Effect of post harvest treatments on *Gladiolus grandiflorus* cut flowers.

Mona Ahmed Darwish¹, Atef Mohamed Zakareia Sarhan¹, Khaled Abd-Mohsen Emam² and Reham Emam Ahmed Alm-Eldeen²

¹Department of Ornamental Horticulture, Faculty of Agriculture, Cairo University, Egypt  
²Horticulture Research Institute, Agriculture Research Center, Egypt

*Correspondence: omshokordom@yahoo.com Accepted: 03 Aug 2018 Published online: 12 Sep. 2018*

Gladiolus is an important commercial crop having major role as a cut flower in the domestic market. An investigation was carried out to study the effect of pulsing in sucrose (Suc.) (20% for 20 hrs.), holding in distilled water (D.W.), Suc. (2% and 4%), salisylc acid (SA) (100 and 200 ppm), lupine (Lup.) (0.2% and 0.5%) and moringa solution (Mor.) (0.2% and 0.5%) on *Gladiolus grandiflorus* "White prosperity" cut flowering stems under the room temperature (21±1°C) or cold storage at 5°C for 7 days. The results indicated that pulsing in 20% Suc. solution for 20 h is the best treatment before transferring them to the preservative solution, as it was significantly improved the change % in fresh weight of inflorescences, water uptake, opening flower, flower diameter, longevity, photosynthetic pigments content in the leaves , as well as total carbohydrates % in the petals comparing with holding in D.W. and other preservative solutions. However, holding in 2% Suc. preservative solution at the room temperature after pretreatment with 20 % Suc. pulsing one gave the best results at all.

**Keywords:** Gladiolus, pulsing and holding solutions, storage temperature

**INTRODUCTION**

Short postharvest vase life is one of the most important problems of the cut flowers. However, longevity of vase life is an important factor in consumer preference.

Gladiolus (*Gladiolus grandiflorus* L.) is an important ornamental and commercial flower known as queen of the bulbous plants, belongs to Iridaceae family and is valued for its wide range of flower colors, attractive shapes, varying sizes, large number of florets per spike, excellent keeping quality and popular as cut flower in the domestic and international market. (Bhat and Sheikh 2015).

Tariq et al., (2016) showed that salicylic acid (SA) is helpful in extending the vase life of gladiolus cut flower, and the highest physiological and biochemical response was at an optimum level of 150 mg SA L-1 of vase solution.

Ramos et al., (2015) showed that treatment with 12 h with 20% sucrose solution was more efficient in prolonging the vase life of gladiolus.

The pulsing treatment with 5% sucrose recorded significantly maximum vase life of 17.25 days with maximum number of florets opened (12.00) and (85.7 %) as compared to control (9.50 days ) and proved best pulsing treatment for prolonging the vase of life gladiolus spike Cv. American Beauty ( Nijasure et al., 2004).

Babaji et al., (2014) reported that the treatment 20% sugar results in a greater number of opened flowers of Gladiolus, marketable condition of spike and longer vase life of spike in days for the gladiolus cv. American Beauty. The parameter of vase life was studied indicated that, the sugar levels increased ultimately increasing the greater number of opened flowers per spike over control.
Kadam and Singh (2009) showed that at higher temperature, there was significant reduction in fresh weight of cut spike of gladiolus at harvest. Senescence was accelerated by increased temperature.

Bhat and Sheikh (2015) found that shorter storage durations of 0 days (S0) recorded higher vase life, longevity of open floret and total water absorption, while days to open the basal floret and floret size were superior in S3 (S3 = 21 days) storage and rest of the parameters were significantly higher in S2 (S2 = 14 days) storage duration. The spikes of cut gladiolus (Gladiolus grandiflorus L.) stored in S4 (S4 = 28 days) treatment did not open either pulsed with chemical solutions or in control.

Avneet et al., (2016) studied that increase in storage duration cause decrease in size of floret and water absorption in spikes of gladiolus being higher in spikes given pulsing treatment with sucrose.

**MATERIALS AND METHODS**

This work was carried out at the Department of Ornamental Horticulture, Faculty of Agriculture, Cairo University and Postharvest Lab. of Floriculture Res. Dept., Hort. Res. Inst., ARC, Giza, Egypt to elicit the response of Gladiolus sp to pulsing solutions and holding in preservative ones under room temperature or cold storage at 5°C for (7 days) one week.

Therefore, cut flowering stems of Gladiolus sp were freshly obtained on February, 1st for each season from the local commercial green houses of Neama Flower Farm (DARAWAN ASHMON, EI-MONOFEA). The flowering stems were picked in the early morning when the beginning of the flower opens basal. They were at similar lengths of 100 cm and transported vertically quickly to the laboratory within 2h. The cut stems were firstly precooled by placing them in a cool water (5-7°C) for 4 hour to remove the field heat. Stem bases were then recut under water by removing about 3 cm, the cut end of leaves were also removed to be away from surface of pulsing or holding solution.

Thereafter, the flowering stems (243) were divided into similar and equal three groups (81 flowering stems per each group), and were pulsed for 20 hours at about 25°C in one of the following solution:

Pulsing in 20% sucrose (suc.) solution.

At the end of pulsing period, the flowering stems of each group (81) were divided into 3 sets (27 flowering stems per each set). They were transferred to be held in one of the following nine preservative solutions for postharvest evaluation till the end of experiment under the room temperature (21±1°C):

- Holding in distilled water (D.W.) as control.
- Holding in 20 g/L sucrose (Suc.) solution.
- Holding in 40 g/L sucrose (Suc.) solution.
- Holding in 100 ppm salislyic acid (SA) solution.
- Holding in 200 ppm salislyic acid (SA) solution.
- Holding in 2 g/L lupin solution.
- Holding in 5 g/L lupin solution.
- Holding in 2 g/L moringa solution.
- Holding in 5 g/L moringa solution.

The third set from precooling treatment was put into polyethylene bag of 13mM thickness (72 x 20 cm). The polyethylene bags were sealed tightly and were packed in cardboard boxes (125 x 33 x 20 cm), which were finally stored at 5°C for 7 days at 80-85% relative humidity. After the end of cold-storage period, boxes with flowering stems inside were kept at 8-10°C for 3h, as preconditioning treatment to avoid temperature stress of the room. It held in one of the nine preservative solutions mentioned above.

The 27 flowering stems of each set were separated into 3 groups (9 flowering stems/group) and each group was subdivided into another 3 subgroups, each one of them was put in a clear glass jar to represent one replicate (3 flowering stems/replicate). The water was changed every 4 days. Hence, the experimental layout of the experiment was: a factorial designed experiment had been carried out within 3 factors; pulsing solutions, holding solutions and the storage temperature.

**Data recorded:-**

The effect of different treatments on longevity and quality of cut Gladiolus inflorescences used in this work were determined through recording the following data:

- The change of fresh weight percentage
- Water uptake (g/ inflorescence)
- The inflorescence longevity (number of days to wilting of the last open flower of the inflorescence).
- Opening flowers
- Flower Diameter
- Longevity

In ethanolic extract, the content of chlorophyll a, b, total chlorophylls and carotenoids (mg/100g f.w.) in fresh leaf samples were measured according to Saric et al., (1976),
while in the dry leaf and petal samples, total carbohydrates content (%) was colorimetrically assessed as described by Dubois et al., (1956).

Statistical analysis
The data were tabulated and subjected to analysis of variance as a factorial experiment using MSTAT-C statistical software (1989) and the means of various treatments were compared by Duncan’s Multiple Range Test at 5% level as indicated by Waller and Duncan (1969).

RESULTS AND DISCUSSION

Effect of pulsing and holding solutions and storage temperature and their interaction treatments.

On Fresh weight of cut flowers
Data presented in Table 1 show that pulsing solution caused a positive increment in fresh weight change % till the 7th day from cut in the first season, while in the second one till the 8th day with significant differences, when compared to pulsing in D.W. in both seasons. A negative decrement was observed afterwards till the end of shelf life in the two seasons (after 26 and 28 days from cut in the 1st and 2nd seasons, respectively). In general, the highest increase in this trait in both seasons was gained by pulsing in 20% suc. solution, which was followed by 20 g/L solution. Also 100 ppm SA solution was the most effective holding solution for improving the percent of change in fresh weight of inflorescences as compared to the other holding solutions whether moringa or lupin throughout the different stages of vase life period in the two seasons. This may be ascribed to the synergistic effect of sucrose as a regulator for the water flux into the xylem vessels by controlling transpiration. Cold storage for 7 days, at 5°C significantly decreased the percent of change in fresh weight of inflorescences in comparison to storage at room temperature (21±1°C) that registered the highest change % in the two seasons as presented in Table 1. Also storage at 5°C was the worst treatment, as it led to wilting of the open flowers from holding and failing the tight buds to open. As for the interaction treatments, Inflorescences stored at 5°C wilted after the 7th day from cut irrespective of the holding solution they were held in. This may be ascribed to the deleterious effects of cold storage on postharvest quality which included the reduction of inflorescence weight and longevity (Ranwala and Miller, 2005). On the other side, storage under room temperature gave the best results during the various stages of shelf life as compared to the treatments of cold storage 5°C for 7 days. While minimum fresh weight obtained from treating by moringa 5g/L (-4.00 in 7th day) in first season and (-5.54 in 7th day) in the second season under storage temperature at 5°C for 7 days in comparison to control (D.W.), also lupin 5 g/L (-5.67 in 7th day) in the first season and (-5.87 in 7th day) in the second season under storage temperature at 5°C for 7 days in comparison to control (D.W.). These results are in agreement with Kadam and Singh (2009) showed that at higher temperature, there was significant reduction in fresh weight of cut spike of gladiolus at harvest.

On longevity (Day):
It is evident from data presented in Table (2) that longevity of gladiolus inflorescences used in this investigation was prolonged with significant differences in the two seasons by 20% Suc. For 20 h pulsed solution compared to other non pulsing treatments. Meanwhile, maximum vase life (26 days) in first season and (28 days) in second season was observed in 20% Suc. For 20 h pulsing solution followed by Suc. 20g/L holding solution then SA. 100 ppm (26 days) in both seasons after pulsing solution of 20% Suc. For 20 h while, minimum vase life obtained from treating by moringa 2g/L (14 days) in first season and (13 days) in the second season and lupin 2 g/L (12 days) in the first season and (13 days) in the second season under storage temperature at 5°C for 7 days. Then the lowest vase life was observed in moringa 5 g/L (11 days) in both seasons and lupin 5g/L (11 days) in first season and (10 days) in second season under storage temperature at 5°C for 7 days. That may be attributed to the role of sucrose which provides flowers with energy necessary for fundamental cellular processes, whereas SA, inhibits the action of ethylene, and so improves the vase life of cut flowers through delaying its senescence. Similarly, holding in 40 g/L Suc. and SA, 200 ppm solution scored the longest vase life (23, 24) in the first season and (22, 25) in the second season Respectively after treating with 20% Suc. For 20 h pulsing solution as compared to holding either in D.W. under the same conditions or under room temperature. These results are in line with Phanindra (1996) observed that the cut flowers of gladiolus Cv. ‘Psittacinus hybrid’ pulsed with a preservative solution containing two per cent sucrose extended the vase life over control.
Table 1. Effect of pulsing and holding solutions and storage temperature and their interaction treatments on Fresh weight (g/inflorescence) of *Gladiolus grandiflorus* “White prosperity” cut flowering stems during 2016 and 2017 seasons.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Fresh weight (g/inflorescence)</th>
<th>Days duration vase life</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st</td>
<td>10th</td>
</tr>
<tr>
<td>Preservative treatments (A)</td>
<td>Room temperature (21±1°C)</td>
<td>Pulsing solutions</td>
</tr>
<tr>
<td>Holding Solutions (B)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control (D.W.)</td>
<td>5.33 G-I</td>
<td>8.67 CD</td>
</tr>
<tr>
<td>Moringa 2g /L</td>
<td>4.67 Hl</td>
<td>7.67 D-F</td>
</tr>
<tr>
<td>Moringa 5g /L</td>
<td>2.11 KL</td>
<td>5.33 G-I</td>
</tr>
<tr>
<td>Sucrose 20g /L</td>
<td>11.34 AB</td>
<td>12.00 A</td>
</tr>
<tr>
<td>Sucrose 40g /L</td>
<td>5.99 F-H</td>
<td>10.03 BC</td>
</tr>
<tr>
<td>Lupin 2g /L</td>
<td>4.32 Hl</td>
<td>5.17 G-I</td>
</tr>
<tr>
<td>Lupin 5g /L</td>
<td>1.99 KL</td>
<td>3.67 l-K</td>
</tr>
<tr>
<td>Salislyc acid 100 ppm</td>
<td>8.33 DE</td>
<td>10.97 AB</td>
</tr>
<tr>
<td>Salislyc acid 200 ppm</td>
<td>7.35 D-F</td>
<td>10.33 A-C</td>
</tr>
<tr>
<td>Mean A</td>
<td>5.72 B</td>
<td>8.21 A</td>
</tr>
</tbody>
</table>

Second season

| Control (D.W.)              | 7.00 I-L                      | 10.13 DE                | 5.49 LM       | 7.54 CD                        | 3.54 Hi                  | 7.12 FG        | -7.02 N | 1.21 E |
| Moringa 2g /L               | 6.33 J-M                      | 9.00 D-G                | 5.00 MN       | 6.78 D                         | 2.00 UJ                  | 4.16 H         | -9.34 O | -1.06 F |
| Moringa 5g /L               | 3.12 OP                       | 7.03 l-L                | 1.11 q       | 3.75 E                         | -1.32 KL                 | 1.45 J         | -12.23PQ | -4.03G |
| Sucrose 20g /L              | 9.33 D-F                      | 14.00 A                 | 8.13 F-I      | 10.49 A                        | 11.34 C                  | 16.32 A        | 0.86 J  | 9.51 A |
| Sucrose 40g /L              | 8.01 F-I                      | 10.43CD                 | 5.93K-M       | 8.13 C                         | 6.02 G                   | 9.34 DE        | -5.67 MN | 3.23 D |
| Lupin 2g /L                 | 3.67 NO                       | 7.33 H-K                | 3.01 OP       | 4.67 E                         | 1.320 J                  | 3.94 H         | -10.87OP | -1.87 F |
| Lupin 5g /L                 | 1.82 PQ                       | 6.00 K-M                | 0.33 Q        | 2.72 F                         | -4.23 M                  | 0.34 JK        | -13.00 Q | -5.63H |
| Salislyc acid 100 ppm       | 9.00 D-G                      | 12.33 B                 | 8.02 F-I      | 9.78 AB                        | 9.12 DE                  | 14.25 B        | -1.54 L | 7.28 B |
| Salislyc acid 200 ppm       | 8.67 E-H                      | 11.83 BC                | 7.67 G-J      | 9.39 B                         | 8.43 EF                  | 10.74 CD       | -2.00 L | 5.72 C |
| Mean A                      | 6.33 B                        | 9.79 A                  | 4.97 C        | 4.02 B                         | 7.52 A                   | -6.76 C        |          |

Continued.
Table 1. Continued.

| Treatments | Fresh weight (g/inflorescence) | Days duration vase life |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | | 19^th | | | | | | | | | |
| | | Room temperature (21±1°C) | Pulsing solutions | Storage (5°C) | Mean B | Room temperature (21±1°C) | Pulsing solutions | Storage (5°C) | Mean B | | |
| Preservative treatments (A) | Holding Solutions (B) | | | | | | | | | | |
| Control (D.W.) | — | — | — | — | | | | | | | |
| Moringa 2g /L | — | -11.12 F | — | -3.71 B | — | — | — | — | — | — | |
| Moringa 5g /L | — | — | — | — | — | — | — | — | — | — | |
| Sucrose 20g /L | -8.067 E | -2.10 B | -25.23 I | -11.80 F | — | — | — | — | — | — | |
| Sucrose 40g /L | -15.09 H | -6.22 E | — | -7.77 E | — | — | — | — | — | — | |
| Lupin 2g /L | — | — | — | — | — | — | — | — | — | — | |
| Lupin 5g /L | — | — | — | — | — | — | — | — | — | — | |
| Salislyc acid 100 ppm | -11.22 F | -4.01 C | -27.98 J | -14.40 G | — | — | — | — | — | — | |
| Salislyc acid 200 ppm | -14.14 GH | -5.17 D | — | -6.43 D | — | — | — | — | — | — | |
| Mean A | -5.39 B | -4.86 A | -5.91 C | — | — | — | — | — | — | — | |
| First season | | | | | | | | | | |
| Second season | | | | | | | | | | |
| Control (D.W.) | -15.12 F | -10.08 D | — | -8.40 E | — | — | — | — | — | — | |
| Moringa 2g /L | — | -12.08 E | — | -4.03 B | — | — | — | — | — | — | |
| Moringa 5g /L | — | — | — | — | — | — | — | — | — | — | |
| Sucrose 20g /L | -6.17 C | -3.13 B | -26.98 G | -12.09 F | — | -12.56 B | — | -4.188 B | — | — | |
| Sucrose 40g /L | -14.06 F | -9.11 D | — | -7.72 D | — | — | — | — | — | — | |
| Lupin 2g /L | — | — | — | — | — | — | — | — | — | — | |
| Lupin 5g /L | — | — | — | — | — | — | — | — | — | — | |
| Salislyc acid 100 ppm | -7.08 C | -4.27 B | -28.68 H | -13.34 G | — | — | — | — | — | — | |
| Salislyc acid 200 ppm | -10.11 D | -6.23 C | — | -5.45 C | — | — | — | — | — | — | |
| Mean A | -5.84 B | -4.99 A | -6.19 B | — | -1.396 B | — | — | — | — | — | |
Moreover De et al., (1996) stated that the cut flowers of gladiolus pulsed with 20 per cent sucrose for 16 hours significantly improved vase life of flower spikes in ‘White Enchantress’ gladiolus. Behind that Nijasure et al. (2004) reported that the pulsing treatment with 5% sucrose recorded significantly maximum vase life as compared to control and proved best pulsing treatment for prolonging the vase of life gladiolus spike Cv. American Beauty. Also Ezhilmathi et al., (2007) found that 5-sulfosalicylic acid as a salicylate derivative was effective in extending vase life of cut gladiolus.

On opening percentage
It is clear from data presented in Table 3 that opening % of gladiolus inflorescences used in this investigation was increased with significant differences in the two seasons by 20% suc. for 20 h pulsing solution compared to other treatments either in under room temperature or in storage. The treatment with 20% suc. for 20h as a pulsing solution, then holding in vase solutions containing suc. 20 g/L was the most effective treatment under room temperature followed by cut flowers non pulsing treatment under room temperature or stored at 5°C for 7 days.
Table 3. Effect of pulsing and holding solutions and storage temperature and their interaction treatments on opening (percentage) of *Gladiolus grandiflorus* "White prosperity" cut flowering stems during 2016 and 2017 seasons.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>First season</th>
<th>Second season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Room Temperature (21±1°C)</td>
<td>Pulsing solutions</td>
</tr>
<tr>
<td>Control (D.W.)</td>
<td>82.20 FG</td>
<td>90.65 C</td>
</tr>
<tr>
<td>Moringa 2g/L</td>
<td>78.33 H</td>
<td>86.84 D</td>
</tr>
<tr>
<td>Moringa 5g/L</td>
<td>71.79 J</td>
<td>81.45 G</td>
</tr>
<tr>
<td>Sucrose 20g/L</td>
<td>93.04 B</td>
<td>97.44 A</td>
</tr>
<tr>
<td>Sucrose 40g/L</td>
<td>83.33 EF</td>
<td>92.86 B</td>
</tr>
<tr>
<td>Lupin 2g/L</td>
<td>74.58 I</td>
<td>83.87 E</td>
</tr>
<tr>
<td>Lupin 5g/L</td>
<td>67.80 L</td>
<td>79.25 H</td>
</tr>
<tr>
<td>Salicylic acid 150 ppm</td>
<td>90.60 C</td>
<td>96.00 A</td>
</tr>
<tr>
<td>Salicylic acid 200 ppm</td>
<td>87.63 D</td>
<td>93.28 B</td>
</tr>
<tr>
<td>Mean A</td>
<td>81.03 B</td>
<td>89.04 A</td>
</tr>
</tbody>
</table>

Similarly, holding in 20 g/L suc. solution scored increasing opening % of *Gladiolus grandiflorus* cv. "White prosperity" as compared to holding either in D.W. or in moringa solution or in lupin solution. Cold storage at 5°C for 7 days before holding was found to induce a negative effect on opening % of gladiolus inflorescences, as this measurement decreased to 59.60 and 60.86 % for storage in two seasons respectively against 89.04 and 89.32 % for storage under room temperature (21±1°C) in the first and second seasons. Also holding in moringa 2g/L solution decrease opening % of *Gladiolus grandiflorus* cv. "White prosperity" to (57.55%) in the first season, (56.67%) in the second season and lupin 2g/L solution decrease opening % to (56.92%) in the first season, (55.26%) in the second season compared to holding in D.W. (59.87) in first season and (61.83%) in second season under storage temperature at 5°C for 7 days. The lowest opening % was observed in moringa 5 g/L (52.50%) in first season and (54.84%) in second season and lupin 5g/L (48.03%) in first season and (51.54%) in second season under storage temperature at 5°C for 7 days. Similar trends were obtained by Tariq et al. (2016) mentioned that salicylic acid at 150 mg L-1 significantly increased the days to open florets of gladiolus cut flowers and percent florets opened. The cut flowers of gladiolus Cv. ‘Psittacinus hybrid’ pulsed with a preservative solution containing two per cent sucrose recorded 84 per cent of opened florets over control (Phanindra, 1996). (De et al., 1996) who stated that the cut flowers of gladiolus pulsed with 20 per cent sucrose for 16 hours significantly improved opening of floret. The pulsing treatment with 5% sucrose recorded significantly maximum number of florets opened of life gladiolus spike cv. American Beauty as compared to control (Nijasure et al., 2004). Babaji et al., (2014) reported that the treatment 20% sugar results in a greater number of opened flowers of gladiolus cv. American Beauty, increasing the greater number of opened flowers per spike

**CONCLUSION**

It could be recommended that pulsing the cut flowering stems of *Gladiolus grandiflorus* "White prosperity" in 20 % Suc. solution for 20 hrs. before holding them in 2% Suc. preservative solution under room temperature (21±1°C) improved the change % in fresh weight of inflorescences, water uptake, opening flower, flower diameter, longevity, photosynthetic pigments content in the leaves, as well as total carbohydrates % in the leaves and petals till the end of vase life.

**CONFLICT OF INTEREST**

The authors declared that present study was performed in absence of any conflict of interest.

**ACKNOWLEDGEMENT**

The authors acknowledge Ornamental Horticulture, Faculty of Agriculture, Cairo University and Horticulture Research Institute,
Agriculture Research Center, Egypt for providing technical and the support for completing this research.

**AUTHOR CONTRIBUTIONS**
All authors contributed equally in all parts of this study.

**Copyrights: © 2017 @ author(s).**
This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author(s) and source are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

**REFERENCES**


