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Studies on the effect of different pulsing solutions on physical parameters of gerbera cv. Break Dance (*Gerbera jamesonii* L.)

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Abstract
This present investigation was conducted at the Department of Floriculture and Landscape Architecture, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.), India, during the 2022-2023 and 2023-2024 growing years. The experiment had a completely randomized block design with eight treatments, a control, and three replications (FCRD). The pulsing solution used in the experiment with three level of biocides viz., Nano silver 8 ppm (C_1), $AgNO_3$ 20 ppm (C_2) and 8-HQC @ 200ppm (C_3), three level of sucrose viz., 10% (S_1), 15% (S_2) and 20% (S_3), two level of pulsing duration 10 hrs (D_1) and 16 hrs (D_2) with a control (water). The results reveled that the minimum scape bending, maximum vase life and days to deterioration was observed in 8-HQC 200 ppm with 20% sucrose and 16 hours duration.

Keywords: Scape bending, deterioration, pulsing duration, sucrose, biocides

Introduction

Gerbera (*Gerbera jamesonii* L.), a tender, stemless, perennial flowering plants is valued for its brilliant-colored flower. It is a diploid species with the somatic chromosome number 2n=50. It is a valuable flower cultivated worldwide as a cut flower. Gerbera are also commonly known as "Transvaal Daisy", "Barberton Daisy" or "African Daisy". It is considered to have originated in South Africa, more particularly Natal, Transvaal province. Gerbera belongs to the family Asteraceae (Compositae), the largest family of flowering plants due to its tremendous variability in respect of flower color, shape and size. The name "Gerbera" has been given in honour of "Traugott Gerber" a German naturalist of 18th century. The flowers are daisy like 7-10 cm across, but in certain hybrids there may be as large as 15cm across. The flower may be single or double and are available in various self-colored cultivars as well as bicolor. The color may be white, cream, lemon, yellow, brick red, orange, pink, salmon, scarlet, maroon as well as many other shades. The flowers are borne in the long slender stalk. The foliage is arranged in the form of a rosette at the base (Danaee *et al*., 2011) [2].

Vase solution and pulsing treatments consisting of various chemicals with sugar source are known to improve post-harvest life in various flowers (Singh *et al*. 2008) [4]. Gerbera has short vase life and is sensitive to microbial contamination at the stem end and in the preservative solution. Microbial contamination causes stem end blockage, imbalance between water uptake and water loss and finally wilting and shortening vase life. Water balance is one of the main factors which determine quality and longevity of cut flowers. Reduced water uptake caused by xylem blockage and enhanced transpiration are the major reason for wilting. The quality and longevity of cut flowers are highly dependent on the pre-harvest and postharvest factors, including stresses such as increased respiration, decreased water uptake and fresh weight, changes in hydraulic conductivity and water content. Gerbera is known for its long lasting quality, which are commonly noticed, result in the reduction of vase life. Pulsing is a short-term pre-shipment treatment with high concentrations of sucrose and various chemicals, the effect of which should last though out the shelf life of cut flowers even when they are held under water, so a study was carried out by pulsing the gerbera flowers with sucrose and various concentrations of Nano silver, AgNO3 and 8-HQC to enhance its post-harvest life.

Hence, to preserve the best quality of its flowers after harvest and to make them resistant to fluctuations in environmental conditions, it is important to give special treatments to cut flowers after harvest to improve their post-harvest quality and vase life. Use of floral preservatives in the form of pulsing and holding solutions has been known for many years in lengthening the vase life of cut flowers. Flower preservatives which form a mixture of sugar, germicides, growth regulators etc. are mainly recommended. Pulsing of flowers before storage helps to improve post storage life of the flowers (Arora and Singh, 2002). Pulsing treatments, which involve short-term exposure to high concentrations of sucrose and chemicals such as nano silver, silver nitrate ($AgNO_3$), and 8-hydroxyquinoline citrate (8-HQC), have shown promise in extending the vase life of gerbera flowers.

Materials and Methods

The present investigation was carried out in the Laboratory of Department of Floriculture and Landscape Architecture Coa, IGKV, Raipur (C.G.) during the year 2022-23 & 2023-24. The experiment was laid out in completely randomized design in factorial arrangement with single control with three levels of biocides *viz.*, Nano silver 8 ppm (C_1), $AgNO_3$ 20 ppm (C_2) and 8-HQC 200 ppm (C_3), three level of sucrose *viz.*, 10% (S_1), 15% (S_2) and 20% (S_3), two level of pulsing duration 10 hrs (D_1) and 16 hrs (D_2) with a control (water). Freshly harvested gerbera flower were placed in glass bottles filled with required pulsing solution as per treatment combinations. Observations *viz.*, Scape bending, vase life (days) and days to deterioration were recorded in three replication in each treatment.

Results and Discussion

A perusal of data in Table 1.0 and 1.1 revealed that the effect of biocides (C), sucrose (S) and pulsing duration (D) on scape bending, longest vase life (days) and days to deterioration were found significant in two consecutive years *i.e.* years 2022-23 and 2023-24.

Effect of biocides

The scape bending, longest vase life and days to deterioration significantly with different preservatives concentration during pooled data of two years, 2022-23 to 2023-24 of experimentation. Among the different biocides 8-HQC @ 200 ppm recorded significantly minimum scape bending (18.95° & 40.83° during 3^{rd} & 6^{th} days) respectively, which was noted *at par* with biocides C_2 at 3^{rd} days, maximum vase life of gerbera flowers (9.31) days and days to deterioration (7.28).

Effect of sucrose

Among the treatments, the minimum scape bending (17.71° & 39.95° during 3^{rd} & 6^{th} day), maximum vase life (10.08) and days to deterioration (7.53) was recorded with 20% sucrose (S_3) pooled mean analysis respectively, showing its superior role in maintaining stem firmness and structural integrity. Which indicated that higher sucrose concentration was more effective in reducing scape curvature.

Effect of pulsing duration

Pulsing duration also showed a significant effect on scape bending, vase life and days to deterioration. The minimum scape bending was observed in flowers pulsed for 16 hours (D_2) *i.e.*, (17.69° on the 3rd day; and 40.63° on the 6^{th} day), vase life (10.07) and day to deterioration (7.56). The treatment indicated that extended exposure to pulsing solution enhances stem rigidity and reduces bending. This suggested that increasing the duration of pulsing significantly improves the mechanical strength of scapes, helping maintain flower posture.

Control vs treatments

The untreated control exhibited the highest degree of scape bending on both the (23.90°) 3rd and 6th day (45.97°) across both years and pooled mean data. In contrast, all treatments involving biocides, sucrose concentrations, and pulsing durations significantly reduced the degree of bending compared to the control. All biocides treatments significantly outperformed the control, which consistently recorded the lowest vase life in comparison with control (6.33 days) in both years and in the pooled data. The untreated control flowers deteriorated much earlier, averaging only (5.00) days in respective treatments both the years and pooled mean they are clearly showed different between control versus treatments.

Interaction

Interaction effect of CXS (biocides and sucrose)

In the interaction between biocides and sucrose concentrations (C × S), the minimum scape bending was recorded in the treatment C_3S_3 (8-HQC @ 200 ppm + 20% sucrose), with values of 17.55° on the 3rd day and 39.39° 6^{th} day in the pooled mean. This treatment was statistically *at par* with C_2S_3 in all observations during the pooled mean at the 3rd day. The combinations C_3S_3 (8-HQC @ 200 ppm + 20% sucrose) recorded the significantly highest vase life (10.17 days) and maximum days to deterioration (8.25 days), respectively, during the pooled mean.

Interaction effect of CXD (biocides and pulsing duration)

In interaction between biocides and pulsing durations (CXD), the lowest scape bending was observed with treatment C_3D_2 (8-HQC @ 200 ppm + 16 hours pulsing), which recorded values of 16.95° at 3^{rd} day and 39.23°at 6^{th} day during pooled mean, respectively. Treatment showed maximum vase life (10.78 days) and was significantly superior over all other combinations, highlighting the benefit of longer pulsing duration with effective biocidal agent. And the maximum days to deterioration (8.11 days) was recorded in C_3D_2 (8-HQC @ 200 ppm + 16 hrs).

Interaction effect of SXD (Sucrose and pulsing duration)

Significant interaction effects were also observed between sucrose concentration and pulsing duration (S × D) on scape bending during both experimental years and the pooled mean. The minimum scape bending was recorded in treatment S_3D_2 (20% sucrose + 16 hours pulsing), with values of 16.58° on the 3^{rd} day and 39.17° on the 6^{th} day in the pooled mean. This treatment was statistically at par with S_2D_2 on the 6^{th} day. S_3D_2 also exhibited the maximum vase life (10.78 days), which was statistically *at par* with S_2D_2, indicating that lower sucrose concentration and shorter pulsing duration negatively affected longevity. Furthermore, the S × D interaction showed a notable influence on days to deterioration, with the highest value (8.22 days) recorded in S_3D_2. These findings suggest that the combination of higher sucrose concentration with longer pulsing duration is more effective in maintaining structural quality and extending the postharvest life of gerbera flowers compared to treatments with reduced sucrose levels and shorter pulsing times.

Interaction effect of CXSXD (biocides, sucrose and pulsing duration)

In the interaction between biocides, sucrose concentrations, and pulsing durations (C × S × D), the least scape bending was observed in treatment $C_3S_3D_2$ (8-HQC @ 200 ppm + 20% sucrose + 16 hours pulsing), which recorded values of 15.26° on the 3rd day and 37.94° on the 6th day during the pooled mean. This treatment was statistically *at par* with C_3S_2D2 in the pooled mean on the 3rd day, indicating that these combinations consistently maintained structural quality across both seasons. Conversely, combinations with lower sucrose content and insufficient pulsing duration possibly limited solute uptake and failed to maintain xylem conductivity and scape strength, resulting in greater bending.

Among the various combinations, $C_3S_3D_2$ also recorded the maximum vase life (11.67 days), which was significantly superior but statistically *at par* with C_3S_2D2 (11.33 days) and $C_2S_3D_2$ (11.00 days) in the pooled analysis. A similar positive effect of 8-HQC in combination with higher sucrose concentration and extended pulsing duration was reported by Shrivastava *et al.* (2023) in *Polianthes tuberosa* L., demonstrating its efficacy in improving postharvest longevity. The maximum days to deterioration (9.50 days) in the pooled mean were also obtained from $C_3S_3D_2$, which was superior to all other interactions. Treatments with shorter pulsing durations, lower sucrose concentrations, and sub-optimal biocide levels were less effective in delaying flower deterioration.

Table 1: Effect of biocides, sucrose and pulsing duration on physical parameters (Pooled data of two years)

	Scape bending (degree)		Vase life (days)	Days to deterioration
	3rd day	6th day		
Biocides (C)				
C_1 (Nano Silver 8 ppm)	19.47	42.41	8.69	6.50
C_2 ($AgNO_3$ 20 ppm)	19.04	41.91	9.11	7.17
C_3 (8-HQC 200 ppm)	18.95	40.83	9.31	7.28
S.Em±	0.12	0.10	0.13	0.11
CD 0.05 %	0.30	0.23	0.30	0.26
Sucrose (S)				
S_1 (10 %)	20.57	43.41	8.19	6.19
S_2 (15 %)	19.19	41.79	8.83	7.22
S_3 (20 %)	17.71	39.95	10.08	7.53
S.Em±	0.12	0.10	0.13	0.11
CD 0.05 %	0.30	0.23	0.30	0.26
Pulsing Duration (D)				
D_1 (10 hrs)	20.62	42.81	8.00	6.41
D_2 (16 hrs)	17.69	40.63	10.07	7.56
S.Em±	0.10	0.08	0.10	0.09
CD 0.05 %	0.24	0.19	0.24	0.21
Control	23.90	45.97	6.33	5.00
S.Em±	0.07	0.06	0.07	0.06
CD 0.05 % (Control VS Treats)	0.17	0.13	0.17	0.15

Table 2: Interaction effect of biocides, sucrose and pulsing duration on physical parameters (Pooled data of two years)

Treatments	Scape bending		Vase life (days)	Days to deterioration
	3rd day	6th day		
CXS (Biocides and sucrose)				
C_1S_1 (Nano silver @ 8ppm + Sucrose 10%)	20.92	43.77	7.66	5.92
C_2S_1 ($AgNO_3$ @ 20 ppm + Sucrose 10%)	20.65	43.52	8.17	6.16
C_3S_1 (8-HQC @ 200 ppm + Sucrose 10%)	19.81	43.12	8.33	6.75
C_1S_2 (Nano silver @ 8ppm + Sucrose 15%)	19.30	42.71	9.00	6.42
C_2S_2 ($AgNO_3$ @ 20 ppm + Sucrose 15%)	18.88	41.81	9.08	7.58
C_3S_2 (8-HQC @ 200 ppm + Sucrose 15%)	19.01	41.35	9.50	7.67
C_1S_3 (Nano silver @ 8ppm + Sucrose 20%)	18.49	40.42	9.11	6.83
C_2S_3 ($AgNO_3$ @ 20 ppm + Sucrose 20%)	18.02	39.97	10.08	6.83
C_3S_3 (8-HQC @ 200 ppm + Sucrose 20%)	17.55	39.39	10.17	8.25
S.Em±	0.22	0.17	0.22	0.19
CD 0.05 %	0.51	0.40	0.52	0.45
CXD (Biocides and pulsing duration)				
C_1D_1 (Nano silver @ 8ppm + 10 hrs)	21.14	43.60	7.78	5.89
C_2D_1 ($AgNO_3$ @ 20 ppm + 10 hrs)	20.44	42.44	7.84	6.50
C_3D_1 (8-HQC @ 200 ppm + 10 hrs)	20.29	42.40	8.39	6.83
C_1D_2 (Nano silver @ 8ppm + 16 hrs)	18.51	41.42	9.39	6.72
C_2D_2 ($AgNO_3$ @ 20 ppm + 16 hrs)	17.61	41.23	10.06	8.00
C_3D_2 (8-HQC @ 200 ppm + 16 hrs)	16.95	39.23	10.78	8.11
S.Em±	0.18	0.14	0.18	0.15
CD 0.05 %	0.42	0.32	0.42	0.37

SXD (Sucrose and pulsing duration)				
S_1 D_1 (Sucrose 10% + 10 hrs)	22.07	44.95	7.00	5.95
S_2 D_1 (Sucrose 15% + 10 hrs)	20.98	42.74	7.61	6.50
S_3 D_1 (Sucrose 20% + 10 hrs)	19.08	41.87	9.39	6.73
S_1 D_2 (Sucrose 10% + 16 hrs)	18.82	40.75	9.39	6.84
S_2 D_2 (Sucrose 15% + 16 hrs)	17.43	39.73	10.56	7.84
S_3 D_2 (Sucrose 20% + 16 hrs)	16.58	39.17	10.78	8.22
S.Em±	0.18	0.14	0.18	0.15
CD $_{0.05\ \%}$	0.42	0.32	0.42	0.37
CXSXD				
$C_1S_1D_1$ (Nano silver @ 8ppm + Sucrose 10 % +10hrs)	22.45	45.86	6.67	5.33
$C_1S_2D_1$ (Nano silver @ 8ppm + Sucrose 15 % +10hrs)	21.55	42.10	7.83	6.00
$C_1S_3D_1$ (Nano silver @ 8ppm + Sucrose 20 % +10hrs)	16.88	39.23	10.67	8.00
$C_1S_1D_2$ (Nano silver @ 8ppm + Sucrose 10 % +16hrs)	17.85	42.96	9.50	7.17
$C_1S_2D_2$ (Nano silver @ 8ppm + Sucrose 15 % +16hrs)	17.05	40.60	10.17	6.84
$C_1S_3D_2$ (Nano silver @ 8ppm + Sucrose 20 % +16hrs)	17.92	40.71	9.67	5.67
$C_2S_1D_1$ (AgNO3 @ 20ppm + Sucrose 10% + 10 hrs)	22.08	44.60	7.00	5.50
$C_2S_2D_1$ ($AgNO_3$ @ 20ppm + Sucrose 15% + 10 hrs)	20.40	44.01	7.33	7.17
$C_2S_3D_1$ ($AgNO_3$ @ 20ppm + Sucrose 20% + 10 hrs)	18.83	42.18	9.00	6.50
$C_2S_1D_2$ ($AgNO_3$ @ 20ppm + Sucrose 10% + 16 hrs)	19.77	41.62	9.33	7.34
$C_2S_2D_2$ ($AgNO_3$ @ 20ppm + Sucrose 15% + 16 hrs)	19.21	43.22	8.67	8.00
$C_2S_3D_2$ ($AgNO_3$ @ 20ppm + Sucrose 20% + 16 hrs)	16.54	38.86	11.00	8.50
$C_3S_1D_1$ (8-HQC @ 200 ppm + Sucrose 10% + 10 hrs)	21.66	44.38	7.33	5.50
$C_3S_2D_1$ (8-HQC @ 200 ppm + Sucrose 15% + 10 hrs)	21.00	42.11	7.67	6.67
$C_3S_3D_1$ (8-HQC @ 200 ppm + Sucrose 20% + 10 hrs)	20.77	40.83	8.50	7.00
$C_3S_1D_2$ (8-HQC @ 200 ppm + Sucrose 10% + 16 hrs)	19.62	41.03	9.33	6.33
$C_3S_2D_2$ (8-HQC @ 200 ppm + Sucrose 15% + 16 hrs)	15.97	38.72	11.33	8.67
$C_3S_3D_2$ (8-HQC @ 200 ppm + Sucrose 20% + 16 hrs)	15.26	37.94	11.67	9.50
S.Em±	0.31	0.24	0.31	0.27
CD $_{0.05\ \%}$	0.73	0.56	0.73	0.63

Conclusion

The treatment $C_3S_3D_2$ (8-HQC @ 200 ppm + 20% sucrose for 16 hours) consistently outperformed all other combinations, recording the lowest scape bending, longest vase life, and maximum days to deterioration. Its effectiveness can be attributed to the combined benefits of 8-HQC in suppressing microbial growth, high sucrose concentration in sustaining respiratory metabolism, and extended pulsing duration in facilitating adequate solute uptake. This synergistic effect helped maintain xylem vessel conductivity, enhance metabolic activity, and strengthen antioxidative defense, thereby delaying senescence. The results clearly establish $C_3S_3D_2$ as the most efficient postharvest treatment for prolonging the decorative value and marketability of gerbera under protected cultivation.

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