Post Harvest Life of Gladiolus Spikes as Influenced by Preharvest Application of GA$_3$, Carbendazim and Mancozeb

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A B S T R A C T

The present investigation was conducted at Horticulture Research Farm, Institute of Agricultural Sciences, whereas all the postharvest parameters were carried out in Postharvest Laboratory of Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during the year 2017-18. The experiment was laid out in a Randomized Block Design (RBD) with twelve treatments i.e., control, GA$_3$ 50 ppm, GA$_3$ 100 ppm, carbendazim 0.4 %, mancozeb 0.4 %, carbendazim 0.4 % + mancozeb 0.4 %, GA$_3$ 50 ppm + carbendazim 0.4 %, GA$_3$ 50 ppm + mancozeb 0.4 %, GA$_3$ 50 ppm + carbendazim 0.4 % + mancozeb 0.4 %, GA$_3$ 100 ppm + carbendazim 0.4 %, GA$_3$ 100 ppm + mancozeb 0.4 %, GA$_3$ 100 ppm + carbendazim 0.4 % + mancozeb 0.4 % and three replications. Results revealed that maximum length of spike after 6$^{th}$ and 9$^{th}$ days in vase was registered with pre-soaking treatment of cut corms in GA$_3$ 50 ppm (53.65 cm and 54.00 cm). Whereas, maximum weight of spike was found with pre-soaking treatment of GA$_3$ 100 ppm + carbendazim 0.4 % + mancozeb 0.4 % and carbendazim 0.4 % + mancozeb 0.4 % treatments after 6$^{th}$ (36.23 g) and 9$^{th}$ day (31.63 g) of observation in vase solution, respectively. A significant effect was found with diameter of 1$^{st}$, 3$^{rd}$ and 5$^{th}$ florets in vase due to various concentrations of GA$_3$, carbendazim 0.4 % and mancozeb 0.4 % as pre-soaking treatment. Maximum water uptake by gladiolus spikes resulted with GA$_3$ 100 ppm + carbendazim 0.4 % + mancozeb 0.4 % after 3 days (26.00 ml) and with GA$_3$ 100 ppm + carbendazim 0.4 % after 9 days (37.25 ml) in vase solution. However, prolonged vase life of spikes was registered with pre-soaking treatment of carbendazim 0.4 % + mancozeb 0.4 % (14.33 days).

K e y w o r d s
Gladiolus, Pre-soaking, Cut corms, GA$_3$, Carbendazim and mancozeb

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Introduction

An easy to grow crop that belongs to bulbous group is gladiolus. Being a popular cut flower in the industry of floriculture, its popularity is also ascribed to its diverse shapes, colours and hues, unique arrangement of flowers and ease of culture. The longevity in gladiolus varies from cultivar to cultivar. Though the flower is perishable in nature due to rapid wilting of florets (He et al., 2006), many research has been conducted to extend the longevity of
gladiolus spikes. Apart from external quality of flowers, vase life is also a key factor for consumers. Typical vase life of individual floret is just 4-6 days that differs from variety to variety. The senescent florets remain attached at the bottom of spikes even after opening of other florets (Yamada et al., 2003). However some post harvest problems like low water uptake and absorption of water, rapid darkening and change in colour of florets, abscission or senescence have been noted in gladiolus. All the developmental as well as senescence processes in cut flowers are under hormonal control. The control over floral characteristics and flowering time in relation to demand of market has been achieved in many cut flowers by adopting use of plant growth regulators (PGRs) (Rashmi and Deen, 2017). The application of PGRs include foliar application, pre-soaking, drenching, etc. In gladiolus, pre-soaking of corms in GA3 or any other growth regulators is now becoming a common method among commercial growers for enhancing growth and flowering yield in gladiolus (Schnelle et al., 2005 and Singh, 2006). But the important fact is that to grow healthy spikes with flowers that are free from any disease infestations. Gladiolus is mostly attacked by fungal diseases like fusarium wilt, botrytis rot, neck rot, etc. that generates a poor quality spikes with small distorted flowers and even produce reduced quality corms. Pre-storage or pre-planting treatment of corms with carbenzamin (0.1%) or mancozeb is effective in reducing the incidence (Singh and Sisodia, 2017). Therefore, the present investigation was proposed to study the postharvest performance of single bud section of gladiolus influenced by various concentrations of GA3, carbenzadim and mancozeb.

Materials and Methods

The present investigation was conducted at Horticultural Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during the year 2017-18. Experiment was laid out in a Randomized Block Design (RBD) with twelve treatments viz., Control, GA3 50 and 100 ppm, carbendazim 0.4 %, mancozeb 0.4 %, carbendazim 0.4 % + mancozeb 0.4 %, GA3 50 ppm + carbendazim 0.4 %, GA3 50 ppm + mancozeb 0.4 %, GA3 50 ppm + carbendazim 0.4 % + mancozeb 0.4 %, GA3 100 ppm + carbendazim 0.4 %, GA3 100 ppm + mancozeb 0.4 %, GA3 100 ppm + carbendazim 0.4 % + mancozeb 0.4 % and three replications. The planting material taken was single bud section of gladiolus cut corms cv. Punjab Morning for this experiment. Pre-soaking treatment of various concentrations of GA3, carbendazim, mancozeb were applied to the cut sections of gladiolus corms for 24 hours including control (distilled water). The cut corms were raised in a plot of size 2.70 × 1.25 m with spacing 30 × 25 cm having proper drainage of water. Well rotten FYM and vermicompost were applied before planting followed by uniform cultural practices. Spikes were harvested when 2-3 florets showed colour and then placed in distilled water for observing the postharvest characters. Postharvest observations include length and weight of spikes at various days, diameter of 1st floret, water uptake and vase life of spikes and then were subjected to statistical analysis.

Results and Discussion

The performance of gladiolus spikes for postharvest studies were evaluated and observed for different concentrations of GA3,
carbendazim and mancozeb at different days interval (Table 1). At the stage harvesting, various concentrations of GA$_3$, carbendazim 0.4 % and mancozeb 0.4 % failed to exert any significant effect on spike length in cut corms of gladiolus. Maximum spike length was noticed with treatment GA$_3$ 100 + carbendazim 0.4 % + mancozeb 0.4 % (53.87 cm), while minimum with treatment mancozeb 0.4 % (38.16 cm). A persual of the result clearly evidents a significant difference on weight of spikes after 6$^{th}$ and 9$^{th}$ day of observation; and length of spike after 3$^{rd}$, 6$^{th}$ and 9$^{th}$ day of observation in vase solution (distilled water) due to the pre-soaking treatment of various concentrations of GA$_3$, carbendazim and mancozeb on gladiolus cut corms. Length of spike was found maximum after 3 and 6 days in vase solution with cut corms pre-soaked in GA$_3$ 50 ppm (53.30 cm and 53.65 cm, respectively) which found statistically at par with GA$_3$ 100 + carbendazim 0.4 % + mancozeb 0.4 % (50.57 cm and 50.42 cm), GA$_3$ 100 + mancozeb 0.4 % (47.60 cm and 47.60 cm), GA$_3$ 50 ppm + mancozeb 0.4 % (52.00 cm and 52.10 cm), carbendazim 0.4 % + mancozeb 0.4 % (51.83 cm and 49.60 cm) and control (47.50 cm and 47.93 cm) and significant to other treatments. While at 9$^{th}$ day of observation, maximum spike length was registered with cut corms pre-soaked in carbendazim 0.4 % treatment (54.13 cm) which found statistically at par with GA$_3$ 50 ppm (29.61 g) and GA$_3$ 100 + carbendazim 0.4 % + mancozeb 0.4 % (37.48 g), respectively. While minimum weight of spike after harvesting and after 3 days of harvesting was recorded with GA$_3$ 100 + mancozeb 0.4 % (22.24 g) and mancozeb 0.4 % treatment (26.52 g), respectively in vase solution. However, on 6$^{th}$ and 9$^{th}$ day of postharvest studies, maximum weight of gladiolus spike in vase solution were registered with GA$_3$ 100 + carbendazim 0.4 % + mancozeb 0.4 % (36.23 g) and carbendazim 0.4 % + mancozeb 0.4 % (31.63 g), respectively which were found statistically at par with GA$_3$ 50 ppm + carbendazim 0.4 % + mancozeb 0.4 % treatment (26.62 g), respectively in vase solution. However, on 6$^{th}$ and 9$^{th}$ day of postharvest studies, maximum weight of gladiolus spike in vase solution were registered with GA$_3$ 100 + carbendazim 0.4 % + mancozeb 0.4 % (36.23 g) and carbendazim 0.4 % + mancozeb 0.4 % (31.63 g), respectively which were found statistically at par with GA$_3$ 50 ppm + carbendazim 0.4 % + mancozeb 0.4 % (31.46 g and 25.66 g), carbendazim 0.4 %
(31.15 g and 25.44 g), and GA$_3$ 100 + carbendazim 0.4 % (30.53 g and 25.94 g) and significant to other treatments; while minimum was recorded with mancozeb 0.4 % treatment (22.08 g and 17.44 g, respectively). Since use of PGRs like GA$_3$ might help in promoting cell division in cut corms that helps in producing more vegetative parts as well as elongation in spikes of gladiolus. The increase in length directly influences the weight of spikes in gladiolus. The increased rate of cell division due to the application of GA$_3$ was resulted by Sindhu and Verma (1997) in gladiolus, Bhalla and Kumar (2008) in gladiolus, Singh et al., (2017) in marigold and Al-Khassawreh et al., (2006) in black iris. However pre-soaking treatment of fungicides like carbendazim and mancozeb individually might help in avoiding infestation of cut corms as well as spikes in vase solution. This also helps in maintaining the weight of spikes free from any postharvest losses.

Pre-soaking treatment of cut corms in various concentrations of GA$_3$, carbendazim, mancozeb have been studied and illustrated for all the postharvest parameters (Table 2). Data revealed for a non significant difference that was exerted on 6th day of volume uptake by gladiolus spikes due to various concentrations of GA$_3$, carbendazim 0.4 % and mancozeb 0.4 % treatments. Maximum uptake of water was observed on 6th day with treatment GA$_3$ 100 + carbendazim 0.4 % + mancozeb 0.4 % (31.00 ml) while minimum with mancozeb 0.4 % (19.00 ml) treatment. However, all the parameters regarding volume uptake at different days interval exhibited a significant effect on flower diameter (1st, 3rd and 5th floret) and vase life of spikes attributable to different concentrations of GA$_3$, carbendazim 0.4 % and mancozeb 0.4 %. Cut corms pre-soaked in treatment GA$_3$ 100 ppm + carbendazim 0.4 % + mancozeb 0.4 % (26.00 ml) exhibited maximum water uptake by gladiolus spikes on 3rd day which was found statistically at par with GA$_3$ 100 + carbendazim 0.4 % (25.75 ml), carbendazim 0.4 % + mancozeb 0.4 % (20.66 ml), GA$_3$ 50 ppm (20.00 ml), GA$_3$ 100 ppm + mancozeb 0.4 % (20.00 ml) and found significant to other treatments; while minimum was obtained with GA$_3$ 50 ppm + mancozeb 0.4 % (13.00 ml) treatment. On 9th day, maximum volume uptake in vase solution was observed with GA$_3$ 100 + carbendazim 0.4 % (37.25 ml) treatment which was found statistically at par with GA$_3$ 100 + carbendazim 0.4 % + mancozeb 0.4 % (33.00 ml), GA$_3$ 50 ppm (31.00 ml), carbendazim 0.4 % + mancozeb 0.4 % (30.00 ml), GA$_3$ 100 + mancozeb 0.4 % (30.00 ml) and found significant to other treatments; while minimum was noted with mancozeb 0.4 % treatment. Water uptake from vase solution remains longer the flower freshness through maintaining an improved vase status and rescues the cut flowers from pre-aging and senescence. Gibberellic acid persuades the flower longevity with improved water status either by increasing water uptake or reducing excess water loss by lowering transpirational water loss (Goszczynska et al., 1990 and Saeed et al., 2014).

Data pertaining to the flower diameter studies revealed a significant difference on diameter of 1st, 3rd and 5th florets owing to various treatments of GA$_3$, carbendazim and mancozeb. Cut corms pre-soaked with GA$_3$ 50 ppm + mancozeb 0.4 % (10.35 cm) solution obtained for a maximum diameter of 1st floret in vase solution which found statistically at par with GA$_3$ 100 + mancozeb 0.4 % (9.75 cm) treatment and found significant to other treatments; while minimum was noted with GA$_3$ 100 + carbendazim 0.4 % (8.55 cm). However, maximum diameter of 3rd floret in vase solution was recorded with cut corms pre-soaked with GA$_3$ 50 ppm + carbendazim 0.4 % + mancozeb 0.4 % treatment (9.47 cm), which found statistically at par with treatments like GA$_3$ 50 ppm + mancozeb 0.4 % (9.35 cm) and carbendazim 0.4 % + mancozeb 0.4 % (8.91 cm) and found significant to other treatments.
### Table 1 Effect of GA$_3$, carbendazim and mancozeb on length and weight of spikes during postharvest studies in gladiolus

| Treatment                                           | Length of spike | Weight of spike |       |       |       |       |       |       |
|-----------------------------------------------------|-----------------|-----------------|-------|-------|-------|-------|-------|-------|
|                                                     | Length of spike at harvesting (cm) | Length of spike after 3 days in vase (cm) | Length of spike after 6 days in vase (cm) | Length of spike after 9 days in vase (cm) | Weight of spike at harvesting time (g) | Weight of spike at 3 days in vase (g) | Weight of spike at 6 days in vase (g) | Weight of spike at 9 days in vase (g) |
| Control                                             | 46.81           | 47.50           | 47.93 | 47.93 | 25.07 | 30.28 | 27.87 | 22.61 |
| GA$_3$ 50 ppm                                       | 52.75           | 53.30           | 53.65 | 54.00 | 29.61 | 37.45 | 33.40 | 26.60 |
| GA$_3$ 100 ppm                                      | 44.71           | 44.73           | 45.65 | 46.16 | 24.60 | 31.45 | 27.66 | 21.09 |
| Carbendazim 0.4 %                                   | 52.44           | 53.22           | 53.36 | 54.13 | 26.54 | 33.91 | 31.15 | 25.44 |
| Mancozeb 0.4 %                                      | 38.16           | 38.46           | 39.33 | 39.20 | 20.40 | 26.52 | 22.08 | 17.44 |
| Carbendazim 0.4 % + Mancozeb 0.4 %                  | 47.93           | 51.83           | 49.60 | 49.90 | 26.41 | 35.10 | 35.60 | 31.63 |
| GA$_3$ 50 ppm + Mancozeb 0.4 %                      | 50.00           | 52.00           | 52.10 | 52.10 | 22.40 | 26.56 | 27.39 | 24.28 |
| GA$_3$ 50 ppm + Carbendazim 0.4 % + Mancozeb 0.4 %  | 44.90           | 45.30           | 45.75 | 46.65 | 25.30 | 31.70 | 31.46 | 25.66 |
| GA$_3$ 100 ppm + Carbendazim 0.4 %                  | 42.40           | 43.40           | 44.27 | 45.17 | 23.14 | 30.73 | 30.53 | 25.94 |
| GA$_3$ 100 ppm + Mancozeb 0.4 %                     | 47.10           | 47.60           | 47.60 | 48.00 | 22.24 | 30.03 | 25.65 | 21.41 |
| GA$_3$ 100 ppm + Carbendazim 0.4 % + Mancozeb 0.4 % | 53.87           | 50.57           | 50.42 | 51.70 | 28.24 | 37.48 | 36.23 | 30.28 |
| C.D. at 5%                                          | NS              | 9.11            | 7.74  | 7.16  | NS    | NS    | 7.86  | 7.00  |

C.D.: Critical Difference at 5%
Table 2 Effect of GA₃, carbendazim and mancozeb on water uptake, flower diameter and vase life during postharvest studies in gladiolus

| Treatments                              | Volume of water absorbed by spike | Diameter of 1ˢᵗ, 3ʳᵈ and 5ᵗʰ florets | Vase life of spike (days) |
|-----------------------------------------|----------------------------------|---------------------------------------|--------------------------|
|                                         | Volume of water uptake by spike at 3 days in vase (ml) | Volume of water uptake by spike at 6 days in vase (ml) | Volume of water uptake by spike at 9 days in vase (ml) | Diameter of 1ˢᵗ floret in vase (cm) | Diameter of 3ʳᵈ floret in vase (cm) | Diameter of 5ᵗʰ floret in vase (cm) |
| Control                                 | 19.33                            | 21.58                                 | 28.33                    | 8.98                      | 8.45                        | 7.81                          | 11.75                      |
| GA₃ 50 ppm                              | 20.00                            | 27.50                                 | 31.00                    | 9.10                      | 8.85                        | 7.35                          | 13.50                      |
| GA₃ 100 ppm                             | 16.33                            | 22.50                                 | 26.50                    | 8.85                      | 8.75                        | 8.32                          | 12.00                      |
| Carbendazim 0.4 %                       | 17.11                            | 25.44                                 | 28.88                    | 9.36                      | 8.47                        | 7.57                          | 13.88                      |
| Mancozeb 0.4 %                          | 14.66                            | 19.00                                 | 20.66                    | 8.86                      | 8.10                        | 8.10                          | 11.33                      |
| Carbendazim 0.4 % + Mancozeb 0.4 %      | 20.66                            | 27.33                                 | 30.00                    | 9.31                      | 8.91                        | 8.42                          | 14.33                      |
| GA₃ 50 ppm + Mancozeb 0.4 %             | 13.00                            | 21.00                                 | 29.00                    | 10.35                     | 9.35                        | 0.00                          | 13.00                      |
| GA₃ 50 ppm + Carbendazim 0.4 % + Mancozeb 0.4 % | 16.50                        | 22.50                                 | 28.50                    | 9.37                      | 9.47                        | 8.30                          | 12.50                      |
| GA₃ 100 ppm + Carbendazim 0.4 %         | 25.75                            | 26.75                                 | 37.25                    | 8.55                      | 8.43                        | 7.98                          | 12.25                      |
| GA₃ 100 ppm + Mancozeb 0.4 %           | 20.00                            | 26.00                                 | 30.00                    | 9.75                      | 9.45                        | 8.45                          | 11.00                      |
| GA₃ 100 ppm + Carbendazim 0.4 % + Mancozeb 0.4 % | 26.00                        | 31.00                                 | 33.00                    | 9.20                      | 9.28                        | 8.37                          | 12.75                      |
| C.D. at 5%                              | 6.03                             | NS                                    | 7.57                     | 0.88                      | 0.68                        | 0.45                          | 1.81                       |
Pre-soaking of cut corms in GA₃ 100 ppm + mancozeb 0.4 % (8.45 cm) resulted maximum diameter of 5th floret in vase solution which found statistically at par with carbendazim 0.4 % + mancozeb 0.4 % (8.42 cm), GA₃ 100 ppm + carbendazim 0.4 % + mancozeb 0.4 % (8.37 cm), GA₃ 100 ppm (8.32 cm), and GA₃ 50 ppm + carbendazim 0.4 % + mancozeb 0.4 % (8.30 cm), mancozeb 0.4 % (8.10 cm) and found significant to other treatments. While minimum diameter of 3rd and 5th florets in vase solution was resulted with treatments mancozeb 0.4 % (8.10 cm) and GA₃ 50 ppm + mancozeb 0.4 % (0.00 cm), respectively. Gibberellins are suggested to be involved in starch hydrolysis into glucose and fructose which helps in opening of flowers (Emongor, 2004). However, it is more promising when used at lower concentration. In gladiolus floral opening is more complex mechanism involving various genes (Kumar et al., 2008). The floral opening involves the GA₃ dependant pathway (Cong et al., 2013). The lower concentration used in pre-soaking of cut corms might help in slow opening of florets with enlarged flower size in present study. This could be the reason that low GA₃ concentration might help in increasing the levels of reducing sugar in stems and flower heads of cut spikes increased the osmotic potential and turgidity of flower heads and hence facilitates the expansion of flowers (Emongor, 2004 and Saeed et al., 2014). Use of fungicides might help in maintaining the disease free growth of spikes as well as flowers. An extending vase life was came to notice when various concentrations of GA₃, carbendazim and mancozeb treatments Regarding vase life study, a significant effect was noticed with gladiolus spikes raised in pre-soaking of various concentrations of GA₃, carbendazim 0.4 % and mancozeb 0.4 % treatments. In present study, application of carbendazim 0.4 % + mancozeb 0.4 % (14.33 days) was found more effective to prolong the vase life of gladiolus spikes which found statistically at par with carbendazim 0.4 % (13.88 days) followed by GA₃ 50 ppm (13.50 days), GA₃ 50 ppm + mancozeb 0.4 % (13.00 days) and GA₃ 100 ppm + carbendazim 0.4 % + mancozeb 0.4 % (12.75 days) while minimum with GA₃ 100 ppm + mancozeb 0.4 % (11.00 days) in vase solution. Here, observations revealed an antagonistic effect of gibberellic acid to abscisic acid that helps in retarding the ABA activity. Also GA₃ at lower concentration delays the flower opening in vase which would be beneficial for the display cut flowers longevity (Anjum et al., 2001). It retained the CAT activity higher which might be as a result of stress tolerance response of gibberellic acid in plants. This CAT (catalase) activity might help in enhancing the vase life of gladiolus by scavenging ROS (Reactive oxygen species) (Ezhilmathi et al., 2007 and Saeed et al., 2014). In accordance to GA₃ treatment, use of carbendazim and mancozeb might help in avoiding disease infestation of cut spikes in vase solution that also helps in prolonging vase life of gladiolus spikes.

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