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Research Article

Response of preservative chemicals on the shelf life of cut lilium (*Lilium* spp.) flower cv. 'Pavia'

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Abstract
Lilium cut flowers have commercial importance and extending their vase life is vital. An increase in the vase life quality and quantity can directly increase the viability and price realization of commercially important flowers like lilium. Shelf life of cut lilium flower is influenced by using different preservative chemicals and sucrose added in vase solution. Such an extension of vase life can be achieved via chemical treatment. The trial was carried out to examine the effect of various concentration of two chemicals, $AgNO_3$ (silver nitrate) and 8-HQC (8-Hydroxyquinoline citrate) along with sucrose on the shelf life of lilium cut flower cv. 'Pavia' (cross between Asiatic and Longiflorum lilies). In the experiment, sucrose (20%), 8-HQC at 3 concentrations (100, 150, 200 ppm) and $AgNO_3$ at 3 concentrations (50, 75, 100 ppm) and water (distilled) as control were tested alone and with combinations. Cut flowers of lilium were treated at one bud opening stage. The trial was carried out in a completely randomized design (CRD) having 16 treatments and one control in three (3) replications. The fresh weight and relative fresh weight of the cut flower spike, opening of all flowers on a spike, vase solution uptake on a day, total vase solution uptake and vase life of lilium cut flower spike showed the best outcome with $AgNO_3$ (50 ppm) and 20% sucrose treatment combination. Out of the two chemicals, silver nitrate showed better results than 8-HQC as a preservative in enhancing the shelf life of cut Lilium flower cv. 'Pavia'. Analysis of this new and exciting method will be useful to research institutes, commercial producers, wholesalers, retailers, consumers or anyone to choose right chemical and concentration of holding solution to maximize the post-harvest life of lilium cut flowers.

Keywords: $AgNO_3$, Cut flowers, 8HQC, Lilium, Sucrose, Vase life

INTRODUCTION

Lilium (*Liliaceae family*) is an important commercial cut flower in the international market due to its long vase life compared to other cut flowers (Nukui *et al.*, 2004) a major characteristic demanded commercially. The cut flower with a lengthier shelf life is considered a significant quality trait in flower cultivation and is preferred by retailers in domestic and export markets (Avilala *et al.*, 2021).The post-harvest life of a cut-flower is influenced by different factors (Mayak *et al.*, 1974; Ichimura *et al.*, 2002). Chiefly, among them are genetics, flower handling, growing conditions (Pizano, 2009), xylem vessels blockage, ethylene level, carbohydrate content, atmospheric composition and chemicals used as preservatives. The end of the shelf life of cut flowers displayed through wilting (He *et al.*, 2006) and water quantity within the cut flowers, along with the balance levels, are key indicators determining quality and durability. The balance between the water (H_2O) intake & its level of transpiration determines the vase life of cut flowers (Da Silva, 2003). The wilting is primarily caused due to larger transpiration level compared to the level of water intake (Halevy and Mayak, 1981). Occlusions, located primarily in the basal end, are often correlated with a lower level of water uptake (He *et al.*, 2006). Microbes cause blockage in xylem vessels and are deposited in vase solution (Marandi *et al.*, 2011), which affects the uptake of water and its transportation in the leaves and tissue of stem (Hassan, 2005), thereby shortening the enhancement of flowers (Kazemi *et al.*, 2011, An *et al.*, 2008). The use of different chemicals can extend cut flowers' vase life. Different chemicals like silver nirate ($AgNO_3$) (Fujino *et al.*, 1983), sodium hypochlorite (Van Doorn *et al.*, 1990), 8-HQC (Van Doorn *et al.*, 1990; Knee, 2000 & Marousky, 1969;), benzalkonium chloride, aluminium sulphate (Ruting, 1991 and Put *et al.*, 1992), 8-HQS (Hussein, 1994), bromopropanediol (Knee, 2000); sodium benzoate (Knee, 2000) and thiabendazole (Halevy *et al.*, 1978; Apelbaum and Katchansky, 1997). These potential chemicals have both merits and demerits (Faragher *et al.*, 2002), with other functions. The response of chemical compounds is not uniform on the cut flowers as the microorganism that is extant on the stems is heterogeneous. They can be comprised of bacteria, filamentous fungi and yeast (Van Doorn, 1997). Applying the above chemicals has a multitude of positive responses, such as growth in increased intake of vase solution, increased fresh weight, total vase life and flower diameter. These are also accompanied by a measured increase in total chlorophyll levels and an increase in carbohydrate and phenol levels, resulting in decreased bacterial count in the vase solution (El-Attar and Sakr, 2022). The most prevalent type of silver salt used in commercial floral preservation solutions is $AgNO_3$, primarily employed as an ethylene binding inhibitor (Vishal *et al.*, 2021). Nair *et al.* (2003), while studying the effect of $AgNO_3$ + sucrose, reported extended vase life and delayed head dropping and discoloration in gerbera cut flowers. Shiva and Bhattacharjee (2003) noticed an initial increase in flower fresh weight until the 3rd day of post-harvest. Mwangi *et al.* (2003) concluded that the Starch content in petals is positively correlated with the flower's vase life as a treatment had an increased level of starch due to the pulsing holding solution.

The keeping quality of the cut rose was evaluated with the treatment of $AgNO_3$ and 8-HQC chemicals, out of which 100 ppm 8-HQC showed the best results in extending the shelf life of rose cut flower cv. 'Grand Gala' and 'First Red' in comparison to control (Son *et al.,*2003). Germicides are often utilized in the floral industry, such as 8-HQC compounds. The utilization of these compounds, either in vase solution or pulse, can have significant and positive effects, such as a reduction in microbial growth and subsequent vascular blockage. These also lead to an increase in water uptake (Butt, 2005). According to Doorn *et al.* (1989), 8-HQC and $AgNO_3$ enhanced the shelf life of cut rose blooms. Vilas *et al.* (2017) found that solution uptake, fresh weight, diameter & shelf life of cut carnation flower was most effectively shown increased results by using 8-HQC 40 ppm solution. Chand *et al.* (2012) reported that flower diameter, shelf life, fresh weight and water uptake were enhanced in rose-cut flowers by using 8-HQC (100 ppm & 200 ppm). Chand *et al.* (2012) also reported that 8-HQC at 200 ppm was the highest in promoting the cut rose flowers cv. 'Grand Gala' and 'First Red' fresh weight.

A perusal of the literature reveals that little work has been carried out so far to enhance the longevity of the shelf life of cut Lilium flowers, with no clear recommendations about chemicals for adoption. This prompted the authors to carry out the present investigation to find a suitable chemical treatment to extend the longevity of lilium cut flowers.

MATERIALS AND METHODS

The experiment was carried out between May 2019 and July 2021 at Amity University (Amity Institute of Horticulture Studies and Research, Noida, U.P, India). Lilium flowers were cut early in the morning at one flower bud opening stage and immediately processed for grading based on flower size and stem length. The stems were recut at 70 cm length and fresh weight was recorded. Single flower spike was placed in preservative in 500 ml capacity glass cylinders under room temperature (24 ± 2 ºC) and humidity conditions between 60 – 70%. Holding solution in the vase consisted of i) distilled water (control), ii) Sucrose (20%), iii) 8-HQC (100, 150 & 200 ppm) and iv) Silver nitrate ($AgNO_3$) (50, 75 & 100 ppm). The stock solution of 1000 ppm of silver nitrate, 8-HQC and sucrose was prepared in water (distilled) and the final volume of solution was made to 500 ml. Observations were recorded on fresh weight (in gm)& percentage (in %) of relative fresh weight of spike, the opening of all flowers (in days), vase solution uptake on a day (ml/spike), total vase solution uptake (ml/spike) and vase life (days).

Statistical analysis

Trial was conducted in CRD (completely randomized designed) with 3 replications. Each replication had 17 glass cylinders with 500 ml capacity, out of which there were 16 treatments and one control (distilled water) containing one cut flower stem each. The details of different treatment combinations of chemicals used in the experiment are given below:

To perform the statistical analysis of research data SPSS statistical software used. Analysis of variance & means of comparison using Duncan's multiple range test (P ≤ 0.05).

Treatment Code	Treatment detail
T_0	Control (only distilled water)
T_1	Distilled Water + Sucrose (20%)
T_2	8-HQC (100 ppm) + Sucrose (20%)
T_3	8-HQC (150 ppm) + Sucrose (20%)
T_4	8-HQC(200 ppm) +Sucrose (20%)
T_5	$AgNO_3$ (50 ppm) +Sucrose (20%)
T_6	$AgNO_3$ (75 ppm) +Sucrose (20%)
T_7	$AgNO_3$ (100 ppm) + Sucrose (20%)
T_8	8-HQC (100 ppm) + $AgNO_3$ (50 ppm) + Sucrose (20%)
T_9	8-HQC (150 ppm) + $AgNO_3$ (50 ppm) + Sucrose (20%)
T_{10}	8-HQC (200 ppm) + $AgNO_3$ (50 ppm) + Sucrose (20%)
T_{11}	8-HQC (100 ppm) + $AgNO_3$ (75 ppm) + Sucrose (20%)
T_{12}	8-HQC (150 ppm) + $AgNO_3$ (75 ppm) + Sucrose (20%)
T_{13}	8-HQC (200 ppm) + $AgNO_3$ (75 ppm) + Sucrose (20%)
T_{14}	8-HQC (100 ppm) + $AgNO_3$ (100 ppm) + Sucrose (20%)
T_{15}	8-HQC (150 ppm) + $AgNO_3$ (100 ppm) + Sucrose (20%)
T_{16}	8-HQC (200 ppm) + $AgNO_3$ (100 ppm) + Sucrose (20%)

RESULTS AND DISCUSSION

Fresh weight

The fresh weight of the flower spike ranged between 81 to 103.83 gm (Fig. 1). Significant variations were noticed among the treatments imposed and it was observed that the treatment combination $AgNO_3$ (50 ppm) + Sucrose (20%) (T_5) resulted in the highest gain of weight (103.83 g) followed by $AgNO_3$ (75 ppm) + Sucrose (20%) (T_6), 8-HQC (100 ppm) + $AgNO_3$ (50 ppm) + Sucrose (20%) (T_8) and 8-HQC (100 ppm) + $AgNO_3$ (75 ppm) + Sucrose (20%) (T_{11}) with 99.0 g, 97.67 g and 97.50 g respectively. While the lowest fresh weight was recorded in control (T_0) with 81.0 g. The value of T_5 differed significantly among the other treatments, while there was little difference between T_8 and T_{11}. This might be due to the very low concentration of macromolecules in water as compared to the preservative solutions with added sugars, which not only retarded the fresh weight losses but also increased the shelf life of the cut flower. Kumar *et al.* (2020) reported that the concentration of $AgNO_3$ and Al_2SO_4 significantly affected rose flower cut stems. Marousky (1972) observed maintained water uptake by stems of cut flowers owing to the growth of microorganisms in vessels xylem. The presence of sucrose in flowers has a plethora of effects, including but not limited to growth in water uptake levels due to increasing osmotic concentration and causing higher fresh weights in stems of cut flowers due to higher water levels consequent of stomatal closure. Sucrose can impact the energy or nutrition supply to flowers. By influencing the closure of stomatal in leaves, sucrose can benefit in maintaining fresh weight of the flower stem and, therefore, reducing water loss. Sucrose can also benefit in maintaining increased fresh weights in cut flower stem by influencing the closure of stomatal in leaves, thus, dropping the loss of water. Chand *et al.* (2012) found the best result to increase the fresh weight of rose-cut flowers by using silver nitrate chemical. Likewise, in our study, treatment with $AgNO_3$ (50 ppm) in combination with 8HQC (200 ppm) was also significantly found to increase the fresh weight of flowers over the control treatment. Shiva and Bhattacharjee (2003) observed an initial gain in the fresh weight of cut roses until 3rd day after harvest. Halevy and Mayak (1981) observed higher loss in weight in vase water having no preservative.The relative fresh weight (%) of lillium cut flowers spike showed significant variation with various treatments of $AgNO_3$ and 8-HQC with the combination of sucrose during both years (Fig. 2). Highest (141.22%) relative fresh weight of lillium spike was observed with the treatment $AgNO_3$ (50 ppm) + Sucrose (20%) (T_5) followed by $AgNO_3$ (75 ppm) + Sucrose (20%) (T_6) and 8-HQC (100 ppm) + $AgNO_3$ (75 ppm) + Sucrose (20%) (T_{11}) with 138.65% and 138.40% gain in relative fresh weight of the spike while lowest was recorded in control with 114.13% increase. The relative fresh weight of cut flower spike ranged from 114.13 to 141.22%. The gain in the relative fresh weight was seen due to the combined impact of $AgNO_3$, sucrose and 8-HQC in the solution. Vilas *et al.* (2017) reported increased fresh weight of cut carnation flowers by using 8-HQC at 40 ppm. Chand *et al.* (2012) reported a significant increase and the highest fresh weight in rose cut flowers cv. 'Grand Gala' over the control (distilled water) by using $AgNO_3$ (100 ppm).

Opening of all flowers on spike

Results showed that more than 80% of flowers were opened on 11th day and treatment combination 50 ppm $AgNO_3$ and 20% sucrose (T_5) took maximum 12.5 days on average to open all the flowers on the spike and resulted in long vase life of the spike followed by 8-HQC (100 ppm) + $AgNO_3$ (75 ppm) + Sucrose (20%) (T_{11}) and $AgNO_3$ (75 ppm) + Sucrose (20%) (T_6) with

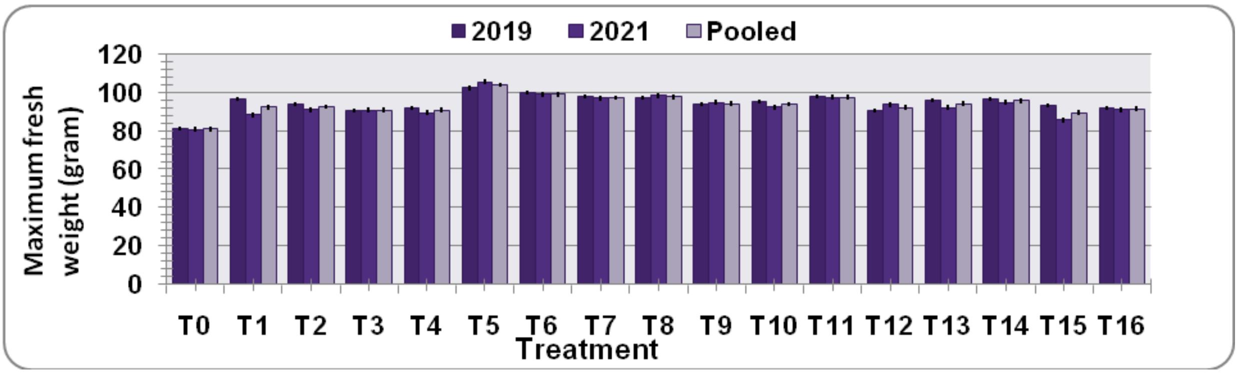

Fig. 1. *Effect of different concentrations of chemicals on fresh weight of flower spike of lilium cut flower cv. 'Pavia'*

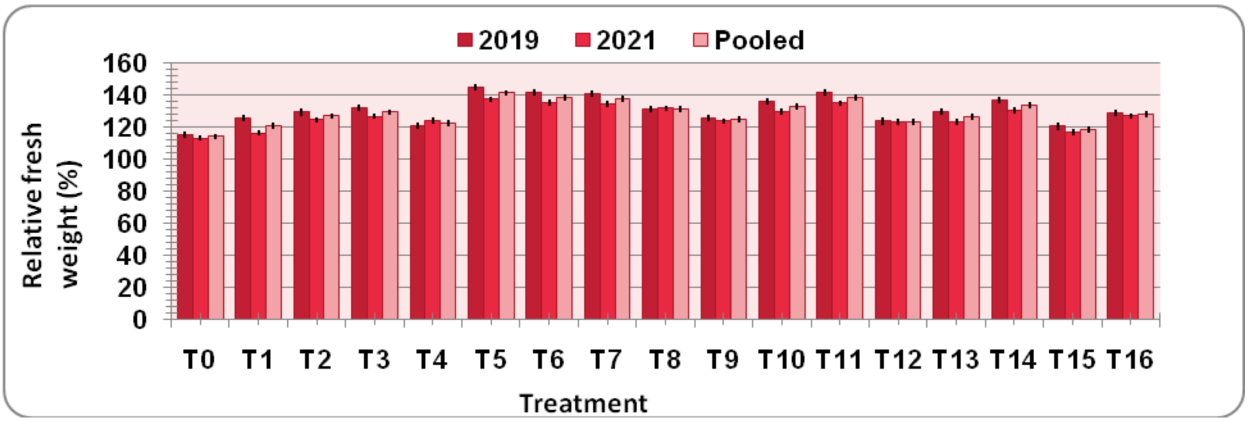

Fig. 2. *Effect of different concentrations of chemicals on relative fresh weight of flower spike of lilium cut flower cv. 'Pavia'*

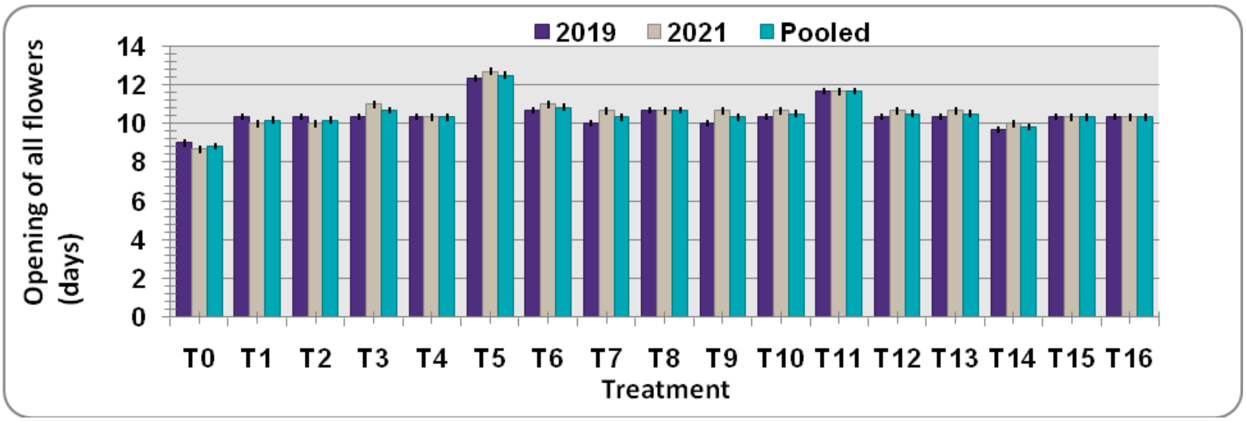

Fig. 3. *Effect of different concentrations of chemicals on opening of all flowers on the spike of lilium cut flower cv. 'Pavia'*

11.67 days and 10.83 days respectively, The lowest was recorded in control with 8.83 days (Fig. 3). Late opening of the flowers resulted in increasing of the longevity of lilium cut flower spike. Days taken to open all flowers on spike ranged from 8.84 to 12.5 days.

Vase solution uptake in a day by flower spike

The vase solution uptake by the cut lilium flower on a particular day showed significant variation with different concentrations of $AgNO_3$, 8-HQC and Sucrose (Table 1). Maximum water uptake of 31.17 ml in a day by the lilium cut flower spike was found in treatment with $AgNO_3$ (50 ppm) + 20% Sucrose (T_5) followed by 8-HQC (100 ppm) + $AgNO_3$ (75 ppm) + Sucrose (20%) (T_{11}) with 29.33 ml and 8-HQC (150 ppm) + $AgNO_3$ (75 ppm) + Sucrose (20%) (T_{12}) with 29.00 ml while the minimum solution uptake of 16.67 ml was recorded in control (T_0). The post-harvest treatment was also significantly affected by T_{10} and T_{14} treatments compared to the control.

Total vase solution uptake

A shift in the concentration of silver nitrate ($AgNO_3$), 8-HQC and sucrose impacted the total intake of vase solution (ml/spike) by cutting liium flower spikes (Table 2). The treatment combination of $AgNO_3$ (50 ppm) and 20% Sucrose (T_5) has significantly increased the water uptake and resulted in the highest solution uptake of

Table 1. Effect of preservative chemicals with their different concentrations on vase solution uptake in a day of lilium cut flower cv. 'Pavia'

Treatments	Symbol	Vase solution uptake in a day (ml/spike)		
		2019	2021	Pooled
Control (only dw)	T_0	16.33	17.00	16.67
Distilled Water + Sucrose (20%)	T_1	21.33	20.67	21.00
8HQC (100 ppm) + Sucrose (20%)	T_2	24.67	25.67	25.17
8HQC (150 ppm) + Sucrose (20%)	T_3	21.67	23.00	22.33
8HQC (200 ppm) + Sucrose (20%)	T_4	27.67	27.33	27.50
$AgNO_3$ (50 ppm) + Sucrose (20%)	T_5	32.33	30.00	31.17
$AgNO_3$ (75 ppm) + Sucrose (20%)	T_6	26.00	25.33	25.67
$AgNO_3$ (100 ppm) + Sucrose (20%)	T_7	23.67	28.33	26.00
8HQC (100 ppm) + $AgNO_3$ (50 ppm) + Sucrose (20%)	T_8	23.33	28.00	25.67
8HQC (150 ppm) + $AgNO_3$ (50 ppm) + Sucrose (20%)	T_9	24.67	28.33	26.50
8HQC (200 ppm) + $AgNO_3$ (50 ppm) + Sucrose (20%)	T_{10}	29.33	28.00	28.67
8HQC (100 ppm) + $AgNO_3$ (75 ppm) + Sucrose (20%)	T_{11}	30.33	28.33	29.33
8HQC (150 ppm) + $AgNO_3$ (75 ppm) + Sucrose (20%)	T_{12}	27.67	30.33	29.00
8HQC (200 ppm) + $AgNO_3$ (75 ppm) + Sucrose (20%)	T_{13}	27.00	26.33	26.67
8HQC (100 ppm) + $AgNO_3$ (100 ppm) + Sucrose (20%)	T_{14}	28.67	26.67	27.67
8HQC (150 ppm) + $AgNO_3$ (100 ppm) + Sucrose (20%)	T_{15}	25.67	27.67	26.67
8HQC (200 ppm) + $AgNO_3$ (100 ppm) + Sucrose (20%)	T_{16}	25.67	27.33	26.50
Mean		**25.65**	**26.37**	**26.01**
Min		16.33	17.00	16.67
Max		32.33	30.33	31.17
SE(m)		0.54	0.84	0.50
C.D. at 5%		1.57	2.43	1.44
C.V. (%)		3.66	5.52	3.32

112.67 ml/spike, followed by 8-HQC (100 ppm) + $AgNO_3$ (75 ppm) + Sucrose (20%) (T_{11}) and $AgNO_3$ (75 ppm) + Sucrose (20%) (T_6) with 108.00 and 104.00 ml/spike respectively while lowest was recorded in control (T_0) with 68.50 ml/spike for uptake of total vase solution in vase life period by lilium flower spike. Kumari et al. (2018) reported that in Asiatic Hybrid Lily cv. 'Arcachon', there is a comparatively larger vase solution uptake due to the application of aluminum sulphate. An increase in net water intake was reported by Shanan *et al.* (2010) in carnation (*Dinathus caryophyllus* L.) for cultivars 'Farida' (10.93%) and 'Madam Collate' (7.95%) in 8-HQ. Chand *et al*. (2012) recorded the largest increase in water intake by using 8-HQC (at 200 ppm) in rose cut flowers. Sharma and Bhardwaj (2015) reported the highest solution uptake of 36.56 ml with $AgNO_3$ solution ($AgNO_3$ (1mM) + Sugar (40%) + citric acid (200 ppm) in carnation cut flowers. Variation in solution uptake in different chemical sucrose 5%+ $AgNO_3$ 300 ppmtreatments were reported in cut rose due to bacterial and fungal species gaining prevalence and commotion in the transpiration pool in vase solution (Destigter and Broekhuysen, 1986). Marousky (1968) noted that the treatment of the gladiolus flower with 8-HQC maintains the pH at a low level hence ensuring the prolong life of flower. A positive effect on the vase life along with appearance was noticed for developed Gladiolus inflorescence var. 'Commando' that were commercially treated by sucrose solutions. The concentration of thirty (30) gm sucrose / dm^3 seems effective treatment (Marwe *et al.*, 1986). The beneficial effect of partial closure of stomata has also been reported with aluminium (Schnable, 1976) and cobalt (Venkatarayappa *et al*., 1981; Reddy and Nagarajaiah, 1988) and which could be the cause for retention water and increasing water uptake. Abdel-Kader *et al.* (2017) found that silver nitrate ($AgNO_3$) had improved the water uptake in cut rose by inhibiting the bacteria growth, which was the main cause of the cut stem for vascular blockage. Mayak and Halevy (1981) found that sucrose act as an energy source to continue the longevity of cut flowers, hence promoted the water relations by prolonging the vase life (Elgimabi and Sliai, 2013). Lü et al. (2010) reported that apart from sucrose, antimicrobial agents such as silver nitrate/silver nano-particles would improve water relations and increase water uptake, thereby increasing the fresh weight and vase life of rose cut flowers cv. 'Movie Star'. Kumar *et al*. (2020) found the highest solution uptake in Gladiolus cut flowers at 104.67 ml with Sucrose 4% + 8-hydroxyquinoline citrate (250 ppm). Abdel-Kader (2012) reported that the application of 8-HQS, Chitosan, $AgNO_3$, and silver nano particles improved the quality and extended the shelf life of cut rose (*Rosa hybrida*) flowers cv. 'Black Magic'.

Vase life of flower spike

Significant result was recorded by using the floral preservative chemicals in increasing the vase life of lilium cut flowers over control treatment (Table 3). Longest vase life of 17.83 days of cut lilium flower was observed with the treatment of 50 ppm $AgNO_3$ and 20% Sucrose (T_5), which significantly influenced the shelf life of lilium flowers while comparing to other treatments followed by the 8-HQC (100 ppm) + $AgNO_3$ (75 ppm) + Sucrose (20%) with 17.00 days (T_{11}) and 8-HQC (100 ppm) + $AgNO_3$ (50 ppm) + Sucrose (20%) with 16.33 days (T_8) while minimum vase life was observed with 12.67 days in control (T_0). The post-harvest treatments with T_6, T_{10}, T_{12} and T_{16} also recorded prolonged vase life of lilium cut flower spike. Kshirsagar *et al.* (2021) found the highest (9 days) vase life in cut rose flower cv. 'Top Secret' by using $AgNo_3$ (30 ppm) + Sucrose 2.0% + Boric Acid (75 mg/l). Van Doorn (1997) found that after harvesting of cut flowers, it faces water stress which causes short vase life due to a high rate of transpiration and water loss, air embolism, growth of microbes and vascular blockage. Some of the prominent effects of bactericides are reduced bacteria growth, vascular blockage, decreased transpiration rate, water loss, inhibited ethylene action and maintained water uptake (Mei-hua *et al.*, 2008; Mohammadiju *et al.*, 2014; Zamani *et al.*, 2011 and Mori *et al.*, 2001). Reddy *et al.* (1988) reported that the pulsing treatment of cut roses (*Rosa hybrida*) using silver nitrate ($AgNO_3$) for 10-20

Table 2. Effect of preservative chemicals with their different concentrations on total vase solution uptake of lilium cut flower cv. 'Pavia'

Treatments	**Symbol**	**Total vase solution uptake (ml/spike)**		
		2019	**2021**	**Pooled**
Control (only dw)	T_0	68.00	69.00	68.50
Distilled Water + Sucrose (20%)	T_1	73.00	80.67	76.83
8HQC (100 ppm) + Sucrose (20%)	T_2	94.33	96.67	95.50
8HQC (150 ppm) + Sucrose (20%)	T_3	82.67	89.33	86.00
8HQC (200 ppm) + Sucrose (20%)	T_4	79.00	81.00	80.00
$AgNO_3$ (50 ppm) + Sucrose (20%)	T_5	114.67	110.67	112.67
$AgNO_3$ (75 ppm) + Sucrose (20%)	T_6	105.33	102.67	104.00
$AgNO_3$ (100 ppm) + Sucrose (20%)	T_7	86.00	93.33	89.67
8HQC (100 ppm) + $AgNO_3$ (50 ppm) + Sucrose (20%)	T_8	92.67	100.33	96.50
8HQC (150 ppm) + $AgNO_3$ (50 ppm) + Sucrose (20%)	T_9	89.00	99.00	94.00
8HQC (200 ppm) + $AgNO_3$ (50 ppm) + Sucrose (20%)	T_{10}	84.00	95.67	89.83
8HQC (100 ppm) + $AgNO_3$ (75 ppm) + Sucrose (20%)	T_{11}	107.00	109.00	108.00
8HQC (150 ppm) + $AgNO_3$ (75 ppm) + Sucrose (20%)	T_{12}	84.33	98.67	91.50
8HQC (200 ppm) + $AgNO_3$ (75 ppm) + Sucrose (20%)	T_{13}	84.67	90.00	87.33
8HQC (100 ppm) + $AgNO_3$ (100 ppm) + Sucrose (20%)	T_{14}	101.33	102.67	102.00
8HQC (150 ppm) + $AgNO_3$ (100 ppm) + Sucrose (20%)	T_{15}	87.33	92.00	89.67
8HQC (200 ppm) + $AgNO_3$ (100 ppm) + Sucrose (20%)	T_{16}	92.67	93.67	93.17
Mean		**89.76**	**94.37**	**92.07**
Min		68.00	69.00	68.50
Max		114.67	110.67	112.67
SE(m)		2.71	3.02	1.89
C.D. at 5%		7.83	8.72	5.47
C.V. (%)		5.24	5.55	3.56

Table 3. *Effect of preservative chemicals with their different concentrations on vase life of flower spike of lilium cut flower cv. 'Pavia'*

Treatments	Symbol	Vase life of flower spike (days)		
		2019	2021	Pooled
Control (only dw)	T_0	12.00	13.33	12.67
Distilled Water + Sucrose (20%)	T_1	14.00	14.33	14.17
8HQC (100 ppm) + Sucrose (20%)	T_2	16.00	16.00	16.00
8HQC (150 ppm) + Sucrose (20%)	T_3	15.67	15.67	15.67
8HQC (200 ppm) + Sucrose (20%)	T_4	15.33	15.33	15.33
$AgNO_3$ (50 ppm) + Sucrose (20%)	T_5	18.00	17.67	17.83
$AgNO_3$ (75 ppm) + Sucrose (20%)	T_6	16.00	16.00	16.00
$AgNO_3$ (100 ppm) + Sucrose (20%)	T_7	15.67	15.33	15.50
8HQC (100 ppm) + $AgNO_3$ (50 ppm) + Sucrose (20%)	T_8	16.33	16.33	16.33
8HQC (150 ppm) + $AgNO_3$ (50 ppm) + Sucrose (20%)	T_9	15.67	15.33	15.50
8HQC (200 ppm) + $AgNO_3$ (50 ppm) + Sucrose (20%)	T_{10}	15.33	16.67	16.00
8HQC (100 ppm) + $AgNO_3$ (75 ppm) + Sucrose (20%)	T_{11}	17.33	16.67	17.00
8HQC (150 ppm) + $AgNO_3$ (75 ppm) + Sucrose (20%)	T_{12}	16.33	15.67	16.00
8HQC (200 ppm) + $AgNO_3$ (75 ppm) + Sucrose (20%)	T_{13}	15.00	16.33	15.67
8HQC (100 ppm) + $AgNO_3$ (100 ppm) + Sucrose (20%)	T_{14}	16.00	15.67	15.83
8HQC (150 ppm) + $AgNO_3$ (100 ppm) + Sucrose (20%)	T_{15}	15.00	15.67	15.33
8HQC (200 ppm) + $AgNO_3$ (100 ppm) + Sucrose (20%)	T_{16}	16.33	15.67	16.00
Mean		**15.65**	**15.75**	**15.70**
Min		12.00	13.33	12.67
Max		18.00	17.67	17.83
SE(m)		0.52	0.52	0.42
C.D. at 5%		1.51	1.51	1.21
C.V. (%)		5.80	5.76	4.64

min had improved the longevity up to 6.0 and 5.3 days, respectively. Veen and Van de Geijn (1978) found improved longevity in cut carnation flowers (*Dianthus caryophyllus* L.) using 8HQS and $AgNO_3$+ sucrose significantly. Bakhsh *et al.* (1999); Doorn*et al.* (1989) & Elgimabi (2011) reported an increase in vase life of tuberose cut flowers by using $AgNO_3$ at 200 ppm and Silver Thio Sulphate (STS) at 4 mM solution. Chand *et al.* (2012) found significant enhancement in shelf life of cut rose flower by using $AgNO_3$ (50 ppm). There was the highest shelf life of cut roses by using the combination of 8-HQC at 100 and 200 ppm (Chaudhary *et al.*(2016); Kumari *et al.* (2018); Kombo and Sahare (2021). Like other experiments conducted on different cut flowers, the treatment with silver nitrate ($AgNO_3$) and Sucrose also showed better results than the control treatment, with a minimum of 12.67 days in control and recorded minimum days 17.83 days as maximum in $AgNO_3$ 50 ppm and 20 % sucrose. This showed the effectiveness of preservative chemical for prolonging the vase life of lilium cut flowers. Primarily, the vase life of lilium cut flowers was influenced by the loss of water and uptake. Silver nitrate ($AgNO_3$) is effective inhibitor for ethylene and also acts as antimicrobial in plant tissues. The treatment of $AgNO_3$ with sucrose extended the vase life lilium cut flowers by inhibiting the ethylene production and microbial activity as compared to the control treatment.

Conclusion

This study concluded that $AgNO_3$ in combination with sucrose was found better than 8-HQC for prolonging the vase life period of cut lilium flowers cv 'Pavia'. Among the studied chemicals and their concentrations, $AgNO_3$ at 50 ppm in combination with sucrose at 20% was most promising for increasing the shelf life of cut lilium flowers cv." Pavia". Proper harvesting and caring of cut flowers played an important role in maximizing the post-harvest life and ensuring high-quality lilium flowers. The findings of this trial can be useful to research institutes, commercial producers, wholesalers, retailers, consumers or anyone to choose the right chemical and concentration of holding solution to maximize the post-harvest life of lilium cut flowers.

Conflict of interest

The authors declare that they have no conflict of interest.

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