Research Article

Enhancing Vase Life of *Nephrolepis Exaltata* by Different Holding Solutions

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Abstract

Cut foliage production has been rapidly increased day by day and it's played an important role in the national income all over the world. This study was conducted during seasons 2019 to investigate the effect of various holding solutions on keeping the quality and extending the longevity of *Nephrolepis exaltata* (L.). Fronds of *Nephrolepis exaltata*, commonly known as Boston fern normally exhibits longer vase life compared to other ferns. Boston fern having local demand and promising export quality. To ensure the availability of the greens for a longer duration, chemical storage holds considerable significance. In this experiment chemicals like GA_3 (50 and 100 ppm), NAA (50 and 100 ppm), Alluminium sulphate (100 and 200 ppm), sucrose (4% and 5%) and tap water as control were used as vase solution. The results emphasized that fronds kept in 5% Sucrose solution could enhance the vase life up to 21 days at 25º to 30°C and 70-75% RH, along with better acceptability, compared to other treatments.

Keywords: Nephrolepis, storage, GA3, NAA, Sucrose, Alluminium sulphate, vase life, holding solution

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Introduction

Cut foliage is one of the major components of floricultural crops that have acquired an important position in the local and foreign markets over the world [1]. Cut foliage constitutes an important part of florist industry everywhere. *Nephrolepis exaltata* (L.) is commonly known as sword fern or Boston fern. It belongs to the family Nephrolepidaceae and is native to North, Central, and South America. It is one of the most popular cut foliage. Leaves are hairy with serrated margins. Generally the foliages of *Nephrolepis* having deep green colour with long lasting properties are most commonly used by the floral industry all over the world [2,3]. As a consequence, the trade of foliage indicates that India has emerged as one of the top suppliers among the developing countries and has been successful in developing a sustainable market in EU [4].

In India, a large amount of ferns are grown in Sikkim. A primary survey made by our team revealed that the florists of Sikkim supply the green foliage to Kolkata market, or entire West Bengal and other states, throughout the year. Based on the information from the florists and various flower shop owners of Mallickghat market, Kolkata, it seemed that Boston fern not only has local demand, but bestowed with promising export potentiality also. Owing to foliage delicacy and tenderness, these are extremely susceptible to mechanical and physical damage during and after harvest. To ensure the availability of the greens for a longer duration, refrigerated storage holds considerable significance [5,6,7]. Thus, to investigate the effect of certain chemicals on vase life of *Nephrolepis exaltata* this experiment was conducted.

Material and Methods

Fronds of "*Nephrolepis exaltata*" were harvested early in the morning from experimental plots of AICRP on Floriculture, Mondouri Nadia, West Bengal and that were brought to the laboratory within 2 hours. Then removing the pinnae from the lower third of the fronds and re-cutting to obtain a uniform length of 30cm, It must be ensure that the basal portion of the cut twigs certainly received a uniform dipping of 4.5 cm under solution those are prepared previously Gibberellic Acid (GA_3) (50ppm and 100ppm), Naphthalene Acetic Acid (NAA) (50ppm and 100ppm), Aluminium Sulphate (Al_2SO_4) (100ppm and 200ppm) and sucrose (4% and 5%) and tap water as control for evaluation of keeping quality in normal room temperature and the observations were recorded.

Effective vase life (days)

Vase life of fronds was recorded as the number of days on vase until the 50% pinnae abscission. When the pinnae fell below 50% from the fronds are regarded as commercially unacceptable and up to this day of observation were considered as vase life.

Cumulative water uptake during vase life (CWU) (g/foliage)

Equal amount of distilled water was taken in each test tube for keeping fronds after solution dipping. Water uptake was recorded daily until the end of vase life of foliage. The difference between initial weight of test tube containing distilled water without spike and weight of same test tube containing water without spike next day was calculated by following formula-

Cumulative water uptake (CWU) = Initial weight of test tube containing distilled water without spike -Weight of same test tube containing water without spike last day.

Transpiration loss (g/foliage)

In this experiment transpiration loss is taken by difference between the initial foliage weight (on the first day) and final foliage weight (on the last day of vase life) along with bottle and solution gives the TL of cut foliage and it was calculated by following formula,

Transpiration loss = Initial weight of foliage spike - Weight of same foliage spike at last day.

Cumulative water balance (g/foliage)

The Cumulative water balance in cut foliage was calculated by following formula,

Cumulative water balance = Cumulative water uptake – Transpiration loss

Water loss/ uptake ratio (%)

Water loss/ uptake ratio of the foliage was determined by following formula,

$$\text{Relative fresh weight (\%)} = \frac{\text{Transpiration loss}}{\text{Cumulative water uptake}} \times 100$$

Relative fresh weight (RFW) (%)

Relative fresh weight of the foliage was determined just before the immersing of the foliage into the solution and repeated every day until the vase life of the foliage were terminated. The fresh foliage of each foliage was expressed relative to the initial weight to represent the water status of the foliage and it was calculated by following formula,

$$\text{Relative fresh weight (\%)} = \frac{\text{Fresh weight on nth day}}{\text{Initial fresh weight}} \times 100$$

Overall acceptability (1-5)

The effect of different temperature on cut foliage ware examined by determining the longevity by the day's number till wilting, the general appearance of foliage quality based on scale, ranking from one to four as described [8].

Results and Discussion

In the present study (**Table 1, Figure 1**), sucrose 5% (T9) was found to have maximum 21 days effect in the vase life of *Nephrolepis*, followed by GA_3 50 ppm (T_2) 17 days. Minimum vase life 7.67 days was found in T7 (Al_2SO_4, 200ppm). Keeping the mature fronds of *Nephrolepis exaltata* in 5% Sucrose solution could enhance the vase life up to 21 days in 25 to 30°C and 70-75% RH, along with better acceptability, compared to control (15 days).

Table 1 Effect of holding solutions on effective vase life (days), cumulative water uptake (ml), cumulative transpirational loss (ml), cumulative water balance (g/foliage), water loss/uptake ratio

Treatments	Effective vase life (days)	Cumulative water uptake in vase (ml)	Cumulative transpirational loss (ml/foliage)	Cumulative water balance (g/foliage)	Water loss/uptake ratio
T_1 (Control)	15.33	2.97	0.52	2.45	0.17
T_2 (GA_3 50 ppm)	17.00	3.33	0.41	2.91	0.12
T_3 (GA_3 100ppm)	16.00	3.18	0.45	2.73	0.14
T_4 (NAA 50ppm)	13.00	2.36	0.55	1.80	0.23
T_5 (NAA 100 ppm)	10.33	1.96	0.57	1.39	0.29
T_6 (Al_2SO_4 100ppm)	8.33	1.79	0.60	1.19	0.33
T_7 (Al_2SO_4 200ppm)	7.67	1.70	0.62	1.08	0.37
T_8 (Sucrose 4%)	19.33	3.98	0.35	3.63	0.09
T_9 (Sucrose 5%)	21.00	4.32	0.31	4.00	0.07
SEm (±)	0.53	0.05	0.03	0.05	0.01
CD at 5%	1.60	0.15	0.09	0.15	0.03

Highest CWU was 4.32 ml in T9 (5% Sucrose) followed by 3.98 in T8 (4% Sucrose).Whereas minimum CWU of 1.70 ml was recorded in T7 (Al_2SO_4 @ 200ppm) (Table 1). This result corroborates with the finding [9]. Possibly sucrose as a vase solution was the main carbohydrate source which decreased the water potential and thus improved the water uptake and fresh weight of the foliages. It was supported by the findings that in *A. plumosus*, pulsing of shoots with chemicals was found to be more effective than the holding treatments but not in *Nephrolepis exaltata*.

The maximum cumulative transpiration loss of 0.62 ml was found in T_7 (Al_2SO_4 @ 200ppm) followed by 0.60 ml in T_6 (Al_2SO_4 @ 100ppm) (Table 1).Whereas minimum cumulative transpiration loss of 0.31 ml was recorded in T_9 (5% Sucrose).

The highest cumulative water balance of 4.00 g/foliage was obtained in fronds treated with sucrose T_9 (5% Sucrose) followed by 3.63 g in T_8 (4% Sucrose) and the lowest cumulative water balance of 1.08 g was observed in T_7 (Al_2SO_4 @ 200ppm) (Table 1). The higher cumulative water balance in cut foliage resulted in high degree of freshness of cut flowers for long period.

The maximum water loss/uptake ratio 0.37 was recorded inT_7 (Al_2SO_4 @ 200ppm) followed by 0.33 was in T_6 (Al_2SO_4 @ 100ppm) (Table 1). Whereas minimum water loss/uptake ratio of 0.07 was recorded in T_9 (5% Sucrose).

Table 2 Effect of holding solutions on chlorophyll content during vase life (mg/g) and Overall acceptability

Total chlorophyll content (mg/g)				Overall acceptability after 7 days
Treatment	**1st Day**	**Last day**	**Loss during storage (mg/g)**	
T_1 (CONTROL)	76.67	71.00	5.67	4.17
T_2 (GA_3 50 ppm)	80.33	76.33	4.00	4.50
T_3 (GA_3 100ppm)	80.67	77.00	3.67	4.33
T_4 (NAA 50ppm)	59.67	54.67	5.00	3.83
T_5 (NAA 100 ppm)	41.33	36.00	5.33	3.67
T_6 (Al_2SO_4 100ppm)	73.00	66.33	6.67	3.33
T_7 (Al_2SO_4 200ppm)	65.00	58.00	7.00	3.10
T_8 (Sucrose 4%)	69.33	65.00	4.33	4.67
T_9 (Sucrose 5%)	65.33	60.67	4.67	4.83
SEm (±)	4.93	4.78	0.92	0.28
CD at 5%	14.75	14.32	NS	0.80

Chlorophyll content during vase life gradually decreased as the duration increased. Lowest (3.67 mg/g) chlorophyll degradation was observed in T_3 (GA_3 100ppm) and highest in T_7 (Al_2SO_4 200ppm) (7.00 mg/g). However, overall acceptability of Boston fern varied significantly in all cases (**Table 2**). Better acceptability (4.83) was found in T_9 (Sucrose 5%) followed by T_8 (Sucrose 4%) (4.67). While the lowest grade of 3.10 was recorded in T_7 (Al_2SO_4 200ppm). After 7th days of storage highest percentage of relative fresh weight of 97.91 per cent was noted in T_9 (sucrose 5%) followed by 97.87 percent in T_8 (sucrose 4%) (**Table 3**). This indicated that, water absorption from the vase maintains a better foliage freshness which saves from early wilting and reflecting on vase life improvement. An increase in fresh weight could be attributed to improved water balance in the foliage. Fronds of *Nephrolepis exaltata* exhibited a continuous decrease in their vase life (Table 1). In the present experiments we found an effect of chemicals on the rate of water uptake and on the recovery of leaf Fresh Weight (FW) when the leaves had been placed in chemical treated water. During vase life the FW of leaves that were held in solution for 11-21 days did not decrease before day 7, thus did not decrease prior to the onset of the increase in pinnae abscission. The increase in ethylene production during vase life might have preceded the increase in pinnae abscission, hence might be the cause of the abscission.

Table 3 Effect of holding solutions on Relative fresh weight (%)

Relative fresh weight (%)							
Treatment	**1st Day**	**4th Day**	**7th Day**	**10th Day**	**13th Day**	**16th Day**	**19th Day**
T_1 (Control)	102.44	95.33	91.99	88.77	86.94	84.82	84.82
T_2 (GA_3 50 ppm)	104.26	99.57	97.20	94.99	92.98	91.03	88.26
T_3 (GA_3 100ppm)	104.62	98.72	95.33	91.99	89.42	86.11	--
T_4 (NAA 50ppm)	102.26	91.17	86.41	83.08	--	--	--
T_5 (NAA 100 ppm)	102.31	91.66	87.00	83.51	--	--	--
T_6 (AL_2SO_4 100ppm)	103.42	91.69	83.34	--	--	--	--
T_7 (AL_2SO_4 200ppm)	103.78	88.45	79.34	--	--	--	--
T_8 (sucrose 4%)	104.24	101.36	97.87	95.08	92.28	89.47	87.83
T_9 (sucrose 5%)	102.81	100.60	97.91	95.76	93.58	91.48	90.24
SE.m (±)	0.83	1.10	1.27	1.38	1.41	1.16	1.09
CD at 5%	NS	3.30	3.80	4.22	NS	NS	NS

T_1 (1^{st} day in vase)

T_1 (Last day in vase)

T_2 (1^{st} day in vase)

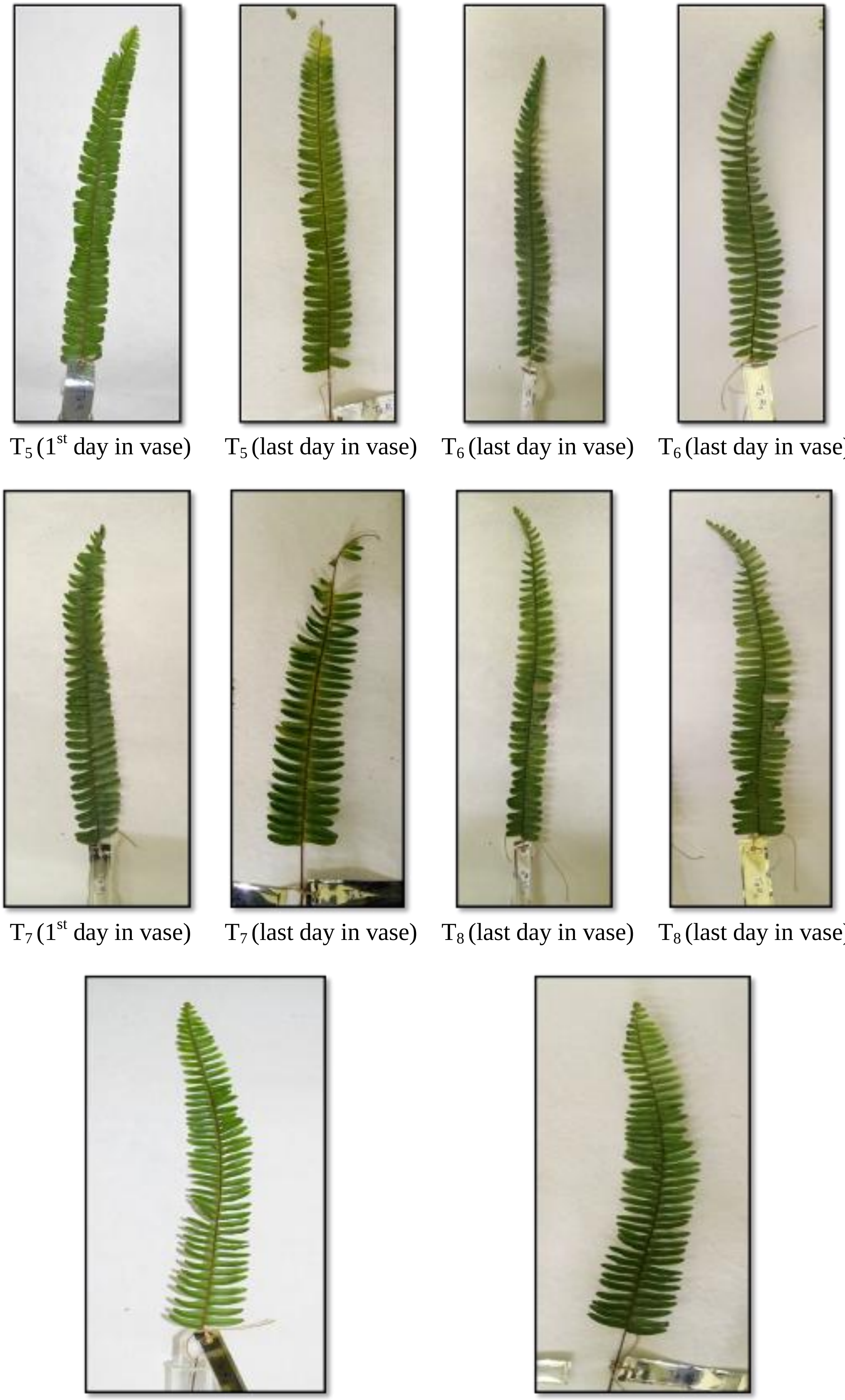
T_2 (Last day in vase)

T_3 (1^{st} day in vase)

T_3 (Last day in vase)

T_4 (1^{st} day in vase)

T_4 (Last day in vase)



T_1: (Control) ; T_2: GA_3 50 ppm; T_3: GA_3 100ppm; T_5: NAA 50ppm; T_5: NAA 100 ppm; T_6: Al_2SO_4 100ppm; T_7: Al_2SO_4 200ppm; T8: Sucrose 4%; T9: Sucrose 5%

Figure 1. *Nephrolepis exaltata* during vase life

Conclusion

In the above study, sucrose (5%) was found to have maximum effect in the vase life of *Nephrolepis* followed by GA_3 (50 ppm). Keeping the mature fronds of *Nephrolepis exaltata* in 5% Sucrose solution could enhance the vase life upto 21 days in 25 to 30ºC and 70-75% RH, along with better acceptability, compared to control (15 days).

Possibly sucrose as a vase solution was the main carbohydrate source which decreased the water potential and thus improves the water uptake and fresh weight of foliages. Normally, cut flowers preserved with sucrose helps to increase the substrate respiration, delaying hydrolysis of cell components, reducing ethylene production, enhance the effects of cytokines and improve the water balance. Probably, in *Nephrolepis* also, sucrose is transported from the media through the xylem and phloem of fronds. Sugar is transported and accumulated in the pinnae, which increases the osmotic pressure and the ability of cut foliages to absorb water and maintains turgor.

References

[1] Abou El-Ghait, E. M., A.O., Gomaa., A.S.M. Youssef., and Y.F. Mohamed., Effect of some postharvest treatments on vase life and quality of chrysanthemum (Dendranthema grandiflorum Kitam) cut flowers. Research J. Agric. and Biological Sci., 2012. 8(2): 261-271.
[2] Pacifici, S.A., Ferrante, A., Mensuali-Sodi., and Serra. G. Postharvest physiology and technology of cut Eucalyptus branches: a review. Agr. Med. 2007, 137: 124-131.
[3] Reid, M.S. and. Jiang, C.Z. Postharvest biology and technology of cut flowers and potted plants. in: Janick, J. (Ed)., Horticulture Reviews, 2012, 14: 1-54.
[4] Ladha, S., and Gunjal, S. Floriculture:International Markets. In: Floriculture Today, 2011,1-4.
[5] Nowak, J., and Rudnicki, R.M. Postharvest Handling and Storage of Cut Flower, Florist Greens and Potted Plants. Timber Press; Portland, Oregon, U.S.A. 1990 pp. 39–43.
[6] Bhattcharjee, S.K. Post-harvest management of cut flowers, cut foliage and post production management of potted plants. J. Ornam. Hort. 1999, 2: 32-39.
[7] Singh, K., Arora, J. S., Bhattacharjee, S. K. Post harvest handling of cut flowers. Tech. Bull. No. 10, All India Co-ordinated Research project on floriculture, IARI, New Delhi, 2001, pp. 39.
[8] Sangwanangkul, P., Saradhuldhat, P., Paull. R.E. Survey of tropical cut flower and foliage responses to irradiation. Postharvest Biology and Technology, 2008, 48: 264-271.
[9] Malakar, M., Acharyya,P., and Biswas, S. Effect of Certain Chemicals on Post Harvest Life of Some Cut Foliages, International Journal of Agriculture, Environment and Biotechnology., 2017,1(2): 199-207.

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