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Effects of Selected Post-harvest Treatments on Vase life of Cut-flower Gladiolus (*Gladiolus grandiflorus*)

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ABSTRACT. A postharvest storage study with different treatments was carried out to investigate a procedure in prolonging the vase life of cut-flower gladiolus. Various chemical and non chemical treatments which are locally available were used. In comparison with the control (distilled water), beverages such as 7-UP™ in different concentrations, specific anti-ethylene compounds, silver nitrate and silver thiosulphate (STS), benzyl amino purine (BAP) in different concentrations, hot water treatment to the base of the flower stalk as a sterilizing method, maintaining the pH at 3.5 using HCl, eylene oxidization with $KMnO_4$ and ethylene absorption with activated charcoal were tested.

The longest vase-life and the best visual quality were achieved by gladiolus flowers treated with 25% 7-UP™. Next best visual quality were achieved by Silver nitrate, 2.25% 7-UP™, 4 mg l^{-1} $KMnO_4$ and STS in the descending order. Flowers treated with 2 mg l^{-1} $KMnO_4$ and the control (distilled water) had the lowest vase life. The visual quality was lowest in flowers treated with 2 mg l^{-1} $KMnO_4$. When the cots of compounds used were considered, the study indicates that the treatment 7-UP™ and $KMnO_4$ were found to be the cheapest, while silver nitrate and silver thiosulphate are comparatively expensive.

INTRODUCTION

A flower is a unique organ composed of morphologically and physiologically complex units such as sepals, petals, andrceoium, gynoecium, stems and often leaves. Each of these parts interact with each other and these interactions influence the water balance and the postharvest quality of flowers. Apart from that ethylene is also a major factor affecting the quality of flowers.

The rapid growth in the production of cut flowers in many developing countries has been driven largely by opportunities to supply high income markets in Europe, North America and increasingly in Asia. There is a potential for the southern hemisphere and tropical locations to supply the northern hemisphere markets because of different or all year growing seasons and lower cost (Anon., 1991).

Gladiolus (*Gladiolus grandiflorus*) is a large, predominantly African genus of cormous perennial herbs (Anon., 1982). The demand for cut gladiolus is consistent throughout the year, because, it is a temperate type cut flower. Gladiolus is grown at higher altitudes, especially in Nuwara Eliya and surrounding areas. Although gladiolus is

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not grown for export purposes in Sri Lanka, it is a popular cut flower in the local market on account of its affordability to the average buyer of cut flowers. However, the main disadvantage is the short vase-life of the cut flower ranging from 3–5 days (Mayak *et al.*, 1974). Thus, the demand can be increased, along with the production, if the vase life is increased.

The present investigation was undertaken to select good preservative solutions to increase the vase-life of cut-gladiolus and also to identify a low cost treatment that may readily be adopted by local retailers and the customers will benefit from the availability of high quality flowers with extended vase-life. The best known preservative solution for cut-gladiolus contains 600 mg l^{-1} of 8-HQC and 4% sucrose (Staby *et al.*, 1978). The longevity of the florets was increased to 6 days with 4% sucrose + 0.5 mM Cobolt compared with 4 days for the control (Murali *et al.*, 1991).

MATERIALS AND METHODS

Gladiolus flowers were collected from growers in and around Nuwara Eliya. The experiment was carried out in a laboratory at the Crop Science Department, Peradeniya. During the period of experiment, the temperature and the relative humidity in the laboratory were 27–30°C and 82–83%, respectively. Fresh gladiolus spikes at one bud open stage were cut on the same day and were brought to the laboratory in water buckets within 3 h of harvesting. Flowers were kept in water for about 2–3 h to recover from the transport stress. Ends of the stems were then cut under water. Each stem was cut leaving 24 cm from the 1st floret. The flowers were placed in jam jars each of which contained 200 ml of solution covering 6 cm of the stem. The following treatments were given and observations were made daily until the quality of all flowers deteriorated.

Treatments

The following treatments were used to evaluate the postharvest quality of cut-gladiolus.

- T 1 - Flower stems dipped in distilled water
- T 2 - Flower stems dipped for 20 min in 5 mg l^{-1} BAP, then placed in distilled water
- T 3 - Flower stems dipped for 20 min in 10 mg l^{-1} BAP, then placed in distilled water
- T 4 - Flower stems dipped for 20 min in 15 mg l^{-1} BAP, then placed in distilled water
- T 5 - Flower stems dipped for 20 min in STS solution, then placed in distilled water
- T 6 - Flower stems dipped for 10 min in 1000 mg l^{-1} $AgNO_3$, then placed in distilled water
- T 7 - Flower stems were continuously dipped in 200 ml solution of 2.25% 7-UP™

T 8 - Flower stems were continuously dipped in 200 ml solution of 25% 7-UP™

T 9 - Flower stems were continuously dipped in 200 ml solution of pH 3.5 (using HCl)

T 10 - Flowers stems were dipped in 4 mg l^{-1} $KMnO_4$, solution and transferred to distilled water after 1 h

T 11 - Flower stems were continuously dipped in 200 ml of 2 mg l^{-1} $KMnO_4$ solution

T 12 - Flower stems were dipped for 2 min in 80°C hot water and then transferred to distilled water

T 13 - Flower stems were continuously dipped in 200 ml distilled water containing 5 g activated charcoal

T 14 - Flower stems were continuously dipped in 200 ml solution of 4% sucrose

Treatments were arranged in a Completely Randomized Design (CRD) with 4 replicates (Gomez and Gomez, 1976). Each replicate had one spike of gladiolus having an average of 6 florets. The treatment response was monitored through of non parametric (colour of petals, wilting of petals, freshness of florets) and parametric (number of buds, number of half open flowers, total number of wilted flowers and total number of open flowers) observations.

As it was a subjective method based on visual characters of flowers, the best gladiolus flower was given a maximum score of 9. Lower scores were given for deteriorated qualities (Table 1).

Table 1. Quality parameters and corresponding scores for gladiolus flowers.

Quality Parameters	Score
Colour of petals	
Coloured petals, no fading or discolouration	3
Slight discolouration	2
Moderate discolouration	1
Severe discolouration and appearance of brown patches	0
Wilting of petals	
No wilting, rigid appearance	3
Slight wilting	2
Moderate wilting	1
Severe wilting	0
Freshness of florets	
Fresh appearance	3
Slight loss of freshness	2
Moderate loss of freshness	1
Severe loss of freshness	0

Parametric observations such as number of buds, number of half open flowers, number of full open flowers, total number of wilted flowers and total number of open flowers (flowers kept open from the beginning) were collected in relation to the vase-life of gladiolus flowers. Data were analysed using Statistical Analysis Software (SAS) System for analysis of variance procedure. Duncan's Multiple Range Test was used for treatment comparisons.

RESULTS AND DISCUSSION

Visual quality

At the beginning of the experiment all treatments received the maximum of score 9 and it was continued up to the 2nd day. After the 2nd day treatments started deviating from each other. According to the marks given by the evaluaters, treatments 3, 6, 7, 8 and 10 obtained the maximum while the other treatments indicated lower scores. Although there is a deviation, all the lines show a similar descending pattern (Fig. 1). Treatment 11 reached zero level on the 7th day, while others descending at lower rates and obtained zero score within next 3 days. Even on the 10th day treatment 8 obtained 2.75 score.

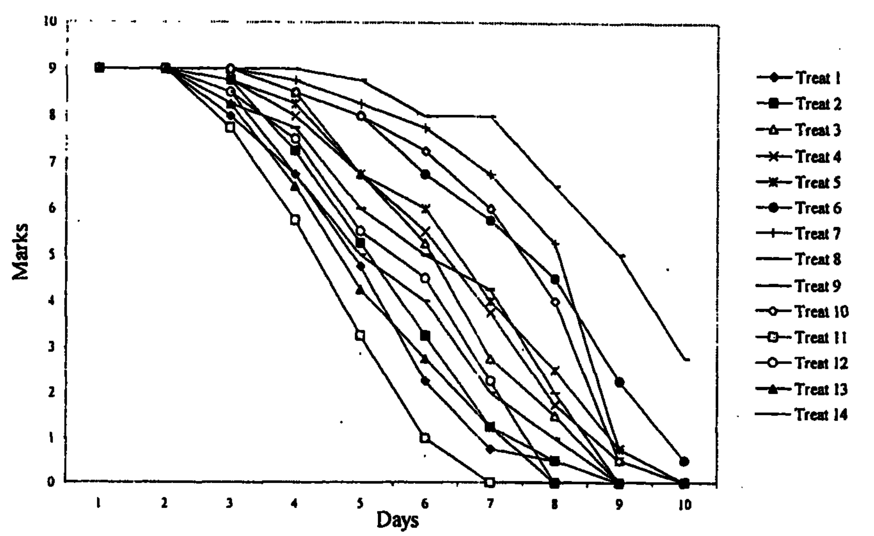

Fig. 1. Visual quality ratings of gladiolus during 10 days in storage.
[Note: T1-Control, T2-BAP 5 mg l^{-1}, T3-BAP 10 mg l^{-1}, T4-BAP 15 mg l^{-1}, T5-STS solution, T6-$AgNO_3$, T7-2.25% 7-UP™, T8-25% 7-UP™, T9-3.5 pH, T10-$KMnO_4$ 4 mg l^{-1}, T11-$KMnO_4$ 2 mg l^{-1}, T12-Hot water, T13-5 g Activated charcoal, T14-Sucrose 4%].

Wilting of flowers

Wilting of 60% of the florets in a spike was considered as the end of vase-life. Wilting was not observed on the 1st day. From the 2nd day onwards treatments 1, 2 and 13 started showing wilting. The treatment 1 (control with distilled water) and treatment 11 showed 60% wilting on the 5th day. Other treatments showed the same pattern of increasing the percentage of wilting in different stages of time (Fig. 2).

Treatment 8 took the longest time in reaching the 60% wilting point. After 10 days of vase-life, treatments 6 and 8 did not reach 100% wilting.

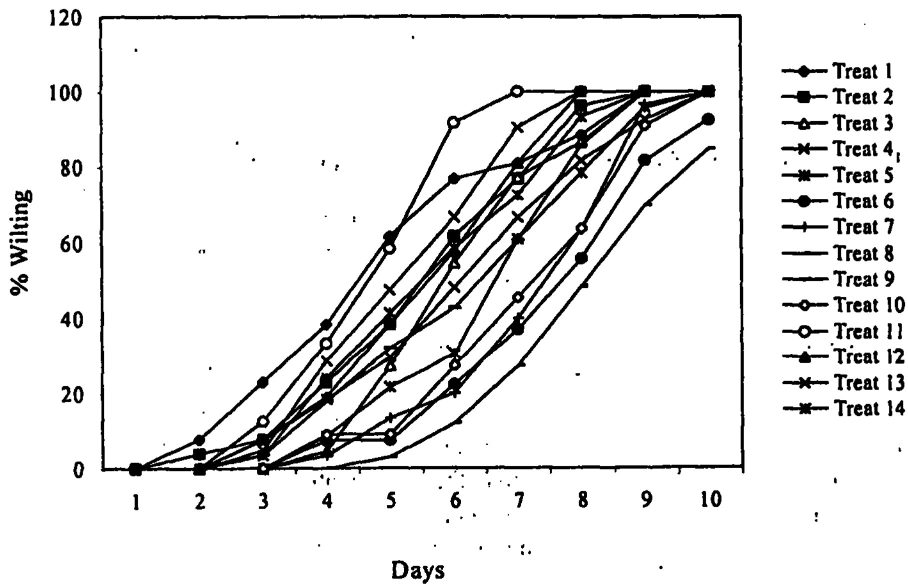

Fig. 2. Percentage of flower wilting of gladiolus during 10 days in storage.
[Note: T1-Control, T2-BAP 5 mg l^{-1}, T3-BAP 10 mg l^{-1}, T4-BAP 15 mg l^{-1}, T5-STS solution, T6-$AgNO_3$, T7-2.25% 7-UP™, T8-25% 7-UP™, T9-3.5 pH, T10-$KMnO_4$ 4 mg l^{-1}, T11-$KMnO_4$ 2 mg l^{-1}, T12-Hot water, T13-5 g Activated charcoal, T14-Sucrose 4%].

Vase life of gladiolus in relation to colour of florets

Treatments 8 showed a better performance compared to other treatments, having scored the highest marks in relation to the colour of the florets. Next best preservative solutions were treatments 7, 6, and 10 in descending order of their performances. There was a significant difference among the low and high BAP levels used as treatments. Low BAP concentration was less effective regarding colour. Lowest scores were gained by treatments 11, 13, 12 and 2 in descending order (Fig. 3).

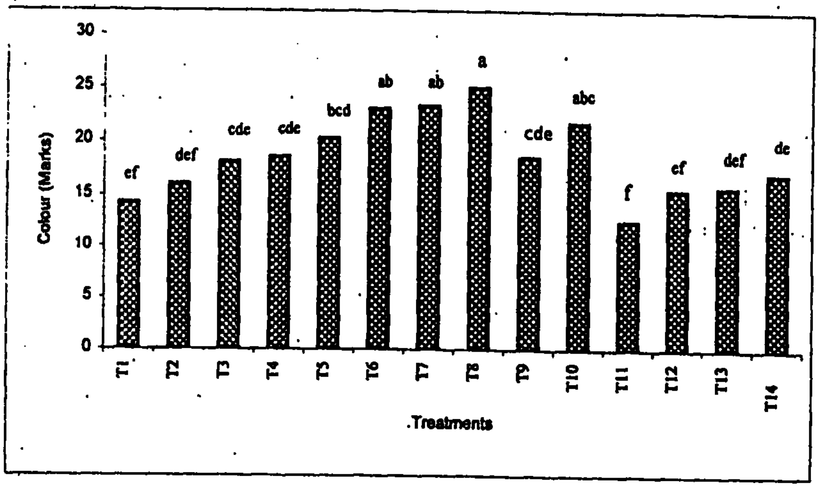

Fig. 3. Effect of different treatments on colour of gadiolus florets.
[Note: T1-Control, T2-BAP 5 mg l^{-1}, T3-BAP 10 mg l^{-1}, T4-BAP 15 mg l^{-1}, T5-STS solution, T6-$AgNO_3$, T7-2.25% 7-UP™, T8-25% 7-UP™, T9-3.5 pH, T10-$KMnO_4$ 4 mg l^{-1}, T11-$KMnO_4$ 2 mg l^{-1}, T12-Hot water, T13-5 g Activated charcoal, T14-Sucrose 4%].

Vase life of gladiolus in relation to wilting of the florets

Statistical analysis shows a significant difference between treatments ($P<0.05$). Preservative treatment 8 was the best in reducing the wilting of the florets. Then treatments 7 and 6 showed better performance than the other treatments (Fig. 4). Treatments 10, 5, 3 and 4 being in the 2nd group of Duncan classification showed a lesser level of performance on reducing the wilting of florets. Treatment 11 showed the least level of performance in reducing wilting.

Vase life of gladiolus in relation to freshness of the florets

Retention of freshness of the florets of gladiolus flowers was greatly achieved by treatment 8 and it was followed by treatment 7, 6 and 10. Treatment 13 and 11 were the treatments that had the least level of impact on the freshness of the florets, being in the last group with the control (Fig. 5).

DISCUSSION

According to the results obtained by the analysis of different treatments, the longest duration of vase-life was observed in treatments 5 (STS solution), 6 (1000 mg l^{-1} $AgNO_3$), 7 (2.25% 7-UP™), 8 (25% 7-UP™), and 10 (4 mg l^{-1} $KmnO_4$). The maximum vase-life was given by treatment 8 which had a mean score of 9 days. This can be

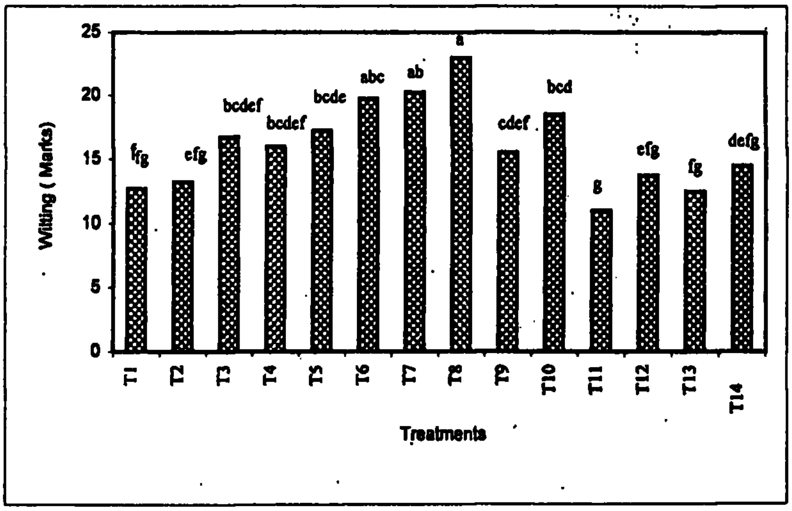

Fig. 4. Treatment effect on wilting of gladiolus florets.
[Note: T1-Control, T2-BAP 5 mg l^{-1}, T3-BAP 10 mg l^{-1}, T4-BAP 15 mg l^{-1}, T5-STS solution, T6-$AgNO_3$, T7-2.25% 7-UP™, T8-25% 7-UP™, T9-3.5 pH, T10-$KMnO_4$ 4 mg l^{-1}, T11-$KMnO_4$ 2 mg l^{-1}, T12-Hot water, T13-5 g Activated charcoal, T14-Sucrose 4%].

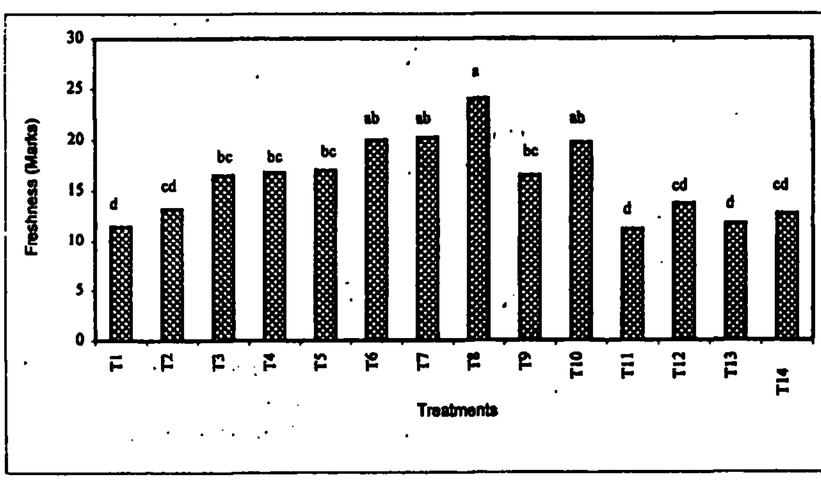

Fig. 5. Treatment effect on freshness.
[Note: T1-Control, T2-BAP 5 mg l^{-1}, T3-BAP 10 mg l^{-1}, T4-BAP 15 mg l^{-1}, T5-STS solution, T6-$AgNO_3$, T7-2.25% 7-UP™, T8-25% 7-UP™, T9-3.5 pH, T10-$KMnO_4$ 4 mg l^{-1}, T11-$KMnO_4$ 2 mg l^{-1}, T12-Hot water, T13-5 g Activated charcoal, T14-Sucrose 4%].

considered the best treatment of those tested for extending the vase life of gladiolus followed by treatment 6, 7, 10 and 5 in order of performance. Though not included in the

1^{st} group of Duncan mean separation, treatments such as pH 3.5, 15 mg l^{-1} BAP, 10 mg l^{-1} BAP and 4% sucrose had a relatively better effect on the vase-life of flowers. Treatments 2 mg l^{-1} $KmnO_4$ and distilled water which was the control showed the shortest vase life.

Generally the post harvest life is expressed in days and there are no well defined criteria and conditions on evaluating the lasting qualities of cut flowers (De *et al.*, 1996). In this study time of placing the flower in preservative solution has been considered as the starting point in evaluation and the day where 60% of the total opened flowers wilted as the end of vase life. It is reported that some researchers considered time of harvest as a starting point and the end point also varies (Garrod and Harris, 1978; Patil *et al.*, 1994 ; Salunkhe *et al.*, 1990). According to the results it is clear that the best performance was given by treatment number 8 (7-UP™ 25%). Although the composition of this carbonated beverage is not known, it can be assumed that it contains citric acid, sugars and carbondioxide. Some of this gas may dissolve in the solution to form carbonic acid.

The citric acid and carbonic acid may have lowered the pH of the solution and reduced microbial growth. Sugars present may have increased the turgidity of the cells while reducing the microbial population. According to Van-Doorn *et al.* (1995) high bacterial counts in the vase water can shorten flower longevity. Hence, this solution may have increased the vase life. Corbondioxide compete with ethylene for recepter sites thereby preventing ehtylene action.

Silver thiosulphate and silver nitrate also had a very good effect on vase-life. Reason behind this is the antagonistic effect of element silver (Ag) on ethylene production. Veen (1983) reported that, Ag ion in the form of thiousulphate complex move readily through the stems and into the flowers thus minimizing the postharvest lossed of cut-flowers. Potassium permanganate acts as an ethylene 'scrubber' by absorbing and oxidizing ethylene. By evaluating the impact of preservative treatments by carrying out further investigations some of the above treatments may be used extensively to lengthen the vase-life of gladiolus.

CONCLUSIONS

According to the results of the study the postharvest life of cut-flower gladiolus was increased by 25% 7-UP™. The vase-life of gladiolus treated with 25% 7-UP™ had a mean value of 9 days. The visual quality was also highest in this same treatment.

Chemicals such as silver nitrate, 2.25% 7-UP™, 4 mg l^{-1} Potassium permanganate ($KMnO_4$) and silver thiosulphate also gave a considerable performance in lengthening the post-harvest life having 8.5, 8.0, 8.0 and 7.8 mean number of days of vase-life, respectively. When the cost of materials used is considered from among the best treatments, the lowest cost treatments were 7-UP™ and $KmnO_4$. It can be recommended that beverage 7-UP™ having a concentration of 25% is the best in treating cut flower gladiolus to increase the vase-life and to retain the visual quality at a higher standard.

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