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Effect of pulsing on improving the vase life of cut chrysanthemum (*Dendranthema grandiflora* Tzevelev.) cv. White Double

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Abstract
A lab experiment was conducted to extend the vase life of cut chrysanthemum cv. White Gold, by pulsing of chemicals. It consisted of three levels of pulsing chemical combinations and three level of duration of pulsing treatments which replicated trice. Among different pulsing treatments, 8-HQS 200 ppm + 20% sucrose recorded maximum water uptake (54.28 g/flower), cumulative water uptake (114.13 g/flower), Cumulative water loss (49.92 g/flower), cumulative water loss (110.23 g/flower), water balance (4.36 g/flower) on first day and fresh weight (116.94%) on 3rd day with maximum vase life of 4.78 days. Whereas, these post-harvest parameters were minimum in control. Among the durations of pulsing, 6h pulsing recorded maximum post-harvest attributes and minimum was in 2 h pulsing. Among the interactions, P_2D_3 influenced maximum water uptake (59.35 g/flower), cumulative water uptake (124.23 g/flower), cumulative water loss (54.38 g/flower), cumulative water loss (120.36 g/flower), water balance (4.97 g/flower) on first day, fresh weight (123.86%) on 3rd day with maximum vase life of 5.33 days.

Keywords: Pulsing, duration of pulsing, 8-HQS, sucrose, vase life, cut chrysanthemum

Introduction

Chrysanthemum is a leading commercial flower crop grown for production of cut flowers, loose flowers and potted plants. Area under flower cultivation in India was 255 thousand hectare with the production of 1754 thousand MT of loose flowers and 543 thousand MT of cut flowers during 2013-14. Area under chrysanthemum cultivation in Karnataka was 30.6 thousand hectare with 211.5 thousand MT of loose flower and 71.5 lakh cut flower production during 2013-14. In Karnataka, major chrysanthemum growing districts are Kolar, Bengaluru, Chitradurga, Haveri, Gadag, Mandya, Hassan, Tumkur, Davanagere and Belgavi (Anonymous, 2015) [2].

Cut chrysanthemums which are required to be sent to a considerably distant market, are harvested when 4 or 5 flowers are opened and presence of 3 to 4 3/4th opened flowers on flower stalks, packed and transported. Such packed and stored flowers often fail to open and result in reduction in vase reservoirs at the retailers/ and consumers point. Hence a common approach adopted in many studies was to select an appropriate pulse formulation that will promulgate and have beneficial effect following short term pre shipment and transfer of flowers to water. Pulsing keeps the flower fresh during transportation and storage. Combination and concentration of floral preservatives in pulsing solution and duration of pulsing are known to vary with the crops, cultivars and weather conditions.

Floral preservatives usually contain water to maintain turgidity, sugar as an energy source, a biocide to inhibit the growth of microorganisms and anti-ethylene chemical and an acidifying agent to decrease the pH 3.0 to 3.5. Post-harvest techniques would add value to the product guaranteeing better returns to the growers. Much scientific work has been done in recent years to conserve the freshness of the cut flowers in various countries, especially in UK, USA, Europe and Japan where the florist trade is becoming a multimillion-dollar business. India is most suitable for floriculture due to its diversified agro climatic regions. Unfortunately application of post-harvest techniques is lacking in our country which affects the export market. Hence, the export of floriculture product from India is only about 0.7 percent of the world market share as compared to Netherland's exports which accounts to about 63 percent, Columbia exports about 9 percent, Israel 7 percent, Italy 3 percent and 11.5 percent from

other countries. According to various studies, about 30-40 percent of cut flowers are lost due to improper post-harvest handling. These post-harvest losses can be minimized by harvesting flowers at proper stage, pulsing with different chemicals such as energy supplying sucrose and antimicrobial agents like 8-hydroxy quinoline sulphate, silver nitrate, cobalt chloride and others (Narasimhamurthy, 2010) [13].

Materials and Methods

A lab experiment was carried out to know the effect of pulsing of chemical preservatives on post-harvest life of cut chrysanthemum cv. White Double. The treatment consisted of two levels of sucrose (10 and 20%) in addition with 8-HQS as a common antimicrobial agent and three levels of pulsing durations (2, 4 and 6 h) on post-harvest life of cut chrysanthemum (P_1- 8-HQS 200 ppm + 10% sucrose, P_2- 8-HQS 200 ppm + 20% sucrose, P_3- Control (distilled water), D_1 - 2 h pulsing, D_2- 4 h pulsing and D_3-6h pulsing) was replicated thrice. For the experiment, flowers stalk with 4 or 5 flowers opened and presence of 3 to 4, 3/4th opened flowers on flower stalk were selected and one flower stalk is used per flask to record the observations. After pulsing at different durations, the flowers were taken out from the pulsing solutions and were placed in distilled water, to know the effect on post-harvest life of cut chrysanthemum.

Results and discussions

Water uptake

The water uptake and cumulative water uptake significantly varied among the treatments (table1).Water uptake increased initially in all the treatments and later on decreased to a greater extent. Among the different treatment concentrations, 20 percent sucrose + 200 ppm 8 HQS pulsed flowers had increased water uptake and reached significantly maximum (54.28 g/flower) on 1st day of vase life and recorded significantly maximum (114.13 g/flower) cumulative water uptake in same treatment. Whereas, reduced (40.14 g/flower) water uptake was recorded in flowers pulsed in solutions without sucrose and without antimicrobial agents (control) and it reached its peak on 3rd day and minimum (80.69 g/flower) cumulative water uptake was recorded in same treatment.

With respect to duration of pulsing significantly maximum water uptake was recorded in 6 h pulsing and reached maximum on 1st day (51.30 g/flower) of vase life and also maximum (105.28 g/flower) cumulative water uptake of vase life was noticed in same treatment. Significantly reduced water uptake was recorded in flowers pulsed 2 h and it reached its peak on 1st day (44.91 g/flower) and reduced cumulative water uptake was also recorded in same treatment (91.80 g/flower).

Among the interaction of pulsing and duration of pulsing P_2D_3 (20 percent sucrose + 200 ppm 8 HQS for 6 h pulsed flowers) had increased water uptake and reached maximum on 1st day (59.35 g/flower) of vase life and maximum (124.23 g/flower) cumulative water uptake was maximum (124.23 g/flower) cumulative water uptake. Significantly reduced water uptake was recorded in treatment combination of P_3D_1 (control + 6 h pulsing) and it reached its peak on 1st day (38.80 g/flower) and reduced (78.71 g/flower) cumulative water uptake was recorded in treatment.

The effect of sucrose and antimicrobial agents previously attributed to its capacity of maintaining high osmotic potential and turgor pressure (Coorts, 1973) [4]. The accumulation of translocated sucrose and antimicrobial in the flowers resulted in increased osmotic concentration which improved the ability of flowers to absorb water thus maintaining turgidity (Halevy, 1976) [6]. Maintenance of improved water status in the flowers seems to be the most important aspect in extension of longevity of flowers (Halevy, 1976 [6]; Roger, 1973) [15]. The results are in confirmation with Harish (2012) [8] in Anthurium.

Water loss

The water loss and cumulative water loss significantly varied among the treatments (table2). Water uptake increased initially in all the treatments and later on decreased to a greater extent. Among the different treatment concentrations, 20 percent sucrose + 200 ppm 8 HQS pulsed flowers had increased water loss and reached significantly maximum (49.92 g/flower) on 1st day of vase life and maximum (110.23 g/flower) cumulative water loss was also noticed in same treatment. Whereas, reduced water loss was recorded in flowers pulsed in solutions without sucrose and without antimicrobial agents (control) and it reached its peak on 1st day (37.86 g/flower) of vase life and minimum (77.96 g/flower) cumulative water uptake was recorded in the same treatment.

With respect to duration of pulsing, significantly maximum water loss was recorded in 6 h pulsing and reached significantly maximum on 1st day (47.29 g/flower) of vase life and minimum (77.96 g/flower) cumulative water uptake was recorded in same treatment. Whereas, reduced water loss was recorded in flowers pulsed 2 h and it reached its peak on 1st day (42.05 g/flower) of vase life and reduced cumulative water loss (88.77 g/flower) was recorded in same treatment.

Among the interaction of pulsing and duration of pulsing treatment P_2D_3 (20 percent sucrose + 200 ppm 8 HQS for 6 h pulsed flowers had increased water uptake and reached maximum (54.38 g/flower) on 1st day of vase life and maximum cumulative water loss (120.36 g/flower) was reduced (76.41 g/flower) cumulative water loss was recorded in treatment. Significantly reduced water loss was recorded in treatment combination of P_3D_1 (control 6 h pulsing) and it reached its peak on 1st day (36.82 g/flower) and reduced (76.41 g/flower) cumulative water loss was recorded in same treatment

Transpiration is an essential evil in extending the vase life of cut flowers and any process which hinders the normal transpiration which will decrease the keeping quality of cut flowers Aarts (1957) [1]. In initial days the chrysanthemum cut flowers had less transpiration loss of water when compared to water uptake and later on water loss increased to some extent than water uptake. Pulsing for 6 hours was found to influence the water loss, in chrysanthemum cut flowers. Results are in confirmation with Maitra and Roychowdhury (2005) [10], Chethana (2011) [3] in bird of paradise and Harish (2012) [8] in Anthurium.

Water balance

Significant variation in water balance was noticed among the treatment (table 3).Water balance increased initially in all treatments and later on decreased to a greater extent. Water balance was the maximum on all the days in flowers pulsed in 20 percent sucrose + 200 ppm 8 HQS for on (4.36 g/flower), on 1st day. The water balance was minimum in flowers pulsed in solutions without sucrose and antimicrobial agents (control) and reached its peak on 1st day (2.27 g/flower).

With respect to duration of pulsing, 6 h pulsing recorded significantly maximum water balance (4.01 g/flower).

Significantly reduced cumulative water balance was recorded in flowers pulsed 2 h (2.86 g/flower).

Among the interactions, combination of P_2D_3 (20 percent sucrose + 200 ppm 8 HQS for 6 h.) pulsed flowers had maximum (4.97 g/flower) water loss, which was at par with P_1D_3 (4.59) and P_2D_2 (4.27). Significantly reduced (1.99 g/flower) water balance was recorded in treatment combination of P_3D_1 (control 6 h pulsing).

Water uptake and water loss influence each other and their interactions determine the water balance (Mayak *et al.*, 1974) [11]. The results are in confirmation with the findings of Hassan (2009) [8] in anthurium and Chethana (2011) [3] in bird of paradise.

Fresh weight

The fresh weight was significantly varied among the treatments (table 4). Fresh weight increased initially in all the treatments and later on decreased to a greater extent. Fresh weight was the maximum (116.94 g/flower) on all the days in flowers pulsed in 20 percent sucrose + 200 ppm 8 HQS for on, on 3rd day. Fresh weight was minimum (77.00 g/flower) in flowers pulsed in solutions without sucrose without antimicrobial agents (control) and it reached its peak on 3rd day.

With respect to duration of pulsing, 6 h pulsing recorded significantly maximum (103.79 g/flower) fresh weight of flower. Significantly reduced Fresh weight was recorded in flowers pulsed for 2 h (91.24 g/flower).

Among the interactions of pulsing and duration of pulsing, P_2D_3 (20 percent sucrose + 200 ppm 8 HQS for 6 h) pulsed flowers had maximum (123.86 g/flower) fresh weight of flower. Significantly reduced (74.27 g/flower) fresh weight of flower was recorded in treatment combination of P_3D_1 (control 6 h pulsing).

The longevity of cut flowers was related to maintenance of fresh weight and it depends on the rate of reduction of fresh weight. The fresh weight of flowers increased initially and later on decreased to some extent. This is mainly attributed to the increased water uptake, cumulative water uptake and reduced microbial load in the pulsing solution during the vaselife period. Fresh weight is known to be maintenance of water uptake and water balance as reported previously in tuberose (Reddy, 1993) [14], in gerbera (Dasgupta, 2006) [5].

Vase life

The vase life was significantly varied among the treatments (table 4). Significantly higher vase life was recorded in cut flowers which were pulsed in solutions containing sucrose as compared that of cut flowers which were pulsed in control. Among the different treatment concentrations, 20 percent sucrose + 200 ppm 8 HQS pulsed flowers had longer (4.78 days) vase life. Significantly reduced (3.11days) vase life was recorded in flowers pulsed in solutions without sucrose and without antimicrobial agents (control).

With respect to duration of pulsing, 6 h pulsing recorded significantly maximum (4.33 day) vase life of flower. Significantly reduced (91.24 g/flower) vase life was recorded in flowers pulsed for 2 h.

Among the interactions, P_2D_3 (20 percent sucrose + 200 ppm 8 HQS for 6 h) had reported maximum (5.33 day) vase life of flower. Significantly reduced (74.27 g/flower) vase life of flower was recorded in combination of P_3D_1 (control 6 h pulsing).

Good water uptake, low transpiration loss and good water balance results in higher vase life of cut flowers (Halevy and Mayak, 1981) [7]. This could be mainly attributed to decreased microbial load in the solution having antimicrobial agent and sucrose which resulted in enhanced water uptake and maintenance of higher water balance. Sucrose is the source of energy and good respiratory substrate for the maintenance of osmotic potential in flower and improves the ability of the tissue to absorb water. Hence it helps in maintaining higher turgidity and thereby increases the vase life of flowers (Mukhyopadyay *et al.*, 1982) [12]. The lowest vase life in control flowers was due to increased microbial growth which might have led to stem blockage and reduced water uptake. The association of water status of flower and tissue with the vase life of flowers has been reported previously by Reddy (1993) [14] in tuberose.

Table 1: Effect of pulsing and duration of pulsing on water uptake of cut chrysanthemum cv. White Double flowers

Treatment	Water uptake (g/flower)				Cumulative water uptake (g/flower)
	Day 1	Day 2	Day 3	Day 4	
P_1- 8-HQS 200 ppm + 10% sucrose	50.03	26.42	15.24	9.88	101.58
P_2- 8-HQS 200 ppm + 20% sucrose	54.28	30.70	17.49	11.66	114.13
P_3- Control (distilled water)	40.14	22.24	11.63	6.68	80.69
S Em±	0.49	0.26	0.18	0.10	0.74
CD at 1%	2.01	1.05	0.75	0.41	3.00
D_1 - 2 h pulsing	44.91	24.87	13.63	8.39	91.80
D_2- 4 h pulsing	48.24	26.53	14.89	9.66	99.32
D_3- 6h pulsing	51.30	27.96	15.86	10.17	105.28
S Em±	0.49	0.26	0.18	0.10	0.74
CD at 1%	2.01	1.05	0.75	0.41	3.00
P_1D_1	46.49	24.42	14.17	8.08	93.16
P_1D_2	50.16	26.18	15.21	10.27	101.82
P_1D_3	53.45	28.67	16.35	11.29	109.77
P_2D_1	49.44	28.24	15.38	10.47	103.53
P_2D_2	54.04	30.96	17.62	11.99	114.62
P_2D_3	59.35	32.89	19.47	12.52	124.23
P_3D_1	38.80	21.94	11.34	6.63	78.71
P_3D_2	40.51	22.45	11.82	6.72	81.50
P_3D_3	41.09	22.32	11.74	6.69	81.84
S Em±	0.85	0.45	0.32	0.18	1.28
CD at 1%	3.48	1.82	1.29	0.71	5.20

Table 2: Effect of pulsing and duration of pulsing on water loss of cut chrysanthemum cv. White Double flowers

Treatment	Water loss (g/flower)				Cumulative water loss (g/flower)
	Day 1	Day 2	Day 3	Day 4	
P_1- 8-HQS 200 + 10% sucrose	46.31	23.34	17.08	10.84	97.57
P_2- 8-HQS 200 + 20% sucrose	49.92	27.26	20.03	13.03	110.23
P_3- Control (distilled water)	37.86	20.72	12.31	7.06	77.96
S Em±	0.47	0.26	0.20	0.12	0.66
CD at 1%	1.90	1.04	0.80	0.49	2.69
D_1 - 2 h pulsing	42.05	22.71	14.92	9.08	88.77
D_2- 4 h pulsing	44.75	23.74	16.52	10.50	95.51
D_3- 6h pulsing	47.29	24.86	17.98	11.35	101.48
S Em±	0.47	0.26	0.20	0.12	0.66
CD at 1%	1.90	1.04	0.80	0.49	2.69
P_1D_1	43.74	21.99	15.51	8.78	90.01
P_1D_2	46.34	22.97	17.10	11.09	97.50
P_1D_3	48.86	25.06	18.63	12.65	105.20
P_2D_1	45.60	25.53	17.27	11.49	99.90
P_2D_2	49.77	27.39	19.99	13.29	110.45
P_2D_3	54.38	28.86	22.82	14.31	120.36
P_3D_1	36.82	20.62	11.98	6.98	76.41
P_3D_2	38.14	20.87	12.47	7.11	78.59
P_3D_3	38.63	20.66	12.48	7.10	78.88
S Em±	0.81	0.44	0.34	0.21	1.14
CD at 1%	3.29	1.81	1.39	0.85	4.65

Table 3: Effect of pulsing and duration of pulsing on water balance of cut chrysanthemum cv. White Double flowers

Treatment	Water balance (g/flower)			
	Day 1	Day 2	Day 3	Day 4
P_1- 8-HQS 200 + 10% sucrose	3.72	3.09	1.84	0.96
P_2- 8-HQS 200 + 20% sucrose	4.36	3.44	2.54	1.37
P_3- Control (distilled water)	2.27	1.52	0.68	0.39
S Em±	0.13	0.10	0.06	0.06
CD at 1%	0.53	0.42	0.26	0.24
D_1 - 2 h pulsing	2.86	2.15	1.29	0.69
D_2- 4 h pulsing	3.49	2.79	1.64	0.83
D_3- 6h pulsing	4.01	3.10	2.12	1.19
S Em±	0.13	0.10	0.06	0.06
CD at 1%	0.53	0.42	0.26	0.24
P_1D_1	2.76	2.43	1.34	0.70
P_1D_2	3.81	3.21	1.89	0.82
P_1D_3	4.59	3.62	2.28	1.36
P_2D_1	3.84	2.71	1.89	1.02
P_2D_2	4.27	3.57	2.37	1.30
P_2D_3	4.97	4.03	3.34	1.78
P_3D_1	1.99	1.32	0.64	0.36
P_3D_2	2.37	1.58	0.65	0.39
P_3D_3	2.46	1.66	0.74	0.41
S Em±	0.23	0.18	0.11	0.10
CD at 1%	0.93	0.73	0.46	0.41

Table 4: Effect of pulsing and duration of pulsing on fresh weight of cut chrysanthemum cv. White Double flowers

Treatment	Fresh weight (%)				Vase life (days)
	Day 1	Day 2	Day 3	Day 4	
P_1- 8-HQS 200 + 10% sucrose	91.93	95.65	98.74	96.90	4.00
P_2- 8-HQS 200 + 20% sucrose	109.14	113.50	116.94	114.41	4.78
P_3- Control (distilled water)	73.20	75.48	77.00	76.32	3.11
S Em±	0.70	0.64	0.60	0.61	0.13
CD @ 1%	2.85	2.60	2.44	2.47	0.52
D_1 - 2 h pulsing	86.22	89.08	91.24	89.94	3.56
D_2- 4 h pulsing	91.38	94.86	97.65	96.01	4.00
D_3- 6h pulsing	96.68	100.69	103.79	101.67	4.33
S Em±	0.70	0.64	0.60	0.61	0.13
CD @ 1%	2.85	2.60	2.44	2.47	0.52
P_1D_1	84.99	87.74	90.17	88.83	3.67
P_1D_2	91.21	95.02	98.23	96.35	4.00
P_1D_3	99.60	104.19	107.81	105.53	4.33
P_2D_1	102.71	106.55	109.26	107.37	4.00
P_2D_2	109.86	114.13	117.70	115.33	5.00
P_2D_3	114.86	119.83	123.86	120.52	5.33
P_3D_1	70.97	72.96	74.27	73.63	3.00
P_3D_2	73.06	75.43	77.01	76.36	3.00
P_3D_3	75.58	78.04	79.70	78.96	3.33
S Em±	1.21	1.11	1.04	1.05	0.22
CD @ 1%	4.94	4.50	4.23	4.27	0.90

Conclusion

Favourable results with respect to uptake of water, water loss, water balance, fresh weight and vase life was reported in Pulsing of chrysanthemum cut flowers in treatment having 20 percent sucrose + 200 ppm 8-HQS for 6 hr. However pulsing in control resulted in reduced vase life.

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