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Influence of Sucrose and Silver Nitrate to Ameliorate Post Harvest Performance of Gladiolus Spikes

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ABSTRACT

The present study on "Influence of sucrose and silver nitrate to ameliorate post-harvest performance of gladiolus spikes" was conducted at Horticultural Lab., The University of Agriculture Peshawar during the year 2021. The experiment was carried out in Complete Randomized Design. There were nine treatments which were replicated three times. These treatments include Control (0), AgNO3 (0.03 g/L), AgNO3 (0.05 g/L), sucrose (40 g/L), sucrose (60 g/L), AgNO3+ Sucrose (0.03 g/L + 40 g/L), AgNO3+ sucrose (0.03 g/L+ 60 g/L), AgNO3 + sucrose (0.05 g/L+40 g/L) and AgNO3 + sucrose (0.05 g/L+60 g/L). Silver nitrate and sucrose significantly affected all the parameters. The mean value of silver nitrate and sucrose showed that cut flowers of gladiolus placed in holding solution of AgNO3 + Sucrose (0.05 g/L + 60 g/L) results in maximum days to opening of 1st floret (3.90), opening of full spike (8), fading of 1st floret (8.66), fading of full spike (23), fresh floret weight (6.36 g), senesced floret weight (0.96 g), reducing sugar (12.83 mg g-1), non-reducing sugar (15.93 mg g-1), total phenolic content (0.63 mg g-1) with minimum electrolyte leakage (63.03%) and maximum vase life (15.33 days) and proved superior as compared to other treatments. It is concluded from the results that application of AgNO3 + Sucrose (0.05 g/L + 60 g/L) in holding solution was most effective to retain the quality of gladiolus floret and spike over extended period and to enhance the vase life of gladiolus cut spikes. However, it was statistically similar to the effect of 0.05 g/L + 40 g/L (AgNO3 + Sucrose) for most of the studied attributes.

INTRODUCTION

Gladiolus is known as herbaceous perennial in nature and an important ornamental bulbous flowering plant. Its family is Iridaceae. There are about 260 species in genus gladiolus. Gladiolus cut flowers have great demand in cut flowers trade in the world. Ornamental horticulture especially floriculture is getting popularity day by day in small farmers and commercial growers of Pakistan. Cut flower production of Pakistan is about 10 to 12 thousand tons per annum and there is a rise in the demand for cut flowers throughout the country. Highest demand exists for roses in cut flower market followed by gladiolus. Gladiolus cut flowers can be produced successfully by commercial growers including small land holders for their livelihood (Nadeem et al. 2011).

Longevity of cut flowers is the demand of the consumer and big challenge for florists. It is because consumer is desirous to have cut flowers with extended post-harvest display life. Being perishable the post-harvest life of gladiolus cut flowers is usually short. It might range from 4 to 6 days and lower florets are opened and senesced first followed by upper ones (Yamada et al. 2003). Cut flowers are generally treated with various chemicals and preservatives including sugars and silver nitrate ($AgNO_3$), for extension in their vase life. $AgNO_3$ has the potential that it slow down the processes of senescence of cut flowers thereby enhances vase life of cut flowers. $AgNO_3$ also act as antimicrobial agent in tissues of plant and prevent diseases (Nowak and Rudnick 1990).

Sugars play an important role in plants as substrates for respiration, materials for cell wall synthesis, and as an osmolyte. Since the amount of sugars contained in cut flowers is limited, addition of sugars such as sucrose to vase water is effective in improving the vase life of many cut flowers. Sucrose increases the longevity of cut flowers (Mor et al. 1981). Ichimura and Hiraya (1999) found that Sucrose resulted in slow down of ethylene production and thus increased the vase life of cut flowers in sweet peas. Sucrose and $AgNO_3$ is commonly used as ethylene inhibitor and prevention of microbes for improving post-harvest performance of cut flowers (Veen 1979). It counters the negative effect of ethylene (Shimizu-Yumoto and Ichimura 2013) and control / minimize bacterial growth (Ichimura and Hiraya 1999). $AgNO_3$ guards against the bacterial contamination of the stem and vase water and hence increases the post-harvest life of cut flowers. Therefore, the use of AgNO3 might be of great help to extend vase life of cut flowers.

Keeping in view the commercial importance of gladiolus and positive aspects of sucrose and silver nitrate on the post-harvest of gladiolus cut spikes, the current experiment was planned to find out the optimum concentration of $AgNO_3$, sucrose and their combination on the post-harvest performance of gladiolus cut-spikes.

MATERIALS AND METHODS

The research on “Influence of sucrose and silver nitrate to ameliorate post-harvest performance of gladiolus spikes” was conducted at Horticultural Lab., The University of Agriculture Peshawar in 2021. It was carried out in completely randomized Design (CRD). The treatments were comprised of various concentrations of $AgNO_3$ and Sucrose alone and in combination in comparison to control i.e. Control (0/distilled water), $AgNO_3$ (0.03 g L^{-1}), $AgNO_3$ (0.05 g L^{-1}), sucrose (40 g L^{-1}), sucrose (60 g L^{-1}), AgNO3+ Sucrose (0.03 g L^{-1} + 40 g L^{-1}), AgNO3+ sucrose (0.03 g L^{-1}+ 60 g L^{-1}), AgNO3 + sucrose (0.05 g L^{-1}+40 g L^{-1}) and AgNO3 + sucrose (0.05 g L^{-1}+60 g L^{-1}).Treatments were replicated three times. Cut flowers / spikes of gladiolus cv. Amsterdam (50 cm) with 2 to 3 florets showing colors were brought in bucket containing water to the lab. early in the morning. The 250 ml g/Lasses were filled with the required solutions. The spikes were cut 5 cm in water again and then were placed in the vases filled with various solutions as per treatments. Data were recorded on days to 1st floret opening, days to full spike opening, days to 1st floret fading, days to full spike fading, fresh floret weight (g), senesced floret weight (g), reducing and non-reducing sugars, total phenolic contents, electrolyte leakage (%), vase life of spike (days).

Statistical Analysis

Data noted on different parameters were subjected to Analysis of variance (ANOVA) using the software statistix 8.1 and least significant difference test was used for separation of means for significant findings (Jan et al. 2009).

RESULTS AND DISCUSSION

Days to 1st Floret Opening

Average data of 1st floret opening in response to sucrose and silver nitrate (Table 1) showed that sucrose and silver nitrate significantly affected 1st floret opening in cut spike of gladiolus. Mean data pertaining to 1st floret opening (Table 1) in response to the treatment of sucrose and silver nitrate showed that maximum days to 1st floret opening (3.90) were noted in cut flowers of gladiolus placed in holding solution of 0.05 g L^{-1} + 60 g L^{-1} ($AgNO_3$ + Sucrose), while least days to 1st floret opening (1.80) were noted in cut flowers placed in vase containing distilled water. It showed that the floret opening process was slow down due to the effect of silver nitrate and sucrose (Prashant 2003). Ahmad et al. (2016) reported that days to 1st floret opening were increased in cut spikes of gladiolus due to silver nitrate and sucrose application. Manzoor et al. (2018) also reported that AgNO3 & sucrose in combination significantly increased days to opening of the basal florets.

Days to Full Spike Opening

Data regarding full spike opening of gladiolus were significantly affected due to treatment of sucrose and silver nitrate (Table 1). Mean data pertaining to opening of full spike (Table 1) due to treatment of sucrose and silver nitrate showed that days to full spike opening were increased to maximum (8.0) in cut flowers of gladiolus placed in holding solution of 0.05 g L^{-1} + 60 g L^{-1} (AgNO3 + Sucrose), which was statistically similar to holding solution of 0.05 g L^{-1} + 40 g L^{-1} (AgNO3 + Sucrose), while least days (3.40) were recorded in cut flowers of vase containing distilled water. It might be due to the fact that $AgNo_3$ is anti-ethylene compound which inhibits the action of ethylene and also has antimicrobial properties, hence its presence in vase solution resulted in more days to full spike opening (Vahdati et al. 2012). Awashti et al. (2013) reported that retention of sugars in flower tissue improved their ability of absorbing more water and to become turgid. These results are in conformity with that of Singh and Sharma (2002) who reported that days to spike opening were enhanced in gladiolus cut spikes when treated with sucrose and silver nitrate in combination.

First Floret Fading (days)

Data pertaining days to 1st floret fading as affected by sucrose and silver nitrate (Table 1) showed that 1st floret fading was significantly affected by treatment of sucrose and silver nitrate. Mean data pertaining to 1st floret fading (Table 1) in response to the treatment of sucrose and silver nitrate showed that maximum days to 1st floret fading (8.66) were recorded in cut flowers of gladiolus placed in vase solution enriched with 0.05 g L^{-1} + 60 g L^{-1} (AgNO3 + Sucrose), while least days to 1st floret fading (4.40) were recorded in cut flowers placed in vase containing distilled water. The reason is beneficial impact of silver ions that inhibited microbial infection and increase longevity whereas sucrose acts as a source of food, slow down protein degeneration and maintain cut flowers turgid due to the maintenance of water balance (Malakar et al. 2019). Awasthi et al. (2013) also reported that 1st floret fading took more days in cut flowers treated with silver nitrate and sucrose. These results are also in line with those of Abadi et al. (2013) and Kumar and Deen (2017).

Days to Full Spike Fading

Results pertaining to full spike fading in response to sucrose and silver nitrate (Table 1). Full spike fading was significantly affected by treatment of sucrose and silver nitrate. Table 1 showed that highest value (23.00 days) was recorded in cut flowers/spikes of gladiolus placed in vase solution enriched with 0.05 g L^{-1} + 60 g L^{-1} ($AgNO^3$ + Sucrose), which was statistically similar to vase solution enriched with 0.05 g L^{-1} + 40 g L^{-1}($AgNO^3$ + Sucrose), while least days to full spike fading (13.00) were recorded in cut flowers placed in vase containing distilled water. Prolong vase life of gladiolus spike is the result of sucrose as it act as energy source (Hussen and Yassin 2013) and regulate osmotic potential and water relation. Sucrose induces a rise in starch content, which indicates the availability of carbohydrates to the flower and keep it fresh. Silver ion control and minimize bacterial growth at the stem end in gardenia with enhanced water uptake and hence slow down wilting (Lin et al. 2019). Manzoor et al. (2018) also observed that silver nitrate and sucrose increased the days to fading of full spike.

Fresh Floret Weight (g)

Treatment of sucrose and silver nitrate significantly affected weight of fresh floret in gladiolus spikes (Table 1). Mean values revealed that highest weight of fresh floret (6.36 g) was recorded in cut florets of gladiolus spikes kept in vase enriched with solution of 0.05 g L^{-1} + 60 g L^{-1} (AgNO3 + Sucrose), which was statistically similar to vase solution enriched with 0.05 g L^{-1} + 40 g L^{-1} (AgNO3 + Sucrose). Least fresh floret weight (2.70 g) was recorded in cut flowers placed in vase solution containing distilled water. Maximum fresh weight of spikes is the fact that sucrose helps in regulating stomatal opening and closing increases fresh weight by preventing the loss of water (Rahman et al. 2012).These findings are in line to that of Bahremand et al. (2014); they also reported that fresh floret weight was increased when cut flower were kept in silver nitrate and sucrose.

Senesced Floret Weight (g)

Mean data (Table 1) clearly revealed that weight of senesced floret was highest (0.96 g) in florets of gladiolus spikes placed in vase solution enriched with 0.05 g L^{-1} + 60 g L^{-1} (AgNO3 + Sucrose), while minimum senesced floret weight (0.26 g) was recorded in cut flowers placed in vase solution containing distilled water. The present study indicate that maximum senesced floret weight in cut flower might be attributed to adequate supply of food (carbohydrates). The availability of sugars in proper concentration to the petal cells resulted in an increase in the dry weight. (Mirjalili 2015). Nasrin et al. (2008) reported that senesced floret weight was maximum due to the application of sucrose in combination with $AgNO_3$ and citric acid.

Table 1

Days to first floret, full spike opening, Fading of 1st floret, full spike (days), Weight of fresh floret & senesced floret (g) of gladiolus cv. Amsterdam as affected by sucrose and silver nitrate.

Treatments	Opening of 1st Floret (days)	Opening of Full spike (days)	Fading of 1st floret (days)	Fading of Full spike (days)	Weight of fresh Floret (g)	Weight of senesced Floret (g)
Distilled water / Control	1.80 E	3.40 G	4.40 H	13 G	2.70 F	0.26 E
0.03 g L^{-1} (AgNO3)	2.36 D	4.16 F	5.53 FG	14.66 F	3.46 E	0.43 D
0.05 g L^{-1} (AgNO3)	2.40 D	4.96 DE	5.83 EF	15.66 F	3.80 E	0.50 D
40 g L^{-1} (Sucrose)	2.53 D	4.76 E	5.40 G	17.66 E	4.26 D	0.53 D
60 g L^{-1} (Sucrose)	3.16 C	5.43 D	6.06 E	18.66 DE	4.73 C	0.66 C
0.03 g L^{-1} + 40 g L^{-1} (AgNO3 + Sucrose)	3.23 C	5.96 C	6.43 D	19.66 CD	4.93 BC	0.70 C
0.03 g L^{-1} + 60 g L^{-1} (AgNO3 + Sucrose)	3.43 BC	6.80 B	7.50 C	21 BC	5.33 B	0.73 BC
0.05 g L^{-1} + 40 g L^{-1} (AgNO3 + Sucrose)	3.63 AB	7.56 A	8.13 B	22 AB	5.93 A	0.83 B
0.05 g L^{-1} + 60 g L^{-1} (AgNO3 + Sucrose)	3.90 A	8.00 A	8.66 A	23 A	6.36 A	0.96 A
LSD (0.05)	0.36	0.50	0.36	1.58	0.45	0.11

Means followed by different letters are significantly different from each other at $p \leq 0.05$.

Reducing Sugars (mg g^{-1} Flower Dry Weight)

Table 2 showed that maximum reducing sugar (12.83 mg g^{-1}) were retained in florets of gladiolus cut spikes placed in vase containing 0.05 g L^{-1} + 60 g L^{-1} (AgNO3 + Sucrose), while minimum reducing sugar (9.73 mg g^{-1}) were recorded in florets of cut spikes placed in vase containing distilled water. Highest retention of reducing sugars occurred in florets of cut spike kept in vase solution of AgNO3 and sucrose. Reducing sugars have a role in energy metabolism (Dinakar et al. 2012). Both reducing and non-reducing sugars are required by the flowers to remain healthy and stable (Singh *et al*., 2008). The shortage of sugars in cells results in onset of senescence (Van Doorn 2004). Sharma and Bhardwaj (2015) reported that reducing sugar of carnation flower increased when cut flowers were kept in solution enriched with $AgNO_3$, Sugar and citric acid.

Non Reducing Sugars (mg g^{-1} Flower Dry Weight)

Table 2 showed that Sucrose and silver nitrate had significant effect on non-reducing sugars of gladiolus florets. Mean data pertaining to non-reducing sugar (Table 2) in response to the treatment of sucrose and silver nitrate showed that maximum non-reducing sugars (15.93 mg g^{-1}) were retained by florets of cut flowers of gladiolus placed in holding solution of 0.05 g L^{-1} + 60 g L^{-1} (AgNO3 + Sucrose), while minimum non-reducing sugars (12.23 mg g^{-1}) were recorded in florets of cut flowers kept in vase containing distilled water. Non-reducing sugars are present in the form of starch as part of cell wall structure (Elbein et al. 2003). Optimum levels of non-reducing sugar plays a significant role in the integrity and health of flowers (Singh et al. 2008). Hatami et al. (2013) also found that silver nitrate in combination with sucrose increased reducing and non-reducing sugars of cut flowers.

Total Phenolic Content (mg g^{-1})

Mean data pertaining to total phenolic content (Table 2) showed that maximum total phenolic contents (0.63 mg g^{-1}) were in florets of gladiolus cut spikes in vase solution of 0.05 g L^{-1} + 40 g L^{-1} (AgNO3 + Sucrose) while minimum total phenolic content (0.41 mg g^{-1}) were recorded in cut flowers placed in vase containing distilled water. The pheonic compounds enhances the antioxidant activity and have a role to slow down the process of senescence thus increases the vase life of cut flowers (Mwangi et al. 2003). Our findings are in line with the results of Franklin et al. (2009), Comotto et al. (2014) and Karakas (2020).

Electrolyte Leakage (%)

Sucrose and silver nitrate significantly affected electrolyte leakage (%) of gladiolus florets (Table 2). Data pertaining to electrolyte leakage (Table 2) showed that maximum electrolyte leakage (89.69 %) was recorded in cut flowers of gladiolus placed in control while minimum electrolyte leakage (63.03 %) was recorded in holding solution of 0.05 g L^{-1} + 60 g L^{-1} (AgNO3 + Sucrose). Electrolyte leakage is one of the indicators of cell membrane stability that reveals and shows the magnitude of senescence in flowers (Gerailoo and Ghasemnezhad 2011). Son et al. (2003) also reported that application of $AgNO_3$ reduced electrolyte leakage by 20 % and significantly enhanced the vase life of rose cut flowers.

Vase Life

Vase life of cut spikes was significantly affected by treatment of sucrose and silver nitrate (Table 2). It is revealed from mean data pertaining to vase life (Table 2) that maximum vase life (15.33) was recorded in cut flowers of gladiolus placed in holding solution of 0.05 g L^{-1} + 60 g L^{-1} (AgNO3 + Sucrose), which was at par with the holding solution of 0.05 g L^{-1} + 40 g L^{-1} (AgNO3 + Sucrose) while minimum vase life (5.66) was recorded in cut flowers placed in vase containing distilled water. Silver nitrate ($AgNO_3$) serves as preservative solution commonly used for enhancing the vase life (Khella et al. 2018). Silver nitrate and sucrose control bacterial populations for preventing xylem blockage, improve water uptake and extend vase life (Abdel-Kader et al. 2017). Shortest vase life in the control treatment might be due to the absence of sucrose (food source) and silver ion as biocide. Manzoor et al. (2018) reported that $AgNO_3$ and sucrose increased vase life of gladiolus spikes. Findings of our experiment are also in line with that of Kumari et al. (2018).

Table 2

Reducing, non-reducing sugar, Total phenolic content (mg g^{-1}), electrolyte leakage (%) and Vase Life (days) of gladiolus as effected by sucrose and silver nitrate.

Treatments	Reducing Sugar (mg g^{-1})	Non Reducing Sugar (mg g^{-1})	Total Phenolic Content (mg g^{-1})	Electrolyte leakage (%)	Vase Life (days)
Distilled water / Control	9.73 H	12.23 G	0.41 G	89.96 A	5.66 G
0.03 g L-1 (AgNO3)	10.16 GH	12.83 F	0.44 FG	86.96 B	7.33 F
0.05 g L-1 (AgNO3)	10.60 FG	13.36 F	0.46 F	83.63 C	7.66 F
40 g L-1 (Sucrose)	10.96 EF	13.93 E	0.48 EF	80.56 D	8 EF
60 g L-1 (Sucrose)	11.30 DE	14.33 DE	0.52 DE	77.06 E	9.33 DE
0.03 g L-1 + 40 g L-1 (AgNO3 + Sucrose)	11.60 CD	14.80 CD	0.55 CD	74.06 F	10.33 CD
0.03 g L-1 + 60 g L-1 (AgNO3 + Sucrose)	12.10 BC	15.03 BC	0.57 BC	70.36 G	11.33 C
0.05 g L-1 + 40 g L-1 (AgNO3 + Sucrose)	12.50 AB	15.50 AB	0.61 AB	67.70 G	13.33 B
0.05 g L-1 + 60 g L-1 (AgNO3 + Sucrose)	12.83 A	15.93 A	0.63 A	63.03 H	15.33 A
LSD (0.05)	0.61	0.56	0.05	2.70	1.36

Means followed by different letters are significantly different from each other at $p \leq 0.05$.

CONCLUSIONS

Among various treatments of silver nitrate and sucrose, the cut spikes of gladiolus kept in vase solution of 0.05 g L^{-1} + 60 g L^{-1} ($AgNO_3$ + Sucrose) resulted in maximum days to 1st floret & full spike opening, 1st floret & full spike fading, fresh & senesced floret weight, reducing & non-reducing sugars, total phenolic content with least electrolyte leakage and extended vase life. It was statistically similar to the effect of 0.05 g L^{-1} + 40 g L^{-1} (AgNO3 + Sucrose) for most of the studied attributes.

RECOMMENDATIONS

The vase solution of 0.05 g L^{-1} + 40 g L^{-1} ($AgNO_3$ + Sucrose) is recommended for better post-harvest attributes including vase life of gladiolus cut spikes.

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