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RESEARCH ARTICLE

Postharvest life of gladiolus cv. Candyman as influenced by locally available preservatives

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ABSTRACT

The investigation was conducted to determine the effect of locally available preservatives on vase life of gladiolus (*Gladiolus grandiflora* L.) cv. Candyman flower. The economic value of cut flowers is dependent on their shelf life and the use of locally available floral preservatives is the best cost efficient post-harvest method to preserve the longevity of the cut flowers. Cut gladiolus flowers were placed in 500 ml bottles containing 300 ml aqueous solution of various preservatives and distilled water as control was prepared. The vase solution containing citric acid 0.05% + cane sugar 2% + commercial bleaching powder 0.005% had the minimum number of days to basal floret opening, maximum basal floret size and also recorded the longest total blooming period and vase life of 9.60 and 7.60 days, respectively. On the other hand, use of commercial bleaching powder 0.005% as a locally available vase life preservative was economically more capable to extend the vase life of gladiolus as the benefit cost returns were recorded to be the highest (3.60) in this treatment. Therefore, the study recommends the use of commercial bleaching powder 0.005% as an ideal vase life concentration for the vase life of gladiolus cv. Candyman.

Keywords: Commercial bleaching powder, economical, gladiolus, local, post-harvest

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INTRODUCTION

Gladiolus (*Gladiolus grandiflora* L.), the queen of bulbous flowers, is commonly called Sword lily because of its blade-like leaves and belongs to the family Iridaceae. It is one of the most popular choices of cut flower, both among the flower growers and the

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customers because of its availability in wide range of hue, shape and versatile utilization in bouquet as well as floral arrangements (Bhat et al. 2017). It has secured fifth position in the international trade (Kashyap et al. 2016) and is the next most economically important cut flower after rose in India (Nath et al. 2020). The economic value of cut flowers is dependent on their shelf life and the use of floral preservatives is the best cost efficient post-harvest method to preserve the longevity of the cut flowers. However, the use of commercial preservatives can be costly and hence locally available ones are proven to be handy and affordable by local florist.The basic components for an effective flower food must include sugar as an energy source, a biocide or germicide and an acidifier to lower pH of solution (Sraventhi, 2019). Due to lack of scientifically proven information on the use of locally available flower preservatives on cut gladiolus flower, the present study has been carried out to determine the effect of some selective locally available preservatives on the post-harvest life of gladiolus cv. Candyman.

MATERIALS AND METHODS

Plant materials and treatments

The present study was carried out in the laboratory, Department of Horticulture, School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema campus, Nagaland during 2021 to 2022. In the experiment, cut gladiolus (Gladiolus grandiflora L.) cv. Candyman flowers were used as plant material. For gladiolus, the spikes were harvested at the stage when their first floret showed colour on April months of both the year 2021 and 2022. The cut was made at the base of the stem at the point just above the forth leaf from the base. In the study, 50 gladiolus flowers were used in total. The cut spikes were immediately placed into a bucket containing clean water. Remove all the leaves and 30 cm stem length was maintain from the cut end of the base to the lower most flower bud. The base of each spike was submerged under water and slantingly cut with a sharp sterile blade, as a preventive measure to avoid entry of air bubbles. Then, 500 ml bottles containing 300 ml aqueous solution of various preservatives and distilled water as control was prepared and one cut spike was placed into each. The neck of the bottle was covered with the help of cotton plugs to check evaporation of the solution or distilled water. 10 preservative treatments used in the study were T_1 (distilled water), T_2 (lime juice 1%), T_3 (citric acid 0.05%), T_4 (cane sugar 10%), T_5 (commercial bleaching powder 0.005%), T_6 (lime juice1% + cane sugar 10%), T_7 (citric acid 0.05% + cane sugar 10%), T_8 (cane sugar 2% + commercial bleaching powder 0.005%), T_9 (lime juice 1% + cane sugar 2% + commercial bleaching powder 0.005%) and T_{10} (citric acid 0.05% + cane sugar 2% + commercial bleaching powder 0.005%).

Based on the above per cent formulae, citric acid 0.05% solutions were prepared by dissolving 500 mg in one litre of distilled water. Similarly, calcium hypochlorite (commercial bleaching powder) 0.005% was prepared by dissolving 50 mg in one litre of distilled water. To prepare 1% lime juice, 10 ml lime juice was extracted and dissolved each in 1000 ml of distilled water. 10% and 2% cane sugar solution was prepared by dissolving 100g and 20g, respectively in one litre of distilled water.

The vase life was conducted under conditions of 25 ± 1°C and 65 ± 5% relative humidity. The parameters such as days to basal floret open, floret size of basal floret, shelf life of first floret, total blooming period, increase in spike length, vase life, vase solution uptake and benefit cost ratio were investigated. There were 10 treatments, replicated 5 times with one spike in each replication in Completely Randomized Design.

Methods

Days to basal floret open = Days to basal floret open was recorded from the date of placing the spike in vase solution to complete opening of the basal floret.

Floret size of basal floret (cm) = The diameter of fully opened basal floret was measured as length and width and the average was calculated.

Shelf life of first floret (days) = Time taken from opening to fading of the lowermost floret was recorded.

Total blooming period (days) = Duration in days, between opening of the first floret and wilting of last floret was considered as total blooming period.

Increase in spike length (cm) = The difference between the length of the spike at the start of experiment and fading was recorded. The length of spike was measured from the basal floret bud to the tip of spike in cm.

Vase life (days) = The duration between the opening of the first basal floret and wilting of the 6th floret from the base of spike was taken.

Vase solution uptake (ml) = Total quantity of water or aqueous solution used by the spike upto wilting of last opened floret was measured in ml at the termination of the experiment.

Benefit cost ratio = The ratio of incremental benefit of shelf life over control to the cost of treatment per scape was calculated and recorded as benefit-cost ratio for a particular treatment combination. It was computed by dividing the incremental benefit of shelf life over control by corresponding cost of treatment per scape.

$$\text{Benefit cost ratio} = \frac{\text{Incremental benefit of shelf life over control}}{\text{Cost of treatment per scape}}$$

Statistical analysis

The data on various observations recorded during the course of investigation was statistically analyzed. Analysis of variance technique (ANNOVA) for different characters was worked out. The appropriate standard error of mean (SEM ±) and the critical difference (CD) was calculated at 5 percent level of probability.

RESULTS AND DISCUSSION

Days to basal floret open

Regarding the days to basal floret opening of cut spikes of gladiolus, it is evident from Table 1 that the different treatments were found to be significant. The pooled analysis of the two years data indicated that T_5 (commercial bleaching powder 0.005%), T_8 (cane sugar 2% + commercial bleaching powder 0.005%) and T_{10} (citric acid 0.05% + cane sugar 2% + commercial bleaching powder 0.005%) recorded the minimum requirement of time for basal floret opening (2.10) and it also showed at par values with the rest of the treatments. Maximum time (2.70 days) were recorded in T_2 (lime juice 1%), T_4 (cane sugar 10%), T_6 (lime juice1% + cane sugar 10%) and T_7 (citric acid 0.05% + cane sugar 10%).

The use of bleaching powder i.e. $CaOCl_2$ as a source of chlorine was reported to slightly improve bud opening of commercial rose cultivars (Singh et al., 2004). It was also reported that maximum floret opening occurred when vase solutions were supplemented with 6% sucrose and 6% citric acid for gladiolus cv. Nova Lux (Dwivedi et. al 2018). Sugar also promoted early unfolding of petals in cut rose cv. Top Secret (Das et al. 2020). Waithika et. al (2001) also reported that opening of gladiolus florets was accompanied by carbohydrate concentration. The obtained results might also be due to a fact that low sugar concentrations promotes bud opening, whereas high sugar concentrations prolongs or delays the same. The pulsed blooms treated with high sugar concentrations last longer and can also withstand transportation to far off destinations (Kumarihami et al., 2017; Lakshman et al., 2014).

Table 1: Pooled data for the effect of locally available preservatives on the post-harvest life of gladiolus cv. Candyman.

Treatments	Days to basal floret opening	Floret size of basal floret (cm)	Shelf life of first floret (days)	Total blooming period (days)	Increase in spike length (cm)	Vase life (days)	Vase solution uptake (ml)
T_1	2.30	8.45	**2.40**	7.40	7.17	5.40	61.80
T_2	2.70	7.91	2.30	8.00	6.43	6.00	32.90
T_3	2.50	8.59	2.10	6.50	5.37	4.50	68.90
T_4	2.70	7.99	2.10	7.90	4.48	5.90	31.00
T_5	**2.10**	8.98	**2.40**	9.20	5.68	7.20	54.90
T_6	2.70	7.72	1.70	7.00	2.30	5.00	47.40
T_7	2.70	8.49	1.90	8.40	6.62	6.40	47.30
T_8	**2.10**	9.09	1.90	7.60	6.83	5.60	**72.10**
T_9	2.20	9.60	1.90	8.30	**7.28**	6.30	65.40
T_{10}	**2.20**	**9.99**	2.30	**9.60**	4.74	**7.60**	63.70
SEm±	0.31	0.29	0.31	0.60	1.87	0.66	10.56
CD at 5%	NS	0.89	NS	2.00	NS	2.00	NS

Floret size of basal floret

The data recorded for floret size of basal floret is also incorporated in Table 1. The pooled data analysis of both years revealed that T_{10} (citric acid 0.05% + cane sugar 2% + commercial bleaching powder 0.005%) recorded the maximum basal floret size (9.99 cm) and was at par with T_9 (lime juice 1% + cane sugar 2% + commercial bleaching powder 0.005%) (9.60 cm). The minimum basal floret size was recorded in T_6 (lime juice 1% + cane sugar 10%) (7.72 cm).

It is now evident from the represented data that the basal floret size was significantly influenced by the different floral preservatives. The increase in size of the basal floret could be due to the fact that sugar supplies the energy required by the flower (Kashyap et al.2016; Nirmala et al. 2019). Similar results were reported on hybrid tea rose var. Mainu Parle, where maximum flower diameter (7.28 cm) was recorded on treatments which were pulsed with bleaching powder (50 ppm or 0.005% chlorine) (Tripathy et al., 2018).

Shelf life of first floret

The response of different treatments on the shelf life of first floret was studied, the data which are presented in Table 1. It was observed that the treatments had no significant effect on the shelf life of the first floret. The pool data of the two years study showed that shelf life of first floret was maximum (2.40 days) for T_1 (control) and T_5 (Commercial bleaching powder 0.005%) and minimum for T_6 (Lime juice1% + Cane sugar 10%) (1.70 days).

The result obtained might be due to the fact that distilled water are free of contaminates such as bacteria and also the addition of commercial bleaching powder which has antimicrobial properties (Singh et. al 2004) that controlled the bacterial growth in the vase life solution, thereby enabling better solution uptake. High water uptake maintained the turgidity and freshness of the spikes and thus increasing the shelf life of the first floret. Similar results were reported by Varun and Barad (2010) in tuberose and Kumar et al. (2007) in gladiolus.

Total blooming period

Regarding total blooming period of cut spikes of gladiolus, it is evident from Table 1 that the different treatments varied significantly and it was found that vase life solutions with a combination of citric acid, cane sugar and commercial bleaching powder resulted in longer blooming period. Total blooming period was the duration in days, between opening of the first floret and wilting of last floret. Mean data of the two years showed that T_{10} (Citric acid 0.05% + Cane sugar 2% + Commercial bleaching powder 0.005%) recorded the longest blooming period (9.60 days) which was at par with T_5 (Commercial bleaching powder 0.005%) (9.20 days), T_7 (Citric acid 0.05% + Cane sugar 10%) (8.40 days), T_9 (Lime juice 1% + Cane sugar 2% + Commercial bleaching powder 0.005%) (8.10 days) and T_2 (Lime juice 1%) (8.00 days). T_3 (Citric acid 0.05%) (6.50 days) noted the shortest blooming period followed by T_6 (Lime juice1% + Cane sugar 10%) (7.00 days) and T_1 (control) (7.40 days).

From the results, it was observed that the addition of the commercial bleaching powder as a chlorine source for the vase life solution extended the blooming period in comparison to the treatments where chlorine source was absent. The antimicrobial properties of commercial bleaching powder controlled the bacterial growth in the vase life solution, thereby enabling better solution uptake which leads to higher turgidity and prolong freshness of the spike (Varun and Barad 2010). In addition, Singh et. al (2004) also reported that 50 ppm i.e. 0.005% was the ideal concentration of chlorine, beyond which would result in reduction of vase life and foliar chlorosis. Similar results were also reported in cut stems of hybrid tea rose var. mainu parle by Tripathy et al. (2018) where maximum vase life was recorded when the stems were pulsed with bleaching powder (50 ppm chlorine).

However, citric acid when used alone failed to maximize the blooming period and recorded the shortest blooming period among all the treatments. Similar results were also reposted in cut roses by Singh et. al (2004). This could have happened due to the high pH of the vase solution caused by leaching out of substrate from the flower stems. Therefore, citric acid must be used in combination with a biocide and a sugar source for more effective results.

Increase in spike length

The data encamped in Table 1 showed that the different vase life solutions failed to exert significant effect on the increase in spike length of gladiolus during the year 2021 and 2022. Pooled analysis of the two years data showed that T_9 (Lime juice 1% + Cane sugar 2% + Commercial bleaching powder 0.005%) (7.28 cm) and the minimum increase in spike length was recorded in T_6 (Lime juice1% + Cane sugar 10%) (2.30 cm).

The results obtained were similar to the findings of Gupta et al. (2020) on gladiolus cv. Red Beauty. After harvest, the continuation of cell division and elongation was observed in all the treatments.

Vase life

Regarding vase life of cut spikes of gladiolus, it is evident from Table 1 that the different treatments varied significantly and it was found that vase life solutions with a combination of citric acid, cane sugar and commercial bleaching powder resulted in longer vase life. To record the observations for the vase life characters, the duration between the opening of the first basal floret and wilting of the 6th floret from the base of spike was taken. Mean data of the two years showed that T_{10} (Citric acid 0.05% + Cane sugar 2% + Commercial bleaching powder 0.005%) recorded the longest vase life (7.60 days) which was at par with T_5 (Commercial bleaching powder 0.005%) (7.20 days), T_7 (Citric acid 0.05% + Cane sugar 10%) (6.40 days), T_9 (Lime juice 1% + Cane sugar 2% + Commercial bleaching powder 0.005%) (6.30 days) and T_2 (Lime juice 1%) (6.00 days). T_3 (Citric acid 0.05%) (4.50 days) noted the shortest vase life followed by T_6 (Lime juice1% + Cane sugar 10%) (5.00 days) and T_1 (control) (5.40 days).

From the results, it was observed that the addition of the commercial bleaching powder as a chlorine source for the vase life solution extended the vase life in comparison to the treatments where chlorine source was absent. Simply placing the cut blooms in vase solution without any biocides reduces the vase life because of the absence of antimicrobials that will suppress the microbial growth which clogs the xylem vessel, hence reducing the water uptake (Vehniwal, 2018). The antimicrobial properties of commercial bleaching powder controlled the bacterial growth in the vase life solution, thereby enabling better solution uptake which leads to higher turgidity and prolong freshness of the spike (Varun and Barad 2010). In addition, Singh et. al (2004) also reported that 50 ppm i.e. 0.005% was the ideal concentration of chlorine, beyond which would result in reduction of vase life and foliar chlorosis. Similar results were also reported in cut stems of hybrid tea rose var. mainu parle by Tripathy et al. (2018) where maximum vase life was recorded when the stems were pulsed with bleaching powder (50 ppm chlorine). Also, sugar acts a carbon source that helps in sustaining the overall keeping quality and helps in the maintenance of the mitochondrial structure within the plant cell (Dwivedi et al., 2018). However, citric acid when used alone failed to maximize the vase life and recorded the shortest vase life among all the treatments. Similar results were also reposted in cut roses by Singh et. al (2004). This could have happened due to the high pH of the vase solution caused by leaching out of substrate from the flower stems. Therefore, citric acid must be used in combination with a biocide and a sugar source for more effective results.

Vase solution uptake

Table 1 showed that the vase solution uptake of cut spikes had no significant effect caused by the application of various vase solutions. The mean data of the two years study showed that T_8 (Cane sugar 2% + Commercial bleaching powder 0.005%) (72.10 ml) recorded the highest while the lowest was found in T_4 (Cane sugar 10%) (31.00 ml).

The obtained results might be due to the combination of sugar and biocides in the vase solution. Sugar acts as a good source of carbon and supplies necessary food to the cut stems, however it also creates favourable condition for the growth of microorganisms that accumulates at the base of the stem. This will create a barrier and block the uptake of water by the vascular tissues due to bacterial plugging. Hence, the addition of commercial bleaching powder has suppressed microbial growth and increase uptake of the vase solution. These results were in accordance with Arunesh et al. (2020) in Gerbera and Asrar (2012) in snapdragon.

Economics of vase life solutions

The possibility of the treatment to be adopted also depends on the economic, therefore the study on the cost and return have to be studied. Economics was worked out on the basis of the total blooming period, incremental benefit of shelf life over control and the cost of each treatment per scape.

The benefit cost ratio was calculated by finding the ratio of incremental benefit of shelf life over control upon the cost of each treatment per scape. The results were presented in the Table 2. The B:C ratio revealed that, most of the treatments were not economically viable. In comparison to control, B:C ratio of T_5 (Commercial bleaching powder 0.005%) recorded the highest (3.60) which was followed by T_{10} (Citric acid 0.05% + Cane sugar 2% + Commercial bleaching powder 0.005%), but the value (0.81) was recorded to be less than one which was similar with the rest of the treatments and therefore, could not qualify as an economical practice for vase life solution.

Table 2: Economics of vase life solutions

Treatments	Total blooming period (days)	Incremental benefit of shelf life over control	Cost of treatment per scape (₹)	B:C
T_1	7.20	0.00	0.00	0.00
T_2	7.80	0.60	2.00	0.30
T_3	6.20	-1.00	1.40	-0.71
T_4	7.60	0.40	4.00	0.10
T_5	9.00	1.80	0.50	**3.60**
T_6	6.80	-0.40	6.00	-0.07
T_7	8.20	1.00	6.40	0.16
T_8	7.40	0.20	1.30	0.15
T_9	8.00	0.80	3.30	0.24
T_{10}	9.40	2.20	2.70	0.81

Among all the treatments, commercial bleaching powder 0.005% was more economical than other treatments. It was observed that combinational treatment T_{10} (citric acid 0.05% + cane sugar 2% + commercial bleaching powder 0.005%) extended the vase life (9.40 days), but was found economically not effective as compared to the individual treatment of T_5 (Commercial bleaching powder 0.005%) which recorded a total blooming period of 9.00 days. Both the treatments showed negligible differences. Hence, it can be concluded that use of commercial bleaching powder 0.005% as a locally available vase life preservative was economically more capable to extend the vase life of gladiolus as the benefit cost returns were recorded to be the highest in this treatment. Similar finding were reported by Sarvanthi in gerbera cv. Stanza (2019).

CONCLUSION

The present study revealed that cut gladiolus spikes when treated in vase solution containing Citric acid 0.05% + Cane sugar 2% + Commercial bleaching powder 0.005% had the minimum number of days to basal floret opening, maximum basal floret size and also recorded the longest total blooming period and vase life of 9.60 and 7.60 days, respectively. On the other hand, use of commercial bleaching powder 0.005% as a locally available vase life preservative was economically more capable to extend the vase life of gladiolus as the benefit cost returns were recorded to be the highest (3.60) in this treatment. Therefore, the study recommends the use of commercial bleaching powder 0.005% as an ideal vase life concentration for the vase life of gladiolus cv. Candyman.

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