Content list available at http://epubs.icar.org.in, www.kiran.nic.in; ISSN: 0970-6429

Indian Journal of Hill Farming

Special Issue 2022, Volume 35, Page 196-207

Influence of Pulsing Treatments on Postharvest Life of Anthurium (*Anthurium andraeanum* Lind) cv. Tropical

Laishram Hemanta[1]* • Jungshienla Jamir[1] • M Preema Devi[2] • M Jangyukala[1]

[1]Department of Horticulture, School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema Campus, Nagaland (797 106), India.

[2]Department of Pomology and Post Harvest Technology, UBKV, Pundibari, Cooch Behar, West Bengal, India.

ARTICLE INFO

Article history:
Received: 05 July, 2022
Revision: 14 July, 2022
Accepted: 28 July, 2022

Key words: Anthurium, pulsing solution, pulsing duration, fresh weight, vase life

DOI: 10.56678/iahf-spl2022.24

ABSTRACT

The present investigation aimed to study the effect of different pulsing solutions and pulsing durations on the postharvest life of cut Anthurium cv. Tropical. Results revealed that among the pulsing solutions, maximum water uptake was recorded in P_4 (Sucrose 5% + 8-HQC 100 ppm) (11.67 g), water loss (10.56 g), water balance (1.34 g), fresh weight (17.88 g), spathe breadth (8.98 cm), spadix length (4.78 cm) and vase life (20.23 days) while P_5 (Sucrose 5% + 8-HQC 200 ppm) recorded maximum stalk elongation (40.48 cm), spathe length (12.15 cm), spathe breadth (9.17 cm) and vase life (19.67 days). Among the different pulsing durations, D_2 (24 hours) recorded maximum water uptake (7.94 g), water loss (7.22 g), water balance (1.10 g), fresh weight (15.90 g), stalk length (40.38 cm), spadix length (5.18 cm) and vase life (19.78 days) while in D_1 (12 hours) the maximum spathe length (12.27 cm) and spathe breadth (9.20 cm) was recorded.

1. Introduction

Anthurium (*Anthurium andraeanum* Lind.) which belongs to the family araceae is commonly known as the Flamingo flower or Flamingo lily. It is an important tropical ornamental plant grown for its exotic beauty, colorful spathe, and attractive foliage. It is one of the most common cut flowers and the highest economic importance in the floriculture industry for decoration and adornment. Anthurium ranks ninth in the global cut flower trade and commands a respectable price both for cut flower and whole plant (Anand *et al.*, 2017). In Asia, India is the third when it comes to Anthurium cut flower production and is next to China and Taiwan with about 60 acres under commercial production (Leeden, 2008). Consumers prefer cut flowers with longer vase life and therefore, short vase life is a problem (Kader, 2003). Short vase life is influenced both by biotic and abiotic factors, e.g. water stress (Paull and Goo, 1985), micro-organisms (Elgimabi, 2011), and ethylene effects (Amin, 2017). Incorporation of different chemical preservatives into the holding solution prolongs the vase life of cut flowers, reduced microbial build-up, and vascular blockage, increased stem water uptake, and arrests the negative effect of ethylene (Amin, 2017). This investigation was done to study the influence of different pulsing solutions and pulsing duration on post-harvest life and the quality of cut anthurium.

2. Materials and Methods

The experiment was carried out in the Department of Horticulture, School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema, Nagaland, during 2018-2019. Factorial Completely Randomized Design (CRD) with three (3) replications was used in which the pulsing treatments (P_0: Control, P_1: Sucrose 5%, P_2: Sucrose 5% + Carbendazim 0.1%, P_3: Sucrose 5% + Carbendazim 0.2%, P_4: Sucrose 5% + 8-HQC 100 ppm and P_5: Sucrose 5% + 8-HQC 200 ppm) as the main factor and pulsing durations (D_1: 12 hours, D_2: 24 hours and D_3: 36 hours) as subfactor. The flower length was uniformly slanted cut to 40 cm. 250 ml conical flasks filled with 200 ml of each of the treatments were used. The mouth of the flask was covered with a cotton plug to prevent the evaporation loss of the water and entry of unwanted microbes. The treatments were replicated thrice with three flowers per replication. In

*Corresponding author: hemanta.horti@gmail.com

each treatment, the pulsing duration was 12, 24, and 36 hours. It was followed by placing them in distilled water solution. Thereafter, observations on various parameters were recorded at 2 days intervals till 50 percent spathe blueing takes place. For the uptake of water (g), the difference between the successive measurements of the flask and solution without cutting the anthurium flower was taken. Water loss (g) was measured as the difference between the consecutive weight of the flask with solution and flower at an interval of 3 days. The ratio of both represents the water balance ratio.

3. Results and Discussion

3.1Effect on water uptake, water loss and water balance

All treatments as the pulsing solution and pulsing duration were significant in the anthurium flowers as compared to untreated (Control) (Table 1a and 1b). Among the pulsing solutions, P_4 (Sucrose 5% + 8-HQC 100 ppm) recorded the maximum water uptake and water loss of 11.67 g and 10.56 g on the 3rd day after treatment while the minimum water uptake and water loss were recorded in P_0 (Control) of 5.89 g and 5.33 g respectively (Table 1a). Further analysis showed that water uptake generally increased till the 3rd day after treatment except for P_5 (Sucrose 5% + 8-HQC 200 ppm) which showed an increase in water uptake till the 6th day after treatment after which it gradually declined. Water loss increased till the 6th day after treatment except for P_3 (Sucrose 5% + Carbendazim 0.2%), P_4 (Sucrose 5% + 8-HQC 100 ppm), and P_5 (Sucrose 5% + 8-HQC 200 ppm) which showed declined in water loss. Due to osmosis, the higher intake of sugars in the petal cells from the vase solution is known to enhance the uptake of water in cut flowers (Ho and Nicholus, 1975) while 8-HQC inhibited stem plugging due to its excellent anti-microbial properties and encouraged the free flow of water uptake (Marousky, 1972). Regarding the water balance, it was also revealed that pulsing with P_4 (Sucrose 5% + 8-HQC 100 ppm) have the highest water balance of 1.11 g while the least was maintained when pulsed with P_3 (Sucrose 5% + Carbendazim 0.2%) of 1.07 g on the 3rd day after treatment while on the 6th day after treatment pulsing with P_4 (Sucrose 5% + 8-HQC 100 ppm) have maximum water balance of 1.34 g and the minimum water balance was observed on P_2 (Sucrose 5% + Carbendazim 0.1%) of 0.94 g. The pulsing duration also showed a significant variation in water uptake till 3rd day after treatment after which it was found to be non-significant (Table 1a). Pulsing duration D_2 (24 hours) was found to perform best on the 3rd day after treatment of 7.94 g while the minimum water uptake was found in D_1 (12 hours) of 7.06 g. The water loss also showed a maximum pulsing duration in D_2 (24 hours) of 7.22 g and a minimum was recorded in D_1 (12 hours) of 6.46 g on the 3rd day; the maximum water loss was recorded in D_1 (12 hours) of 7.56 g while the minimum was in D_3 (36 hours) of 6.94 g on the 6th day. Regarding the water balance, it was also revealed that a higher water balance in comparison to the rest of the treatments was observed when pulsed with D_2 (24 hours) except at senescence i.e. on the 15th day after treatment the water balance was highest in D_1 (24 hours) of 0.76 g. The interaction effect of different treatments was found to be significant at all the dates of observation, where the maximum water uptake on the 3rd and 9th day after treatment were recorded in treatment P_4D_2 of 14.33 g and 8.00 g, respectively followed by P_4D_3 at the 3rd day after treatment of 10.67 g and P_4D_1 of 10.67 g and 7.33 g at 6th and 9th day after treatment (Table 1b). This result was following the findings of Jain *et al.* (2007) who also reported that the interaction of pulsing solution (Sucrose 3% + 8-HQC 200 ppm) and pulsing duration (24 hours) resulted in maximum absorption of the solution. In terms of water loss, three days after treatment, P_4D_2 recorded the maximum water loss of 13 g while the minimum water loss was recorded in P_0D_1 at 5.22 g (Table 1b). The water loss was recorded as maximum in P_4D_1 of 11.02 g while the minimum was observed in P_0D_2 of 5.33 g on the sixth day. On the 15th day after treatment, the maximum water loss was maintained in P_4D_1 at 5.19 g and the minimum was observed in treatment P_2D_2 at 2.86 g. Aarts (1957) stated that water update depends on water loss to sustain the flow of uptake to continue. Regarding the water balance P_4D_1 also recorded the maximum water balance of 1.14 g, 1.51 g, and 0.99 g on the 3rd, 6th and 9th day after treatment while the minimum was observed in P_2D_1 of 1.07 g, 0.91 g and 0.85 g on the 3rd, 6th and 9th day after treatment respectively (Table 1b). On the 15th day after treatment, the maximum water balance was recorded in P_5D_1 at 0.97 g and the minimum was observed in treatment P_1D_1 at 0.65 g. These findings corroborate those of Devi and Jawarharlal (2005) in anthurium, Marousky (1972) and Dias and Patil (2003) in rose and Valsalakumari *et al.* (2007) in orchid, who stated that different chemicals used in pulsing treatment have varying effects on cut flowers which leads to variation in water balance. An increase in water balance due to sucrose might be attributed to the fact that carbohydrates and food are supplied through sucrose which improves water balance (Maitra and Roychowdhury, 2005).

3.2 Effect on fresh weight

Among the pulsing solutions, P_4 (Sucrose 5% + 8-HQC 100 ppm) revealed the highest fresh weight of 17.51 g, 17.88 g, and 15.70 g while the least was recorded in P_3 (Sucrose 5% + Carbendazim 0.2%) of 15.22 g, 14.52 g and 12.40 g on the 3rd, 6th and 15th day after treatment, respectively (Table 2a). 8-HQ at higher concentration being more effective in its antimicrobial activities resulted in higher

solution uptake, which might have caused higher weight gain (Brahmankar *et al.*, 2005). In terms of pulsing duration, D_1 (12 hours) showed the maximum fresh weight while the minimum fresh weight was recorded in D_3 (36 hours) on all the days after treatment. The interaction effect for fresh weight between different chemicals and durations showed a significant increase on the 3rd day after treatment over the initial weight and a decrease from the 6th day after treatment except in the treatments P_4D_1, P_4D_2, P_4D_3, P_5D_1 and P_5D_2 which showed an increase in fresh weight till the 6th day after treatment after which the fresh weight declined (Table 2b). The maximum fresh weight was recorded in P_4D_2 at 18.22 g on the 6th day after treatment which was closely followed by P_4D_1 at 18.11 g while the minimum fresh weight was recorded in P_0D_3 at 13.44. An increase in fresh weight is associated with both increases in growth and higher water absorption rate than transpiration. Similarly, the fresh weight decrease when the absorption rate decline and the transpiration rate exceed the absorption rate. Further analysis of the data shows that the fresh weight in treatment P_4 (Sucrose 5% + 8-HQC 100 ppm) and P_5 (Sucrose 5% + 8-HQC 200 ppm) recorded a gradual increase of fresh weight on the 6th day of 17.88 g and 16.46 g, respectively. For fresh weight, the flowers which were treated for 6 hours with Sucrose 5% + Cobalt chloride 250 ppm retained the highest value due to regulations of maximum water balance and pulsing with sugar to meet the carbohydrate requirement (Coorts, 1973; Halevy and Mayak, 1981).

3.3 Effect on stalk length

There was some variation in the length of the stalk when treated with different pulsing solutions (Table 2a). The maximum stalk length was increased on P_5 (Sucrose 5% + 8-HQC 200 ppm) by 40.48 cm and the minimum increase was observed in treatment P_0 (control) of 40.17 cm on the 9th day. Among the pulsing durations, D_2 (24 hours) gave the longest stalk elongation of 40.38 cm on the 9th day while the least was recorded in D_3 (36 hours) at 40.31 cm. the pulsing solution on the 3rd day statistically did not affect the stalk length. The interaction showed that the rate of stem elongation was observed till the 9th day where the maximum stem elongation was recorded in P_5D_2 at 40.56 cm and the least was recorded in P_0D_3 at of 40.14 cm (Table 2b). These results are following the findings of Cameron and Ride, 2001 and Asrar, 2012 which stated that the use of a treatment combination of sucrose with 8-HQ as a pulsing solution helps in increasing the stalk and foliage size of cut flowers.

3.4 Effect on spathe length and spathe breadth

There was a significant variation on the spathe length and breadth among the different pulsing solutions (Table 3a and 3b). The maximum spathe length and breadth were recorded in P_5 (Sucrose 5% + 8-HQC 200 ppm) of 12.15 cm and 9.17 cm respectively on the 6th day while the minimum spathe length and breadth were recorded in P_1 (Sucrose 5%) and P_2 (Sucrose 5% + Carbendazim 0.1%) of 11.58 cm and 8.85 cm respectively. Among the pulsing durations, D_1 (12 hours) had the maximum spathe length and breadth on the 6th day of 12.27 cm and 9.20 cm respectively while the minimum spathe length and breadth were recorded in D_3 (36 hours) of 11.59 cm and 8.59 cm respectively. The interactions effect of different pulsing solutions and durations showed that P_4D_1 recorded the maximum increase in spathe length and breadth on 6th day of 12.64 cm and 10.23 cm respectively while the minimum spathe length and breadth were recorded in P_3D_3 andP_4D_3 of 10.99 cm and 8.17 cm respectively (Table 3b). These results are in accordance with the findings of Cameron and Ride (2001) and Asrar (2012) which stated that the use of treatment combination of sucrose with 8-HQ as pulsing solutions helps in increasing the stalk and foliage size of cut flowers.

3.5 Effect on spadix length and spadix girth

There was an increase in spadix length and girth as influenced by various pulsing solutions. The maximum increase in spathe length was recorded in P_1 (Sucrose 5%) of 5.88 cm on the 6th day and gradually decreases on the 9th day while the maximum spadix girth was recorded in P_3 (Sucrose 5% + Carbendazim 0.2%) of 8.26 mm (Table 4a). Among the pulsing durations, D_2 (24 hours) had the maximum spadix length and girth on the 6th day of 5.18 cm and 8.11 mm respectively (Table 4a). The interactions effect of different pulsing solutions and durations showed that P_1D_1 recorded the maximum increase in spadix length on the 3rd day of 6.61 cm while the maximum increase in spadix girth was recorded in P_1D_2 of 8.56 mm (Table 4b). These results are following the determinations of Cameron and Ride (2001) and Asrar (2012) who stated that the use of a treatment combination of sucrose with 8-HQ as a pulsing solution helps in increasing the stalk and foliage size of cut flowers.

3.6 Effect on vase life

The vase life of cut Anthurium was highly significant among the different pulsing solutions (Table 4a). P_4 (Sucrose 5% + 8-HQC 100 ppm) recorded the maximum vase life of 20.33 days closely followed by P_5 (Sucrose 5% + 8-HQC 200 ppm) of 19.67 days whereas the minimum vase life of cut Anthurium was observed on P_0 (Control) of 16.11 days. Among the pulsing durations, D_2 (24 hours) gave the highest vase life of 19.78 days while the minimum was recorded in D_3 (36 hours) at 16.76 days (Table 4a). The interactions effect of different pulsing solutions and durations showed statistically significant where P_4D_2 recorded the maximum vase life of 22.33 days followed by

P_0D_1 of 21 days, while P_0D_1 recorded the minimum vase life of 16.11 days (Table 4b). Sucrose acts as a source of nutrition for tissues approaching carbohydrate starvation and it may also act as an osmotically active molecule, thereby having a role in subsequent water relations (Kuiper et al., 1995). Hence, the use of sucrose as the pulsing solution could be of practical significance in prolonging the vase life of cut flowers and foliage (Cameron and Ride, 2001). Hydroxyquinoline prevents the growth of microorganisms in xylem vessels, maintaining water uptake and extending flower vase life (Asrar, 2012). Thus the treatment combination of sucrose with 8-HQ help towards higher solution uptake thereby leading to higher fresh weight and increased vase life. The association of water relations in flower tissue with the longevity of cut flowers has been also documented by , Singh et al. (2003) in carnation, Reddy et al. (2005) in Bird of Paradise, Reddy (1988) in Rose, and Murali and Reddy (1993) in gladiolus.

4. Conclusion

From the above results, it has been found that pulsing of Anthurium (*Anthurium andraeanum* Lind.) cv. Tropical with sucrose 5% + 8-HQC 100 ppm for 24 hours is the best for increasing its postharvest life.

5. Acknowledgment

The authors are thankful to the department of Horticulture, SASRD, Nagaland University, Medziphema campus for the financial assistance

6. References

Aarts JFT (1957) Over de hundbaarheid van snijbloemen (on the keep ability of cut flowers). Meded Landbouwhoqeschoot 57: 1-62.

Amin OA (2017) II-Effect of some chemical treatments on keeping quality and vase life of cut chrysanthemum flowers. Middle East Journal of Agriculture Research 6(1): 221-243.

Anand M, Sankari A, Arulmozhiya R, Kayalvizhi K (2017) Evaluation of different varieties of anthurium (*Anthurium andraeanum* Linden Ex André) for cut flower production under Shevaroys Hills. Electronic Journal of Plant Breeding 8(3): 792-798.

Asrar AWA (2012) Effects of some preservative solutions on vase life and keeping quality of snapdragon (*Antirrhinum majus* L.) cut flowers. Journal of the Saudi Society of Agricultural Sciences 11: 29-35.

Brahmankar SE, Dhaduk BK, Singh A (2005) Effect of harvesting stages and chemical preservatives on postharvest life of golden rod (Solidago Canadensis Linn.) panicles. Journal of Ornamental Horticulture 8(1): 23-26.

Cameron AC, Reid MS (2001) 1-MCP blocks ethylene induced petal abscission of *Pelargonium peltatum* but the effect is transient. Postharvest Biology and Technology 22: 169-177.

Coorts GD (1973) Internal metabolic changes in cut flowers. Horticultural Sciences 8: 195-198.

Devi RA and Jawaharlal M (2005) Effect of holding solution on postharvest life of cut flowers in Anthurium (*Anthurium andraeanum* Lind) cv. Temptation. Journal of Ornamental Horticulture 8(4): 318-319.

Dias SMF and Patil AA (2003) Chemically fortified solutions to enhance the longevity of cut rose cv. Arjun. Karnataka Journal of Agricultural Sciences 16(2): 324-326.

Elgimabi EL (2011) Vase life extension of rose cut flowers (*Rose hybrida*) as influenced by silver nitrate and sucrose pulsing. American Journal of Agricultural and Biological Sciences 6(1): 128-133.

Halevy AH and Mayak S (1981) Senescence and post harvest physiology of cut flowers part-I. Horticultural Reviews. (J. Janick Ed.) 1: 204-206.

Ho LC, Nicholus R (1975) The role of phloem transport in the translocation of sucrose along the stem of carnation cut flowers. Annals of Botany 39: 439-446.

Jain R, Bhalla R, Dhiman SR (2007) Effect of pulsing treatments on postharvest life of Rose cv. First Red. Journal of Ornamental Horticulture 10(3): 143-147.

Kader AA (2003) A perspective on postharvest horticulture. Journal of Horticultural Science 38: 1004-1008.

Kuiper D, Ribot S, Van Reenen HS, Marissen N (1995) The effect of sucrose on the flower bud ripening of Madelon cut roses. Scientia Horticulturae 60: 325-336.

Leeden MVD (2008) Anthurium in India. Souvenir, In: International Floriculture Show. Sikkim, 14th - 16th March, pp. 137-139.

Maitra S and Roychoudhry N (2005) Effect of pulsing and holding solutions on postharvest life of cut flowers in *Anthurium andraeanum* Lind. cv. Nitta. Journal of Ornamental Horticulture 8(3): 186-191.

Marousky FJ (1972) Water relations, effects of floral preservatives on bud opening and keeping quality of cut flowers. Horticultural Society 7: 114-116.

Murali TP and Reddy TV (1993) Post harvest life of gladiolus as influence by sucrose and metal salts. Acta Horticulturae 343: 117-120.

Paull RE, Goo TTC (1985) Ethylene and water stress in the senescence of cut anthurium flowers. Journal of American Society of Horticulture Science 110: 84-88.

Reddy CBH, Gopinath G and Chikkasubbanna V (2005) Effect of pulsing, 8-HQC and citric acid on the vase life of Bird of Paradise (*Sterlitzia reginae* Ait.) cut flowers. Journal of Research Angrau 33(3): 29-32.

Reddy TV (1988) Mode of action of cobalt in extending the vase life of cut roses. Scientia Horticulturae 36: 303-313.

Singh K, Parminder S and Manish K (2003) Effect of vase and pulsing solutions on keeping quality of standard carnations cut flowers. Journal of Ornamental Horticulture 10(1): 20-24.

Valsalakumari PK, Juliemol T, Rajeevan PK and Geetha CK (2007) Improvement in post harvest quality of orchid flowers (Dendrobium varieties). The Journal of the Orchid Society of India 21(1-2): 51-55.

Table 1a. Effect of different pulsing solution and duration on water uptake, water loss and water balanceof Anthurium cv. Tropical

Treatments	Water uptake (g/plant)					Water loss (g/plant)					Water balance (g/plant)				
	3rd DAT	6th DAT	9th DAT	12th DAT	15th DAT	3rd DAT	6th DAT	9th DAT	12th DAT	15th DAT	3rd DAT	6th DAT	9th DAT	12th DAT	15th DAT
Pulsing solution															
P_0: Untreated (Control)	5.89	5.89	4.33	3.11	2.56	5.33	6.03	5.18	3.96	2.78	1.10	0.99	0.85	0.78	0.72
P_1: Sucrose 5%	6.56	5.56	4.89	3.67	2.89	6.00	6.44	5.44	4.59	3.70	1.09	1.02	0.90	0.81	0.73
P_2: Sucrose 5% + Carbendazim 0.1%	6.89	6.11	5.00	4.67	2.22	6.33	6.96	5.82	4.03	2.89	1.10	0.94	0.95	0.83	0.73
P_3: Sucrose 5% + Carbendazim 0.2%	7.44	6.78	5.67	4.78	2.78	7.00	6.89	5.74	5.67	3.41	1.07	1.00	1.04	0.81	0.77
P_4: Sucrose 5% + 8-HQC 100 ppm	11.67	10.11	7.56	4.89	4.00	10.56	9.67	8.48	6.48	4.07	1.11	1.34	0.96	0.80	0.78
P_5: Sucrose 5% + 8-HQC 200 ppm	6.67	7.11	5.89	3.78	3.00	6.15	7.00	5.85	3.96	2.67	1.09	1.08	1.07	0.92	0.84
SEm±	*0.34*	*0.31*	*0.27*	*0.28*	*0.23*	*0.30*	*0.22*	*0.18*	*0.13*	*0.22*	*0.03*	*0.05*	*0.06*	*0.04*	*0.22*
CD (p=0.05)	*0.98*	*0.88*	*0.77*	*0.79*	*0.66*	*0.86*	*0.62*	*0.53*	*0.39*	*0.64*	*NS*	*0.14*	*0.18*	*NS*	*0.64*
Pulsing duration															
D_1: 12 hours	7.06	7.11	5.67	4.11	3.28	6.46	7.56	5.85	4.91	3.19	1.09	0.94	0.84	0.80	0.76
D_2: 24 hours	7.94	6.78	5.50	4.39	2.67	7.22	7.00	6.39	4.59	3.19	1.10	0.97	0.86	0.81	0.72
D_3: 36 hours	7.56	6.89	5.50	3.94	2.78	7.00	6.94	6.02	4.85	3.39	1.09	0.99	0.85	0.77	0.73
SEm±	*0.24*	*0.22*	*0.19*	*0.20*	*0.16*	*0.21*	*0.15*	*0.13*	*0.17*	*0.16*	*0.02*	*0.02*	*0.03*	*0.04*	*0.02*
CD (p=0.05)	*0.69*	*NS*	*NS*	*NS*	*NS*	*0.61*	*0.44*	*0.37*	*0.48*	*0.45*	*NS*	*NS*	*0.09*	*NS*	*NS*

Note: DAT = Days after treatment

NS = Non-significant at 5% level of significance

Table 1b. Interaction effect of different pulsing solution and duration on water uptake, water loss and water balance of Anthurium cv. Tropical

Treatments	Water uptake (g/plant)					Water loss (g/plant)					Water balance (g/plant)				
	3rd DAT	6th DAT	9th DAT	12th DAT	15th DAT	3rd DAT	6th DAT	9th DAT	12th DAT	15th DAT	3rd DAT	6th DAT	9th DAT	12th DAT	15th DAT
P_0D_1	5.67	5.67	4.67	3.00	2.67	5.22	7.33	5.44	4.22	3.87	1.08	0.77	0.77	0.71	0.67
P_0D_2	6.33	6.33	4.00	3.00	2.33	5.67	5.33	4.67	3.77	3.25	1.11	1.15	0.86	0.79	0.75
P_0D_3	5.67	5.67	4.33	3.33	2.67	5.11	5.44	4.77	3.89	3.45	1.11	1.04	0.91	0.86	0.75
P_1D_1	7.00	7.00	5.67	4.33	3.33	6.56	6.67	6.19	6.11	5.35	1.06	1.04	0.94	0.77	0.65

P_1D_2	7.33	5.67	6.00	4.00	3.33	6.56	6.67	6.43	5.11	4.45	1.12	1.07	0.89	0.83	0.80
P_1D_3	5.33	4.00	3.00	2.67	2.00	4.89	6.00	5.88	4.00	3.13	1.09	0.93	0.86	0.82	0.73
P_2D_1	6.67	5.67	5.00	3.33	2.00	6.22	6.22	6.13	5.81	2.87	1.07	0.91	0.85	0.77	0.73
P_2D_2	5.67	5.00	4.00	5.00	2.33	5.11	6.33	6.36	6.23	2.86	1.11	0.94	0.93	0.82	0.78
P_2D_3	8.33	7.67	6.00	5.67	2.33	7.66	8.33	5.81	5.92	3.53	1.11	0.96	0.93	0.91	0.69
P_3D_1	7.33	6.33	5.67	5.67	3.00	6.67	7.22	5.44	5.78	3.87	1.10	0.88	1.11	0.67	0.82
P_3D_2	6.67	6.33	5.00	5.67	2.00	6.33	7.00	5.44	5.88	2.88	1.05	1.07	1.07	0.93	0.88
P_3D_3	8.33	7.67	6.33	3.00	3.33	8.00	6.45	7.11	5.67	4.16	1.04	1.05	0.93	0.83	0.77
P_4D_1	10.00	10.67	7.33	4.67	4.67	8.78	11.02	6.55	4.49	5.19	1.14	1.51	0.99	0.78	0.78
P_4D_2	14.33	10.33	8.00	5.00	3.67	13.00	9.66	8.22	4.75	4.87	1.10	1.46	1.00	0.82	0.70
P_4D_3	10.67	9.33	7.33	5.00	3.67	9.89	8.33	8.00	4.66	4.97	1.08	1.04	0.88	0.81	0.80
P_5D_1	5.67	7.33	5.67	3.67	4.00	5.34	6.88	5.12	4.69	4.27	1.07	1.16	1.38	1.07	0.97
P_5D_2	7.33	7.00	6.00	3.67	2.33	6.67	7.00	7.11	4.83	3.78	1.10	1.07	0.93	0.82	0.69
P_5D_3	7.00	7.00	6.00	4.00	2.67	6.44	7.11	7.00	4.67	3.56	1.09	1.00	0.90	0.87	0.85
SEm±	*0.59*	*0.53*	*0.46*	*0.48*	*0.39*	*0.52*	*0.38*	*0.33*	*0.23*	*0.23*	*0.02*	*0.04*	*0.06*	*0.09*	*0.05*
CD (p=0.05)	*1.70*	*1.53*	*1.33*	*1.37*	*1.13*	*1.48*	*1.08*	*0.94*	*0.67*	*0.67*	*NS*	*0.10*	*0.18*	*0.25*	*0.14*

Note: DAT = Days after treatment

NS = Non-significant at 5% level of significance

Table 2a. Effect of different pulsing solution and duration on fresh weight and stalk length of Anthurium cv. Tropical

Treatments	Fresh weight (g/plant)						Stalk length (cm)					
	Initial	3rd DAT	6th DAT	9th DAT	12th DAT	15th DAT	Initial	3rd DAT	6th DAT	9th DAT	12th DAT	15th DAT
Pulsing solution												
P_0: Untreated (Control)	15.00	15.55	14.96	14.36	13.70	13.11	40.00	40.17	40.21	40.17	40.12	40.10
P_1: Sucrose 5%	15.04	15.63	14.92	14.48	13.74	13.26	40.00	40.30	40.35	40.32	40.25	40.15
P_2: Sucrose 5% + Carbendazim 0.1%	14.51	15.07	14.22	13.59	13.15	12.48	40.00	40.25	40.33	40.30	40.23	40.17
P_3: Sucrose 5% + Carbendazim 0.2%	14.77	15.22	14.52	13.85	13.04	12.40	40.00	40.22	40.31	40.33	40.25	40.19
P_4: Sucrose 5% + 8-HQC 100 ppm	16.40	17.51	17.88	17.11	16.48	15.70	40.00	40.24	40.36	40.45	40.35	40.27

P_5: Sucrose 5% + 8-HQC 200 ppm	15.74	16.29	16.46	15.78	15.11	14.55	40.00	40.27	40.40	40.48	40.38	40.30
SEm±	*0.30*	*0.31*	*0.30*	*0.32*	*0.30*	*0.28*	*0.00*	*0.04*	*0.04*	*0.03*	*0.03*	*0.03*
CD (p=0.05)	*0.86*	*0.88*	*0.86*	*0.91*	*0.85*	*0.79*	*NS*	*NS*	*0.10*	*0.10*	*0.09*	*0.10*
Pulsing duration												
D_1: 12 hours	15.66	16.29	16.02	15.35	14.61	14.02	40.00	40.24	40.33	40.33	40.26	40.19
D_2: 24 hours	15.14	15.90	15.48	14.92	14.29	13.74	40.00	40.24	40.34	40.38	40.29	40.22
D_3: 36 hours	14.92	15.44	14.98	14.31	13.70	13.00	40.00	40.25	40.32	40.31	40.24	40.18
SEm±	*0.21*	*0.22*	*0.21*	*0.23*	*0.21*	*0.20*	*0.00*	*0.03*	*0.02*	*0.02*	*0.02*	*0.02*
CD (p=0.05)	*NS*	*0.62*	*0.61*	*0.65*	*0.60*	*0.56*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*

Note: DAT = Days after treatment

NS = Non-significant at 5% level of significance

Table 2b. Interaction effect of different pulsing solution and duration on fresh weight and stalk lengthof Anthurium cv. Tropical

Treatments	Fresh weight (g/plant)						Stalk length (cm)					
	Initial	3rd DAT	6th DAT	9th DAT	12th DAT	15th DAT	Initial	3rd DAT	6th DAT	9th DAT	12th DAT	15th DAT
P_0D_1	16.55	16.99	16.33	15.66	14.66	14.33	40.00	40.13	40.22	40.19	40.12	40.10
P_0D_2	14.77	15.44	15.11	14.43	14.00	13.33	40.00	40.15	40.20	40.17	40.12	40.10
P_0D_3	13.66	14.22	13.44	13.00	12.44	11.67	40.00	40.19	40.21	40.14	40.12	40.10
P_1D_1	16.22	16.78	16.33	16.00	15.22	14.44	40.00	40.30	40.34	40.27	40.23	40.13
P_1D_2	14.11	14.89	14.22	13.89	13.11	12.78	40.00	40.30	40.36	40.33	40.26	40.16
P_1D_3	14.78	15.22	14.22	13.55	12.89	12.55	40.00	40.30	40.36	40.33	40.26	40.16
P_2D_1	15.11	15.55	15.00	14.22	13.66	13.00	40.00	40.26	40.35	40.32	40.24	40.19
P_2D_2	14.66	15.22	13.89	13.22	12.89	12.55	40.00	40.25	40.35	40.35	40.25	40.17
P_2D_3	13.77	14.44	13.78	13.33	12.89	11.89	40.00	40.23	40.29	40.24	40.20	40.15
P_3D_1	14.66	15.33	14.44	13.77	13.00	12.33	40.00	40.23	40.33	40.35	40.26	40.19
P_3D_2	14.77	15.11	14.44	13.88	13.11	12.44	40.00	40.21	40.31	40.39	40.30	40.22
P_3D_3	14.88	15.22	14.66	13.88	13.00	12.44	40.00	40.22	40.30	40.26	40.20	40.15

P_4D_1	16.55	17.77	18.11	17.44	16.78	16.11	40.00	40.21	40.36	40.46	40.36	40.27
P_4D_2	16.44	17.77	18.22	17.55	16.88	16.00	40.00	40.25	40.36	40.47	40.36	40.30
P_4D_3	16.22	17.00	17.33	16.33	15.78	15.00	40.00	40.26	40.36	40.40	40.33	40.24
P_5D_1	14.89	15.33	15.93	15.00	14.33	13.89	40.00	40.27	40.36	40.40	40.33	40.26
P_5D_2	16.11	17.00	17.00	16.55	15.78	15.31	40.00	40.27	40.46	40.56	40.46	40.38
P_5D_3	16.22	16.55	16.44	15.78	15.22	14.44	40.00	40.27	40.36	40.47	40.34	40.27
SEm±	*0.52*	*0.53*	*0.52*	*0.55*	*0.51*	*0.48*	*0.00*	*0.07*	*0.06*	*0.06*	*0.06*	*0.06*
CD (p=0.05)	*1.49*	*1.53*	*1.49*	*1.58*	*1.47*	*1.38*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*

Note: DAT = Days after treatment

NS = Non-significant at 5% level of significance

Table 3a. Effect of different pulsing solution and duration on spathe length and spathe breadth of Anthurium cv. Tropical

Treatments	Spathe length (cm)						Spathe breadth (cm)					
	Initial	3rd DAT	6th DAT	9th DAT	12th DAT	15th DAT	Initial	3rd DAT	6th DAT	9th DAT	12th DAT	15th DAT
Pulsing solution												
P_0: Untreated (Control)	11.46	11.54	11.60	11.51	11.45	11.37	8.66	8.71	8.74	8.68	8.61	8.51
P_1: Sucrose 5%	11.45	11.53	11.58	11.49	11.36	11.28	8.74	8.82	8.87	8.80	8.74	8.71
P_2: Sucrose 5% + Carbendazim 0.1%	11.91	11.97	12.03	11.89	11.77	11.67	8.75	8.81	8.85	8.80	8.75	8.67
P_3: Sucrose 5% + Carbendazim 0.2%	11.58	11.67	11.69	11.62	11.55	11.45	8.74	8.82	8.86	8.86	8.77	8.71
P_4: Sucrose 5% + 8-HQC 100 ppm	12.01	12.10	12.14	12.13	12.05	12.02	8.80	8.90	8.98	9.00	9.06	8.98
P_5: Sucrose 5% + 8-HQC 200 ppm	12.07	12.13	12.15	12.07	12.02	11.97	9.04	9.10	9.17	9.13	9.06	9.01
SEm±	*0.18*	*0.17*	*0.15*	*0.17*	*0.17*	*0.19*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
CD (p=0.05)	*0.51*	*0.49*	*0.43*	*0.50*	*0.49*	*0.56*	*0.61*	*0.56*	*0.60*	*0.56*	*0.59*	*0.63*
Pulsing duration												

D_1: 12 hours	12.17	12.23	12.27	12.20	12.08	12.05	9.08	9.14	9.20	9.19	9.16	9.07
D_2: 24 hours	11.62	11.68	11.74	11.66	11.56	11.50	8.82	8.89	8.95	8.90	8.85	8.80
D_3: 36 hours	11.45	11.54	11.59	11.50	11.46	11.33	8.46	8.55	8.59	8.54	8.49	8.43
SEm±	*0.13*	*0.12*	*0.11*	*0.12*	*0.12*	*0.14*	*0.15*	*0.14*	*0.15*	*0.14*	*0.14*	*0.15*
CD (p=0.05)	*0.36*	*0.35*	*0.30*	*0.35*	*0.35*	*0.39*	*0.43*	*0.40*	*0.42*	*0.39*	*0.41*	*0.44*

Note: DAT = Days after treatment

NS = Non-significant at 5% level of significance

Table 3b. Interaction effect of differentpulsing solution and duration on spathe length and spathe breadth of Anthurium cv. Tropical

Treatments	Spathe length (cm)						Spathe breadth (cm)					
	Initial	3rd DAT	6th DAT	9th DAT	12th DAT	15th DAT	Initial	3rd DAT	6th DAT	9th DAT	12th DAT	15th DAT
P_0D_1	12.12	12.19	12.19	12.11	12.08	11.93	8.96	8.98	9.04	9.05	8.99	8.85
P_0D_2	11.16	11.27	11.41	11.30	11.22	11.18	8.58	8.66	8.69	8.60	8.50	8.41
P_0D_3	11.09	11.18	11.20	11.11	11.06	11.00	8.43	8.49	8.49	8.39	8.34	8.26
P_1D_1	11.63	11.71	11.77	11.67	11.52	11.41	8.83	8.92	8.96	8.85	8.83	8.70
P_1D_2	10.91	10.94	11.03	10.93	10.83	10.72	8.44	8.49	8.54	8.45	8.41	8.40
P_1D_3	11.81	11.94	11.95	11.86	11.74	11.71	8.93	9.06	9.11	9.10	8.99	8.94
P_2D_1	12.34	12.40	12.46	12.35	12.24	12.16	8.93	8.97	9.02	8.94	8.90	8.80
P_2D_2	11.59	11.68	11.72	11.62	11.41	11.33	9.11	9.20	9.23	9.21	9.16	9.10
P_2D_3	11.79	11.85	11.90	11.71	11.65	11.53	8.21	8.27	8.31	8.24	8.20	8.11
P_3D_1	12.47	12.54	12.58	12.50	12.45	12.45	8.44	8.53	8.57	8.58	8.50	8.42
P_3D_2	11.38	11.44	11.50	11.41	11.32	11.23	9.42	9.49	9.56	9.53	9.46	9.37
P_3D_3	10.91	10.93	10.99	10.95	10.85	10.68	8.35	8.44	8.47	8.47	8.36	8.34
P_4D_1	12.54	12.62	12.64	12.64	12.59	12.54	10.07	10.17	10.23	10.27	10.37	9.25
P_4D_2	12.49	12.57	12.60	12.60	12.57	12.55	8.33	8.43	8.54	8.53	8.52	8.02
P_4D_3	11.00	11.10	11.17	11.14	11.00	10.98	8.00	8.10	8.17	8.20	8.30	8.27
P_5D_1	11.91	11.94	11.97	11.92	11.89	11.78	9.24	9.29	9.38	9.43	9.36	9.27

P_5D_2	12.19	12.19	12.19	12.08	12.03	12.02	9.02	9.09	9.14	9.10	9.04	8.42
P_5D_3	12.12	12.16	12.31	12.21	12.13	12.11	8.86	8.93	8.98	8.85	8.77	8.23
SEm±	*0.31*	*0.30*	*0.26*	*0.30*	*0.30*	*0.34*	*0.37*	*0.34*	*0.36*	*0.34*	*0.35*	*0.38*
CD (p=0.05)	*0.88*	*0.85*	*0.74*	*0.87*	*0.85*	*0.97*	*1.05*	*0.97*	*1.03*	*0.96*	*1.01*	*1.09*

Note: DAT = Days after treatment

Table 4a. Effect of different pulsing solution and duration on spadix length,spadix girth and vase life of Anthurium cv. Tropical

Treatments	Spadix length (cm)						Spadix girth (mm)						Vase life (days)
	Initial	3rd DAT	6th DAT	9th DAT	12th DAT	15th DAT	Initial	3rd DAT	6th DAT	9th DAT	12th DAT	15th DAT	
Pulsing solution													
P_0: Untreated (Control)	5.44	5.49	5.52	5.46	5.38	5.38	8.15	8.15	8.15	8.15	8.15	8.15	16.11
P_1: Sucrose 5%	5.80	5.86	5.88	5.86	5.81	5.76	8.00	8.00	8.00	8.00	8.00	8.00	17.22
P_2: Sucrose 5% + Carbendazim 0.1%	4.28	4.29	4.30	4.27	4.23	4.19	7.96	7.96	7.96	7.96	7.96	7.96	18.11
P_3: Sucrose 5% + Carbendazim 0.2%	4.78	4.81	4.83	4.80	4.77	4.69	8.26	8.26	8.26	8.26	8.26	8.26	18.15
P_4: Sucrose 5% + 8-HQC 100 ppm	4.67	4.71	4.78	4.78	4.73	4.66	7.81	7.81	7.81	7.81	7.81	7.81	20.23
P_5: Sucrose 5% + 8-HQC 200 ppm	5.06	5.10	5.13	5.16	5.04	4.98	7.96	7.96	7.96	7.96	7.96	7.96	19.67
SEm±	*0.18*	*0.19*	*0.17*	*0.18*	*0.17*	*0.18*	*0.21*	*0.21*	*0.21*	*0.21*	*0.21*	*0.21*	*0.23*
CD (p=0.05)	*0.52*	*0.53*	*0.50*	*0.53*	*0.50*	*0.51*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*0.66*
Pulsing duration													
D_1: 12 hours	5.00	5.04	5.07	5.09	5.03	4.98	8.04	8.04	8.04	8.04	8.04	8.04	18.26
D_2: 24 hours	5.08	5.13	5.18	5.15	5.11	5.05	8.11	8.11	8.11	8.11	8.11	8.11	19.78
D_3: 36 hours	4.93	4.96	4.97	4.92	4.84	4.80	7.92	7.92	7.92	7.92	7.92	7.92	16.76
SEm±	*0.13*	*0.13*	*0.12*	*0.13*	*0.12*	*0.13*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.16*
CD (p=0.05)	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*0.47*

Note: DAT = Days after treatment

NS = Non-significant at 5% level of significance

Table 4b. Interaction effect of differentpulsing solution and duration on candle length, candle girth and vase life of Anthurium cv. Tropical

Treatments	Spadix length (cm)						Spadix girth (mm)						Vase life (days)
	Initial	3rd DAT	6th DAT	9th DAT	12th DAT	15th DAT	Initial	3rd DAT	6th DAT	9th DAT	12th DAT	15th DAT	
P_0D_1	5.53	5.57	5.57	5.54	5.47	5.50	8.11	8.11	8.11	8.11	8.11	8.11	16.11
P_0D_2	4.96	5.00	5.05	4.99	4.93	4.90	8.00	8.00	8.00	8.00	8.00	8.00	16.67
P_0D_3	5.83	5.90	5.93	5.84	5.73	5.73	8.33	8.33	8.33	8.33	8.33	8.33	15.00
P_1D_1	6.55	6.61	6.60	6.57	6.53	6.45	8.00	8.00	8.00	8.00	8.00	8.00	17.00
P_1D_2	5.85	5.90	5.93	5.93	5.86	5.85	8.56	8.56	8.56	8.56	8.56	8.56	19.00
P_1D_3	5.00	5.07	5.10	5.07	5.03	4.97	7.44	7.44	7.44	7.44	7.44	7.44	15.67
P_2D_1	4.23	4.27	4.27	4.27	4.23	4.20	7.67	7.67	7.67	7.67	7.67	7.67	17.67
P_2D_2	4.50	4.57	4.60	4.53	4.50	4.47	8.11	8.11	8.11	8.11	8.11	8.11	19.67
P_2D_3	4.10	4.03	4.03	4.00	3.97	3.90	8.11	8.11	8.11	8.11	8.11	8.11	17.00
P_3D_1	4.83	4.90	4.93	4.97	4.97	4.87	8.45	8.45	8.45	8.45	8.45	8.45	18.22
P_3D_2	4.47	4.47	4.57	4.50	4.43	4.37	8.11	8.11	8.11	8.11	8.11	8.11	20.00
P_3D_3	5.03	5.07	5.00	4.93	4.90	4.83	8.22	8.22	8.22	8.22	8.22	8.22	16.22
P_4D_1	4.30	4.37	4.43	4.50	4.43	4.33	8.22	8.22	8.22	8.22	8.22	8.22	20.67
P_4D_2	5.07	5.10	5.17	5.17	5.20	5.10	8.00	8.00	8.00	8.00	8.00	8.00	22.33
P_4D_3	4.63	4.67	4.73	4.67	4.57	4.53	7.22	7.22	7.22	7.22	7.22	7.22	18.00
P_5D_1	4.53	4.53	4.63	4.67	4.57	4.50	7.78	7.78	7.78	7.78	7.78	7.78	19.33
P_5D_2	5.63	5.73	5.73	5.80	5.70	5.60	7.89	7.89	7.89	7.89	7.89	7.89	21.00
P_5D_3	5.00	5.03	5.03	5.00	4.87	4.83	8.22	8.22	8.22	8.22	8.22	8.22	18.67
SEm±	*0.31*	*0.32*	*0.30*	*0.32*	*0.30*	*0.31*	0.36	0.36	0.36	0.36	0.36	0.36	*0.40*
CD (p=0.05)	*0.90*	*0.93*	*0.86*	*0.91*	*0.87*	*0.88*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*1.15*

Note: DAT = Days after treatment

NS = Non-significant at 5% level of significance