

Effect of silver nitrate and sucrose on the vase life of *Gerbera* (*Gerbera jamesonii* H. Bolus) cut flowers

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ABSTRACT

Gerberas (*Gerbera jamesonii* H. Bolus) quite familiar in 'Transvaal daisy' name, a renowned cut flower since it has secured 5th position out of top ten commercially viable cut flowers of the world. Protracted durability for interior and vase decoration become mandatory, that's why we had endeavored to find out the impact of silver nitrate ($AgNO_3$) at divergent concentrations of 1000, 500, 100 and 50ppm along with sucrose 4% and deionized water (DW) both as pulsing and holding solution treatments on 3 gerbera cultivars namely 'Rosalin' (pink), 'Dana Ellen' (yellow) and 'Sun Way' (orange) gathered from a flower entrepreneur of Baruipur, South-24-Paraganas as it has moderate longevity. Out of 10 treatments, pulsing treatments consisted of $AgNO_3$ @1000 and 500ppm duo with sucrose 4% had markedly extended the longevity of employed cut gerberas as compared to the untreated flowers. Besides, $AgNO_3$ @25ppm+ sucrose 4% as holding solution also appreciably enhanced their vase-life. Among 3 cultivars 'Dana Ellen' registered utmost vase-life of 22.3 days followed by 'Rosalin' (21.5 days) and 'Sun Way' (19.9 days). Other vase-life characteristics manifested variable responses towards the treatments composed of preservative chemicals. Here, the yielded data of rest of seven treatment combinations exhibited their moderate efficacy in extending the vase-life while in some cases they adversely affected their longevity also. A strong correlation between the longevity of cut flowers and the amount of solution uptake was also established here.

Keywords: Gerbera, silver nitrate, sucrose and vase-life

Gerberas (*Gerbera jamesonii* H. Bolus) popularly known as 'Transvaal daisy', are grown all over the world for garden decoration and also as cut flowers for interior decorations. The flowers are very attractive in appearance with moderate longevity, suitable for flower arrangements and are available in different sizes, color and their shades. It is one of the top ten commercially important cut flowers of the world secured 4th position out of top ten commercially viable cut flowers of the world as on 2014 at the Dutch auctions (Source-Flora Holland; Retrieved from: <https://www.cbi.eu>). Presently they are available in various sizes with a diameter ranging from 5 to 15 cm (approx.) in the market to meet the varied requirements of the flower users. However, approximately 70per cent of the gerberas in the international flower markets are mini gerberas (Davarynejad *et al.*, 2008). To investigate the right stage for harvesting of gerbera flowers, Dagwar *et al.* (2004) conducted an experiment on the vase life of cut gerbera flowers cultivars 'Rodis', 'Ruby Red' and 'Rosalin'. They opined that florets harvested during the 3/4th opened stage revealed the maximum vase life of 11.3, 10.7 and 12.0 days for 'Rodis', 'Ruby Red' and 'Rosalin', respectively. The accumulation of bacteria and fungi in vase water and subsequent xylem clogging by bacteria and different fungal pathogens are often associated with premature senescence in many species of cut flowers including gerbera (Abdel-Kader and Rogers, 1986). Wilting of florets appears to be due to rapid decline in water uptake as compared to water loss resulting to

desiccation of flowers (Amiri *et al.*, 2009). Chakroborty (2011) reported that pulsing treatment of $AgNO_3$ @ 1000 ppm + Sucrose@4% manifested beneficial effect in extending their longevity.

As this prepossessing flower is quite costly, customers expect its freshness for a week or so, so that they can relish its beauty for some time. As a consequence, research on the extension of longevity or keeping quality, a vital parameter of it should be emphasized. Hence, considering the commercial importance of gerbera as a cut flower and the efficacy of silver nitrate to prolong the vase life of cut flowers, an investigation was initiated with various concentrations of silver nitrate both as pulsing and holding solution treatments along with sucrose on 3 cultivars of gerbera cut flower with the objectives of evaluating their vase-life.

MATERIALS AND METHODS

The experiment was carried out with three cultivars of gerbera namely 'Rosalin', 'Dana Ellen' and 'Sun Way' popular as cut flower to enhance the vase life through the use of floral preservatives. Materials were summoned from a commercial flower grower of Baruipur, South-24-Paraganas during early morning at a stage when the ray florets were 3/4th opened and were perpendicular to the flower stalk or scape. Immediately after being brought from field they were placed in a bucket of fresh and clean water. The stalks of the employed cultivars were maintained to a length of 35cm. Individual flowers

were sleeved using polythene packets and assembled in bunches of ten, being tied with rubber bands. They were grouped into 10 sets having three flowers in each set thus comprising thirty flowers per cultivar. For ten divergent treatment combinations Silver nitrate (AgNO_3) @1000, 500, 100 and 25ppm, sucrose @4% and distilled water were utilized. Prior of placing the flowers in the holding solutions initial basal diameter (0.84 cm diameter) of the individual flower scapes and diameter of the individual flowers (1.67 cm diameter) were measured too. Total 30 conical flasks (250ml. capacity) were wrapped with black carbon paper. A uniform volume of 200ml. of freshly made solutions was kept in each flask. The observation on the final length and basal diameter of their stalk, longevity of blooms, quantity of water uptake and diameter of flowers at the end of vase life of each flower were documented.

The experiment was conducted in laboratory under ambient condition at the Dept. of Horticulture, Institute of Agricultural Science, University of Calcutta during 2014-2015. To minimize the error variance, the same experiment was repeated twice after as Experiment-1 and 2. The 1st set of experiment was initiated on 20.12.14 and continued for 24 days upto 12.1.15 while 2nd set of experiment was set up on 12.1.15 and also continued for 24 days upto 4.2.15. The experimental observations and conclusions were drawn on the basis of the mean results of aforesaid 2 set of experiment. During the period of experiment, temperature of laboratory was varied between 18-29.7 p C and RH was within the range of 40-83%.

Assigning variety and treatment as treatment factors, analysis of variance (ANOVA) was carried out by Completely Randomized Block Design (CRD) using SPSS 10.0 statistical package. The least significant

difference (LSD) test was applied to evaluate the significance of difference between individual treatment factors. The treatment means were compared by Duncan's Multiple Range Test at 0.05.

RESULTS AND DISCUSSION

After the completion of experiments, slight increase (1.17-5.62cm.) in the length of cut flower stalks from its initial length of 35cm were recorded in all 3 cultivars owing to the action of diverse concentrations of chemicals (Table 2-4). Utmost enhance of 5.62cm of flower stalk length was noted in cv. 'Sun Way' as an action of AgNO_3 @1000ppm (pulsing) + sucrose@4% as holding solution) followed by 5.45cm in cv. 'Rosalin' and 4.27 cm in Dana Ellen by AgNO_3 @ 25 ppm + sucrose@4% as holding solution. Those are in full accordance with the findings of Wang *et al.* (2001); Kim *et al.* (2004); Cinotti *et al.* (2005), Sen (2010) and Chakroborty (2011). It is evidenced from table 1-3 that the basal diameter of cut flowers were reduced irrespective of materials used due to the impact of various treatment combinations of this investigation. Our findings are correspondence with the outcome of Kirad *et al.* (2008); Wankhede and Gajbhiye (2012). However, the reduction was negligible in all 3 cultivars and all the treatments were at par with each other. The influence of stem diameter and weight had been investigated and none had been found to be critical in extending the vase life of gerbera flowers (Garibaldi and Jona, 1988).

The investigation was conducted to ascertain the impact of divergent treatments of AgNO_3 and sucrose used in order to protract the vase life of gerbera cut flowers and also to select the unsurpassed treatment/s among the 10 combinations. It has been observed that in all three cultivars divergent treatments showcased

Table 1: Details of treatment combinations used in this study.

Sl. No.	Treatments	Details of treatments
A) Pulsing treatments		
1.	T ₁	Silver nitrate (AgNO_3) @1000ppm for 10mins pulsing treatment. Sucrose 4% in Distilled Water (DW) used as holding solution
2.	T ₂	AgNO_3 @1000ppm for pulsing treatment (10mins) + DW as holding solution
3.	T ₃	AgNO_3 @500ppm for pulsing treatment (10mins). Sucrose 4% in DW used as holding solution
4.	T ₄	AgNO_3 @500ppm for pulsing treatment (10mins) + DW as holding solution
B) Holding Solution		
5.	T ₅	AgNO_3 @100ppm+4% sucrose in DW
6.	T ₆	AgNO_3 @100ppm + DW
7.	T ₇	AgNO_3 @25ppm + sucrose 4% in DW
8.	T ₈	AgNO_3 @25ppm + DW
9.	T ₉	Sucrose 4% in DW
10.	T ₁₀	Distilled Water (control)

Table 2 : Mean vase life characteristics of cut gerbera cultivar ‘Rosalin’ (designated as V₁)

Treatment	Length of flower stalk (cm)	Decrease in basal diameter of flower stalk (cm)	Longevity of flowers (days)	Increase/decrease in longevity of flowers (%)	Drooping of flower heads (%)	Water Uptake (ml)	Increase/decrease in water uptake (%)	Decrease in flower diameter (cm)
T ₁	39.33 ^{ab}	0.067 ^a	21.33 ^a	29.34	-	124.00 ^c	31.17	1.483 ^a
T ₂	37.43 ^{cd}	0.067 ^a	15.67 ^c	(-) 5.07	83.50	81.50 ^b	(-) 14.15	1.183 ^{abc}
T ₃	40.08 ^a	0.050 ^a	21.50 ^a	30.30	-	150.00 ^a	58.31	1.417 ^{abc}
T ₄	37.40 ^{cd}	0.033 ^a	15.50 ^c	(-) 6.06	83.50	88.00 ^g	(-) 7.55	0.800 ^{bc}
T ₅	39.70 ^{ab}	0.050 ^a	19.00 ^b	15.21	6.66	128.50 ^b	35.08	1.267 ^{abc}
T ₆	37.03 ^{cd}	0.050 ^a	16.00 ^c	(-) 3.04	100.00	86.00 ^g	(-) 9.31	1.467 ^{ab}
T ₇	40.45 ^a	0.050 ^a	19.67 ^a	19.30	-	127.00 ^{bc}	33.43	1.383 ^{abc}
T ₈	37.03 ^{cd}	0.067 ^a	16.17 ^c	(-) 1.96	100.00	107.50 ^e	11.96	1.633 ^a
T ₉	38.03 ^{bc}	0.100 ^a	15.00 ^c	(-) 9.11	33.33	114.00 ^d	19.29	1.150 ^{abc}
T ₁₀	36.17 ^d	0.067 ^a	16.50 ^c	-	100.00	95.50 ^f	-	1.550 ^a

N.B: Similar alphabets containing data are statistically at par.
Data containing different alphabets are statistically different at 0.05p

Table 3 : Mean vase life characteristics of cut gerbera cultivar ‘Dana Ellen’ (designated as V₂)

Treatment	Length of flower stalk (cm)	Decrease in basal diameter of flower stalk (cm)	Longevity of flowers (days)	Increase/decrease in longevity of flowers (%)	Drooping of flower heads (%)	Water Uptake (ml)	Increase/decrease in water uptake (%)	Decrease in flower diameter (cm)
T ₁	39.05 ^a	0.083 ^a	20.83 ^a	27.49	-	131.00 ^a	22.50	0.967 ^a
T ₂	38.83 ^{ab}	0.050 ^a	14.67 ^c	(-) 10.39	100.00	94.00 ^{de}	(-) 10.79	1.050 ^a
T ₃	38.88 ^{ab}	0.083 ^a	22.33 ^a	36.75	-	122.50 ^b	15.41	0.717 ^a
T ₄	38.42 ^{ab}	0.067 ^a	15.50 ^{bc}	(-) 4.97	100.00	105.50 ^c	(-) 3.00	0.767 ^a
T ₅	39.08 ^a	0.083 ^a	17.33 ^b	5.75	16.66	120.00 ^b	12.77	0.767 ^a
T ₆	38.32 ^{ab}	0.050 ^a	15.17 ^{bc}	(-) 7.03	100.00	88.50 ^e	(-) 17.30	0.783 ^a
T ₇	39.27 ^a	0.067 ^a	20.17 ^a	23.35	-	123.50 ^b	17.69	0.917 ^a
T ₈	39.22 ^a	0.050 ^a	14.00 ^c	(-) 14.39	83.33	76.00 ^f	(-) 28.51	0.667 ^a
T ₉	38.32 ^{ab}	0.067 ^a	14.33 ^c	(-) 12.29	-	100.50 ^{cd}	(-) 0.36	0.667 ^a
T ₁₀	38.27 ^{ab}	0.083 ^a	16.33 ^{bc}	-	83.50	106.50 ^c	-	0.850 ^a

N.B: Similar alphabets containing data are statistically at par.
Data containing different alphabets are statistically different at 0.05p

Table 4 : Mean vase life characteristics of cut gerbera cultivar 'Sun Way' (designated as V₂)

Treatment	Length of flower stalk (cm)	Decrease in basal diameter of flower stalk (cm)	Longevity of flowers (days)	Increase/decrease in longevity of flowers (%)	Drooping of flower heads (%)	Water Uptake (ml)	Increase/decrease in water uptake (%)	Decrease in flower diameter (cm)
T ₁	40.62 ^a	0.067 ^a	18.33 ^{bc}	8.94	-	154.50 ^a	58.44	1.550 ^{ab}
T ₂	39.35 ^b	0.067 ^a	17.33 ^{cd}	3.00	50.00	115.50 ^c	17.55	1.233 ^{abc}
T ₃	40.22 ^a	0.050 ^a	19.50 ^{ab}	15.91	33.33	129.50 ^b	30.40	1.550 ^{ab}
T ₄	39.08 ^b	0.050 ^a	17.00 ^{cd}	1.01	49.99	128.50 ^b	29.88	0.883 ^{bc}
T ₅	39.23 ^b	0.083 ^a	15.50 ^d	(-) 7.99	50.0	100.00 ^d	1.39	1.650 ^a
T ₆	39.25 ^b	0.067 ^a	17.17 ^{cd}	1.98	66.66	116.50 ^c	18.14	1.167 ^{abc}
T ₇	39.17 ^b	0.067 ^a	20.17 ^a	19.97	50.00	157.50 ^a	61.55	0.983 ^{abc}
T ₈	39.23 ^b	0.050 ^a	16.83 ^{cd}	-	66.66	115.00 ^c	16.28	0.833 ^c
T ₉	39.25 ^b	0.050 ^a	10.17 ^e	(-) 39.71	-	77.50 ^e	(-) 22.81	1.050 ^{abc}
T ₁₀	38.50 ^b	0.050 ^a	16.83 ^{cd}	-	50.00	99.00 ^d	-	1.050 ^{abc}

N.B: Similar alphabets containing data are statistically at par.

Data containing different alphabets are statistically different at 0.05p

variable action on flower longevity. In cv. 'Rosalin' maximum increase in vase life by 30.3per cent was documented due to the action of silver nitrate (AgNO₃)@500ppm pulsing treatment followed by 29.3per cent by silver nitrate (AgNO₃) @1000ppm for 10mins pulsing treatment. Two other treatments *i.e* T₇ and T₅ also protract durability by 19.3 and 15.2per cent respectively. On the contrary, most of the treatments *viz.* T₂ (AgNO₃ @1000ppm for pulsing treatment (10mins) + DW as holding solution), T₄ (AgNO₃@500ppm for pulsing treatment (10mins) + DW as holding solution), T₆ (AgNO₃@100ppm + DW), T₈ (AgNO₃@25ppm + DW) and T₉ (Sucrose 4% in DW) adversely affected cut flowers' durability and abbreviated the vase life to an extent of 1.96-9.1%. AgNO₃ is a very effective biocide which inhibits the microbial growth. It is in conformity with the findings of Kesta *et al.* (1995) who observed that silver nitrate prevented microbial occlusions of xylem vessels in *Dendrobium* orchid cultivar 'Pompadour' resulting enhanced water uptake and increased longevity. Later on Liu *et al.* (2009) reported that both pulse and holding solution treatments with nano-silver (NS) individually and/or in combination augment the flower durability as an antimicrobial material. Collaterally, in cv. 'Dana Ellen' (V₂) T₃ (AgNO₃@500ppm for pulsing treatment (10mins) followed by sucrose 4% in DW used as holding solution), T₁ (AgNO₃@1000ppm for 10mins pulsing treatment. Sucrose 4% in DW used as holding solution) and T₇ (AgNO₃@25ppm + Sucrose 4% in DW) exhibited noteworthy extension of 36.7, 27.5 and 23.3% respectively. Astonishingly, in cv. 'Sun Way' slightly lesser degree in vase life extension was found in both pulsing and holding treatment. The holding treatment T₇ and pulsing treatment T₃ protract no. of days insignificantly (Table 3) while T₉ drastically cut short the vase life by 39.7per cent. The beneficial impact of Ag⁺ ions might inhibit the rise of ethylene precursor and increase longevity whereas sucrose acts as a food source or a substrate for respiration, delay the degradation of proteins and improves the water balance of cut plant parts (Awad *et al.*, 1986; Kofranck and Paul, 1973; Sacalis, 1993 and Agarwal, 2009). Sucrose antagonizes the effect of ABA promotes senescence too (Halevy and Mayak, 1979). Out of three cultivars, 'Dana Ellen' showed highest prolonged vase life up to 22.3 days as against control (16.3 days) followed by cv. 'Rosalin' (21.5 days) and v. 'Sun Way' (20.2 days) indicating the presence of varietal characteristics in response towards divergent floral preservative treatments.

In all the cultivars drooping heads or breakage of stem neck were recorded. But in cv. 'Rosalin' and 'Dana Ellen' treatment combinations T₃ (AgNO₃@500ppm for pulsing treatment (10mins) followed by sucrose 4% in

DW used as holding solution) and T₇ (AgNO₃@25ppm + Sucrose 4% in DW) resulted total control on it. Collaterally, sucrose 4% (T₉) showcased beneficial impacts on cv. 'Dana Ellen' and 'Sun Way' here. Agarwal (2009) reported also that the effective delay of gerbera's drooping flower heads can be accomplished by treatment of 1000ppm AgNO₃ for 10min solely. However, the cv. 'Rosalin' showed the maximum frequency (50.7%) followed by cv. 'Dana Ellen' (48.3%) and 'Sun Way' (41.7%). Wilting of gerbera flowers occurred after the stem plugging by bacteria. Their stems are susceptible to water blocking and may cause flower heads to droop. Bent neck is the result of vascular clogging which results insufficient water uptake may be due to occurrence of microorganisms in vase water. The noxious impact of used water couldn't be corrected if flowers were transferred 24 hours later into fresh water (Sheela *et al.*, 2004).

Treatments of different concentrations appreciably influenced the water uptake. In cv. 'Sun Way', 'Rosalin' and 'Dana Ellen' significant water uptake by 157.50ml (61.5%), 150ml (58.3%) and 131ml (22.5%) were registered owing to the effect of T₇ (AgNO₃@25ppm + Sucrose 4% in DW), T₃ (AgNO₃@500ppm for pulsing treatment (10mins) followed by sucrose 4% in DW used as holding solution) and T₁ (AgNO₃@1000ppm for 10mins pulsing treatment. Sucrose 4% in DW used as holding solution). On the other hand, marked reduction in water uptake also found in cv. 'Sun Way' & 'Dana Ellen' due to the action of sucrose 4% and AgNO₃@25ppm+distilled water only which was in tune with the observations of Van-Doorn and Witte (1994), Ketsa *et al.* (1995). Nair *et al.* (2003); Prashanth and Chandrasekhar (2007); Antes *et al.* (2009); Sen (2010) and Chakroborty (2011). Maintenance of optimum water status was most important factors in cut flower's vase life but the underlying mechanisms leading to disturbed water balance was still unresolved (Mayak *et al.*, 1974).

In all three cultivars, the variations b/w the initial and final measurements of flower diameter due to slight petals withering were found to be insignificant. However, statistically different treatments in cv. 'Rosalin' and 'Sun way' revealed some variation among themselves and in cv. 'Dana Ellen' all the treatments were at par. Findings of Pettersen and Gislerod (2003); Wankhede and Gajbhiye (2012) confirm our observations regarding the existence of varietal differences in gerbera flowers.

In cv. 'Rosalin' and 'Dana Ellen' treatments T₁ (AgNO₃@1000ppm for 10mins pulsing treatment. Sucrose 4% in DW used as holding solution), T₃ (AgNO₃@500ppm for pulsing treatment (10mins) followed by sucrose 4% in DW used as holding solution), T₅ (AgNO₃@100ppm+4% sucrose in DW) and T₇

(AgNO₃@25ppm + Sucrose 4% in DW) magnified the longevity to an extent of 15.2-30.3per cent, in parallel facilitated also the water uptake by 31.2-58.3per cent, establishing a direct correlation b/w vase-life and water uptake since vase-life is dependent on water balance, capacity for water uptake, water transport and transpiration (Mayak *et al.*, 1974; Alexe and Amariutei, 1998). Similar type of correlation was also pointed out in cv. 'Sun Way' where increased longevity (15.9-20%) accelerated the water absorption (30.4-61.5%) whereas T₉ impaired the longevity by 39.7per cent as well as reduced water imbibitions by 22.8per cent.

Here, out of 10 treatments, the pulsing treatment with AgNO₃ @1000ppm+sucrose 4% (T₁) and also AgNO₃ @500ppm+sucrose 4% (T₃) had markedly extended the longevity of employed cut gerberas as compared to the untreated control flowers. Besides, treatment combination of AgNO₃ @25ppm+ sucrose 4% (T₇) as holding solution also appreciably enhanced their vase-life. Except these 3 treatments other 7 treatments were either not so effective in extending the vase-life or in some cases were found to be adversely affecting the vase-life of cut flowers. Among 3 cultivars 'Dana Ellen' registered utmost vase-life of 22.3 days followed by 'Rosalin' (21.5 days) and 'Sun Way' (19.9 days). Other vase-life characteristics manifested variable responses towards the treatments composed of preservative chemicals. A strong correlation between the longevity of cut flowers and the amount of solution uptake was also established here. Thus, conclusively the pulsing treatments were enough competent to magnify the vase-life of these 3 utilized gerbera cultivars than the holding treatments (T₅-T₁₀). Hence, this sort of research work suggests viable means and ways to minimize flowers' loss by employing diverse biocides.

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