacts of various chemicals, sugars, and growth regulators on prolonging the vase life of commercially significant cut flowers [7, 8].

Maintaining the postharvest quality of cut flowers is crucial to reward the efforts invested in increasing production and enabling successful commercialization of the product. With this in mind, the present work, "Germicidal Interventions to Prolong Vase Life and Quality of White Friendship Gladiolus Cultivar" has been undertaken to evaluate the postharvest quality and vase life with the following objectives:

1. To study the effect of different germicides and sucrose on postharvest flower quality and vase life of gladiolus.
2. To identify the best germicidal combination as a preservative for cut gladiolus.

Materials and Methods

The present study titled "Germicidal Interventions to Prolong Vase Life and Quality of White Friendship Gladiolus Cultivar" took place in the experimental laboratory of the Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Chidambaram, during the year 2021. Uniform gladiolus (*Gladiolus grandiflorus* L.) cv. White Friendship spikes, free from physical harm, diseases, and insect infestations, were procured from Southern Flora, Hosur, and employed for the experimentation.

The experiment followed the principles of a completely randomized design with nine treatments using four germicides: Sodium dichloro iso-cyanurate dihydrate (NaDCC), 8-Hydroxyquinoline (HQ), 8-Hydroxyquinoline sulfate (HQS), and silver nitrate ($AgNO_3$), along with a preservative (Sucrose). The treatments were replicated three times as follows:

T_1 - Na DCC 0.6 ppm + sucrose 4 %
T_2 - Na DCC 0.8 ppm + sucrose 4 %
T_3 – 8- HQ 150 ppm + sucrose 4 %
T_4 - 8- HQ 250 ppm + sucrose 4 %
T_5 - 8- HQS 150 ppm + sucrose 4 %
T_6 - 8- HQS 300 ppm + sucrose 4 %
T_7 - $AgNO_3$ 50 ppm + sucrose 4 %
T_8 - $AgNO_3$ 100 ppm + sucrose 4 %
T_9 - Control (Distilled water).

Results and Discussion

The water uptake decreased from the test day until the end of the vase life period across all treatments. Gladiolus spikes held in 8-HQS at 300 ppm + 4% sucrose (T_6) exhibited the highest water uptake, followed by 8-HQ at 250 ppm + 4% sucrose (T_4), while the control (T_9) recorded the lowest. The increased water uptake in T_6 could be attributed to effective transportation within the floral stems and reduced stem blockage, corroborating previous findings [9-14].

The transpirational loss of water was highest in spikes held in T_6 (8-HQS at 300 ppm + 4% sucrose), possibly due to the higher water uptake to avoid temporary water stress and maintain membrane viscosity. The control exhibited the lowest transpirational loss owing to reduced water uptake and subsequent wilting. Adequate transpiration is essential for extending the vase life of cut flowers, as hindrances in this process decrease the keeping quality [15, 16].

Table 1: Effect of different germicides on water uptake (g/s) & transpirational loss of water (g/s) of gladiolus cv. White Friendship.

Treatments	Water uptake (g/s)			Transpirational loss of water (g/s)		
	3rd day	5th day	7th day	3rd day	5th day	7th day
T_1 - NaDCC 0.6 mg/l + Sucrose 4%	49.83	17.00	9.33	33.83	26.50	25.67
T_2 - NaDCC 0.8 mg/l + Sucrose 4%	47.83	15.83	9.67	32.17	24.83	27.83
T_3 – 8- HQ 150 ppm + Sucrose 4%	46.17	27.17	21.83	34.17	31.50	39.17
T_4 - 8- HQ 250 ppm + Sucrose 4%	51.50	30.67	24.83	40.17	31.91	41.50
T_5 – 8- HQS 150 ppm +Sucrose 4%	47.83	23.83	20.83	32.50	21.33	36.50
T_6 – 8- HQS 300 ppm +Sucrose 4%	61.67	32.17	25.67	49.50	33.67	44.67
T_7 - $AgNO_3$ 50 ppm + Sucrose 4%	48.33	18.00	12.00	35.33	29.17	36.00
T_8 - $AgNO_3$ 100 ppm + Sucrose 4%	45.50	23.67	8.33	39.33	29.33	30.33
T_9 – Control	42.33	10.83	8.33	27.67	18.83	22.17
SED	3.41	1.78	0.36	2.10	0.71	0.84
CD (P=0.05)	7.94	3.32	0.75	4.22	1.52	1.63

Water balance, a critical factor influencing postharvest quality and longevity, was highest in T_6 (8-HQS at 300 ppm + 4% sucrose) on day 7. The presence of 8-HQS with sucrose likely improved water balance by facilitating stomatal closure [17].

The highest fresh weight change was recorded in T_6 (8-HQS at 300 ppm + 4% sucrose), followed by T_4 (8-HQ at 250 ppm + 4% sucrose) on day 3, while the control exhibited the lowest fresh weight change on day 8. The beneficial effect of 8-HQS with sucrose on cut flower longevity could be attributed to increased water uptake, maintained transpirational loss, improved water balance, and consequently, increased fresh weight, corroborating previous findings [14, 18, 19].

Table 2: Effect of different germicides on water balance (g/s) & fresh weight change (%) of gladiolus cv. White Friendship.

Treatments	Water balance (g/s)			Fresh weight change (%)		
	3rd day	5th day	7th day	3rd day	5th day	7th day
T_1 - NaDCC 0.6 mg/l + Sucrose 4%	5.34	4.58	4.17	127.67	108.67	76.00
T_2 - NaDCC 0.8 mg/l + Sucrose 4%	5.49	4.89	4.45	123.67	105.67	69.33
T_3 – 8- HQ 150 ppm + Sucrose 4%	5.77	4.80	4.28	131.33	128.33	79.67
T_4 - 8- HQ 250 ppm + Sucrose 4%	6.92	6.12	5.58	135.33	129.33	88.67
T_5 – 8- HQS 150 ppm +Sucrose 4%	5.68	4.74	3.97	121.67	115.00	83.67
T_6 – 8- HQS 300 ppm +Sucrose 4%	6.95	6.63	5.97	149.33	132.00	99.67
T_7 - $AgNO_3$ 50 ppm + Sucrose 4%	5.48	4.72	4.31	116.00	114.33	84.00
T_8 - $AgNO_3$ 100 ppm + Sucrose 4%	5.17	4.42	3.79	133.67	122.33	78.33
T_9 – Control	5.06	3.66	3.31	108.67	92.67	65.00
SED	0.01	0.12	0.14	2.61	0..89	0.68
CD (P=0.05)	0.03	0.24	0.28	4.39	1.77	1.24

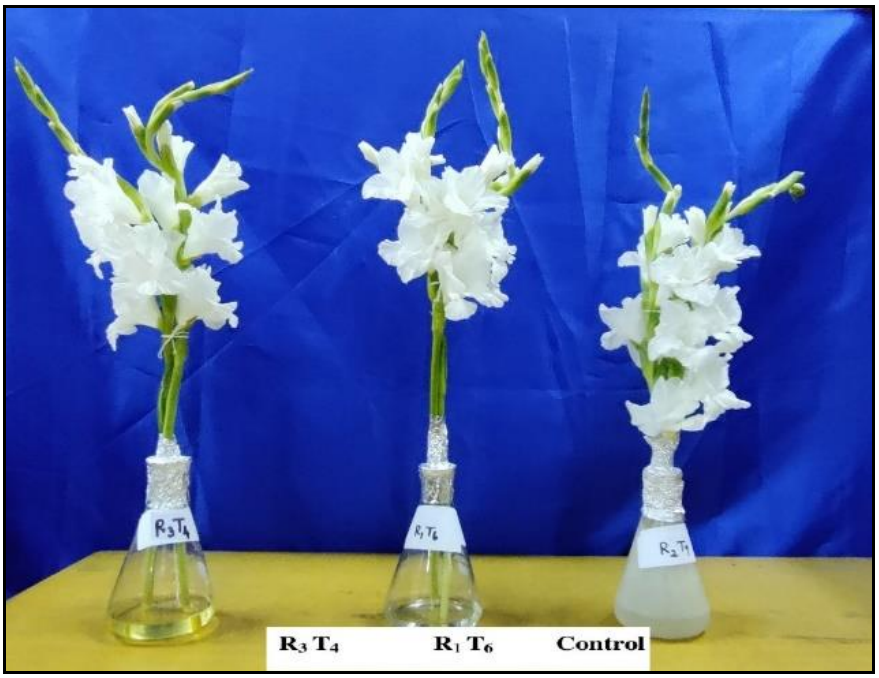
The optical density of the vase solution, an indicator of microbial growth, was lowest in T_6 (8-HQS at 300 ppm + 4% sucrose) on day 3, suggesting effective microbial inhibition. Conversely, the control exhibited the highest optical density on day 7, implying substantial microbial proliferation and vascular blockage. The bacteriostatic and fungistatic properties of 8-HQS, through precipitation of essential minor elements, likely contributed to the reduced microbial growth [20, 21].

Among the treatments, T_6 (8-HQS at 300 ppm + 4% sucrose) exhibited the maximum vase life, followed by T_4 (8-HQ at 250 ppm + 4% sucrose), while the control recorded the shortest vase life. The extended vase life in T_6 could be attributed to improved water relations, delayed protein degradation, maintained membrane integrity, and slowed petal senescence, as reported in previous studies [9, 22].

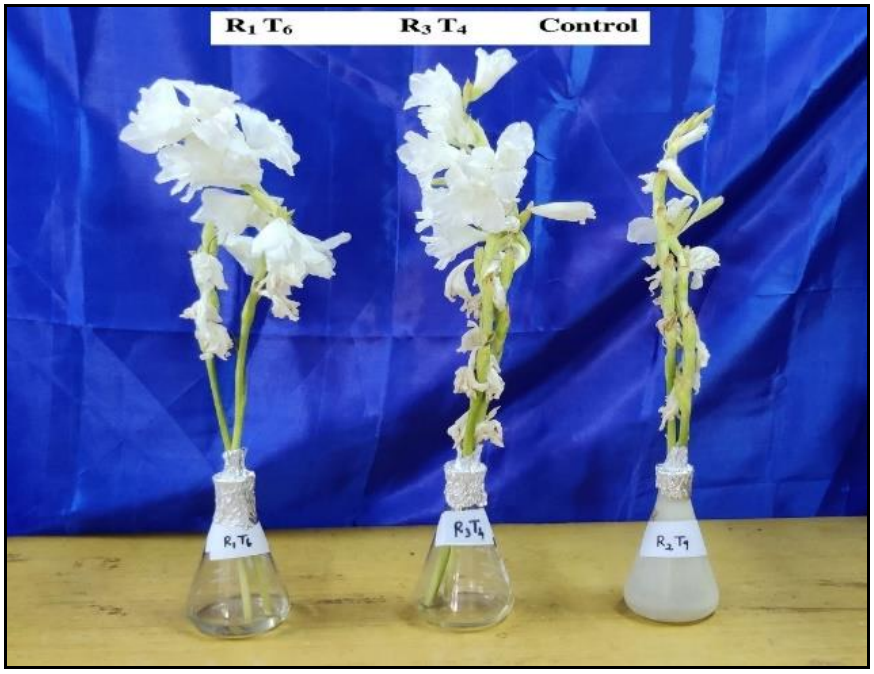
Table 3: Effect of different germicides on Optical density of vase solution & Vase life (days) of gladiolus cv. White Friendship.

Treatments	Optical density of vase solution			Vase life (days)
	3rd day	5th day	7th day	
T_1 - NaDCC 0.6 mg/l + Sucrose 4%	0.0326	0.1483	0.2227	9.27
T_2 - NaDCC 0.8 mg/l + Sucrose 4%	0.0298	0.1349	0.2022	9.07
T_3 – 8- HQ 150 ppm + Sucrose 4%	0.0354	0.1611	0.2416	9.55
T_4 - 8- HQ 250 ppm + Sucrose 4%	0.0223	0.1022	0.1387	9.69
T_5 – 8- HQS 150 ppm +Sucrose 4%	0.0244	0.1095	0.1633	10.28
T_6 – 8- HQS 300 ppm +Sucrose 4%	0.0207	0.0948	0.1089	11.19
T_7 - $AgNO_3$ 50 ppm + Sucrose 4%	0.0343	0.1551	0.2329	8.49
T_8 - $AgNO_3$ 100 ppm + Sucrose 4%	0.0309	0.1403	0.2117	8.23
T_9 – Control	0.0383	0.2228	0.2936	8.06
SED	0.0006	0.0028	0.0011	0.10
CD (P=0.05)	0.0012	0.0058	0.0022	0.21

Plates



Effect of germicides and sucrose on vase life of gladiolus spikes cv. White Friendship on day 2.



Effect of germicides and sucrose on vase life of gladiolus spikes cv. White Friendship on day 11.

Figures

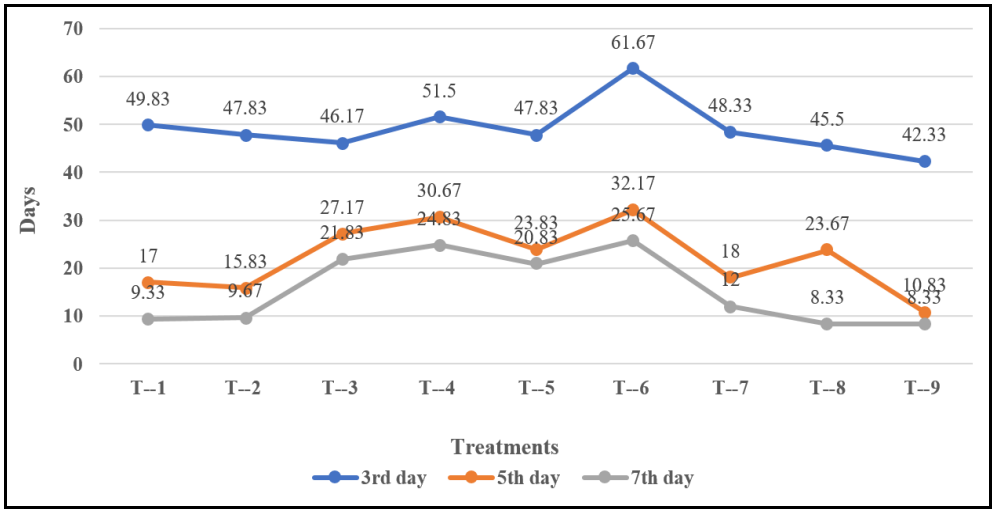


Fig 1: Effect of different germicides on water uptake (g/s) of gladiolus cv. White Friendship.

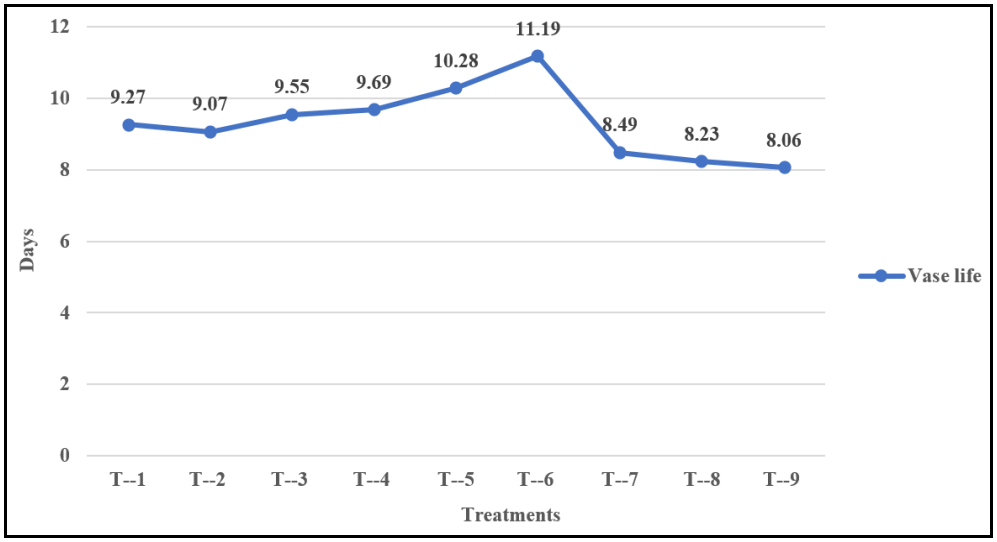


Fig 2: Effect of different germicides on Vase life (days) of gladiolus cv. White Friendship.

Conclusion

The study concluded that the use of a vase solution formulated with 8-Hydroxy Quinoline Sulphate (8-HQS) at a concentration of 300 parts per million (ppm), coupled with a 4% sucrose supplement, proved to be the most efficacious treatment for prolonging the vase life and maintaining the quality attributes of cut gladiolus spikes cv. White Friendship. These findings have practical implications for the commercial cut flower industry, enabling better management of post-harvest losses and enhancing consumer satisfaction.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Data availability statement

All data created and analysed in this study is available within this manuscript.

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