Original Research Article

Effect of Polyamines on Post Harvest Physiology and Vase life of Cut Gerbera

ABSTRACT

Thestudy was intended to study the influence of polyamines (spermine, spermidine and putrescine) on postharvest physiology of gerbera with the basic objective to extend its vase lifeat College of Horticulture, SKLTSHU, Rajendranagar, Hyderabad, India. Significantly highest relative water content (74.22%) and carotenoid content (5.58 mg) were recorded in spermine 1.0 mM compared to spermidine 1.5 mM and putrescine 3.0 mM. The impact of spermine in increasing the petal carotenoid content might be delaying carotenoid degradation via their enzymatic oxidation in the chromoplasts and prevent the breakdown of flavonoids to make the flower fresh by improving water absorption. An increase in membrane stability index (55.87%) as indicated by ion leakage was found to be delayed or reduced (25.93%) by the use of spermine 1 mM. While the control was at highest (38.58%) and prolonged flower longevity compared with untreated flowers. Spermine 1.0 mMwas found to be more effective in maintaining higher levels of TSS (10.37^o Brix) and soluble sugars are involved in membrane stability and reduce the flower wilting.Thus, the treatments of spermine @ 1.0 mM ppm influenced the postharvest physiology of gerbera flowers and extendedthe vase life of gerbera by 4-5 days as compared to control.

Keywords: Gerbera, Polyamines, Spermine, TSS, Vase life

INTRODUCTION

Gerbera is a well known cut flower crop of the world due to the attractive daisy shape of flowers. This highly decorative flower plant is currently fifth most popular cut flower in the world. Due to its high vase life this plant has become very popular as a cut flower and is now widely cultivated. The gerbera belongs to the Asteraceae or daisy/sunflower family. It is a tender perennial herb, also known as African daisy, Transvaal daisy or Barberton daisy. The large flower heads of these daisies have ray-like petals around a center disk of tiny green or black flowers. There are four different classes of Gerbera daisies: single flower, semi-double flower, double flower, and spider flower. Each class delineates the number, position, and type of petals. The leaves of the plant are lobed or pinnate and often toothed.

Gerbera is an herbaceous perennial herb and it has a very good export potential because of its graceful appearance, hardiness & long shelf life during transportation.

According to global trends in floriculture, it occupies the 4th place among cut flowers. It is used in floral arrangements, flower beds, borders, pots and rock gardens. Besides floral arrangements, gerbera is widely used in bouquets and in dry flower crafts.It is in considerable demand in both domestic and export market. Besides, the problem with gerbera cut flowers is the short postharvest life. Vase life is often used as an indicator of postharvest longevity in cut flowers, and is determined by the number of days from harvest until flower senescence.

Postharvest life is an important parameter determining the marketability of cut flower as they are generally highly perishable. Nearly, 30-50 per cent losses of cut flowers occur due to improper postharvest handling during entire market chain (Kumar *et al.*2012).The vase life of gerbera is limited due to petal wilting, premature senescence, stem plugging, stem breaking and scape bending. Few scientists have worked on postharvest technology in gerbera using polyamines.

Polyamines (PAs) are small aliphatic amines that are ubiquitous in all plant cells and known for their anti-senescence effects during ageing sequence of plant tissue by retarding ethylene synthesis by inhibiting ACC synthesis. PAs showed positive effects on postharvest quality and vase life of cut gerbera due to their impacts on ROS and antioxidant capacity. Polyamines *viz.*, spermine, spermidine and putrescine are a new class of aliphatic amines, seem to be more effective in preventing senescence-related events in plants and improve the keeping quality of cut flowers. Hence, this experiment was intended to study the influence of polyamines (spermine, spermidine and putrescine) on postharvest physiology of gerbera with the basic objective to extend its vase life.

MATERIAL AND METHODS

The experiment was conducted at Department of Horticulture, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad during 2016-17. The experiment was arranged in completely randomized design with three replications. The required number of conical flasks were washed, weighed, and labelled as per the schedule of treatments. Similarly, a calculated quantity of each Polyamines, *viz.*,spermine, spermidine and putrescine were weighed and then dissolved in the required quantity of distilled water to make the requiredconcentration as per the technical programme.

Gerbera cut spikes were collected from the plants grown under the poly house of Horticulture Garden. Gerbera flowers of the variety 'Goliath' were harvested when all the florets opened fully and were perpendicular to the stalk. The flowers were harvested early in the morning by cutting the stalk with sharp secateurs having the stalk length of above 50 to 60 cm from the flower head. Flowers were kept in wateriimmediately after harvest. The flower stalks are given slant cut to provide more solution accumulated area and remove any surface embolism. The cut flowers were precooled at 4±2°C for about 4 hours and then immediately unpacked, sorted to uniform length and quality of capitulum. Recutting the base before placing them in differentpolyamine solution are essential for extension of vase life of cut flowers. The flowers were sorted out for uniform flower size so as to maintain uniformity with inthe replication. Stems were then cut to a uniform length of 45 cm, then each flower stalk was placed in 600 ml bottle containing 500 ml of aqueous solutions of different polyamines were used individually or in combinations as described seprately in each experiment.

The weight of each container and the test solution with and without flower scapes were recorded once in two days, while recording weights recutting of the floral stems (about 0.5 cm) was done under water. The flowers were continuously held in the treatment solutions till the end of the vase life period.Observations were recorded for Relative water content, Total soluble solids, Carotenoids, Electrolyte leakage and Membrane stability index

RESULTS AND DISCUSSION

1. Relative water content (RWC%)

Higher RWC was maintained in gerbera cut flowers placed in spermine 1.0 mM (74.22%) followed by spermidine 1.5 mM (72.09%) and putrescine 3.0 mM (70.42%).While RWC was affected by various polyamine treatments where in control (50.56%) cut flowers had significantly lower relative water content during experiment, significantly highest hydration level in the petals was found with spermine 1.0 mM on day 3, 6 and 9 (81.27%, 73.92% and 67.46% respectively) which were on par with spermidine 1.5 mM (79.22%, 71.67% and 65.37 %). The lowest RWC was however, noted with the treatment T_{13} on day 3,6, and 9 (64.58, 50.62 and 36.48) which were on par with spermidine 3.0 mM (65.17%, 52.41% and 42.49%) and putrescine 3.0 mM (77.38%, 69.95% and 63.94%) on day 3,6 and 9.

Liu *et al*. (2000) and Yamaguhi*et al*. (2007) proposed a model describing a role of polyamines during drought stress, which is correlated with cut flowers senescence. Polyamines may modulate the activities of certain ion channels, especially Ca^{2+} permeable channels and raise cytoplasmic Ca^{2+} concentration. This event is known to inactivate the K^+ inward rectifier at the plasma membrane, which could stimulate stomatal closure. As a consequence of polyamines causes decrease in transpiration and may increase relative water content. Similar effects of improving relative water content with spermine reported by Rubinowska*et al.* (2012) in cut roses.

2. Total soluble solids (^{0}Brix)

Highest TSS with spermine 1.0 mM (10.37 ^{o}Brix) followed by spermidine 1.5 mM (10.13^{o}Brix) and putrescine 3.0 mM (9.88^{o}Brix). While control was recorded lowest TSS (.7.26^{o}Brix).The TSS initially increased from day 3 (10.08 ^{0}Brix**)** to day 9 (7.65 ^{0}Brix) and thereafter decreased towards end of the vase period.On day 3, highest TSS (11.53 ^{o}Brix) which was on a par with spermidine 1.5 mM (11.25^{o}Brix) and putrescine 3.0 mM (10.96^{o}Brix) whereas the lowest TSS (8.65^{o}Brix) was recorded in control. On day 6 and 9 also, similar trend was observed with highest TSS recorded by flowers held in spermine 1mM (10.34 and 9.24^{o}Brix) followed by spermidine 1.5 mM (10.13 and 9.00^{o}Brix) and putrescine 3.0 mM (9.93 and 8.76^{o}Brix). While control recorded lowest TSS (7.42 and 5.72^{o}Brix) on day 6 and 9 respectively.

Highly retained fresh weight might have restricted the degradation of macro molecules *viz.*, starch, proteins, nucleic acid, lipids and stimulate their synthesis in the petal cells and thus contributed to maintained higher levels of TSS. Soluble sugars are involved in membrane stability and reduce the flower wilting (Hashemi *et al.* 2013). Similar findings observed in roses treated with 10 ppm spermine showed maximum TSS reported by Sumathi Tatte*et al.* 2015, Palagani and Singh, 2017 and Mohammadi*et al.* 2020.

3. Carotenoids (mg / g f wt)

According to results shown in table 3carotenoid content was decreased progressively during experiment of cut gerbera.Highest carotenoid content was recorded in gerbera cut flowers with spermine 1.0 mM (5.58 mg) followed by spermidine 1.5 mM (5.49 mg) and putrescine 3.0 mM (5.42 mg).Highest carotenoid content was recorded in gerbera cut flowers with spermine 1.0 mM from 3rd day (6.21 mg) to 9th day (4.86 mg) which was on a par with spermidine 1.5 mM (4.77 mg) and putrescine 3.0 mM (4.72 mg). However, control recorded lowest carotenoid content (3.84 mg). Polyamines are more appropriate to keep the petal pigments.The impact of spermine in increasing the petal carotenoid content might be delaying carotenoid degradation via their enzymatic oxidation in the chromoplasts and prevent the breakdown of flavonoids to make the flower fresh by improving water absorption. Similar findings reported by Rubinowska*et al.* (2012) in cut rose.

4. Electrolyte leakage(EL) (%)

The flower scapes treated with spermine 1.0 mM recorded significantly lowestEL (25.93%), however highest EL was registered in control (33.69%) followed by spermidine 3.0 mM (30.46) and spermine 2.0 mM (29.71).Similarly, ELin the petal tissue of gerbera flowers held in spermine 1.0 mM (23.27, 26.18 and 28.35 %) followed by spermidine 1.5 mM (23.58, 26.47 and 28.67 %) and putrescine 3.0 mM (23.91, 26.94 and 29.15%) recorded on 3rd, 6th and 9th day respectively was much lower than control (27.73, 33.58 and 39.75%) as recorded on 3rd, 6th and 9th day of vase life.

The electrolyte leakage showed increasing trend from day 3 (25.17) and day 9(31.54). This might be due to senescence accompanied by dramatic increase in electrolyte leakage of many molecules including pigments, amino acid, sugars, K^+ and total electrolytes. The leakage of ions is known to coincide with the decrease in water content of the flower petals and senescence had indicated free radical scavenging effect of polyamines that reduce electrolyte leakage. The present result in accordance with the findings reported by Sumathi *et al.* (2015) in cut roses and in gladiolus observed by Dantuluri *et al*. (2008).

5. Membrane stability index (%)

Greater Membrane stability indexis recorded inspermine 1.0 mM (55.87%) followed by spermidine 1.5 mM (54.49 %) and putrescine 3.0 mM (53.12 %). Whereas control however recorded lowest MSI (38.58 %).MSI in the flower tissue treated with spermine 1.0 mM (68.34, 56.91 and 42.36%) recorded more followed by spermidine 1.5 mM (66.95, 55.34 and 41.18%) and putrescine 3.0 mM (65.17, 54.26 and 39.24 %) on 3rd, 6th and 9th day respectively was much higher than control (51.48, 41.85 and 22.42 %) on 3rd, 6th, 9th day of vase life.

Membrane stability index declined with onset of senescence. Polyamines greatest contribution to plants in membrane stabilization as free radical scavengers and rate of ion leakage was four times higher just before wilting. In a research, Dantuluri *et al*. (2008) found that application of spermine on cut gladioli flowers delay aging by increasing the membrane stability. Similar results were obtained in cut roses with spermine and spermidine by Yang *et al.*(2000).In addition, polyamines are also known to prolong flower longevity by reducing membrane seepage thereby conferring membrane stability (Sedaghathoor*et al.*, 2020)

Table 1. Effect of polyamines on relative water content (%) of cut gerbera

Treatments	RWC (%)			Mean
	3rd day	6th day	9th day	
T_1	70.35	61.37	56.37	62.70
T_2	81.27	73.92	67.46	74.22
T_3	69.00	57.62	52.71	59.78
T_4	66.28	53.43	46.52	55.41
T_5	72.74	63.74	58.84	65.11
T_6	79.22	71.67	65.37	72.09

T_7	75.63	67.53	62.58	68.58
T_8	65.17	52.41	42.49	53.36
T_9	68.73	59.14	54.53	60.80
T_{10}	74.11	65.84	60.32	66.76
T_{11}	77.38	69.95	63.94	70.42
T_{12}	68.67	55.35	49.61	57.88
T_{13}	64.58	50.62	36.48	50.56
Mean	71.78	61.74	55.17	
SEm±	1.84	1.64	0.73	
CD@ 5%	5.38	4.79	2.19	

Table 2. Effect of polyamines on TSS (^{0}Brix) of cut gerbera

Treatments	**Total soluble solids (^{0}Brix)**			**Mean**
	3rd day	**6th day**	**9th day**	
T_1	10.00	8.91	7.73	8.88
T_2	11.53	10.34	9.24	10.37
T_3	9.73	8.51	7.15	8.46
T_4	9.25	7.90	6.62	7.92
T_5	10.24	9.15	7.94	9.11
T_6	11.25	10.13	9.00	10.13
T_7	10.72	9.76	8.53	9.67
T_8	8.83	7.73	6.21	7.59
T_9	9.95	8.75	7.43	8.71
T_{10}	10.53	9.37	8.28	9.39
T_{11}	10.96	9.93	8.76	9.88
T_{12}	9.43	8.34	6.83	8.20
T_{13}	8.65	7.42	5.72	7.26
Mean	10.08	8.94	7.65	
SEm±	0.38	0.33	0.24	
CD@ 5%	1.11	0.97	0.72	

Table 3. Effect of polyamines on carotenoid content (mg / g f wt) of cut gerbera

Treatments	**Carotenoid content (mg / g f wt)**			**Mean**
	3rd day	**6th day**	**9th day**	
T_1	5.15	5.37	4.37	4.96
T_2	6.21	5.67	4.86	5.58
T_3	5.27	4.85	4.18	4.77
T_4	5.12	4.63	3.97	4.57
T_5	5.67	5.41	4.46	5.18
T_6	6.13	5.58	4.77	5.49
T_7	5.85	5.49	4.68	5.34

T_8	5.00	4.48	3.92	4.47
T_9	5.32	4.96	4.25	4.84
T_{10}	5.79	5.45	4.52	5.25
T_{11}	6.00	5.53	4.72	5.42
T_{12}	5.20	4.74	4.10	4.68
T_{13}	4.86	4.28	3.84	4.33
Mean	5.33	5.29	4.36	
SEm±	0.32	0.11	0.19	
CD@ 5%	0.93	0.33	0.55	

Table 4. Effect of polyamines on electrolyte leakage (%) of cut gerbera

Treatments	**Electrolyte leakage (%)**			**Mean**
	3rd day	**6th day**	**9th day**	
T_1	25.00	28.37	30.83	28.07
T_2	23.27	26.18	28.35	25.93
T_3	25.72	29.00	32.00	28.91
T_4	26.41	29.79	32.93	29.71
T_5	24.86	27.96	30.39	27.74
T_6	23.58	26.47	28.67	26.24
T_7	24.12	27.28	29.56	26.99
T_8	26.84	30.10	34.45	30.46
T_9	25.37	28.64	31.52	28.51
T_{10}	24.41	27.65	29.91	27.32
T_{11}	23.91	26.94	29.15	26.67
T_{12}	26.00	29.41	32.47	29.29
T_{13}	27.73	33.58	39.75	33.69
Mean	25.17	28.57	31.54	
SEm±	0.70	0.73	1.02	
CD@ 5%	2.06	2.12	2.98	

Table 5. Effect of polyamines on membrane stability index (%) of cut gerbera

Treatments	**Membrane Stability Index (%)**			**Mean**
	3rd day	**6th day**	**9th day**	
T_1	59.79	50.64	34.69	48.37
T_2	68.34	56.91	42.36	55.87
T_3	57.00	48.00	31.62	45.54
T_4	55.35	45.83	27.63	42.94
T_5	61.74	51.67	35.84	49.75
T_6	66.95	55.34	41.18	54.49
T_7	63.88	53.63	38.71	52.07
T_8	54.00	44.57	25.39	41.32
T_9	58.53	49.25	33.27	47.02

T_{10}	62.25	52.31	37.25	50.60
T_{11}	65.17	54.26	39.94	53.12
T_{12}	56.15	47.14	29.57	44.29
T_{13}	51.48	41.85	22.42	38.58
Mean	60.05	50.11	33.84	
SEm±	1.74	1.72	1.65	
CD@ 5%	5.09	5.04	4.84	

T_1–Spermine @ 0.5 mM
T_2–Spermine @ 1.0 mM
T_3–Spermine @ 1.5 mM
T_4–Spermine @ 2.0 mM
T_5–Spermidine@ 1.0 mM
T_6–Spermidine@ 1.5 mM
T_7–Spermidine@ 2.0 mM
T_8–Spermidine@ 3.0mM
T_9– Putrescine @ 2.0 mM
T_{10}–Putrescine @ 2.5 mM
T_{11}–Putrescine @ 3.0 mM
T_{12}–Putrescine @ 4.0 mM
T_{13}–Control

CONCLUSION

From the present study,it may conclude that different polyamines had significant impact on vase life quality of cut gerbera. The longest vase life obtained with spermine 1 mM followed by spermidine 1.5 mM. Whereas control recorded short vase life of cut flowers. An increase in membrane stability index (55.87%) as indicated by ion leakage was found to be delayed or reduced by the use of spermine 1mM. While the control was at highest (38.58%) and discoloration or fading of flowers due to poor water relations and early degradation of sugars. Hence, Spermine is more appropriate to keep the petal pigmentsand extend the vase life period in cut gerbera.

The enhanced vase life of gerbera cut flowers in this treatment can be attributed to increased water uptake, higher retention of fresh weight and high petal sugar status. Further it reduced water stress and stabilized membrane integrity and cellular structure as indicated by higher membrane stability index which ultimately delayed petal senescence and the increase the longevity.

Conference disclaimer:

Abstract of this manuscript was previously presented in the conference: **International Seminar on Exotic and Underutilized Horticultural Crops**The Digital Experience dated from (17-19, October, 2023)Bengaluru, India ,Web Link of the proceeding: https://hortsem.iihr.res.in/

REFERENCES

Dantuluri, V.S R., Misra, R. L and Singh, V. P. 2008. Effect of polyamines on post harvest lifeof Gladiolus spikes. *Journal of Ornamental Horticulture*. 11(1): 66-68.

Hashemi, M., Mirdahghan, S, Farahmand, H and Dashti, H. 2013. Effect of salicylic acid andmethyl jasmonate on quality and vase life of cut flowers of gerbera. *Journal of Horticultural Science*. 26(3): 230-311.

Kumar, MS., Ponnuswami V, Jawaharlal, M and Kumar, RA. 2012. Effect of plant growth Regulatorson growth, yield and exportable quality of cut roses. *The Bioscan*.7(4):733-738.

Liu, K., Fu, H, Bei, Q and Luan, S. 2000. Inward potassium channel in guard cells as a targetfor polyamine regulation of stomatal movements. *Plant Physiology*. 124: 1315-1326.

Mohammadi, M., Aelaei, M, and Saidi, M. 2020. Pre-harvest and pulse treatments of spermine, γ- and β-aminobutyricacid increased antioxidant activities and extended the vase life ofgerbera cut flowers 'Stanza'. *Ornamental Horticulture*. 26(2): 306-316.

PalaganiN and Singh, A. 2017. Influence of postharvest application of chemicals on postharvest physiology and vase life of gerberavar. Alcatraz. *International Journal of Chemical Studies*.5(6): 413-416.

Rubinowska, K, Pogroszewska, E and Michałek, W. 2012. The effect of polyamines on physiological parameters of post-harvest quality of cut stems of *Rosa* 'Red Berlin'. *Acta ScientiarumPolonorumHortorum Cultus*. 11(6): 81-93.

Sedaghathoor, S.,Narouei, Z., Sajjadi, S. A. and Piri, S. 2020. The effect of chemical treatments (silver thiosulfate and putrescine) on vase life and quality of cut *Chrysanthemummorifolium* (Ram.) flowers. *Cogent Biology*.6(1): 1754320

Sumathi Tatte., Singh, A and Ahlawat, T. R. 2015. Effect of polyamines on Post harvest qualityand vaselife of rose var. Samurai. *An international Quarterly Journal Life Sciences*. 10(2): 675-678.

Yamaguhi, K., Takahashi, Y, Berberich, T, Imai, A, Takahashi, T, Michael, A.J and Kusano,T.2007. A protective role for the polyamine spermine against drought stress in *Arabidopsis*. *Biochemical and Biophysical Research Communications*. 352: 486-490.

Yang, C. W. He., S. G. Jiang, Y. M and Yi, S. 2000. Effect of polyamines on

Biochemicaland physiological changes and vase life of cut rose R. chinensis (var. Bellane flowers) during senescence. *Journal of Tropical and Subtropical Bot*any. 8(2): 104-108.

Fig 1. View of laboratory study

Fig 2: Effect polyamines in holdingsolution on vase life of cut gerbera cv.Goliath