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Effect of pulsing treatments for enhancing shelf-life of cut Asiatic lilium cv. Elite

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ABSTRACT

Studies were conducted on cut Asiatic *Lilium* cv. Elite to assess the effectiveness of various floral preservatives as pulsing treatments for delaying senescence and prolonging vase life. Uniform spikes of lilium at bud colour break stage were brought to the laboratory in the morning and placed in 8 different pulsing solutions consisting of sucrose (Suc) 5%, aluminium sulphate (AS) 400 ppm, silver thio-sulphate (STS) 2.0 mM and citric acid (CA) 1000 ppm alone and in combination with sucrose. Distilled water without any chemical served as the control. Among individual treatments, STS 2.0 mM maintained better water relations and flower quality compared to others. STS also showed superiority over other treatments when combined with Suc 5% by providing largest flower size (16.74 cm) with maximum vase life (17.29 days) owing to most-favourable water relations parameters.

Key words: *Lilium*, pulsing treatment, vase life

INTRODUCTION

Among various commercially grown cut flowers, lilium has just opened its way in cut flower market in our country, and enjoys a status of pride among cut flowers in world, being next only to tulip. Lilium ranks 6th among top ten cut flowers of the world. In production of cut flowers, one of the most important aspects is to deliver the flowers in garden – fresh condition to the market. About 28-32% annual loss has been recorded in flowers due to traditional methods of growing and poor post-harvest handling measures (Dadlani, 1997). Although vase life and quality of flowers are genetically decided, it can be manipulated to certain extent by improved production technology and by adopting effective post-harvest handling measures. Early senescence poses difficulties in transport and long distance marketing of flowers. The quality and vase life of cut flowers can be improved by loading them with sugars immediately after harvest as pulsing treatment. Different biocides/ antioxidants have also been used as supplement to the pulsing solutions (Khan *et al*, 2007; Singh *et al*, 2007). However, efforts made with regard to lilium are meagre. Therefore, in order to delay the senescence and reduce the post-harvest losses the present work was planned to find out the effective pulsing treatments for prolonging the vase life and quality of cut lilium.

MATERIAL AND METHODS

Lilium cv. Elite was grown in the experimental fields of the Division of Floriculture, Medicinal and Aromatic Plants, SKUAST-K, Shalimar during the summer of 2006-07. Healthy, good looking, stout and uniform sized spikes (90 cm) with comparable flower bud diameter (1.80 cm) were harvested in the morning at bud colour break stage, brought to the laboratory and pre-cooled at 1^{0}C for a period of 45 minutes. The spikes were re-cut and placed in various preservative solutions comprised of sucrose (Suc 5% - T_1), aluminium sulphate (AS 400 ppm - T_2), silver thio-sulphate (STS 2.0 mM - T_3), citric acid (CA 1000 ppm - T_4), T_1 + T_2 (T_5), T_1 + T_3 (T_6), T_1 + T_4 (T_7) and water as control (T_8) for 12 h. All the treatments were replicated thrice with five spikes as one sample unit. The volume of solution provided to each spike was 200 ml. The vases were kept in the laboratory at room temperature (20 ± 2 ^{0}C) with 70 ± 5% relative humidity under natural light. Various post harvest parameters were estimated at every two day's intervals as under:

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- Water uptake (g/spike)- (W_u) = $[C + S]_1 - [C+S]_2$
- Water loss (g/spike)- (W_l) = $[C + S + F]_1 - [C+S+ F]_2$
- Water balance (g/spike)- (W_b) = $W_u - W_l$
- Water loss/water uptake ratio = W_l / W_u
- Fresh weight changes (%) – (F_w) = $\frac{FW_1 - FW_2}{FW_1} \times 100$

Where, C = weight of container (g); S = weight of solution (g); F = weight of flower spike (g); FW_1 = Initial weight of flower spike; FW_2 = Final weight of flower spike; 1 = initial; 2= final

Vase life of the spike was recorded from the day of anthesis of the first flower bud to the senescence of last flower. The diameter of second flower was measured with the help of measuring scale when it was full open. Data obtained were analyzed for critical difference among the various treatments under completely randomized design (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Water uptake

Data presented in Table 1 revealed that different pulsing treatments have significant effect on water uptake in cut lilium spikes. Sucrose 5% + STS 2.0 mM (T_6) exhibited the highest water uptake throughout the vase period followed by sucrose 5% + AS 400 ppm (T_5) and sucrose 5% + citric acid 1000 ppm (T_7) against the minimum water uptake in control (T_8), which in turn was also reflected in their cumulative water uptake of 32.55 (T_6), 29.87 (T_5), 27.44 (T_7) and 19.11 g/spike (T_8). Sucrose and other chemicals also individually improved daily as well as cumulative water uptake significantly with aggregated amounts in order of 19.95 g/spike (sucrose 5% - T_1), 22.35 g/spike (CA 1000 ppm – T_4), 23.60 g/spike (AS 400 ppm- T_2) and 24.50 g/spike (STS 2.0 mM – T_3). Data also showed that the rate of water uptake was faster during early days (day 2 to day 8) and thereafter gradually declined during later days (day 8 to day 14) to reach minimum on 14th day. These results are also in close agreement with those of Gowda (1994), who observed that solutions of sucrose, STS alone or in combination improved water uptake in gladiolus. Maintenance of higher water uptake in pulsing solution of sucrose may be attributed to its role in absorbing more water through lowering the osmotic potential of flower tissues. Aluminium sulphate, silver thio-sulphate and citric acid are well known germicides which inhibit the vascular blockage caused by various micro organisms and used for improving the shelf life of cut flowers. The higher water uptake in combined treatments of sucrose plus other biocides may be attributed to their additive role by clearing the path of water movement through inhibiting the vascular blockage (Khan *et al*, 2007).

Water loss

Data presented in Table 2 revealed that various pulsing treatments had significant influence on water loss behaviour of cut Asiatic lilium throughout the period compared with control which could also be evidenced from the cumulative data on water loss. The pattern of daily as well as cumulative water loss was similar to that of the water uptake, i.e. it was faster during the early days and declined afterward wherein T_6 showed maximum water loss which was followed by T_5, T_7, T_2, T_4, T_1, T_8 and T_3 with the cumulative water loss of 17.73, 17.35, 16.69, 15.91, 14.88, 13.99, 13.86 and 11.47 g/spike, respectively. Our results are in close conformity with those of Gowda and Murthy (1992) who reported that water uptake and thus water loss was significantly higher in sucrose + STS treatments in case of cut gladiolus.

Water balance

Statistical analysis of the data portrayed that different pulsing solutions have significant consequence on

Table 1. Effect of pulsing treatment on daily water uptake (g/spike) in cut *Lilium* cv. Elite

Treatment	Daily water uptake (g/spike) Days after pulsing							Cumulative water uptake (g/spike)
	2	4	6	8	10	12	14	
T_1-Suc 5%	2.87	4.51	4.63	3.61	3.21	1.01	0.11	19.95
T_2-AS 400 ppm	3.06	4.84	4.96	4.31	3.91	2.11	0.41	23.60
T_3-STS 2.0 mM	3.08	5.01	5.16	4.71	4.01	2.46	0.61	24.50
T_4-CA 1000 ppm	3.00	4.62	4.79	3.91	3.61	1.81	0.16	22.35
T_5-Suc 5% + AS 400 ppm	2.98	5.82	5.98	5.31	4.51	3.01	2.26	29.87
T_6-Suc 5% + STS 2.0 mM	3.10	6.00	6.21	5.91	4.81	3.51	3.01	32.55
T_7-Suc 5% + CA 1000 ppm	3.13	5.64	5.71	5.01	4.31	2.71	0.93	27.44
T_8-Control	3.11	4.32	4.46	3.21	3.01	0.94	0.06	19.11
CD *(p=0.05)*	0.005	0.005	0.011	0.010	0.007	0.006	0.012	0.038

Table 2. Effect of pulsing treatment on daily water loss (g/spike) in cut *Lilium* cv. Elite

Treatment	Daily water loss (g/spike) Days after pulsing							Cumulative water loss (g/spike)
	2	4	6	8	10	12	14	
T_1-Suc 5%	1.00	2.33	3.16	3.21	2.90	1.11	0.28	13.99
T_2-AS 400 ppm	1.09	2.38	3.31	3.31	2.98	2.06	0.51	15.91
T_3-STS 2.0 mM	1.08	2.41	3.36	3.36	3.01	2.39	0.66	11.47
T_4-CA 1000 ppm	1.01	2.35	3.26	3.26	2.91	1.88	0.21	14.88
T_5-Suc 5% + AS 400 ppm	1.10	2.48	3.48	3.51	3.11	2.46	1.21	17.35
T_6-Suc 5% + STS 2.0 mM	1.13	2.51	3.52	3.61	3.21	2.51	1.26	17.73
T_7-Suc 5% + CA 1000 ppm	1.12	2.46	3.41	3.41	3.06	2.41	0.82	16.69
T_8-Control	1.15	2.26	3.11	3.16	2.86	1.06	0.26	13.86
CD *(p=0.05)*	0.042	0.008	0.010	0.011	0.009	0.009	0.004	0.039

water balance of cut lilium spikes. Data (Table 3) revealed that in general, water balance increased during initial days (Day 2 to day 4) and subsequently decreased to reach minimum at day 14. It is also interesting to note that all the combined treatments sustained a positive water balance throughout the post harvest life with greatest amount in "sucrose 5% + STS 2.0 mM" (0.40 g/spike) followed by "sucrose 5% + AS 400 ppm" (0.11 g/spike) and "sucrose 5% + CA 1000 ppm" (0.03 g/spike) on the last day of observation, whereas, all other treatments showed negative values owing to more water loss through transpiration than absorption. This disparity in water balance due to various pulsing treatments was also apparent in case of cumulative water balance with greatest quantity in "sucrose 5% + STS 2.0 mM" (14.80g /spike), followed by "sucrose 5% + AS 400 ppm" (12.52 g/spike), "sucrose 5% + CA 1000 ppm" (10.75 g/spike) against the minimum of 5.25 g/spike in control. The differences in water balance were the outcome of the water uptake and water loss behaviour (Table 4). Instrumental role of sugars in improving the water uptake and restricting the stomatal closer might have resulted in improved water balance. Antimicrobial agents further supplemented the water balance by inhibiting vascular blockage (Reddy *et al*, 1996).

Table 3. Effect of pulsing treatment on daily water balance (g/spike) in cut *Lilium* cv. Elite

Treatment	Daily water balance (g/spike) Days after pulsing							Cumulative water balance (g/spike)
	2	4	6	8	10	12	14	
T_1-Suc 5%	1.87	2.18	1.47	0.40	0.31	-0.10	-0.17	5.96
T_2-AS 400 ppm	1.97	2.46	1.65	1.00	0.93	0.05	-0.10	7.96
T_3-STS 2.0 mM	2.00	2.60	1.80	1.35	1.00	0.07	-0.05	8.77
T_4-CA 1000 ppm	1.99	2.27	1.53	0.65	0.70	-0.07	-0.05	7.02
T_5-Suc 5% + AS 400 ppm	1.88	3.34	2.50	1.80	1.40	0.55	1.05	12.52
T_6-Suc 5% + STS 2.0 mM	1.97	3.49	2.69	2.30	1.60	1.00	1.75	14.80
T_7-Suc 5% + CA 1000 ppm	2.01	3.18	2.30	1.60	1.25	0.30	0.11	10.75
T_8-Control	1.96	2.06	1.35	0.05	0.15	-0.12	-0.20	5.25
CD *(p=0.05)*	0.010	0.010	0.005	0.008	0.009	0.038	0.039	0.300

Table 4. Effect of pulsing treatment on daily water loss/water uptake ratio in cut *Lilium* cv. Elite

Treatment	Daily water loss/water uptake ratio Days after pulsing						
	2	4	6	8	10	12	14
T_1-Suc 5%	0.34	0.51	0.68	0.88	0.90	1.09	2.56
T_2-AS 400 ppm	0.35	0.49	0.66	0.76	0.76	0.97	1.24
T_3-STS 2.0 mM	0.35	0.48	0.65	0.71	0.75	0.97	1.08
T_4-CA 1000 ppm	0.33	0.50	0.68	0.83	0.80	1.03	1.34
T_5-Suc 5% + AS 400 ppm	0.36	0.42	0.58	0.66	0.68	0.81	0.53
T_6-Suc 5% + STS 2.0 mM	0.36	0.41	0.56	0.61	0.66	0.71	0.41
T_7-Suc 5% + CA 1000 ppm	0.35	0.43	0.59	0.68	0.71	0.88	0.88
T_8-Control	0.36	0.52	0.69	0.98	0.95	1.12	4.43
CD *(p=0.05)*	0.002	0.050	0.035	0.018	0.047	0.203	0.047

Water loss/water uptake ratio

Data reflected that in general, water loss/water uptake ratio of cut lilium spikes increased gradually with time to reach maximum on the last day of the treatments (Table 4). Pulsing of spikes in sucrose 5% in combination with other preservatives resulted in lesser values of water loss/ water uptake ratio as compared with the individual chemicals whereas, the maximum water loss/ water uptake ratio was recorded in control. Water loss/ water uptake ratio on day 14 clearly indicated that among the combined treatments, T_6 maintained a better ratio (0.41) as compared to T_5 (0.53) and T_7 (0.88) whereas individual treatments gave better result with T_3 (1.08) followed by T_2 (1.24), T_4 (1.34) and T_1 (2.56) against a poor ratio of 4.43 in control. Though the treatments which showed more water uptake also accompanied with more water loss, the differences in water loss/water uptake ratio in various treatments may be attributed to the differences in degree of water loss due to various treatments. The lowered water loss/water uptake ratio in treated spikes as compared to control was in line with the finding that water balance significantly increased by sucrose plus metallic salts when compared to control in case of gladiolus (Reddy *et al*., 1996).

Fresh weight change

As evidenced from the data fresh weight change differed significantly among the treatments and the difference increased with time in the vase (Table 5). Fresh weight was found to be increased in all the treatments up to day 6 and then decreased sharply from day 8 to the last day. Spikes treated in pulsing solutions of sucrose plus other chemicals in combination (T_5, T_6 and T_7) were able to maintain a positive value of fresh weight change even on last day indicating a gain in their fresh weight while as all other treatments including control showed negative values owing to loss in their fresh weight. At day 6 the maximum fresh weight gain of 20.13 per cent was exhibited by T_6 followed by other treatments of sucrose in combination with other metabolites and the chemicals alone which were at par with each other. Superiority of T_6 in maintaining the fresh weight was sustained even at day last where a fresh weight gain of 2.01 per cent was recorded as compared to 1.51 and 0.96 per cent increase in fresh weight by T_5 and T_7, respectively. Stimart (1983) reported that there was initial increase in fresh weight followed by decline and the increase being larger in flowers kept in sucrose than those kept in de-ionized water. Decline in fresh weight of spikes may be attributed to decrease in water relation parameters. Beside, the second peak (climacteric rise) in the respiratory drift, which is considered to decide the final senescence stage (Swarup, 1993) and decrease in pool of dry matter and respirable substrates especially in petals might be considered as other important factors responsible for decrease in fresh weight of lilium spikes.

Flower size

Data pertaining to the effect of various pulsing treatments on floral attributes described that various floral traits varied significantly on account of different pulsing solutions (Table 6). Combined treatments of sucrose with other chemicals exhibited better results in terms of floral attributes as compared with individual effect of different chemical preservatives. A maximum size of flower in terms of flower diameter (16.74 cm) was recorded in “sucrose 5% + STS 2.0 mM”, followed by “sucrose 5% + AS 400 ppm” (15.61 cm) and “sucrose 5% + CA 1000 ppm” (15.21 cm) against the lowest flower diameter (13.81 cm) in control, while sucrose and other chemical treatments individually gave flower diameter in between. Our results also confirm the findings of Khan *et al* (2007). Therefore, in the present studies STS in combination with sucrose might have inhibited the vascular blockage by acting as antimicrobial agents thus enhanced water uptake and there by increased cell growth/ volume hence improved the flower size.

Table 5. Effect of pulsing treatment on fresh weight change (%) of cut *Lilium* cv. Elite

Treatment	Fresh weight change (%) Days after pulsing						
	2	4	6	8	10	12	14
T_1-Suc 5%	11.83	17.71	19.01	11.01	7.04	-2.01	-3.85
T_2-AS 400 ppm	12.01	17.54	18.46	8.01	3.11	0.22	-1.98
T_3-STS 2.0 mM	12.33	18.12	19.03	8.54	4.33	0.56	-1.79
T_4-CA 1000 ppm	11.93	17.94	18.01	8.22	1.51	-1.58	-2.31
T_5-Suc 5% + AS 400 ppm	12.71	18.49	19.73	12.11	7.32	3.01	1.51
T_6-Suc 5% + STS 2.0 mM	13.01	19.72	20.13	13.72	8.49	4.32	2.01
T_7-Suc 5% + CA 1000 ppm	11.73	18.02	19.52	10.74	5.31	2.49	0.96
T_8-Control	13.02	19.03	19.72	7.76	2.11	-2.22	-3.91
CD *(p=0.05)*	0.032	0.035	0.019	0.047	0.032	0.054	0.030

Table 6. Effect of pulsing treatment on floral attributes of cut *Lilium* cv. Elite

Treatment	Flower diameter (cm)	Longevity of 1st flower (day)	Days taken to open 2nd flower	Longevity of 2nd flower(day)	Vase life (day)
T_1-Suc 5%	14.01	4.47	1.25	4.30	12.01
T_2-AS 400 ppm	14.61	4.49	1.50	4.32	12.34
T_3-STS 2.0 mM	14.91	4.81	1.75	4.43	14.34
T_4-CA 1000 ppm	14.31	4.64	2.00	4.32	13.61
T_5-Suc 5% + AS 400 ppm	15.61	5.04	2.00	4.78	16.01
T_6-Suc 5% + STS 2.0 mM	16.74	5.08	2.50	4.98	17.29
T_7-Suc 5% + CA 1000 ppm	15.21	4.98	2.00	4.57	14.61
T_8-Control	13.81	3.93	1.00	3.54	11.34
CD *(p=0.05)*	0.046	0.101	0.005	0.082	0.021

Flower longevity

Sucrose 5% along with STS 2.0 mM (T_6) also resulted in maximum flower longevity of the 1st and 2nd flower (5.08 and 4.98 day) as well as the days taken to open 2nd flower (2.50 day) while among the individual treatments the highest longevity of the 1st and 2nd flower (4.81 and 4.43 day) and days taken to open 2nd flower (1.75 day) was recorded with T_3 against the minimum values of these attributes (3.93, 3.54 and 1.00 day) in control. Sucrose in combination with preservative (STS) showed significant increase in flower longevity as sucrose supply the necessary energy requirements while as STS is known to work as anti-ethylene and biocide agents.

Vase life

A significant improvement in vase life of cut lilium was witnessed due to various pulsing treatments. Combined treatments again showed their superiority as exhibited highest vase life with maximum of 17.29 day in T_6, followed by T_5 (16.01 day) and T_7 (14.61 day), while the vase life of cut lilium in individual treatments remained between 12.01 day and 14.34 day against a minimum vase life (11.34 day) recorded in control. Similar results have also been reported by earlier workers (Reddy *et al,* 1996).

Starvation in sugar pool, plugging of vascular tissues by micro-organisms and damage by ethylene have been identified as the major cause of poor keepability of many cut flowers (van Doorn, 2004). Applied sugars might have recompensed the starved sugars while as STS improved the water balance and protect the flowers from the damaging effect of ethylene and thus maintained an improved vase life of flowers.

Pulsing of spikes in sucrose 5% + STS 2.0 mM for a period of 12 hours proved most influential in maintaining a good water relations which consequently improved flower quality and vase life by about 6 days as compared to control. Therefore, the technique may be exploited for the transport and shipment of lilium spikes to fetch the beautiful return and promote the floriculture industry.

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