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Prolonging Vase Life of Gladiolus (*Gladiolus grandiflorus* L.) var. Arka Amar with Various Preservative Solutions

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ABSTRACT

Background: Arka Amar is a most popular variety of gladiolus which is used as cut flower and cut flowers are highly perishable materials and pregnable to large post-harvest losses. There is an immense post-harvest losses in value of cut flowers which is seen all along the marketing channels and it can be up to 40-50%. So, an experiment was carried out to find out the best combination of preservative solutions to enhance the vase life of Gladiolus (*Gladiolus grandiflorus* L.) var. Arka Amar.

Methods: In this laboratory study during March 2022 to April 2022, different preservative solutions were analyzed to find out the maximum longevity of spikes. The experiment was laid out in C.R.D. with nine different combinations of sucrose, $Al_2(SO_4)_3$, $AgNO_3$ and citric acid including control (distilled water).

Result: The study revealed that the treatment T_9 (Sucrose 2% + $AgNO_3$ 50ppm + citric acid 100 ppm) increased the percentage of water uptake both in weight and volume basis, minimize the days taken for opening of 1st floret (4.83 days), increase the length (7.41 cm) and diameter (13 cm) of floret, increase the percentage of opening of florets/spike (96.92%), maximize the longevity of floret (22 days) and flowering duration of spike (14.66 days). Visual scoring on appearance (8.71) and freshness (8.93) were also found significant for the above treatment combination.

Key words: Gladiolus, Longevity, Preservative solution, Vase life.

INTRODUCTION

Arka Amar is a high yielding variety of Gladiolus, was selected for the experiment. Florets are pink with white blotch, yielding about 30.24 spikes/m^2/crop season which can be grown in winter season in our Odisha condition with profuse flowering. Gladiolus has earned tremendous popularity due to its majestic flower spike with acropetal flower opening, attractive shade, brilliant colour tone, ease of cultivation and long vase life. Hence, it is regarded as “Queen of Bulbous Plants”. They are grown as a commercial crop for cut flower production which is frequently used to make floral decorations, vase decorations and bouquets. But cut flowers are highly perishable materials and pregnable to large post-harvest losses. There is an immense post-harvest losses in value of cut flowers which is seen all along the marketing channels and it can be up to 40-50% (Bhattacharjee, 1999). The most appreciable elements of quality are shape, size, colour and freshness of the flower from the market point of view.

Hence the determinative aim of the consumer is to maintain these components as much as possible and to maintain the flowers in fresh condition. So, enhancing the vase life of cut flowers began as a tenderfoot interest in the recent years and it is being practiced on a commercial scale based on scientific principles. Longevity of flowers is affected by pre harvest and post-harvest factors. Pre-harvest factors are genetic or inherent makeup and growing conditions of flowers. In post-harvest factors water relations, respiration, relative humidity, growth regulators, preservative solutions, pre-cooling and storage, packaging and transporting are there. These factors can be taken into consideration to improve the longevity of the flowers. The flowers should be cooled as soon as possible after harvest to minimize deterioration. Cooling does this by reducing respiration rate, water loss, ethylene production, microbial development *etc*. But most of the farmers in Odisha are lacking these modernized technologies which leads to poor keeping quality of flowers resulting in heavy loss to them. Hence this trial was carried out to find out the possible way to enhance the vase life of gladiolus without pre-cooling.

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MATERIALS AND METHODS

The experiment was conducted at PG research laboratory, Department of Horticulture, Institute of Agricultural Sciences (IAS), Siksha ‘O’ Anushandhan (Deemed to be University),

Bhubaneswar during February to March 2022 to find out the best combination of preservative solutions for enhancing the vase life of gladiolus var. Arka Amar.

During the trial, following treatments were tested for enhancing the vase life of gladiolus var. Arka Amar.

Treatments	Details of treatment
T_1	Control (Distilled water)
T_2	Sucrose 2%
T_3	Sucrose 2% + $Al_2(SO_4)_3$ (100 ppm)
T_4	Sucrose 2% + $Al_2(SO_4)_3$ (50 ppm)
T_5	Sucrose 2% + $AgNO_3$ (50 ppm)
T_6	Sucrose 2% + $AgNO_3$ (100 ppm)
T_7	Sucrose 2% + Citric acid (100 ppm)
T_8	Sucrose 2% + $Al_2(SO_4)_3$ (50 ppm) + Citric acid (100 ppm)
T_9	Sucrose 2% + $AgNO_3$ (50 ppm) + Citric acid (100 ppm)

The above treatments were analyzed using Completely Randomized Design with three replications and 54 gladiolus spikes were taken for the above treatments with two numbers of spikes per treatment.

Before execution of this trial, 54 number of 1000ml capacity conical flasks were cleaned and properly sterilized to hold the solution. The spikes were harvested at its colour break stage and immediately after harvesting these cut spikes were kept in bucket of water. The spikes were taken for the trial without pre-cooling in a cooling chamber. Then the spikes were kept in vertical position by giving a slanting cut with a properly sterilized blade for the better absorption under ambient condition.

Observations on percentage of water uptake both on weight basis and volume basis, days taken for opening of first floret, length of floret, diameter of floret, percentage opening of floret, longevity of floret, flowering duration of spike and quality of flowers by scoring were taken in 24 hrs. interval every day. After 2 days the stems were cut up to 2 cm to remove blockage and better absorption of the solution. The data for that day was taken before and after the stem cutting. Visual scoring was done on 4th day of the experiment where the gladiolus spikes were scored based on their colour and freshness. For this purpose, 10 persons were asked to score the flowers out of 10.

Statistical analysis

The data regarding vase life recorded for various parameters were subjected to statistical analysis based on their sample means, (Gomez and Gomez, 1984). The analysis of variance table was prepared. The effects were tested by F test at 5 per cent level of significance. The critical difference at 5 per cent level was calculated for comparing the treatment means.

RESULTS AND DISCUSSION

Percentage of water uptake (weight and volume basis)

Maximum water uptake was observed under treatment T_9 (sucrose 2% + $AgNO_3$ 50 ppm + citric acid 100 ppm) both based on weight and volume (Table 1 and Table 2) which is in confirmation with Mishra and Khanal (2019) who revealed that maximum water uptake was found in 150 ppm $AgNO_3$+ 4% sucrose in gladiolus. This might be due to the antimicrobial property of $AgNO_3$ that play an important role in improving the water uptake of gladioli by preventing the growth of micro-organism in xylem and thus maintained water uptake by flower stems (Ha *et al*., 2017). Ag^+ in $AgNO_3$ helps in preventing ethylene activity by blocking the special receptors present on the cell membrane (Kiamohammadi and Hashemaabadi, 2011).

It is also in agreement with Muraleedharan and Joshi (2017) who stated that citric acid can alleviate water uptake and extend vase life due to its anti-embolism trait (Imsabai *et al*., 2013). Citric acid is also known as an acidifier which inhibits the growth of micro-organisms and is commercially advised for a number of cut flowers (Dole and Wilkins, 1999).

Days taken for opening of 1st floret

The minimum days (4.83 days) were taken for opening of first floret under treatment T_9 (sucrose 2% + $AgNO_3$ 50 ppm + citric acid 100 ppm) while maximum days were taken (2.16 days) taken under control (Table 3). Similar confirmation was given that Sucrose, citric acid, $AgNO_3$ and $Al_2(SO_4)_3$

Table 1: Effect of different preservative solutions on percentage of water uptake (weight basis) by the spikes.

Treatments	Percentage of water uptake (weight basis)	
	Day 3	Day 5
T_1; Control (Distilled water)	10.76	11.26
T_2; Sucrose 2%	11.87	12.09
T_3; Sucrose 2% + $Al_2(SO_4)_3$ (100 ppm)	12.51	13.68
T_4; Sucrose 2% + $Al_2(SO_4)_3$ (50 ppm)	12.44	12.91
T_5; Sucrose 2% + $AgNO_3$ (50 ppm)	12.30	12.35
T_6; Sucrose 2% + $AgNO_3$ (100 ppm)	12.69	13.96
T_7; Sucrose 2% + Citric acid (100 ppm)	12.48	13.65
T_8; Sucrose 2% + $Al_2(SO_4)_3$ (50 ppm) + Citric acid (100 ppm)	12.90	14.08
T_9; Sucrose 2% + $AgNO_3$ (50 ppm) + Citric acid (100 ppm)	14.72	15.31
SEM	0.535	0.409
CD 5%	1.591	1.216

individually, increased bud opening. The results of current experiment about being more effective of high sucrose concentrations are agreed with Doi and Reid (1995) on gladiolus and liatris.

It is also in confirmation with Sharma *et al*. (2017) who recorded early floret opening in treatment with sucrose 5% + $AgNO_3$ at 300 ppm as compared to control. This might be due to the fact that sucrose provides energy for growth and accelerated the opening of flower bud (Farnham *et al*., 1972).

Length of floret

Maximum length (7.41 cm) of floret was observed in treatment T_9 (sucrose 2% + $AgNO_3$ 50 ppm + citric acid 100 ppm) (Table 3). Similar finding is given by Kumari *et al*., (2018) in cut tuberose that, maximum floret length (3.84) was observed in treatment with Sucrose 5% + $AgNO_3$ at 25ppm whereas minimum floret length (3.20) was observed in Control. Findings were in similar with Talukdar and Barooah (2010) on effect of pulsing and different holding solutions on flower quality and vase life of tuberose (*Polianthes tuberose* L.) cv. Calcutta Double.

Diameter of floret

Maximum diameter (13 cm) of floret was observed in treatment T_9 (sucrose 2% + $AgNO_3$ 50 ppm + citric acid 100 ppm) (Table 3). Similar finding is given by Kumari *et al*., (2018) in cut tuberose that the maximum flower diameter was observed in treatment Sucrose 2.5% + $AgNO_3$ at 15 ppm whereas the minimum flower diameter was observed in Control.

It is also in confirmation with Talukdar and Barooah (2010) who recorded maximum diameter of floret in 4% sucrose + 2% citric acid + 20 ppm $AgNO_3$.

Percentage opening of florets/spike

The highest percentage of opening of florets/spike was seen under treatment T_9 (sucrose 2% + $AgNO_3$ 50 ppm + citric acid 100 ppm) whereas lowest percentage was observed in control (Table 3), which is in confirmation with Nasrin *et al*., (2008) in gladiolus and Talukdar and Barooah (2010) in tuberose. This might be due to the fact that best combination of solutions as sucrose acts as a food source or respiratory

Table 2: Effect of different preservative solutions on percentage of water uptake (volume basis) by the spikes of gladiolus cv Arka Amar.

Treatments	Percentage of water uptake (volume basis)			
	Day 3	Day 5	Day 7	Day 9
T_1; Control (Distilled water)	1.66	1.08	0.99	0.83
T_2; Sucrose 2%	2.02	1.36	1.17	0.86
T_3; Sucrose 2% + $Al_2(SO_4)_3$ (100 ppm)	3.88	3.80	3.59	2.30
T_4; Sucrose 2% + $Al_2(SO_4)_3$ (50 ppm)	2.72	2.76	2.58	1.55
T_5; Sucrose 2% + $AgNO_3$ (50 ppm)	2.48	2.27	1.97	1.04
T_6; Sucrose 2% + $AgNO_3$ (100 ppm)	4.81	4.67	3.93	2.43
T_7; Sucrose 2% + Citric acid (100 ppm)	3.19	2.76	2.74	2.16
T_8; Sucrose 2% + $Al_2(SO_4)_3$ (50 ppm)+ Citric acid (100 ppm)	5.45	5.08	4.67	2.70
T_9; Sucrose 2% + $AgNO_3$ (50 ppm)+ Citric acid (100 ppm)	7.02	6.11	5.78	4.50
SEM	0.231	0.189	0.168	0.444
CD 5%	0.687	0.563	0.499	1.321

Table 3: Effect of different chemical preservatives on days taken for opening of 1st floret, length of floret, diameter of floret, percentage of opening of florets per spike, longevity of floret and flowering duration of spikes of gladiolus var. Arka Amar.

Treatments	Days taken for opening of 1st floret (days)	Length of floret (cm)	Diameter of floret (cm)	Percentage of opening of florets/spike (%)	Longevity of floret (days)	Flowering duration f spike o (days)
T_1; Control (Distilled water)	4.83	6.16	11.73	78.59	6	11.33
T_2; Sucrose 2%	4.16	6.38	11.8	86.51	6.33	11.83
T_3; Sucrose 2% + $Al_2(SO_4)_3$ (100 ppm)	3.33	7.08	12.6	93.1	6.66	13.66
T_4; Sucrose 2% + $Al_2(SO_4)_3$ (50 ppm)	3.66	6.8	12.3	90.67	6.16	12.83
T_5; Sucrose 2% + $AgNO_3$ (50 ppm)	3.83	6.58	12.1	89.98	6.5	12.66
T_6; Sucrose 2% + $AgNO_3$ (100 ppm)	2.83	7.15	12.71	93.88	6.83	14
T_7; Sucrose 2% + Citric acid (100 ppm)	3.66	6.9	12.41	91.56	6.33	13.33
T_8; Sucrose 2% + $Al_2(SO_4)_3$ (50 ppm)+ Citric acid (100 ppm)	2.33	7.28	12.83	95.01	7.16	14.33
T_9; Sucrose 2 % + $AgNO_3$(50 ppm)+ Citric acid (100 ppm)	2.16	7.41	13	96.92	7.33	14.66
SEM	0.192	0.054	0.058	0.948	0.175	0.184
CD 5%	0.571	0.161	0.172	2.817	0.521	0.547

Table 4: Visual score on appearance and freshness obtained by spikes of gladiolus cv Arka Amar treated with different preservative solutions.

Treatments	Visual scoring	
	Appearance	Freshness
T_1; Control (Distilled water)	7.53	6.71
T_2; Sucrose 2%	7.93	7.3
T_3; Sucrose 2% + $Al_2(SO_4)_3$ (100 ppm)	8.33	8.28
T_4; Sucrose 2% + $Al_2(SO_4)_3$ (50 ppm)	8.2	7.97
T_5; Sucrose 2% + $AgNO_3$ (50 ppm)	8.13	7.78
T_6; Sucrose 2% + $AgNO_3$ (100 ppm)	8.41	8.43
T_7; Sucrose 2% + Citric acid (100 ppm)	8.28	8.23
T_8; Sucrose 2% + $Al_2(SO_4)_3$ (50 ppm) + Citric acid (100 ppm)	8.43	8.46
T_9; Sucrose 2% + $AgNO_3$ (50 ppm) + Citric acid (100 ppm)	8.71	8.93
SEM	0.109	0.112
CD 5%	0.325	0.335

substance and delays the degradation of proteins and improves water balance of cut flowers.

Longevity of floret

Treatment T_9 (sucrose 2% + $AgNO_3$ 50 ppm + citric acid 100 ppm) was found best for maximum longevity of florets (Table 3). As $AgNO_3$is both potent ethylene inhibitor and antimicrobial agent (Vahdati Mashhadian *et al*., 2012), treatment containing these take a longer day to basal floret senescence. This might be due to sucrose that causes an increase in starch concentration as starch is an indication of carbohydrate availability to the petals thus providing energy for florets to retain their freshness. (Halevy *et al*.,1979) found that citric acid was widely used to decrease the pH of water balance and reduce stem plugging. Citric acid showed positive effect in increasing the longevity of florets.

Flowering duration of spike

Treatment T_9 (sucrose 2% + $AgNO_3$ 50 ppm + citric acid 100 ppm) was found best for longest flowering duration of spike (Table 3). This might be due to the use of sucrose in combination with antimicrobial agent and ethylene inhibitor is used a synergistic effect, improves the water balance and osmotic potential. $AgNO_3$ inhibits the microbial growth, arrest the negative effect of ethylene (Nigussie, 2005) and sucrose was observed to reduce moisture stress in cut flowers by affecting stomata closure, preventing transpiration and water loss as well as it provides energy required by flower. Thus, resulting in longer vase life. Improvement in vase life of spikes with citric acid was due to acidification of the solution improved water balance and reduction in stem plugging (Durkin, 1979).

It is in close agreement with Talukdar and Barooah (2010). Chemicals like $AgNO_3$, citric acid might have decreased microbial growth and prevented vascular blockage, thereby helped in increasing vase life and improving turgidity of the spike. Similar results have been recorded by several workers (Murali, 1990, Gowda and Gowda, 1990, Singh *et al*., 2000).

Visual scoring

The maximum score (8.71) was obtained by treatment T_9 (sucrose 2% + $AgNO_3$ 50 ppm + citric acid 100 ppm) for both appearance and freshness (Table 4). This is may be due to the combined effect of sucrose, silver nitrate and citric acid. $AgNO_3$ showed minimum percentage of wilting and better physiological characteristics compared to other treatments. $AgNO_3$ act as potent to anti-microbial and ethylene inhibitor. Sucrose at various concentrations prolong the time required for opening of flower (Bajwa *et al*., 2016). According to Paulin (1986), sucrose in the vase solution is found to increase the vase life. Citric acid acidifies the solution which improved water balance and reduction in stem plugging which improves the vase life (Durkin, 1979).

CONCLUSION

From the trial, it can be concluded that, among sucrose, Al_2SO_4, $AgNO_3$ and citric acid, the performance of treatment T_9 (sucrose 2% + $AgNO_3$50 ppm + citric acid) was found best for enhancing the vase life of gladiolus spikes var. Arka Amar.

Conflict of interest: None.

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