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EFFECT OF HOLDING SOLUTIONS ON VASE LIFE OF PULSED *DENDROBIUM* CV. SONIA INFLORESCENCES

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Abstract: Effect of different holding solutions on vase life of pulsed and packed inflorescences of *Dendrobium* cv. Sonia were studied. Inflorescences treated with sucrose 2% + 8-HQ 400 mg l^{-1} + $AgNO_3$ 30 mg l^{-1} recorded the highest vase life of 22 days against tap water control which gave 8.33 days. Holding solutions could influence the sugar content of flowers and stalks. However, changes in fresh weight and size of the flowers were not found influenced.

Key words: *Dendrobium*, holding solutions, pulsing, vase life

INTRODUCTION

Dendrobium cv. Sonia is one of the most important cut flower orchids grown. The vase life of cut flowers, including orchids, depends on several pre- and post-harvest factors (Halevy and Mayak, 1979, 1981). To preserve the quality of cut flowers after harvest and to make them resistant to fluctuations in environmental conditions, treatment with floral preservatives is recommended. Using floral preservative solutions throughout the marketing channel reduces flower waste, improves flower longevity, general qualities and consumer satisfaction and ultimately flower value. Commercially available preservative materials usually contain a source of energy such as sugar, a biocide like 8-HQ or $AgNO_3$ to inhibit the growth of microorganisms and an acidifying agent to reduce the pH (Reid and Kofranek, 1980). This study was undertaken to establish recommendations for extending vase life of *Dendrobium* cv. Sonia using different holding solutions. The study investigated the effects of combinations of sugar (sucrose), a germicide (8-hydroxyquinoline) and Ag^+ in the form of $AgNO_3$.

MATERIALS AND METHODS

Inflorescences of *Dendrobium* cv. Sonia with a minimum of six to seven flowers with all except the terminal bud in the fully opened stage, harvested in the morning were used for the study. The freshly cut inflorescences were subjected to conditioning and pulsing treatments standardized previously (Jomy, 1998), which consisted of placement in tap water of pH 3.0 for 2 h followed by treatment with four per cent sucrose + 400 mg l^{-1} 8-HQ for 6 h and then wet packed in cardboard cartons. Standard cardboard cartons of size 75 x 20 x 15 cm were used. Wet packing was done by wrapping cotton moistened with distilled water at the basal end of each inflorescence and then inserting them in small polythene bags, which were tied up using rubber bands. After 24 hours of simulation of transport and transit, the inflorescences were placed in various treatment solutions (Table 1).

The vase life, fresh weight, dry weight, water content and size of the flowers, sugar content of flowers and stalks and electrical conductivity of vase solutions were observed. Number of days taken for the appearance of symptoms of senescence in the first flower was recorded as vase life. The vase solution was replaced on alternate days after cutting 0.5 cm of the stalk base. This process was repeated until the cessation of vase life. Total sugar was determined and expressed as percentage of glucose equivalent, on dry weight basis. Fresh weight of the inflorescence was recorded at different periods during the vase life [on first day (P_1), 4th day (P_2), 7th day (P_3) and at cessation of vase life (P_4)]. At cessation of vase life, inflorescences were dried in a hot air oven and weight of dried samples was recorded. Difference in weight of fresh and oven-dried inflorescences at cessation of vase life were recorded and its ratio to fresh weight was taken as water content. The maximum length and width of each flower in the inflorescences was taken at different periods [on first day (P_1), 7th day (P_2) and at cessation of vase life (P_3)]. Electrical conductivity of vase solutions was recorded by using conductivity bridge at different periods during the vase life. The data generated was subjected to analysis of variance using the methods suggested by Panse and Sukhatme (1985).

Table 1. Vase life, sugar content, dry weight and water content of the inflorescences

Treatments	Vase life (days)	Sugar content (%)		Dry weight (g)	Water content (%)
		Flowers	Stalks		
T1 Sucrose 2 % + 8-HQ 200 mg l^{-1} + $AgNO_3$ 20 mg l^{-1}	12.00	24.96	12.31	2.24	89.73
T2 Sucrose 2 % + 8-HQ 200 mg l^{-1} + $AgNO_3$ 30 mg l^{-1}	8.33	24.78	12.22	2.31	88.06
T3 Sucrose 2 % + 8-HQ 200 mg l^{-1} + $AgNO_3$ 40 mg l^{-1}	18.00	25.21	10.50	1.71	89.80
T4 Sucrose 2 % + 8-HQ 300 mg l^{-1} + $AgNO_3$ 20 mg l^{-1}	18.67	27.64	11.90	1.90	88.50
T5 Sucrose 2 % + 8-HQ 300 mg l^{-1} + AgNO, 30 mg l^{-1}	11.67	16.61	9.36	1.47	90.08
T6 Sucrose 2 % + 8-HQ 300 mg l^{-1} + $AgNO_3$ 40 mg l^{-1}	14.00	25.88	12.95	2.01	90.45
T7 Sucrose 2 % + 8-HQ 400 mg l^{-1} + AgNO, 20 mg l^{-1}	12.33	25.92	12.35	1.83	90.37
T8 Sucrose 2 % + 8-HQ 400 mg l^{-1} + AgNO, 30 mg l^{-1}	22.00	21.61	11.04	2.17	90.26
T9 Sucrose 2 % + 8-HQ 400 mg l^{-1} + AgNO, 40 mg l^{-1}	21.67	25.48	14.26	2.29	88.27
T10 Sucrose 4 % + 8-HQ 200 mg l^{-1} + $AgNO_3$ 20 mg l^{-1}	14.33	22.02	10.04	2.26	89.25
T11 Sucrose 4 % + 8-HQ 200 mg l^{-1} + AgNO, 30 mg l^{-1}	21.67	14.32	8.48	2.07	88.11
T12 Sucrose 4 * + 8-HQ 200 mg l^{-1} + $AgNO_3$ 40 mg l^{-1}	18.67	19.65	10.27	2.01	90.35
T13 Sucrose 4 % + 8-HQ 300 mg l^{-1} + $AgNO_3$ 20 mg l^{-1}	12.00	24.52	12.40	1.89	89.46
T14 Sucrose 4 % + 8-HQ 300 mg l^{-1} + $AgNO_3$ 30 mg l^{-1}	18.00	22.71	12.77	1.99	89.72
T15 Sucrose 4 % + 8-HQ 300 mg l^{-1} + $AgNO_3$ 40 mg l^{-1}	20.67	20.97	13.73	2.14	90.22
T16 Sucrose 4 % + 8-HQ 400 mg l^{-1} + AgNO, 20 mg l^{-1}	13.00	24.97	12.46	2.01	88.30
T17 Sucrose 4 % + 8-HQ 400 mg l^{-1} + AgNO, 30 mg l^{-1}	20.00	20.60	11.84	1.76	90.19
T18 Sucrose 4 % + 8-HQ 400 mg l^{-1} + $AgNO_3$ 40 mg l^{-1}	15.33	22.79	13.14	2.17	89.31
T19 Sucrose 6 % + 8-HQ 200 mg l^{-1} + AgNO, 20 mg l^{-1}	9.67	22.03	12.31	1.57	90.52
T20 Sucrose 6 % + 8-HQ 200 mg l^{-1} + AgNO, 30 mg l^{-1}	17.33	18.38	10.53	1.79	90.11
T21 Sucrose 6 % + 8-HQ 200 mg l^{-1} + AgNO, 40 mg l^{-1}	16.00	20.53	11.54	2.00	88.19
T22 Sucrose 6 % + 8-HQ 300 mg l^{-1} + $AgNO_3$ 20 mg l^{-1}	18.33	24.32	14.11	1.70	89.62
T23 Sucrose 6 % + 8-HQ 300 mg l^{-1} + AgNO, 30 mg l^{-1}	14.33	26.12	12.45	1.94	88.82
T24 Sucrose 6 % + 8-HQ 300 mg l^{-1} + AgNO, 40 mg l^{-1}	15.33	21.28	11.08	1.76	89.43
T25 Sucrose 6 % + 8-HQ 400 mg l^{-1} + AgNO, 20 mg l^{-1}	13.67	19.74	9.79	1.68	90.85
T26 Sucrose 6 % + 8-HQ 400 mg l^{-1} + $AgNO_3$ 30 mg l^{-1}	12.33	19.83	10.87	2.14	89.02
T27 Sucrose 6 % + 8-HQ 400 mg l^{-1} + $AgNO_3$ 40 mg l^{-1}	17.67	13.70	7.94	1.66	90.17
T28 Distilled water	9.67	21.77	11.04	1.88	89.89
T29 Tap water	8.33	20.92	11.72	1.01	89.32
CD (0.05)	3.042	5.045	2.803	NS	NS
SE	1.075	1.784	0.991	0.430	0.150

NS = not significant

RESULTS AND DISCUSSION

The holding solutions had a significant influence on the vase life of the pulsed orchid inflorescences (Table 1). Those treated with T_8 (sucrose 2% + 8-HQ 400 mg l^{-1} + $AgNO_3$ 30 mg l^{-1}) recorded the highest vase life of 22 days, which was on par with T_9, T_{11}, T_{15} and T_{17}. All the treatments were superior to the tap water control (T_{29}) except T_2. The relatively low sucrose concentration of these effective holding solution treatments indicates that pulsed flowers responded to lower sugar concentrations probably due to their being already loaded with sugar. In holding solutions of high sugar concentration, reduction of water absorption due to increase in osmotic potential has been reported (Borochov *et al.*, 1976). In the pulsed flowers, a reduction in vase life observed in holding solutions having high sugar concentrations may be attributed to a similar effect. Several workers have reported beneficial effects on vase life enhancement in orchids by the use of holding solutions containing sucrose, 8-HQ salts and $AgNO_3$. Ketsa and Boonrote (1990) recommended 4% glucose with 225 mg l^{-1} of 8-HQS and 30 mg l^{-1} of $AgNO_3$ as being optimum for *Dendrobium* `Youppadeewan'. Nowak and Vacharotayan (1980) found improvement in flower quality and vase life of *Arachnis*, *Aranthera*, *Dendrobium*, *Oncidium*, *Vanda* and *Vandopsis* cultivars for up to 20 days, in holding solutions containing 2 to 5% sucrose, 200 to 400 mg l^{-1} 8-HQC and 25 mg l^{-1} $AgNO_3$. In *Dendrobium* `Pompadour' and D. `Jacquelin Thomas', the combination of 2% sucrose and 200 mg l^{-1} 8-HQC was found to be better while Ketsa *et al.* (1995) reported that the combination of glucose, 8-HQS and

silver nitrate was better for enhancing the vase life of *Dendrobium* `Pompadour' flowers. Post-harvest conditions have been reported to effect in loss of turgidity (Wongkaew and Techapinyawat, 1992) and to trigger autocatalytic ethylene production leading to the onset of senescence (Arditti, 1979; Nair, 1984) in orchid flowers.

The holding solution treatments significantly influenced Che sugar *content* of the flowers. *It* was found to be the highest (27.64%) with T_4 (sucrose 2% + 8-HQ 300 mg l^{-1} + $AgNO_3$ 20 mg l^{-1}) which was on par with T_1, T_2, T_3, T_6, T_7, T_9, T_{13}, T_{14}, T_{18}, T_{22} and T_{23}. The lowest sugar content of flowers was observed with T_{27} (13.7%), which was on par with T_5, T_{11} and T_{20}. Spikes treated with T_9 (sucrose 2% + 8-HQ 400 mg l^{-1} + $AgNO_3$ 40 mg l^{-1}) recorded the highest sugar content of 14.26% in their stalks which was on par with T_1, T_2, T_4, T_6, T_7, T_{13}, T_{14}, T_{15}, T_{16}, T_{17}, T_{18}, T_{19} T_{21}, T_{22}, T_{23}

Table 2. Fresh weight of the inflorescences at different periods of vase life

Treatments (T)	Different periods (P)				Mean (g)
	P_1 (First day)	P_2 (Fourth day)	P_3 (Seventh day)	P4 (At cessation)	
T1	23.45	24.90	23.16	21.07	23.14
T2	22.83	24.11	23.16	20.00	22.53
T3	19.53	21.23	20.00	17.11	19.47
T4	19.26	21.33	19.50	16.88	19.24
T5	17.42	18.68	17.44	14.91	17.11
T6	23.76	25.88	24.22	20.95	23.70
T7	22.35	23.74	22.30	19.27	21.91
T8	23.77	27.85	25.36	21.79	24.69
T9	24.30	26.87	24.98	20.49	24.16
T10	22.90	24.39	22.89	20.18	22.59
T11	21.54	24.28	22.91	17.65	21.60
T12	24.46	26.78	24.90	21.60	24.44
T13	21.39	22.75	21.34	18.16	20.91
T14	22.21	24.42	23.38	19.29	22.32
T15	26.51	30.18	28.00	22.95	26.91
T16	20.17	21.72	20.29	17.21	19.85
T17	21.48	24.64	22.18	17.86	21.54
T18	22.70	24.58	23.32	20.16	22.69
T19	19.98	21.26	19.80	16.86	19.50
T20	21.78	22.57	21.46	18.35	21.30
T21	19.93	22.53	20.60	16.28	19.84
T22	19.83	21.32	20.14	16.34	19.41
T23	20.31	21.76	20.22	17.07	19.84
T24	21.21	22.98	21.79	18.26	21.06
T25	20.19	21.45	20.36	18.41	20.10
T26	19.88	20.77	18.44	17.00	19.02
T27	21.54	24.33	22.74	19.24	21.96
T28	20.00	21.28	20.24	16.87	19.60
T29	18.86	19.54	17.60	15.80	17.95
Mean (g)	21.50	23.42	21.82	18.55	-
		CD (0.01)		SE	
T (28, 58)		NS		4.372	
P (3, 174)		0.184		0.066	
TP (84, 174)		0.994		0.358	

Table 3. Size of the flowers at different periods of vase life

Treatments (T)	Length (cm)				Width (cm)			
	P,	P_2	P_3	Mean	P,	P_2	P,	Mean
T1	7.78	7.79	7.48	7.68	7.36	7.35	6.86	7.19
T2	7.42	7.39	6.82	7.21	6.55	6.54	6.01	6.37
T3	7.25	7.22	6.77	7.08	6.39	6.38	5.59	6.12
T4	7.64	7.62	6.90	7.38	7.20	7.14	5.98	6.77
T5	7.74	7.71	6.84	7.43	7.23	7.21	6.34	6.91
T6	7.32	7.31	6.25	6.96	6.98	7.02	6.22	6.74
T7	8.16	8.15	7.57	7.96	7.38	7.35	6.85	7.19
T8	7.46	7.48	6.82	7.25	7.04	7.03	6.14	6.74
T9	7.52	7.46	7.19	7.39	7.16	7.07	6.70	6.98
T10	7.79	7.83	7.33	7.65	7.21	7.21	6.77	7.06
T11	7.10	7.10	6.71	6.97	6.48	6.48	5.83	6.26
T12	8.18	8.13	7.60	7.97	7.58	7.51	7.21	7.43
T13	7.96	7.95	7.45	7.79	7.59	7.56	6.96	7.37
T14	7.13	7.13	6.76	7.03	6.57	6.63	5.67	6.29
T15	7.73	7.69	7.30	7.57	7.28	7.23	6.73	7.08
T16	7.89	7.90	7.50	7.76	7.24	7.26	6.91	7.14
T17	7.22	7.22	6.81	7.08	6.49	6.49	5.85	6.28
T18	7.00	6.98	6.42	6.80	6.86	6.82	6.27	6.65
T19	6.82	6.83	6.00	6.95	6.60	6.61	5.46	6.22
T20	7.55	7.55	6.93	7.34	7.14	7.13	6.48	6.92
T21	7.12	7.11	6.48	6.90	6.44	6.45	5.86	6.25
T22	7.88	7.89	7.25	7.67	7.52	7.49	7.07	7.36
T23	7.88	7.88	7.37	7.71	7.17	7.17	6.88	7.67
T24	7.83	7.80	7.54	7.72	7.33	7.32	6.85	7.17
T25	8.16	8.04	7.63	7.94	7.54	7.44	6.88	7.28
T26	7.84	7.84	7.53	7.74	7.32	7.34	6.92	7.19
T27	7.68	7.69	7.32	7.57	7.17	7.18	6.61	6.99
T28	7.23	7.25	6.71	7.06	6.81	6.80	6.19	6.60
T29	7.97	7.74	7.49	7.73	8.05	7.94	7.55	7.85
Mean	7.60	7.58	7.06		7.09	7.07	6.47	
	CD (0.01)		SE		CD (0.01)		SE	
T (28, 58)	NS		0.541		NS		0.560	
P (2, 116)	0.047		0.017		0.060		0.021	
TP (56, 116)	NS		0.092		NS		0.118	

and T_{29}. The lowest sugar content of 7.94% was recorded by those treated with T_{27} which was on par with T_3, T_5, T_{10}, T_{11}, T_{12}, T_{20} and T_{25} (Table 1). Flowers with the highest sugar content at harvest have been observed to keep the longest (Knappenberger *et al.*, 1955). The low sugar content in the stalks of the flowers indicates that active mobilization from the stalks was probable.

Fresh weight of the inflorescences was not influenced by the different treatments but significant changes in fresh weight were observed during the different periods of the vase life. The initial mean fresh weight of 21.50 g on the first day (P_1) increased significantly to the highest value of 23.42 g on the fourth day of the vase life (P_2). Thereafter, a gradual reduction was observed and the lowest mean fresh weight was recorded at cessation of the vase life (P_4) (Table 2). Interaction of the treatments with the different periods was significant. All the treatments on fourth day (P_2) recorded a significantly greater fresh weight

than their initial fresh weight (P_1). Interaction effects resulted in inflorescences treated with T_{15} (sucrose 4% + 8-HQ 300 mg l^{-1} + $AgNO_3$ 40 mg l^{-1}) recording the highest fresh weight of 30.18 g on the fourth day of the vase life and those treated with T_5 (sucrose 2% + 8-HQ 300 mg l^{-1} + $AgNO_3$ 30 mg l^{-1}) recording the lowest, at cessation of vase life. The results indicate that flowers having a greater vase life could maintain a greater fresh weight for longerperiods.

Dry weight and water content of the spikes did not significantly differ among the treatments (Tablel). The electrical conductivity of the holding solution treatments was observed to be in treatments beyond the delectable range at different periods during vase life. This suggests that the solute concentration was not an influential factor affecting the uptake of the solutions.

Flower size was not influenced by the treatments. However, the length and the width of the flowers differed significantly at the different periods of the vase life (Table 3). The mean length was highest (7.60 cm) on the first day of vase life (P_1), which was on par with (P_2). Then it was significantly reduced to 7.06 cm at cessation of vase life (P_3). The mean width also followed the same pattern. The greatest mean width of 7.09 cm was recorded on the first day (P_1), which was on par with P_2 and the lowest width (6.47 cm) was recorded at cessation of vase life. These results indicated that structural changes in the lip and dorsal sepal leading to a reduction in the length of the displayed flower surface took place earlier than structural changes of the lateral sepals leading to reduction in the width of the flowers. Structural changes in the length and width of the flowers followed a similar pattern, in all treatments, during the vase life period. The maximum length and width were maintained from the first to the fourth day and reduction took place thereafter. The pulsing given to these flowers may have acted to retard structural changes.

For pulsed inflorescences of *Dendrobium* cv. Sonia, the use of floral preservatives in holding solutions can result in considerable extension of vase life. The time taken for the first flower to senesce (22 days) in the inflorescences treated with T_8, T_9, T_{11}, T_{15} and T_{17} indicates an extended period of post-harvest life for the inflorescences as a whole, which benefits detailed study for evolving commercial formulations of preservatives for different cultivars.

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