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MEMBRANE STABILITY AND POST HARVEST KEEPING QUALITY OF GLADIOLUS CUT SPIKES AS INFLUENCED BY CERTAIN CHEMICALS WITH SUCROSE IN VASE SOLUTION

ALKA SINGH[1]*, JITENDRA KUMAR[1], PUSHPENDRA KUMAR[2] AND V.P. SINGH[3]

[1]Department of Horticulture, C.C.S. University, Meerut- 250004
[2]Department of Botany, C.C.S. University, Meerut- 250004
[3]Division of Plant Physiology, I.A.R.I., New Delhi-110012

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SUMMARY

Influence of silver nitrate ($AgNO_3$), silver thiosulphate (STS), 8-Hydroxy Quinoline (8-HQ) and sucrose as vase solution on the post harvest keeping quality of gladiolus cut spikes, was studied. The treatment of antimicrobial agent, 8-HQ (200 and 300ppm) with sucrose (5%) improved the keeping quality of the cut spikes. The treatment of 300 ppm 8-HQ with 5% sucrose significantly enhanced the per cent gain in fresh and dry weight of the cut spikes as well as recorded higher reducing, non-reducing sugar content, carotenes and anthocyanin pigments in the petals of the cut spikes on 4th day after treatment (DAT). The vase solution treatment 300 ppm 8-HQ + 5% sucrose maintained higher activities of antioxidant enzymes, superoxide dismutase (SOD) and glutathione reductase (GR), reduced lipoxygenase (LOX) activity and lipid peroxidation (TBARS) in the petals of the cut spikes on 5th DAT. All these factors contributed towards better membrane integrity exhibited as high MSI, which delayed the petal senescence and significantly doubled the vase life and improved the flower quality of gladiolus cut spikes.

Key Words: **Anthocyanins, antioxidant enzymes, carotenes, gladiolus, membrane stability, petal senescence**

INTRODUCTION

Studies on the cut flower physiology, biochemistry and petal senescence, is an important area of research for the improvement of the post harvest life and quality of cut flowers. The post harvest physiology and molecular biology studies of cut flowers have been concentrated mostly on climacteric flowers (rose, carnation, orchids etc) as compared to non-climacteric flowers (gladiolus, tulips, day lily, etc.). Gladiolus is one of the popular cut flower but is highly perishable in nature with limited vase life of 7-8 days.

Silver salts extend the vase life of cut flowers as possess antibacterial and anti-ethylene properties (Aarts 1957, Halevy and Kofranek 1997, Nowak and Rudnicki 1990). On the other hand, 8-HQ has been known to possess strong anti-microbial properties that eliminate vascular blockage and enhance water uptake so as to maintain water balance reduced by transpiration from flower tissues (Rogers 1973, Jowkar 2005). Flowers of the most plants are heterotrophic and require imported carbohydrates for their development. The flower bud is a major sink for assimilates under favourable growth conditions, whereas a shortage of carbohydrates often

*Corresponding author's present addess: ASPEE College of Horticulture & Forestry, Navsari Agricultural University Navsari, (Gujarat). Email: alkapushpendra@yahoo.co.in

leads to the arrest of flower development (Halevy 1987). The petal senescence in cut flowers is associated with increased activity of hydrolytic enzymes like lipoxygenase (Peary and Prince 1990), lipid peroxidation, decrease in activities of anti-oxidative enzymes like superoxide dismutase (SOD), glutathione reductase (GR) and loss of cellular compartmentalization with leakiness of cell membranes (Bartoli *et al*. 1995). The role of $AgNO_3$, STS and 8-HQ with sucrose in vase solution on petal pigments and cell membrane stability for delaying senescence and improving the flower quality of the gladiolus cut spikes are investigated in this study.

MATERIALS AND METHODS

The fresh cut spikes of gladiolus cv. Peter Pears were procured from the nearby farm in Meerut, which were grown according to standard cultural practices. The experiment was conducted in completely randomized block design with the factorial concept in the laboratory at ambient temperature 15-18°C. The spikes at tight bud stage, having 16-18 buds and basal 2-3 buds showing colour were sorted and selected for uniform size (90 ± 5) cm and fresh weight (70 ± 5 g). The spikes were weighed individually and the fresh weight was recorded. The initial dry weight was also determined for ten spikes to calculate the per cent change in dry weight of spikes under treatments on 3rd DAT.

The solution for 31 treatment combinations of $AgNO_3$ (0.2, 0.4 and 0.6 mM), STS (0.2, 0.4 and 0.6 mM) and 8-HQ (100, 200 and 300 ppm) each with sucrose (2, 5 and 8%), only sucrose treatments (2, 5 and 8%) and control (water) were prepared. The spikes were cut at base for uniform size of 90 cm and the basal end of spikes were immediately dipped in the prepared solutions and kept for observation. The observations on different parameters were recorded at different time intervals during the vase life. The change in fresh and dry weight was recorded on 3rd DAT. The reducing, non-reducing sugars content, carotene and anthocyanin pigments were estimated from the petals of basal 3rd-4th florets of cut spike on 4th DAT according to the methods given by Nelson (1944), Machlis and Torrey (1956) and Lees and Francis (1972) respectively. The enzyme activity of superoxide dismutase (SOD) and glutathione reductase (GR), LOX activity and Lipid peroxidation in the form of thiobarbutaric acid reactive substances (TBARS) were estimated from the petals of basal 3rd-4th florets of cut spike on 5th DAT according to the methods of Dhindsa *et al*. (1981), Smith *et al*. (1988), Albert *et al*. (1992) and Heath and Parker (1968) respectively. The MSI was calculated on the basis of electrolyte leakage of the petal tissue. The electrolyte leakage was measured on 6th DAT by taking five petals discs (1 cm^2) of the forth flower from the basal end. The petal discs were rinsed well in tap water and then in deionized water prior to keep them for incubation in 5 ml of deionized water for three h at room temperature. After incubation the conductivity (value A) of the bathing solution was measured with conductivity meter. The petal discs were boiled with bathing solution for 10 minutes to kill the tissue. After cooling to room temperature, the conductivity (value B) of the bathing solution was again measured. Potassium chloride (0.01mM) was used as a standard, which gives specific conductance of 1.41 mmhos per cm. The electrolyte leakage was expressed as percent value i.e. (value A/value B) x100. The membrane stability index (MSI) was further calculated with the formula, MSI = (1-A/B)100. Finally, the vase life was recorded in days till 75% senescence of the spike for each treatment.

RESULTS AND DISCUSSION

The results showed significantly enhanced gain in fresh weight and dry weight of the cut spikes placed in vase solution enriched with 8-HQ and sucrose compared to other vase solution treatments and control that showed slight gain in fresh weight and higher loss in dry weight. The maximum gain in fresh weight (26.00%) and dry weight (13.43%) was recorded in the cut spikes placed in vase solution of 300 ppm 8-HQ with 5% sucrose (T_9S_2) among all treatments (Table 1). The treatment (T_9S_2), further enhanced the content of reducing (26.45 mg g^{-1} fw) and non-reducing sugars (17.20 mg g^{-1}fw) in the petals of the cut spikes significantly over control (18.40 and 11.30 mg g^{-1} fw respectively) as shown in Table 2. The vase solution treatment of 300 ppm 8-HQ with 5% sucrose was found superior over all other treatment combinations. The higher sucrose solution showed non-significant result probably due to the reduced

Table 1. Effect of certain chemicals and sucrose in vase solutions on change in fresh weight and dry weight of gladiolus cut spikes on 3rd DAT

Treatments	Change in fresh weight (%)				Change in dry weight (%)			
	sucrose				sucrose			
Chemicals	**S_1 (2%)**	**S_2 (5%)**	**S_3 (8%)**	**Mean (T)**	**S_1 (2%)**	**S_2 (5%)**	**S_3 (8%)**	**Mean (T)**
T_{0} (no chemical)	9.40 (17.85)	10.33 (18.74)	9.0 (17.46)	9.58 (18.02)	-2.33 (-8.78)	-1.10 (-5.97)	-3.00 (-9.97)	-2.14 (-8.24)
T_{1} (0.2mM AgNO3)	9.80 (18.28)	10.50 (18.91)	9.70 (18.11)	10.00 (18.43)	-2.00 (-8.13)	-0.93 (-5.54)	-2.30 (-8.03)	-1.74 (-7.23)
T_{2} (0.4mM AgNO3)	9.90 (18.35)	10.70 (19.09)	9.73 (18.18)	10.11 (18.54)	-1.47 (-6.95)	-1.00 (-5.74)	-1.87 (-7.89)	-1.44 (-6.85)
T_{3} (0.6mM AgNO3)	9.50 (17.95)	10.50 (18.87)	9.40 (17.85)	9.79 (18.22)	-1.73 (-7.56)	-1.10 (-6.01)	-2.03 -8.20)	-1.62 (-7.25)
T_{4} (0.2mM STS)	9.70 (18.14)	10.60 (19.00)	9.63 (18.08)	9.98 (18.41)	-1.50 -7.03)	-1.17 (-6.18)	-2.13 (-8.40)	-1.60 (-7.20)
T_{5} (0.4mM STS)	9.60 (18.05)	10.33 (18.75)	9.40 (17.85)	9.78 (18.22)	-2.7 (-7.49)	-0.83 (-5.23)	-1.93 (-7.99)	-1.49 (-6.90)
T_{6} (0.6mM STS)	9.80 (18.24	10.73 (19.12)	9.60 (18.05)	10.04 (18.47)	-1.37 (-6.71)	-1.17 (-6.17)	-1.93 (-7.99)	-1.49 (-6.96)
T_{7} (100ppm 8-HQ)	12.00 (20.27)	14.80 (22.63)	9.10 (17.54)	11.97 (20.15)	3.73 (11.11)	6.90 (15.22)	3.57 (10.87)	4.73 (12.40)
T_{8} (200ppm 8-HQ)	12.00 (20.27)	20.67 27.04)	9.00 (17.46)	13.89 (21.59)	9.17 (17.63)	11.87 (20.42)	9.17 (17.62)	10.07 (18.55)
T_{9} (300ppm 8-HQ)	18.66 (25.59)	26.00 (30.66)	15.80 (23.42)	20.16 (26.56)	11.03 (19.39)	13.43 (21.43)	10.43 (18.84)	11.63 (19.91)
Mean (S)	11.04 (19.30)	13.51 (21.28)	10.03 (18.40)		1.18 (-0.45)	F2.49 (1.63)	0.80 (-1.11)	
Control	9.0 (18.50)				-2.1 (-8.2)			
CD at 5 %	T: 0.20, S: 0.12				T: 0.50, S: 0.27			
	SxT: 0.34 C x all: 0.34				SxT: 0.85 C x all: 0.91			

(Figures in parenthesis are arc sine transformed values)

water potential, which might have led to reduced uptake. All combinations of $AgNO_3$ (0.2, 0.4 and 0.6 mM) and STS (0.2, 0.4 and 0.6 mM) with sucrose (2, 5 and 8%) showed only intermediate effects. This could be due to ethylene insensitive property of the gladiolus (van Doorn 2001) as Ag^{++} are mainly associated with anti-ethylene property and specific response of gladiolus to different germisides (Jones and Hill 1993). Among all chemicals, 8-HQ was observed to be most suitable and effective being broad spectrum bactericide and fungicide as also observed by Jowkar (2005) in Narcissus. The only sucrose treatments also failed to show significant effects on all

parameters probably due to enhanced microbial growth in sucrose solution, which ultimately restricted the solution uptake and caused water and sugar stress in the cut spikes.

The encouraging results of 8-HQ (300ppm) with sucrose (5%) could be attributed, firstly, to the strong anti-microbial activities of 8-HQ (Rogers 1973 and Marousky 1971) that restricted the growth of microorganisms in the solution and eliminated the vascular occlusion in the xylem. This ultimately resulted into resistance free solution uptake (Halevy 1976 and Burdett 1970) in the cut spikes and gain in fresh weight. Secondly, the applied sucrose (as vase solution), being taken up through vascular tissue, and upon accumulation in the petal cells (Ho and Nichols 1977 and Mayak and Halevy 1974), might have affected the osmotic potential of the cells and thus further increased the gain in fresh weight and content of sugars (reducing and non-reducing sugars) by facilitating higher solution uptake. Further, the optimum availability of sugars to the petal cells facilitated the continuity of the optimum metabolic activities and restricted the reserve remobilization (Koch 1996) and thus contributed towards increased dry weight. All the treatments showed slight increase in fresh weight due to some solution uptake by the cut spikes but recorded loss in dry weight probably due to the metabolic activities and respiration. In untreated cut spikes, the limited photosynthates, might have been depleted during respiration. This condition led to sugar starvation in the cells for the further continuation of metabolic activities and there may be accelerated hydrolysis of cellular components, *viz*. carbohydrates, lipids and proteins (Yu 1999) causing decreased per cent dry weight (van der Meuler *et al*. 2001).

The cut spikes placed in vase solution enriched with 300 ppm 8-HQ and 5% sucrose recorded significantly enhanced petal pigments, carotenes (0.91 mg g^{-1} fw) and anthocyanins (0.60 mg g^{-1} fw) in the petals on 4th DAT while in control the pigments were much degraded (0.52 and 0.23 mg g^{-1} fw respectively) as shown in Table 2. The carotenes located in chromoplasts are lipid compounds attached to protein complex. The sugars are known to arrest lipid and protein degradation (Eason *et al*. 1997) and stimulate protein synthesis (Koch 1996). Thus, the availability of sucrose in the petals, might have exhibited protective role for the ultra structure of the chromoplast from damaging.

Further, sucrose serves protective role for tonoplast structure and intactness (van Doorn 2004) and maintains vacuolar structure, the site of anthocyanins. Moreover, sucrose is known to have stimulating effect on anthocyanin production in plant cells (Weiss 2000). Similarly, Uddin *et al.* (2000) reported stabilization of petal colour and intensity with exogenous sugar application in cut flowers. Thus, the optimum sugar availability in the petals of the cut spikes treated with 300 ppm 8-HQ and 5% sucrose as vase solution might have increased the content of petal pigments.

The treatments of 300 ppm 8-HQ with 5% sucrose (T_9S_2) significantly, increased the activity of SOD (17.80 units mg^{-1} fw min^{-1}) and GR (4.50 ΔOD g^{-1} fw min^{-1}), lowered the activity of LOX (8.5 ΔOD min^{-1} g^{-1} fw) and diminished the lipid peroxidation (TBARS: 9.0 nmol g^{-1} fw) in the petals of gladiolus cut spikes (Table 3). The untreated cut spikes (control) recorded minimum activity of SOD (2.33 units mg^{-1} fw min^{-1}) and GR (1.50 ΔOD g^{-1} fw min^{-1}), increased activity of LOX (25.5 ΔOD min^{-1} g^{-1} fw) and higher lipid peroxidation in form of TBARS (24.7 nmol g^{-1} fw) in the petals. The enhanced anti-oxidative defense activities in the petals can be attributed to the well-maintained stress free conditions in the plant cells (Asada and Takahashi 1987) for longer duration during the vase life with the adequate availability of sugars and water balance in the cut spikes. These stress free conditions, might have diminished the generation of reactive oxygen species (ROS) (Elstner *et al.* 1988) and ABA and thus lowered the LOX activity and lipid peroxidation. Further, the adequate supply of sucrose to the petal cells might have facilitated the continuation of the metabolic activities to the optimum, arrested the reserve remobilization and stimulated the synthesis of lipids (Koch 1996 and Yu 1999) and this was exhibited as decreased peroxidation of lipids in the petal cells.

Finally, cut spikes placed in vase solution enriched with 300 ppm 8-HQ and 5% sucrose (T_9S_2) recorded high membrane stability index (82.33%), maximum vase life (19.8 days) and excellent flower quality (5 grade) as

Table 2. Effect of certain chemicals and sucrose as vase solutions on reducing sugars, non-reducing sugars, carotene and anthocyanin pigments in the petals of gladiolus cut spikes on 4th DAT

Treatments (T)	Reducing sugars (mg g^{-1}fw)				Non-reducing sugars (mg g^{-1}fw)				Carotenes (mg g^{-1} fw)				Anthocyanins (mg g^{-1}fw)			
	sucrose				sucrose				sucrose				sucrose			
Chemicals	S_1 (2%)	S_2 (5%)	S_3 (8%)	Mean (T)	S_1 (2%)	S_2 (5%)	S_3 (8%)	Mean (T)	S_1 (2%)	S_2 (5%)	S_3 (8%)	Mean (T)	S_1 (2%)	S_2 (5%)	S_3 (8%)	Mean (T)
$T_{0\ (no\ chemical)}$	19.70	19.90	19.8	19.81	11.50	11.93	12.50	11.98	0.54	0.59	0.54	0.56	0.23	0.28	0.24	0.25
$T_{1\ (0.2\ mM\ AgNO3)}$	18.50	19.0	19.03	18.84	11.33	12.00	11.43	11.59	0.53	0.56	0.54	0.54	0.22	0.26	0.24	0.24
$T_{2\ (0.4\ mM\ AgNO3)}$	19.10	19.33	19.90	19.44	12.10	12.33	12.10	12.18	0.56	0.55	0.56	0.56	0.27	0.26	0.28	0.27
$T_{3\ (0.6\ mM\ AgNO3)}$	19.80	20.10	20.23	20.06	11.67	12.10	11.83	11.83	0.55	0.58	0.54	0.56	0.25	0.28	0.28	0.27
$T_{4\ (0.2\ mM\ STS)}$	19.70	19.43	19.90	19.68	11.40	11.83	12.20	11.81	0.55	0.60	0.58	0.58	0.22	0.28	0.27	0.25
$T_{5\ (0.4\ mM\ STS)}$	19.90	19.80	20.10	19.91	11.40	12.20	11.33	11.66	0.54	0.58	0.59	0.57	0.28	0.28	0.29	0.28
$T_{6\ (0.6\ mM\ STS)}$	19.70	19.96	20.20	19.96	12.50	12.00	12.10	12.20	0.58	0.60	0.58	0.59	0.26	0.31	0.26	0.28
$T_{7\ (100\ ppm\ 8\text{-}HQ)}$	20.30	21.00	20.63	20.66	13.37	14.00	13.43	13.60	0.60	0.66	0.60	0.62	0.29	0.31	0.28	0.29
$T_{8\ (200\ ppm\ 8\text{-}HQ)}$	22.50	23.27	23.00	22.92	14.50	14.83	14.80	14.71	0.69	0.76	0.68	0.71	0.33	0.45	0.34	0.37
$T_{9\ (300\ ppm\ 8\text{-}HQ)}$	24.30	26.45	25.90	25.56	15.03	17.20	15.93	16.06	0.70	0.91	0.68	0.76	0.38	0.60	0.40	0.46
Mean (S)	20.35	20.83	20.86		12.47	13.04	12.77		0.58	0.64	0.59		0.26	0.33	0.29	
Control (C)	18.40				11.30				0.52				0.23			
C.D. at 5%	T: 0.21 S: 0.11				T: 0.20 S: 0.11				T: 0.16 S: 0.09				S: 0.01 T: 0.03			
	SXT: 0.36 C x all: 0.21				SXT: 0.34 C x all: 0.20				SXT: 0.03 C x all: 0.02				SXT: 0.06 C x all: 0.05			

Table 3. Effect of certain chemicals and sucrose as vase solutions on superoxide dismutase (SOD) and glutathione reductase (GR) and lipoxygenase (LOX) activity and lipid peroxidation in the petals of gladiolus cut spikes on 5th DAT

Treatments (T)	Superoxide dismutase (units mg^{-1}fw min^{-1})				Glutathione reductase (ΔOD 412 g^{-1} fw min^{-1})				LOX activity (ΔOD min^{-1} g^{-1}fw)				Lipid peroxidation (TBARS nmol g^{-1} fw)			
	sucrose				sucrose				sucrose				sucrose			
Chemicals	S_1 (2%)	S_2 (5%)	S_3 (8%)	Mean (T)	S_1 (2%)	S_2 (5%)	S_3 (8%)	Mean (T)	S_1 (2%)	S_2 (5%)	S_3 (8%)	Mean (T)	S_1 (2%)	S_2 (5%)	S_3 (8%)	Mean (T)
$T_{0\ (no\ chemical)}$	2.50	2.63	2.10	2.34	1.80	2.00	1.53	1.78	24.4	23.3	22.60	23.91	24.47	23.50	24.03	24.0
$T_{1\ (0.2\ mM\ AgNO3)}$	2.35	2.60	2.0	2.32	1.73	2.00	1.53	1.76	25.33	24.30	24.27	24.63	25.0	24.23	24.27	24.5
$T_{2\ (0.4\ mM\ AgNO3)}$	2.40	2.83	3.00	2.74	2.00	2.00	1.90	1.97	24.57	23.83	24.37	24.26	24.40	23.67	24.47	24.18
$T_{3\ (0.6\ mM\ AgNO3)}$	2.50	3.50	2.37	2.79	1.70	2.00	1.60	1.76	24.3	24.50	24.43	24.08	24.20	23.33	24.27	23.93
$T_{4\ (0.2\ mM\ STS)}$	2.60	3.60	2.10	2.78	1.70	1.93	1.90	1.84	24.87	24.60	24.07	24.51	25.0	124.60	24.07	24.56
$T_{5\ (0.4\ mM\ STS)}$	2.43	4.00	2.93	3.12	1.50	2.10	1.60	1.73	24.60	23.87	24.13	24.20	24.60	23.50	24.07	24.06
$T_{6\ (0.6\ mM\ STS)}$	2.50	3.60	2.50	2.87	1.90	2.132	1.80	1.94	24.20	23.87	24.27	24.11	24.20	23.50	24.40	24.03
$T_{7\ (100\ ppm\ 8\text{-}HQ)}$	16.33	16.90	15.77	6.33	3.63	4.00	3.53	3.72	15.33	16.83	19.23	17.13	15.67	13.77	19.17	16.2
$T_{8\ (200\ ppm\ 8\text{-}HQ)}$	16.70	17.26	16.50	6.82	4.00	4.20	3.80	4.00	17.00	9.33	12.90	13.08	13.83	9.17	13.40	12.13
$T_{9\ (300\ ppm\ 8\text{-}HQ)}$	16.60	17.80	16.43	6.94	3.93	4.50	3.70	4.04	12.00	8.50	11.70	10.71	13.50	9.00	13.20	11.10
Mean (S)	6.69	7.45	6.57		2.04	2.24	1.98		21.67	20.29	21.34		21.48	119.9	21.58	
Control (C)	2.33				1.50				25.50				24.7			
C.D. at 5%	T: 0.21 S: 0.12 SXT: 0.37 C x all: 0.28				S: 0.07 T: 0.12 SXT: 0.35 C x all: 0.20				S: 0.77 T: 1.4 SXT: 2.4 C x all: 2.34				S: 0.19 T: 0.35 SXT: 0.60 C x all: 0.60			

Table 4. Effect of certain chemicals and sucrose as vase solutions on membrane stability index (%) of the petal tissue on 6th DAT, vase life and flower quality of gladiolus cut spikes

Treatments (T)	Membrane stability index (MSI)				Vase life (days)				Flower quality (Visual basis)		
	sucrose				sucrose				sucrose		
Chemicals	**S_1 (2%)**	**S_2 (5%)**	**S_3 (8%)**	**Mean (T)**	**S_1 (2%)**	**S_2 (5%)**	**S_3 (8%)**	**Mean (T)**	**S_1 (2%)**	**S_2 (5%)**	**S_3 (8%)**
T_0 (no chemical)	68.33 (56.27)	69.83 (56.68)	70.43 (57.25)	69.7 (56.74)	07.8	09.8	09.7	09.17	2	2	2
T_1 (0.2 mM AgNO3)	67.83 (55.45)	69.83 (56.69)	68.83 (56.07)	68.8 (56.07)	09.8	10.8	10.8	10.50	2	3	2
T_2 (0.4 mM AgNO3)	69.83 (56.69)	70.83 (57.31)	70.17 (57.20)	70.3 (57.07)	11.4	12.5	11.8	12.17	2	3	2
T_3 (0.6 mM AgNO3)	69.83 (56.69)	70.83 (57.52)	69.67 (56.38)	70.1 (56.86)	10.5	11.4	11.5	11.50	2	2	2
T_4 (0.2 mM STS)	68.3 (55.56)	69.83 (56.69)	68.83 (56.28)	69.0 (56.31)	09.8	10.8	10.5	10.50	2	3	2
T_5 (0.4 mM STS)	70.07 (56.83)	70.83 (57.52)	70.43 (56.98)	70.4 (57.12)	11.2	11.8	11.7	10.50	2	3	2
T_6 (0.6 mM STS)	69.96 (57.03)	70.83 (57.31)	69.67 (56.61)	70.2 (56.99)	11.1	11.4	11.8	11.83	2	3	2
T_7 (100 ppm 8-HQ)	73.83 (59.23)	75.83 (60.78)	74.83 (59.89)	74.8 (59.97)	13.8	14.8	13.8	14.17	3	4	3
T_8 (200 ppm 8-HQ)	75.83 (60.56)	77.83 (61.91)	76.83 (58.12)	76.8 (60.20)	15.8	17.9	16.5	16.83	5	5	5
T_9 (300 ppm 8-HQ)	79.83 *(63.31)	82.33 (65.40)	79.83 (63.31)	80.7 (64.01)	16.8	19.8	16.5	17.83	5	5	5
Mean (S)	71.42 (57.80)	72.88 (57.78)	71.95 (57.81)		11.93	13.23	1	2	.	6	3
Control (C)	67.0 (55.10)				8.3				2.0		
C.D. at 5%	T: 1.02 S: 0.60 SXT; 1.77 C x all: 1.7				S: 0.15 T: 1.0 SXT: 0.47 C x all: 0.41				**Grading on visual basis:** 5: Excellent, 4: Good, 3: Intermediate, 2: Poor, 1: very poor		

compared to all other treatments (Table 4). The control recorded minimum MSI (67%), vase life (8.3 days) and poor flower quality (2 grade). The role of 8-HQ with sucrose on membrane stability and vase life has been outlined in Fig. 1. The stabilized membrane integrity of the petal tissue with the above mentioned treatment can be attributed to diminished lipid peroxidation in the petal cells, which, sustained the fluidity and integrity of the lipid bilayers of the membrane system (Borochov and Woodson 1989). Secondly, the increased activities of SOD and GR facilitated a protective role on stabilization of bio-membranes (Scandalios 1993, Klapheck 1988).

Fig. 1. Role of 8-HQ and sucrose on membrane stability index of the petal tissue and vase life of gladiolus cut spikes

The increased vase life and improved flower quality with the 300 ppm 8-HQ and 5% sucrose as vase treatment was thus a combined effect of optimum metabolic cell activities with the sufficient sucrose availability to the cells with enhanced fresh weight and dry weight with optimum water uptake. The well established SOD and GR activity, decreased lipid peroxidation and high MSI of the petal tissue delayed the petal senescence and extended the longevity of the cut spikes. The increased LOX activity inducing lipid peroxidation has been associated with wilting and senescence of cut flowers (Paliyath and Droillard 1992). The cut spikes treated with 200 or 300 ppm 8-HQ and 5% sucrose appeared fresh and turgid with optimum water and sugar status and developed bright petal colour on account of increased petal pigments and thus exhibited excellent flower quality.

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