

Influence of pulsing and dry cool storage on cut spikes of tuberose cv. 'Double'

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Abstract

A study was conducted to find out the effect of three pulsing chemicals and two durations of dry cool storage, on cut spikes of tuberose cv. 'Double'. The pulsing and cool storage improved the postharvest life and quality of tuberose cut flowers. Among the different chemicals tried, pulsing with sucrose (10%) + $\text{Al}_2(\text{SO}_4)_3$ (250 ppm) for 12 hours and cut spikes stored for 4 days was found to be the best in respect to rachis length, delay in wilting of first, third and last opened floret pair, extension of useful life, retention of fragrance, water uptake, opening of florets, increase in diameter and length of first, third and last opened floret pair and vase life over the cut spikes which were not pulsed but dry cool stored as well as cut spikes neither pulsed nor stored. The maximum vase life of 8.90 days for 4 days storage was recorded with treatment of sucrose (10%) + aluminium sulphate (250 ppm) treatment.

Key words: Pulsing, cool storage, postharvest, quality, tuberose, cut flowers, chemicals, sucrose

Introduction

Tuberose (*Polianthes tuberosa*) is one of the most important bulbous commercial flowers being grown in tropical and subtropical areas. Its long flowering spike is considered excellent for use as cut flower. The cut flowers can withstand unknown detrimental condition if treated with suitable chemical solutions (Halevy and Mayak, 1974). Such treatments improved postharvest life and quality of stored flowers when used before, after or during the storage of cut flowers (Rudnicki *et al.*, 1986). Pulsing treatment prevents vascular infections and inhibits ethylene production which results in prolonged storage period and quality flowers with increased vase life (Paulin, 1986). Keeping above in view an investigation was undertaken to study the effect of pulsing and dry cool storage treatments on postharvest life and quality of tuberose cut spikes of cultivar 'Double'.

Materials and methods

The present investigation was carried out during 2001 and 2002 in the Division of Floriculture and Landscaping, IARI, New Delhi. The cut spikes were harvested between 7 a.m. to 8 a.m., at a stage when lowermost one-two pairs of basal florets fully opened. These were transferred immediately to a bucket containing freshly collected tap water. All cut spikes were cut to a uniform length of 60 cm. After pulsing treatments, the cut spikes were packed in polyethylene bags (70 cm x 40 cm) of 80-gauge thickness. The open end of the bags folded twice and then stapled. Eight holes of uniform size were made in each bag for ventilation. Five spikes were packed in each bag per replication under each treatment and then immediately transferred to cold storage. After 4 and 5 days of dry cool storage, the cut spikes were taken out and kept in uniform sized vase bottles (500 ml capacity) containing 300 ml of tap water. One set of cut spikes was not pulsed but kept in cold storage for 4 and 5 days, while another set of cut spikes was neither pulsed nor stored but kept in tap water which served

as control. The pulse treatment of sucrose (10%) + $\text{Al}_2(\text{SO}_4)_3$ (250 ppm) for 12 hours, sucrose (10%) + STS (0.5mM) for 12 hours and sucrose (8%) + 8-HQC (200 ppm) for 12 hours were given to cut spikes of tuberose and then dry cool stored at low temperature (4-5°C) for two different duration *i.e.* 4 and 5 days. The cut spikes pulsed with these chemicals were kept at low temperature storage (4-5°C) for two different durations *viz.*, 4 and 5 days. For each pulsing chemical treatment, separate experiments were conducted in the laboratory in completely randomized design (CRD). There were altogether five treatments for each experiment, replicated four times and five spikes were taken for each replication. Vase life evaluation was done in the laboratory under ambient conditions. Useful life was recorded from the period of keeping cut spikes in vase to the period when maximum basal florets remain fresh with maximum beauty. The cut spikes kept in vase bottles containing tap water were observed every day for senescence and the total period of vase life was noted in days. The end of useful vase life was marked either by wilting of florets or that of other symptoms like browning, dropping of florets, drying up of outer petals. The total number of days upto which half of the florets on a spike wilted was recorded as vase life.

Results and discussion

Influence of pulsing with sucrose (10%) + $\text{Al}_2(\text{SO}_4)_3$ (250 ppm) and storage on floret quality and vase life: It is evident from Table 1 that pulsing with sucrose (10%) and aluminium sulphate (250 ppm) had significant effects on increase in rachis length, delay in wilting of first, third and last opened floret pair, fragrance retention, useful life, water uptake and vase life of cut spikes. The maximum increase in rachis length (3.58 cm) was recorded under 4 days dry cool stored pulsed spikes and the minimum (1.01 cm) under 5 days stored unpulsed spikes. Floret longevity of first pair, third pair and last opened pair (2.40, 3.40 and 5.20 days, respectively) was recorded under 4 days dry cool stored

Table 1. Effect of pulsing with sucrose (10%) + Al₂(SO₄)₃ (250 ppm) and storage duration on floret quality and vase life of cut spikes of tuberose cv. Double

Storage days	Increase in rachis length (cm)	Number of florets per spike	1st floret pair wilting (days)	3rd floret pair wilting (days)	Useful life (days)	Last opened floret pair wilting (days)	Fragrance (days)	Water uptake (ml)	Vase life (days)
4a	3.58	35.80	2.40	3.40	2.90	5.20	3.00	49.00	8.90
5a	3.42	36.60	2.20	3.20	2.60	4.80	2.80	42.00	8.60
4b	1.44	36.00	1.50	2.10	1.60	3.10	1.60	30.00	4.10
5b	1.01	37.30	1.20	1.82	1.10	2.20	1.20	23.00	3.40
Control	2.99	37.00	2.00	2.90	2.00	3.50	2.10	39.00	5.20
SEm ±	0.05	0.83	0.03	0.05	0.04	0.07	0.05	0.07	0.16
CD (p=0.05)	0.18	NS	0.12	0.18	0.14	0.22	0.16	2.22	0.50

a-Cut spikes pulsed and stored, b-Cut spikes not pulsed but stored, Control-Cut spikes neither pulsed nor stored, NS - Non significant

Table 2. Effect of pulsing with sucrose (10%) + Al₂(SO₄)₃ (250 ppm) and storage duration on floret opening and quality of cut spikes of tuberose cv. Double

Storage days	Number of florets fully opened	Number of florets half opened	Number of pairs unopened	1st floret pair		3rd floret pair		Last opened floret pair	
				Diameter (cm)	Length (cm)	Diameter (cm)	Length (cm)	Diameter (cm)	Length (cm)
4a	17.80	6.20	11.60	3.07	6.51	2.91	5.49	2.01	5.05
5a	17.60	6.40	12.60	3.01	5.42	2.82	5.46	2.00	5.03
4b	7.20	7.40	21.40	2.81	5.00	2.45	4.72	1.78	4.49
5b	6.40	8.70	22.20	2.69	4.93	2.37	4.65	1.61	4.38
Control	10.80	5.60	20.80	2.88	5.03	2.51	4.81	1.85	4.52
SEm ±	0.24	0.13	0.41	0.05	0.13	0.04	0.12	0.04	0.11
CD (p=0.05)	0.76	0.41	1.30	0.17	0.41	0.15	0.39	0.12	0.37

a-Cut spikes pulsed and stored, b-Cut spikes not pulsed but stored, Control-Cut spikes neither pulsed nor stored

pulsed spikes over the control (2.00 days, 2.90 days and 3.50 days, respectively). The useful life was enhanced under pulsed and 4 days dry cool stored cut spikes (2.90 days) while it was minimum (1.10 days) under 5 days dry cool stored unpulsed spikes. The maximum water uptake was recorded in 4 days dry cool stored pulsed cut spikes (49.00 ml) while the minimum (23.00 ml) under 5 days dry cool stored unpulsed cut spikes. The maximum vase life (8.90 days) was recorded in 4 days dry cool stored pulsed cut spikes while the minimum (3.40 days) in 5 days stored unpulsed cut spikes. Cut spikes of tuberose cv. 'Double' can be dry cool stored for 5 days after pulsing with sucrose (10%) + aluminium sulphate (250 ppm) without affecting the vase life.

Influence of pulsing with sucrose (10%) + Al₂(SO₄)₃ (250 ppm) and storage on floret opening and quality of cut spikes of tuberose cv. Double: Pulsing of cut spikes with sucrose (10%) + aluminium sulphate (250 ppm) significantly affected number of fully opened, half opened and unopened florets (Table 2). The maximum number of fully opened florets (17.80) was observed in the cut spikes which were dry cool stored for 4 days, the second best treatment in order was 5 days dry cool stored flowers (17.60). The opening of florets was inhibited in the spikes which were not pulsed but stored and the minimum number of fully opened florets was observed in 5 days dry cool stored unpulsed cut spikes. Significant variation was observed in diameter and length of 3rd floret pair and length of last opened floret pair. The diameter and length of floret decreased with the increase in storage period. Pulsing of tuberose spikes and storing the same for 4 day at 4-5°C temperature was found to be the most beneficial in enhancing floret opening and floret size.

Influence of pulsing with sucrose (8%) + 8-hydroxyquinoline citrate (200 ppm) and storage on floret quality and vase life: Pulsing of tuberose cut spikes with sucrose (8%) + 8-HQC (200 ppm) significantly affected the rachis length, delay in wilting of first and last opened floret pair (Table 3). The maximum increase in rachis length (3.50 cm) was observed in pulsed and 4 days dry cool stored spikes. The increase in rachis length was inhibited in those cut spikes which were not pulsed but stored. Floret wilting was delayed to the maximum extent, in 4 days dry cool stored pulsed spikes. The maximum water uptake (45.00 ml) was observed in 4 days dry cool stored pulsed spikes over the control (39.00 ml). There was marked reduction in water uptake in unpulsed but dry cool stored spikes (23.00 ml) for 5 days. The second best treatment in the order was 4 days dry cool stored unpulsed spikes (30.00 ml). The maximum fragrance retention (2.70 days) was observed in pulsed and 4 days dry cool stored spikes over the control (2.10 days). The maximum useful life (2.60 days) was found in pulsed and 4 days dry cool stored spikes over the control (2.00 days). Decrease in useful life was recorded in unpulsed but stored spikes. The vase life of cut spikes improved with pulsing and storing the same for 4 days (7.00 days) over the control (5.20 days). It has been observed that vase life, useful life, retention of fragrance, floret life and rachis length were improved in pulsed spikes stored for 4 days over the control.

Influence of pulsing with sucrose (8%) + 8-HQC (200 ppm) and storage on floret opening and quality of cut spikes: It is evident from Table 4 that pulsing of cut spikes with sucrose (8%) + 8-HQC (200 ppm) had significant effect on floret opening, diameter and length of third floret pair as well as last opened floret pair. The maximum number of fully opened (17.10) florets were observed

Table 3. Effect of pulsing with sucrose (8%) + 8-HQC (200 ppm) and storage duration on floret quality and vase life of cut spikes of tuberose cv. Double

Storage days	Increase in rachis length (cm)	Number of florets per spike	1st floret pair wilting (days)	3rd floret pair wilting (days)	Useful life (days)	Last opened floret pair wilting (days)	Fragrance (days)	Water uptake (ml)	Vase life (days)
4a	3.50	36.20	2.20	3.00	2.60	4.80	2.70	45.00	7.00
5a	3.40	36.90	2.10	2.80	2.50	4.60	2.50	41.00	6.60
4b	1.44	36.00	1.50	2.10	1.60	3.10	1.60	30.00	4.10
5b	1.01	37.30	1.20	7.82	1.10	2.20	1.20	23.00	3.40
Control	2.99	37.20	2.00	2.90	2.00	3.50	2.10	39.00	5.20
SEm ±	0.07	1.02	0.04	0.14	0.06	0.10	0.06	1.42	0.12
CD (p=0.05)	0.23	NS	0.13	0.44	0.20	0.32	0.20	4.49	0.39

a-Cut spikes pulsed and stored, b-Cut spikes not pulsed but stored, Control-Cut spikes neither pulsed nor stored, NS - Non significant

Table 4. Effect of pulsing with sucrose (8%) + 8-HQC (200 ppm) and storage duration on opening quality and quality of cut spikes of tuberose cv. Double

Storage days	Number of florets fully opened	Number of florets half opened	Number of pairs unopened	1st floret pair		3rd floret pair		Last opened floret pair	
				Diameter (cm)	Length (cm)	Diameter (cm)	Length (cm)	Diameter (cm)	Length (cm)
4a	16.90	8.20	11.10	2.99	5.41	2.86	5.40	1.87	4.96
5a	17.10	9.10	10.70	2.95	5.42	2.81	5.39	1.82	4.92
4b	7.20	7.40	21.40	2.81	5.00	2.45	4.72	1.78	4.49
5b	6.40	8.70	22.20	2.69	4.93	2.37	4.65	1.61	4.38
Control	10.80	5.60	20.80	2.88	5.03	2.51	4.81	1.85	4.52
SEm ±	0.36	0.22	0.55	0.07	0.17	0.06	0.12	0.04	0.10
CD (p=0.05)	1.14	0.71	1.75	NS	NS	0.18	0.39	0.14	0.33

a-Cut spikes pulsed and stored, b-Cut spikes not pulsed but stored, Control-Cut spikes neither pulsed nor stored, NS - Non significant

in pulsed and 5-days dry cool stored spikes over the control (10.80). Floret opening was retarded to a great extent in spikes which were not pulsed (6.40) but dry cool stored for 5 days. Similarly, the maximum number of unopened florets (22.20) was recorded in 5 days dry cool stored spikes over the control (20.80). The diameter and length of the florets was much less in spikes which were not pulsed but stored over the control. The enhancement of floret size of third and last opened pair as well as opening of florets was improved with this chemical treatment.

Influence of pulsing with sucrose (10%) + silver thiosulphate (STS) at 0.5 mM and storage on floret quality and vase life of cut spikes: Increase in rachis length, floret life of first, third and last opened pair, retention of fragrance, water uptake, useful life and vase life of cut spikes were recorded when they were pulsed with sucrose (10%) + silver thiosulphate (0.5 mM) and dry cool stored for 4 days (Table 5). The maximum increase in rachis length (3.51 cm) was recorded in cut spikes which were pulsed and dry cool stored for 4 days over the control (2.99 cm). The minimum increase in rachis length (1.01 cm) was recorded in cut spikes which were not pulsed but dry cool stored for 5 days. Floret wilting of first, third and last opened pair (2.30, 3.20 and 4.70 days, respectively) was significantly delayed over the control. The maximum retention of fragrance (2.70 days) was recorded in pulsed spikes which were dry cool stored for 4 days while the minimum fragrance retention (1.20 days) was recorded in unpulsed spikes which were stored for 5 days over the control (2.10 days). The maximum water uptake (46.00 ml) was recorded in pulsed and 4 days dry cool stored spikes over the control (39.00 ml). The minimum water uptake (23.00 ml) was recorded in unpulsed 5 days dry cool stored cut spikes. The maximum useful life (2.50 days) was recorded in pulsed and 4 days dry cool stored cut spikes over the control

(2.00 days). The vase life of spikes decreased with the increase in storage days. The maximum vase life (6.30 days) was recorded in pulsed and 4 days stored cut spikes over the control (5.20 days). The minimum vase life (3.40 days) was recorded in unpulsed 5 days stored cut spikes. The beneficial effects of pulsing and dry cool storage for 4 days were recorded in rachis length increase, floret longevity, fragrance retention, water uptake, useful life and vase life of cut spikes.

Influence of pulsing with sucrose (10%) + STS (0.5 mM) and storage on floret opening and quality of cut spikes: It is evident from Table 6 that pulsing with sucrose (10%) + silver thiosulphate (0.5 mM) and dry cool storage of spikes for 4 days had significant effect on opening of florets, diameter and length of third floret pair and length of last opened floret pair. The maximum number of fully opened florets (16.70) was recorded in pulsed and 4 days dry cool stored spikes while the minimum (6.40) was recorded in unpulsed 5 days dry cool stored cut spikes over the control (10.80). Significant variation in diameter (2.88 cm) and length (5.41 cm) of third floret pair and length (4.98 cm) of last opened floret pair in 4 days dry cool storage was recorded over the control. Number of unopened florets, diameter and length of first floret pair and diameter of last opened floret pair did not vary significantly. The maximum beneficial effects of pulsing with this chemical and 4 days dry cool storage was achieved in opening of florets and improving the diameter and length of third floret pair.

Among three pulsing treatments tried, pulsing with sucrose (10%) + aluminium sulphate (250 ppm) for 12 hours and dry cool storage for 4 days was found to be the best in respect to rachis length increase, delay in wilting of first, third and last opened floret pair, extension of useful life, retention of fragrance, water uptake,

Table 5. Effect of pulsing with sucrose (10%) + silver thiosulphate (0.5 mM) and storage duration on floret quality and vase life of cut spikes of tuberose cv. Double

Storage days	Increase in rachis length (cm)	Number of florets per spike	1st floret pair wilting (days)	3rd floret pair wilting (days)	Useful life (days)	Last opened floret pair wilting (days)	Fragrance (days)	Water uptake (ml)	Vase life (days)
4a	3.51	36.80	2.30	3.20	2.50	4.70	2.740	46.00	6.30
5a	3.43	38.50	2.10	3.10	2.30	4.60	2.30	43.00	5.80
4b	1.44	36.00	1.50	2.10	1.60	3.10	1.60	30.00	4.10
5b	1.01	37.30	1.20	1.82	1.10	2.20	1.20	23.00	3.40
Control	2.99	37.20	2.00	2.90	2.00	3.50	2.10	39.00	5.20
SEm ±	0.08	1.08	0.05	0.08	0.08	0.12	0.07	1.27	0.15
CD ($p=0.05$)	0.25	NS	0.16	0.26	0.26	0.40	0.22	4.03	0.47

a-Cut spikes pulsed and stored, b-Cut spikes not pulsed but stored, Control-Cut spikes neither pulsed nor stored, NS - Non significant

Table 6. Effect of pulsing with sucrose (10%) + silver thiosulphate (0.5 mM) and storage duration on floret opening and quality of cut spikes of tuberose cv. Double

Storage days	Number of florets fully opened	Number of florets half opened	Number of pairs unopened	1st floret pair		3rd floret pair		Last opened floret pair	
				Diameter (cm)	Length (cm)	Diameter (cm)	Length (cm)	Diameter (cm)	Length (cm)
4a	16.70	7.30	13.20	3.02	5.45	2.88	5.41	2.00	4.98
5a	14.20	9.20	15.10	2.95	5.40	2.79	5.35	1.97	4.88
4b	7.20	7.40	21.40	2.81	5.00	2.45	4.72	1.78	4.49
5b	6.40	8.70	22.20	2.69	4.93	2.37	4.65	1.61	4.38
Control	10.80	5.60	20.80	2.88	5.03	2.51	4.81	1.85	4.52
SEm ±	0.41	0.23	0.55	0.09	0.15	0.08	0.14	0.06	0.13
CD ($p=0.05$)	1.29	0.75	NS	NS	NS	0.26	0.44	NS	0.43

a-Cut spikes pulsed and stored, b-Cut spikes not pulsed but stored, Control-Cut spikes neither pulsed nor stored, NS - Non significant

opening of florets, increase in diameter and length of first, third and last opened floret pair and vase life over the spikes which were not pulsed but dry cool stored as well as spikes neither pulsed nor stored. The maximum vase life (8.90 days) for 4 days dry cool storage was recorded with sucrose (10%) + aluminium sulphate (250 ppm) pulsing treatment. Sucrose supports the fundamental processes for prolonging vase life, such as maintaining mitochondrial structure and functions, improving water balance by regulating transpiration and increasing water uptake (Nowak and Rudnicki, 1990). Influence of sucrose and aluminium sulphate in enhancing the vase life and improving the quality of flowers has been reported in tuberose cv. 'Single' (Mukhopadhyay, 1980). Aluminium sulphate is known to influence the vase life of cut flowers by acidifying the vase solution, keeps it free from microorganisms and helps in preventing the plugging of conducting tissues (Halevy and Mayak, 1981) resulting in greater solution uptake (Narayana Gowda, 1990). Mukhopadhyay (1980) attributed the improvement in the floral development and keeping quality of cut spikes in tuberose to antimicrobial properties of aluminium sulphate. Sucrose reduced the moisture loss in the cut flowers by decreasing the aperture size of the stomata (Marousky, 1971) which resulted in improved water balance by the spike tissue which might have prevented the increase in endogenous levels of ABA and delayed senescence (Bhaskar *et al.*, 2000).

8-HQC is commonly used as bactericide and the use of bactericides with their resulting reduction of bacterial population improves water balance, inhibit senescence and prolong the vase life of rose flowers (Burdett, 1970). Pulsing treatment using a combination of sucrose + 8-HQC was found to be beneficial in

different rose cultivars (Ichimura *et al.*, 1999). Sucrose provide the respirable substrate whereas 8-HQC reduces bacterial contamination. HQC may affect floral longevity by reducing solution pH and thereby inhibiting stem plugging. The anionic STS complex is mobile in the rose cut stem and its action is supposed to prevent the ill effects of exogenous ethylene (Reid *et al.*, 1989). Beneficial effect of STS as a pulsing chemical was also reported by Bhattacharjee and De (1998).

References

- Bhattacharjee, S.K. and L.C. De, 1998. Influence of pulsing with different chemicals on postharvest life and biochemical constituents of cut roses. *PKV Res. J.*, 22(2): 183-187.
- Bhaskar, V.V., P. Venkata Rao and Y.N. Reddy, 2000. Effect of certain chemicals on the postharvest life of cut tuberose cv. Double. *J. Ornament. Hort.* New series, 3(1): 6-11.
- Burdett, A.N. 1970. The causes of bent neck in roses. *J. Amer. Soc. Hort. Sci.*, 95: 427-431.
- Halevy, A.H. and S. Mayak, 1974. Transport and conditioning of cut flowers. *Acta Hort.*, 44: 291-306.
- Halevy, A.H. and S. Mayak, 1981. Senescence and postharvest physiology of cut flowers. Part 2. In: *Horticultural Reviews*. Vol. 3 (Janick, J.ed.). AVI Publishing Westport, Conn., pp 59-143.
- Ichimura, K., S. Ueyamo and R.C. Goto, 1999. Possible roles of soluble carbohydrate constituents in cut rose flowers. *J. Japanese Soc. Hort. Sci.*, 68(3): 534-539.
- Marousky, F.J. 1971. Inhibition of vascular blockage and increased moisture retention in cut roses induced by 8-hydroxy-quinoline citrate and sucrose. *J. Amer. Soc. Hort. Sci.*, 96: 38-41.

- Mukhopadhyay, T.P. 1980. Effects of chemicals on floral development and vase life of tuberose (*Polianthes tuberosa*). *South Indian Hort.*, 28: 281-284.
- Narayana Gowda, J.V. 1990. Effect of sucrose and aluminium sulphate on the postharvest life of tuberose 'Double'. *Curr. Res.*, 19: 14-16.
- Nowak, J. and R.M. Rudnicki, 1990. *Postharvest Handling and Storage of Cut Flowers, Florist Greens and Potted Plants*. Timber Press, Portland, Oregon, U.S.A., pp-29-30 and 44-45.
- Paulin, A. 1986. Influence of exogenous sugars on the evaluation of some senescence parameters of petals. *Acta Hort.*, 181: 183-193.
- Reid, M.S., R.Y. Evans, L.L. Dodge and Y. Mor, 1989. Ethylene and silver thiosulphate influence opening of cut rose flowers. *J. Amer. Soc. Hort. Sci.*, 114(3): 436-440.
- Rudnicki, R.M., D.M. Goszezynska and J. Nowak, 1986. Storage of cut flowers. *Acta Hort.*, 181: 285-290.