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Effect of Pulsing Solution and Duration on Post-Harvest Longevity of Asiatic lily CV. Black Out

Kongkana Gogoi*, Sunil Bora, Madhumita Choudhury Talukdar

Department of Horticulture, Assam Agricultural University, Jorhat, Assam, India

ABSTRACT

An experiment was carried out in the experimental laboratory of Department of Horticulture, Assam Agricultural University, Jorhat during January-February, 2016-2017 to study the effect of pulsing solutions on post-harvest life of lily flowers. Lily stems were harvested when the first flower bud showed full color. The experiment was laid out in Completely Randomized Design with 6 treatments and 2 pulsing duration (12 h and 24 h), replicated 3 times. The pulsing treatments were P0 (distilled water), P1 (10% sucrose), P2 (100 ppm AgNO3), P3 (10% sucrose+100 ppm AgNO3), P4 (50 ppm BA) and P5 (10% sucrose+50 ppm BA). After the treatments, each stem was maintained for postharvest evaluation in an individual 300 ml conical flask with 100 ml of 2% sucrose solution. Within each treatment, the number of buds per stem was kept constant as possible for ease of data recording. Pulsing of cut stems with 10% sucrose and 50 ppm BA (P5) for 24 h was observed to be best in terms of vase life (13.00 days), quality and biochemical parameters viz., uptake of pulsing solution (6.21 ml/stem), higher rate of vase solution uptake (15.48 g/stem), fresh weight (125.30%), flower diameter (17.67 cm), total chlorophyll content (1.17 mg/g FW), and total soluble solid (4.45^{0}Brix). However flower stems were pulsed with 10% sucrose and 100 ppm AgNO3 for 24 h gave the maximum bud length (8.27 cm) & highest reducing sugar (5.18%) in tepals. Thus considering the positive effects on vase life of lily cut flowers, 10% sucrose and 50 ppm BA for 24 h could be considered as the best combination for pulsing solution.

Key words: *Benzyladenine (BA); Silver Nitrate (AgNO3); Sucrose, Total chlorophyll content; Total soluble solids; Vase life*

Introduction

Lily (*Lillium)* is one of the most beautiful and popular ornamental bulbous plants belonging to the order Liliales, subclass Monocotyledonae and family Liliaceae. The appearance, beauty and color of the bloom are very spectacular and attractive. Nowadays, cut flowers occupy an important position in the local and foreign markets because of their importance as a source of national income. Flowers are very popular in floral bouquets and flower arrangement. Hence, maintaining good quality of cut flowers and extending the vase life are considered important and practical for having acceptable products for the markets.

Several horticultural products including cut flowers are highly perishable in nature. It is estimated that approximately 30-50% losses incurred due to poor handling and mismanagement of cut flowers during post-harvest handling [1]. Today floriculture industry is facing a threat as a consequence of non-adoption of proper post-harvest handling practices. In many developing countries, the supply of cut flowers is very seasonal due to the lack of pre-treatment, refrigeration, and poor packaging leads to poor product quality and short vase life [2]. Like other cut flowers, the short vase life of lilies may be one of the most important reasons for the inability of florists to develop a suitable market [3]. The main symptoms that shorten the vase life are abscission of buds, lack of bud opening, petal wilting, and leaf yellowing due to the sensitivity of cut lilies to ethylene. The vase life of lilies depends on the cultivated varieties, as well as the duration of the handling and shipping [4]. Hence, flower longevity of lilies, as with other cut flowers, is a commercially important parameter or post-storage quality characteristic. Keeping of cut flowers in various preservatives has effectively been used form long time to improve their longevity [5]. Pulsing refers to loading of cut stems with sucrose and chemicals for a period ranging from several hours to as long as 2 days [6]. It is one of the most important steps in the sequence of post-harvest handling of cut flowers. The use of pulsing solution is becoming common for enhancing flower vase life and to keep leaves green for longer period on flower branches. Pulsing solutions for lilies are often composed of a mixture of chemicals, such as carbohydrates, plant growth regulators, ethylene inhibitors, biocides, and acidifiers [7]. Sucrose is the major source of carbon for petal growth and the energy supply for cut flowers [8]. Silver nitrate ($AgNO_3$) is a well-known germicide & the inclusion of $AgNO_3$ in to the pulsing solutions generally makes xylem vessels clean and thereby improve the solution uptake. The role of plant growth regulators like BA (Benzyl Adenine) and GA_3 is also important in postharvest flower quality and life of different commercial cut flowers [9,10]. These chemicals affect several metabolic processes in plants like inhibit ethylene production, translocate sugars, decreasing membrane permeability, maintain cell turgor pressure, reduce respiration, transpiration and delay senescence.

Specific pre-harvest and post-harvest handling methods are lacking for cut flowers, and therefore farmers, traders, and retailers face problems to market and distribute high quality flowers to consumers [11]. Several researches in lily flower for extending its longevity has been reported, but it is meagre (particularly on lily cv. Black Out) as large variation exists among the cultivars. Standardization and evaluation of proper technique of packaging and storage of lily is important for development of market strategy and accessibility at international market for enhancing export potential. Since an attempt was made to find out the effects of pulsing treatment with Sucrose, BA & $AgNO_3$ on the post storage attributes of cut lilies at Assam Agricultural University, Jorhat.

Materials and Methods

Plant Materials

This experiment was conducted at the experimental laboratory of Department of Horticulture, Assam Agricultural University during January-February, 2016-2017. Uniform, superior quality cut flower stems were harvested in the morning hours (8-9 am) or in the late evening with the help of sharp secateurs. The stems were harvested at commercial stage of harvest, when the largest flower bud showed full color. After harvesting, the flowers were taken to the experimental laboratory in a bucket containing clean water and immediately prepared for the experiment.

Treatment Details

The pulsing treatments were P_0 = Control (Distilled water), P_1 = 10% Sucrose, P_2 =100 ppm $AgNO_3$, P_3 = 10% Sucrose+100 ppm $AgNO_3$ **,** P_4 = 50 ppm Benzyl adenine (BA), P_5= 10% Sucrose+50 ppm Benzyl adenine (BA) to study the effect of pulsing solution and duration on post-harvest life of cut Asiatic lily CV. Black Out. The cut lilies were treated for 2 set of duration viz. D_1= 12 h & D_2= 24 h. Hence total treatments were 12 (6 x 2) and these were T_1 (P_0D_1): Distilled water for 12 h; T_2 (P_1D_1): 10% sucrose for 12 h; T_3(P_2D_1): 100ppm $AgNO_3$ for 12 h; T_4 (P_3D_1): 10% sucrose+100 ppm $AgNO_3$ for 12 h; T_5(P_4D_1): 50ppm BA for 12 h; T_6(P_5D_1): 10% sucrose+50 ppm BA for 12 h; T_7 (P_0D_2): Distilled water for 24 h; T_8 (P_1D_2): 10% sucrose for 24 h; T_9 (P_2D_2): 100 ppm $AgNO_3$ for 24 h, T_{10} (P_3D_2): 10% sucrose+100 ppm $AgNO_3$ for 24 h; T_{11} (P_4D_2): 50ppm BA for 24 h and T_{12} (P_5D_2): 10% sucrose+50 ppm BA for 24 h.

Preparation of Cut Stems for Experiment

As soon as arrival to the laboratory all the cut stems were trimmed to 45 cm length by cutting with the help of sharp and sterilized secateurs and the lower 10 cm of the stems were defoliated. After that, flowers were weighed and then were immersed in different concentration of pulsing solutions for 12 h and 24 h respectively. A slanting cut of 2 cm was given to the lower end of cut stem before placing in the pulsing solution. For each treatment, the number of buds per stem was kept constant as possible for ease of data recording. After the pulsing treatments, each stem was maintained for postharvest evaluation in an individual 300 ml conical flask with 2% sucrose at room condition. The mouth of the vase was closed with polyethylene sheets to check evaporation to reduce further contamination. Wilting of last flower of the inflorescence, browning of flowers and shedding of tepals were used as the criteria for terminating vase life or end of vase life.

The data generated from the experiment were subjected to appropriate statistical analysis. Completely Randomized Design (CRD) was followed separately for each observation and each treatment was replicated thrice. The analysis of variance and interpretation of data were done as per procedure given by Panse and Sukhatame [12]. Level of significance used in 'F' test was P=0.05. Critical Difference (CD) values were calculated only wherever the 'F' tests was found significant.

Results and Discussion

The present research work was carried out to study the effect of pulsing solution and duration on post harvest longevity of Asiatic lily CV. Black Out. The data pertaining to various characters obtained from the present investigation as well as relevant discussion have been summarized below:.

Pulsing Solution Uptake (ml/stem)

Data presented in Table 1, showed significant variation in pulsing solution uptake. From the analysis of data, it was evident that the highest uptake of pulsing solution (6.21 ml/stem) was in treatment comprising 10% sucrose and 50ppm BA for 24 h. All the treatments showed an increase in solution uptake till 4th day and thereafter followed a declining trend till the senescence of individual flowers. The higher absorption of pulsing solution may be attributed to the combined effect of sucrose and BA. Sucrose in the pulse solution provided additional respirable substrate to the cut flowers resulting in longer vase life [13].

Bud Length (cm) and Opening of Florets (%)

From the Table 1, it was observed that bud length and opening of florets did not differ significantly due to different treatments. All the treatments exhibited better flowering percentage as each and every bud reached to full blooming. The bud length was found maximum with a value of 8.13 cm in P_5D_2 (10% sucrose + 50 ppm BA for 24 h). The possible reason might be due to that each flower bud contains sufficient carbohydrate for bud opening and for maintaining flower longevity [8]. Arrom and Munné-Bosch reported that sucrose addition to pulsing solution accelerated flower opening, delayed senescence and altering the hormonal balance of several floral tissues [14]. This might be attributed to improved water uptake, lower respiration rate and improved water balance [15]. Similar findings have been reported by Hutchison et al.in tuberose and Dhiman et al. in *Lilium* [16,17].

Vase Solution Uptake (g/flower stem)

It was observed from Table 1, that all the treatments showed an increase in solution uptake till 4th day and thereafter followed a declining trend till the senescence of individual flowers. The highest uptake of solution was in treatment comprising 10% sucrose and 50 ppm BA for 24 h. The higher absorption of vase solution in this treatment may be attributed to the combined effect of sucrose and BA. Sucrose in the pulse solution provided additional respirable substrate to the cut flowers. Also cytokines delay petal senescence by protecting cells and proteins and thereby increased solution uptake. Reddy and Singh reported that translocated sugars accumulated in flowers which increased the osmotic potential and improved the ability of stems to absorb water [18].

Flower Diameter (cm)

A significant increase in flower diameter was obtained due to different treatment combinations. The largest flower diameter was recorded in the flowers treated with 10% sucrose and 50 ppm BA for 24 h. The increase in flower diameter in presence of BA might be due to acceleration of cell elongation and maintenance of structural integrity of chloroplast membrane system as well as stimulate photosynthesis [19]. In Lilium, Dhiman et al. found a maximum flower diameter of 18.70 cm and 18.60 cm respectively in 25 ppm BA solution over control [17].

Fresh Weight (%)

From Table 2, significant differences in fresh weight were observed till the end of the vase life due to different pulsing treatments. In all the treatments, flowers lost their fresh weight from 4th day onwards. On 4th day of vase period fresh weight was found highest (125.30%) in the flowers pulsed with 10% sucrose + 50 ppm BA for 24 h and lowest (103.57%) was in T_2 (P_2D_1 =10% sucrose for 12 h). More decrease in fresh weight was observed in flowers held in distilled water. This loss in fresh weight might be due to the increase in transpiration loss. Any problem in supply of water can be correlate with rapid wilting of stem, petal, leaves and decrease in fresh weight. In the other hand the pulsed flowers maintained a higher rate of fresh weight till senescence. This might be due to the presence of sucrose that increased the rate of water uptake and maintained better water balance throughout the vase period [18]. Addition of BA also resulted in higher rate of fresh weight and delayed the loss in fresh weight by improving the solution uptake. Hutchinson reported that BA supplemented vase solutions gave better water balance and maintained higher fresh weight over a longer time during which control flowers lost more than 60% of their initial fresh weight [16].

Vase Life

It was apparent from the data presented in the Table 2 that use of pulsing solutions significantly increased the vase life of lily cut flowers. The vase-life of lily cut flowers pulsed with 10% sucrose and 50ppm BA for 24 h before holding

Table 1: Data of pulsing solution uptake, bud length, opening of florets & vase solution uptake on consecutive days.

Treatment	Pulsing Solution Uptake (ml/stem)	Bud Length (cm)	Opening Of Florets (%)	Vase Solution Uptake (g/flower stem)					
				2nd day	4th day	6th day	8th day	10th day	12th day
P_0D_1: Distilled water for 12 h	3.00	7.35	100.00	4.00	7.62	4.05	1.51	0.00	0.00
P_1D_1: 10% sucrose for 12 h	5.00	7.77	88.89	5.00	9.17	6.70	3.41	1.07	0.00
P_2D_1: 100 ppm $AgNO_3$ for 12 h	4.48	8.00	100.00	8.32	12.00	8.92	4.97	1.84	0.00
P_3D_1: 10% sucrose + 100 ppm $AgNO_3$ for 12 h	5.93	8.01	100.00	10.03	13.00	10.00	5.07	3.19	1.74
P_4D_1: 50 ppm BA for 12 h	3.63	7.61	100.00	8.32	12.33	9.54	5.61	1.18	0.00
P_5D_1: 10% sucrose + 50 ppm BA for 12 h	5.77	8.03	100.00	11.40	14.00	11.41	7.87	4.01	1.98
P_0D_2: Distilled water for 24 h	3.30	7.83	100.00	4.74	8.00	4.33	1.80	0.00	0.00
P_1D_2: 10% sucrose for 24 h	5.33	7.83	100.00	5.56	10.29	7.50	3.83	1.40	0.00
P_2D_2: 100 ppm $AgNO_3$ for 24h	5.38	8.10	88.89	9.00	13.22	10.33	4.17	2.25	1.33
P_3D_2: 10% sucrose + 100 ppm $AgNO_3$ for 24 h	6.20	8.27	100.00	11.74	14.11	11.82	5.05	3.00	2.04
P_4D_2: 50 ppm BA for 24 h	4.03	7.96	100.00	9.40	11.35	9.67	5.63	1.38	1.35
P_5D_2: 10% sucrose + 50 ppm BA for 24 h	6.21	8.13	100.00	12.70	15.48	12.00	8.71	4.51	2.23
S.Ed(±)	0.12	0.22	3.70	0.59	0.74	0.53	0.43	0.23	0.12
$CD_{0.05}$	0.20	NS	NS	1.01	1.27	0.91	0.77	0.40	0.20

Table 2: Effect of pulsing solution & duration on fresh weight, flower diameter & vase life.

Treatment	Fresh Weight (%)						Flower Diameter (cm)	Vase Life (days)
	2nd day	4th day	6th day	8th day	10th day	12th day		
P_0D_1: Distilled water for 12 h	99.58	105.33	83.00	60.07	0.00	0.00	15.13	7.12
P_1D_1: 10% sucrose for 12 h	101.14	103.57	95.80	74.81	64.34	0.00	15.43	8.13
P_2D_1: 100 ppm $AgNO_3$ for 12 h	105.17	108.73	99.68	79.45	65.08	0.00	16.07	10.00
P_3D_1: 10% sucrose + 100 ppm $AgNO_3$ for 12 h	107.74	123.72	113.21	98.33	90.95	77.15	17.33	11.65
P_4D_1: 50 ppm BA for 12 h	108.79	119.50	111.26	94.67	75.25	0.00	15.83	9.00
P_5D_1: 10% sucrose + 50 ppm BA for 12 h	111.02	124.08	113.82	103.88	94.62	79.41	17.03	12.02
P_0D_2: Distilled water for 24 h	100.81	105.67	84.35	63.33	0.00	0.00	15.50	7.38
P_1D_2: 10% sucrose for 24 h	102.60	104.15	96.50	76.15	65.14	0.00	15.60	8.52
P_2D_2: 100 ppm $AgNO_3$ for 24h	106.75	110.28	101.05	81.52	67.92	60.37	16.23	10.19
P_3D_2: 10% sucrose + 100 ppm $AgNO_3$ for 24 h	108.18	124.29	113.51	99.45	91.84	78.05	17.50	12.83
P_4D_2: 50 ppm BA for 24 h	109.86	120.54	112.07	96.26	77.22	70.55	16.33	10.67
P_5D_2: 10% sucrose + 50 ppm BA for 24 h	113.41	125.30	114.30	105.29	95.38	80.13	17.67	13.00
S.Ed(±)	1.10	0.92	0.83	0.94	0.53	0.32	0.24	0.30
$CD_{0.05}$	1.87	1.57	1.42	1.60	0.91	0.54	0.41	0.51

in 2% sucrose was increased by 6 days than the non-pulsed flower (Distilled water treated flowers). The increase in vase life might be due to more solution uptake by the cut stems. Also inclusion of Cytokinins to the pulsing solution delayed petal senescence by protecting cells and proteins & thereby increases the cut flower longevity. Similar results have been recorded by Janowska and Stanecka in Calla lily [20]. Javed et al. reported a close relationship between vase life and water uptake in cut flowers [21]. Hutchison, reported that pulsing of tuberose flowers in 10% sucrose for 24 h with subsequent holding in 25 or 50 ppm BA significantly improved vase life by 2-4 days [16].

Total Chlorophyll Content (mg/g fresh weight)

The data depicted in Table 3 showed the changes in total chlorophyll content in the leaves of lily flowers between 2nd and 7th day of treatments. It was evident from the table that the chlorophyll content gradually decreases till senescence in all the treatments. The degradation rate of total chlorophyll content (0.51 mg/g FW) was found faster in P_3D_1 (10% sucrose + 100 ppm $AgNO_3$ for 12 h) at 7th day of treatments. However, the treatment containing 10% sucrose and 50 ppm BA for 24 h significantly delayed the chlorophyll degradation and thereby recorded the highest chlorophyll content (1.17 mg/g FW) at 7th day, vase life as compared to others. The possible reason for higher chlorophyll content might be due to the inclusion of BA to the pulsing solution, which can stop chlorophyll degradation [22]. Cytokinin (Particularly BA), usually inhibit leaf yellowing in many sensitive cut flowers species [23]. Emongor and Tshwenyane reported that, Benzyl adenine can increase chloroplast development and chlorophyll synthesis even after harvest and during postharvest handling of cut flowers [24].

Dry Weight (%)

Data from Table 3 showed that the lily cut flowers pulsed in different treatments differed significantly with respect to dry weight. The dry weight of flowers at senescence was recorded highest in pulsed flowers as compared to non-pulsed i.e. distilled water treated flowers. The flower stems pulsed with 10% sucrose and 50 ppm BA for 24 h significantly minimized the loss of dry weight. This might be due to the addition of cytokines like BA to the solution. The presence of BA was found best in postharvest quality of cut flowers that delayed the reduction in petal dry weight. Similar results were obtained by Amariutei et al. on gerbera who demonstrated that the dry weight of flowers was greater in pulsed inflorescences than those in water only [25].

Total Soluble Solids (°Brix)

A significant difference was observed among the treatments regarding the TSS content at senescence. It was observed from the Table 3 that TSS content increased initially and later on gradually decreased till senescence in all the treatments. Initially a higher TSS content was found ranged from 5.50°Brix to 6.00°Brix. Amongst the treatments, those flower treated with 10% sucrose + 50 ppm BA for 24 h recorded the highest TSS (4.45°Brix), which was found significantly higher than other treatments, However, the lowest value of TSS (2.67°Brix) observed in flowers held in distilled water for 12 h (P_0D_1). This could be correlated with that due to pulsing with high concentration of sucrose led to the increased levels of fructose and glucose in flower stalk and later on decreased, because of higher respiration rate as senescence starts [26].

Reducing Sugar (%)

A significant variation was observed among the treatments regarding to reducing sugar content of tepals at senescence (Table 2). The flowers pulsed in treatment comprising 10% sucrose and 100 ppm $AgNO_3$ for 24 h maintained a higher content of reducing sugar in tepals. This might be due to the higher concentration of sucrose added to the pulse solution. Nichols reported that absorbed sucrose was rapidly converted in petals to reducing sugars, which accumulated in the corolla [27]. Figueroa et al. reported that using of sucrose as holding solution significantly maximized the percentage of reducing sugars [28].

Table 3: Effect of pulsing solution & duration on total chlorophyll content, DW, TSS & reducing sugar.

Treatment	Total chlorophyll content (mg/g FW)		DW (%)	TSS (°Brix)	Reducing sugar (%)
	2nd day	7th day			
P_0D_1: Distilled water for 12 h	0.99	0.61	36.91 (6.16)	2.67	4.65
P_1D_1: 10% sucrose for 12 h	0.93	0.58	33.32 (5.86)	4.00	4.64
P_2D_1: 100 ppm $AgNO_3$ for 12 h	0.98	0.67	32.71 (5.80)	3.26	4.76
P_3D_1: 10% sucrose + 100 ppm $AgNO_3$ for 12 h	0.98	0.51	28.33 (5.41)	4.13	5.07
P_4D_1: 50ppm BA for 12 h	1.11	0.91	29.74 (5.54)	3.09	4.17
P_5D_1: 10% sucrose + 50 ppm BA for 12 h	1.20	1.04	27.71 (5.36)	4.22	5.03
P_0D_2: Distilled water for 24 h	0.97	0.63	34.81 (5.98)	2.77	4.89
P_1D_2: 10% sucrose for 24 h	0.96	0.54	29.81 (5.51)	4.18	5.17
P_2D_2: 100 ppm $AgNO_3$ for 24 h	1.11	0.63	31.78 (5.72)	3.50	4.94
P_3D_2: 10% sucrose + 100 ppm $AgNO_3$ for 24 h	1.08	0.56	26.89 (5.28)	4.40	5.18
P_4D_2: 50 ppm BA for 24 h	1.21	1.02	32.08 (5.75)	3.16	4.37
P_5D_2: 10% sucrose + 50 ppm BA for 24 h	1.34	1.17	25.74 (5.17)	4.45	5.08
S.Ed(±)	0.08	0.07	0.13	0.11	0.12
$CD_{0.05}$	NS	0.13	0.22	0.20	0.20

Conclusion

From the aforesaid findings and discussion, it could be concluded that the pulsing solutions played a vital role and showed better performance in terms of post-harvest characteristics of cut Asiatic lily flowers. Pulsing of cut stems with 10% sucrose and 50 ppm BA (P_5) for 24 h was observed to be best in terms of vase life (13.00 days), quality and biochemical parameters *viz.,* uptake of pulsing solution (6.21 ml/stem), higher rate of vase solution uptake (15.48 g/stem), fresh weight (125.30%), flower diameter (17.67 cm), total chlorophyll content (1.17 mg/g FW), and total soluble solid (4.45^{o}Brix). However flower stems were pulsed with 10% sucrose and 100 ppm $AgNO_3$ for 24 h gave the maximum bud length (8.27 cm) & highest reducing sugar (5.18%) in tepals. Among the two set of pulsing duration, 24 h pulsed flowers showed better results as compared to 12 h. Thus considering the positive effects on vase life of lily cut flowers, 10% sucrose and 50 ppm BA for 24 h could be considered as the best combination for pulsing solution.

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