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Effect of different pulsing treatments on longevity and freshness of some decorative cut foliages

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ABSTRACT

Incorporation of tropical foliages of magnificent hues and shape are quite contemporary but status in domestic and export markets duo are deep-rooted. But post-harvest behavior of few commercially viable cut foliages viz. Aglaonema commutatum macculatum Schott, Asparagus plumosus Bekar, Cordyline terminalis cv. 'Firebrand' L. Kunth, Nephrolepis cordifolia L. and Spathyphyllum × Clevelandii L. are less investigated. In this backdrop the current experiment was conducted to evaluate pulsing effect under ambient condition of sucrose 4%, sucrose 4% +$AgNo_3$@100 and 200ppm, sucrose 4%+$Al_2(SO_4)_3$@100 and 200ppm and sucrose 4%+Disprin 1(490mg) and sucrose 4%+ Disprin 2 (980mg) to regulate aforementioned foliage's senescence and post-harvest deterioration. Combination of $Al_2(SO_4)_3$ @ 200ppm+ sucrose 4% yielded protracted vase-life of 29, 12.66 and 7 days in Aglaonema sp., Nephrolepis sp. and Spathyphyllum sp. respectively while fusion of sucrose 4%+$AgNo_3$@100 and 200ppm both exhibited significant longevity of 13 and 14 days for Asparagus sp. and Cordyline sp. respectively. In Spathyphyllum sp. only sucrose 4%+ disprin @ 490 mg contains acetylsalicylic acid, calcium carbonate and citric acid efficiently prolonged vase-life. In N. cordifolia only two biocides and disprin@490mg along with sucrose4% failed to improve the total water uptake while elevated uptake of solutes was prominent in all employed foliages. Enhanced pigment level was observed in all treatment combinations. Conclusively, pulsing by combination of 2 biocides with sucrose 4% can fruitfully magnify these cut foliage's longevity.

Keywords: $AgNo_3$, $Al_2(SO_4)_3$, cut foliages, disprin, sucrose and vase-life

Ornamental foliage plants play an important role in interior decoration and also fetch good returns in terms of money from domestic and international market (Shtein *et al.*, 2009). Freshness of ferns, splash of colors in *Cordyline* sp., the tender *Asparagus* sp., the deep green leaves of *Aglaonema* sp. or the glossy green leaves of *Spathiphyllum* sp. against the background of its white spathe reflect the dignity and charm of foliages depicting youthful exuberance of beauty (Reid and Jiang, 2012). Considering the world wide floricultural trade, the export trade of cut flowers and foliages has been expanded rapidly in almost all developing and developed countries (Mukherjee, 2008). According to the flower trade report of the world (2014), total value of foliage trade amounted to 1319 million US $ in the world (Source- Flora Holland) and constituted 15 per cent of total floricultural trade. Now-a-days, several tropical foliage plants are gaining export value in temperate states of Europe and America owing to scarcity of floral materials during extreme climatic condition (Abou-dahab *et al.,* 2013, Bayleyegn *et al.*, 2012). On other words, foliages being preferred over flowers due to their endurance under low temperature situation.

Fortunately foliage's less susceptibility to rapid wilting and last long in flower arrangement as a filler element (Sindhu and Rajeevan, 2005) escalate its fame. On the contrary, they undergo a sequential disorganization of cell organelles (Perera *et al.*, 2009) which ultimately impair the quality and ornamental value whereas color change is the most common symptom of leaf senescence a highly organized process involving structural, biochemical and molecular changes leading to disruption of water balance, degradation of quality characteristics and desiccation within a short period (Weaver *et al.,* 1998) regulated by various external and internal factors which acts synergistically (Saha, 2009).

Major reasons for various post harvest loss are stem blockage and ethylene production at cut end of the stem or leaves can be mitigated through chemical agents applied as pulsing or holding solution either alone or in combination (Faragher *et al.*, 2002). Fujino *et al.*, (1983) found fivefold increase in vase-life of *Adiantum raddianum* by solutions containing 25 mg l^{-1} Ag^+ while citric acid@ 300 mg l^{-1}, benzyl adenine@ 10 mg l^{-1} and aluminum sulfate and gibberelin @ 50 mg l^{-1} both also enhanced the longevity of *Asparagus densiflorus* effectively (Singh and Singh, 2002).

Thus, due to enhanced value of different form, texture, color and freshness of well-furnished sprays along with stem, the current study was conducted to explore the impact of dissimilar chemical solutions as pulsing treatment on durability and freshness of aforementioned decorative cut foliages under ambient condition.

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MATERIALS AND METHODS

Fresh, uniform, mature leaves of each employed species were collected from different Agri-Horticultural Society of India (AHSI) during the early hours of morning. Here, *Cordyline terminalis* and *Aglaonema commutatum macculatum* leaves were summoned from the garden of National Library, Kolkata, *Nephrolepis cordifolia* and *Asparagus plumosus* from Mallickghat flower retail market, Kolkata and *Spathyphyllum* × *Clevelandii* from Agri-Horticultural Society of India (AHSI), Kolkata during the month of December, 2013. After fetching them under the ambient condition, 3-5cm portion of leaf petiole were recut followed by placing them in a bucket of water to avoid possible air embolism of xylem vessels and it was continued upto 1 hour till they were put into respective treatment solutions. Before subjecting them in different pulsing treatments, the opposite length of dressed cut stems of each species were maintained *i.e* 10, 9, 15, 7 and 10 cm for *C. terminalis, A. commutatum macculatum, N. cordifolia, A. plumosus* and *Spathyphyllum* × *Clevelandii* respectively. For this investigation, total 8 treatments including control were used such as sucrose 4% (200ml), sucrose 4% (200 ml) + $AgNO_3$ @ 100ppm, sucrose 4% (200 ml) + $AgNO_3$ @ 200 ppm, sucrose 4% (200 ml) + $Al_2\ (SO_4)_3$ @ 100 ppm, sucrose 4% (200 ml) + $Al_2\ (SO_4)_3$ @200ppm, sucrose 4% (200 ml)+ 1 disprin tablet (490 mg), Sucrose 4% (200ml) + 2 disprin tablets (980mg) and lastly distilled water as control. Requisite amount of chemicals were weighed (1ppm= mg l^{-1} and 1% = 10,000ppm) and the respective pulsing solutions were prepared accordingly in distilled water. Disprin tablets were utilized by dissolving in sucrose solution. Thereafter, 200ml. of ready solutions were poured into conical flasks followed by wrapping of their mouth using impermeable plastic coated paper to minimize evaporation loss and a hole was slit at its centre to insert the leaf petiole. Pulsing treatment was provided to twigs by dipping them in respective solutions for 48hrs. followed by placing in distilled water till their effective vase-life. Weights of conical flasks alone as well as with solutions were measured while initial fresh weight of fronds along with pigment estimation (chlorophyll and anthocyanin) was also executed before commencement of experiment. Observations were documented on water uptake and change in mean fresh weight of leaf upto 192 hours. Collaterally, vase life studied up to the senescence. The experiment was conducted in the laboratory of the Department of Horticulture, Institute of Agricultural Science, University of Calcutta, Kolkata and throughout the experiment the temperature range of 12.2-24.1^{0}C and relative humidity of 48-65 per cent were recorded. The room was illuminated with aid of five fluorescent tube lights of 40 watt each for 24 hours and intensity varied from 30-60 lux.

The experiment was laid out in Complete Randomized Design (Panse and Sukhatme, 1985) maintaining single twig in each conical as replication and 3 replications for each treatment. The data were subjected to ANOVA using SPSS 10.0 statistical package. The treatment means were compared by Duncan's New Multiple Range Test (DNMRT) at 5 per cent probability level.

RESULTS AND DISCUSSION

Improvement in mean fresh weight only was observed upto 48 hrs and thereafter sharp decline was noted at 96 hrs and onwards irrespective of all treatments and species (Fig. 1). Observations of Aros *et al.,* 2016 are in correspondence with our findings. Significant gain in fresh weight was obtained by sucrose 4% alone (4.26 and 2.26gm) in case of *C. terminalis* and *S.* × *Clevelandii* respectively as it in general improves water uptake and reduce proteolytic breakdown (Halevy, 1995). Combination of sucrose 4% + $AgNO_3$ @ 100ppm uplift the fresh weight by 1.93gm as compared to control treatment concerning *A. commutatum macculatum* while both concentrations of silver nitrate along with sucrose 4% for *S.* × *Clevelandii* failed to show its ability (Table 1). Combination of sucrose 4% along with $Al_2\ (SO_4)_3$ @100 and 200 ppm duo in *N. cordifolia* enhanced the mean fresh weight of 0.40g while both concentrations of the same also increased 0.67 and 4g of weight in *A. commutatum macculatum* and *C. terminalis* respectively. Findings of Nooh *et al.,* 1986 and Sivaswamy and Bhattacharjee, 2000 are quite alike with our present outcome. On the other hand, use of disprin @ 490 (1 tablet) and 980 (2 tablets) mg both with sucrose 4% surprisingly boosted up only *A. commutatum macculatum*'s and *N. cordifolia*'s fronds fresh weight evident from table 1. However, all the treatment combinations failed to reveal their significant impact on the aforementioned parameter with respect to *A. plumosus* (Table 1).

The role of chemical preservatives to extend the vase-life is well known. Our experimental results manifested that $AgNO_3$ and $Al_2\ (SO_4)_3$ at their both strengths in fusion with sucrose 4% could efficiently protract the longevity of employed cut foliages (Table 1). Silver nitrate enacted an indispensable role to diminish few predominant post-harvest problems analogous with cut flowers and foliages by interfering the binding sites of ethylene (Abou El-Ghait *et al.*, 2012, Pacifici *et al.*, 2007, Perera *et al.*, 2009). Extension of effective vase-life to 14, 14.60 and 13.30 days were found in *C. terminalis* by sucrose 4% + $AgNO_3$ @ 100 and 200ppm and sucrose 4% + $Al_2\ (SO_4)_3$@ 200ppm respectively as compared

Table 1: Effect of pulsing treatments on diverse parameters of *Cordyline terminalis* cv. 'Firebrand', *Aglaonema commutatum macculatum, Nephrolepis cordifolia, Asparagus plumosus* and *Spathyphyllum* × *Clevelandii*

Treatments	Initial mean fresh weight (g)	Weight loss or gain (g)	Effective vase life (days)	Anthocyanin or chlorophyll content (mg 100^{-1} g)	Total water uptake (ml)	Total transpiration loss (ml)	Water balance	Observations (at 75% senescence)
***Cordyline terminalis* cv. 'Firebrand'**								
Control	15.66	4.20	11^{cd}	58.50^{d}	6.12^{a}	10.32	-4.20	Yellowing, browning, distorted lamina
Sucrose 4%	12.40	4.26	9.6^{d}	56.30^{d}	3.86^{bc}	8.13	-4.27	Drying of lamina
Sucrose 4%+$AgNO_3$@ 100ppm	10.93	2.20	14.00^{ab}	70.10^{b}	5.59^{ab}	7.79	-2.20	Blackening of margin, curling
Sucrose 4%+$AgNO_3$@ 200ppm	13.66	2.20	14.60^{a}	75.00^{a}	7.25^{a}	9.45	-2.20	Slight yellowing, tip drying
Sucrose 4%+ $Al_2(SO_4)_3$ @100ppm	14.00	4.00	11.70^{bcd}	61.20^{c}	6.73^{a}	10.73	-4.00	Wrinkled, drying, blackening
Sucrose 4%+ $Al_2(SO_4)_3$ @ 200ppm	15.26	3.00	13.30^{abc}	68.20^{b}	6.66^{a}	9.66	-3.00	Wrinkled, tip drying
Sucrose 4%+ Disprin 1 tablet	13.06	1.20	6.30^{e}	47.90^{e}	2.00^{cd}	3.20	-1.20	Yellowing, decay of petiole
Sucrose 4%+ Disprin 2 tablet	12.86	1.00	4.70^{e}	38.30^{f}	1.60^{d}	2.59	-0.99	Decay and breakage of petiole
Aglaonema commutatum macculatum								
Control	11.93	0.33	18.66^{c}	0.37^{c}	4.12^{a}	4.45	-0.33	Yellowing of lamina
Sucrose 4%	8.20	0.54	26.00^{b}	0.46^{b}	3.32^{a}	3.86	-0.54	Yellowing, curled margin
Sucrose 4%+$AgNO_3$ @100ppm	12.66	1.93	8.66^{e}	0.19^{e}	3.66^{a}	5.59	-1.93	Softening of petiole, yellowing
Sucrose 4%+$AgNO_3$ @200ppm	8.66	0.86	15.00^{d}	0.25^{d}	2.72^{a}	4.33	-1.40	Loss of turgidity
Sucrose 4%+ $Al_2(SO_4)_3$ @100ppm	11.20	0.34	29.70^{a}	0.51^{a}	3.66^{a}	4.00	-0.34	Yellowing, loss of turgidity
Sucrose 4%+ $Al_2(SO_4)_3$ @200ppm	10.80	0.67	29.00^{a}	0.49^{ab}	2.72^{a}	3.39	-0.67	Yellowing, curled margin
Sucrose 4%+Disprin 1 tablet	10.46	1.26	8.00^{e}	0.16^{ef}	3.72^{a}	4.98	-1.26	Decayed stalk, yellowing
Sucrose 4%+Disprin 2 tablet	8.26	1.70	6.70^{e}	0.15^{f}	3.32^{a}	5.02	-1.70	Decayed stalk, drying

*Note: *Figures bearing same superscripts did not differ significantly*

Table Contd.

Treatments	Initial mean fresh weight (g)	Weight loss or gain (g)	Effective vase life (days)	Anthocyanin or chlorophyll content (mg 100^{-1} g)	Total water uptake (ml)	Total transpiration loss (ml)	Water balance	Observations (at 75% senescence)
Nephrolepis cordifolia								
Control	2.13	0.13	8.00^{bc}	0.16^{c}	7.45^{a}	7.58	-0.13	Yellowing, abscission of pinna
Sucrose 4%	2.13	0.13	10.33^{ab}	0.19^{b}	5.38^{a}	5.25	0.13	Drying and browning of pinna
Sucrose 4%+$AgNO_3$@ 100ppm	2.80	0.14	11.00^{a}	0.19^{b}	6.66^{a}	6.80	-0.14	Browning & abscission of pinna
Sucrose 4%+$AgNO_3$@ 200ppm	2.53	0.20	12.00^{a}	0.28^{a}	5.78^{a}	5.98	-2.20	Abscission of pinna, tip drying
Sucrose 4%+ $Al_2(SO_4)_3$ @100ppm	2.86	0.40	12.33^{a}	0.29^{a}	3.05^{a}	3.45	-0.40	Tip drying of frond
Sucrose 4%+ $Al_2(SO_4)_3$ @200ppm	2.93	0.40	12.66^{a}	0.30^{a}	2.99^{a}	3.19	-0.20	Tip drying of frond
Sucrose 4%+Disprin 1 tablet	3.40	1.40	6.33^{c}	0.12^{d}	4.66^{a}	6.06	-1.40	Browning, drying, abscission of pinna
Sucrose 4%+Disprin 2 tablets	2.60	1.14	6.00^{c}	0.11^{d}	4.79^{a}	5.93	-1.14	Browning, drying, abscission of pinna
Asparagus plumosus								
Control	0.78	0.54	8.00^{bc}	0.19^{e}	4.46^{bca}	5.00	-0.54	Yellowing and blackening
Sucrose 4%	0.68	0.14	10.33^{ab}	0.37^{d}	5.86^{ab}	6.00	-0.14	Yellowing and falling of cladodes
Sucrose 4%+$AgNO_3$@ 100ppm	0.79	0.20	13.00^{a}	0.71^{a}	7.53^{a}	7.73	-0.20	Do
Sucrose 4%+$AgNO_3$@ 200ppm	0.86	0.01	11.70^{a}	0.45^{c}	5.06^{bc}	5.07	-0.01	Do
Sucrose 4%+ $Al_2(SO_4)_3$ @100ppm	1.00	0.08	12.30^{a}	0.57^{b}	7.26^{a}	7.34	-0.08	Do
Sucrose 4%+ $Al_2(SO_4)_3$ @200ppm	0.68	0.01	12.70^{a}	0.60^{b}	6.19^{ab}	6.20	-0.01	Do
Sucrose 4%+Disprin 1 tablet	0.37	0.23	6.70^{c}	0.14^{f}	3.06^{cd}	3.29	-0.23	Do
Sucrose 4%+Disprin 2 tablets	0.44	0.21	6.00^{c}	0.12^{f}	2.90^{d}	3.13	-0.21	Do

Table Contd.

Spathyphyllum × Clevelandii

Treatments	Initial mean fresh weight (g)	Weight loss or gain (g)	Effective vase life (days)	Anthocyanin or chlorophyll content (mg 100^{-1} g)	Total water uptake (ml)	Total transpiration loss (ml)	Water balance	Observations (at 75% senescence)
Control	3.53	1.26	4.33^{c}	0.12^{e}	4.16^{bc}	5.43	-1.27	Drying, yellowing and tip blackening
Sucrose 4%	3.66	2.26	4.00^{cd}	0.10^{e}	2.26^{de}	4.582	-2.26	Wrinkling and yellowing
Sucrose 4%+$AgNO_3$ @100ppm	3.80	1.20	4.70^{c}	0.20^{d}	4.13^{bc}	5.33	-1.20	Yellowing, drying
Sucrose 4%+$AgNO_3$ @200ppm	3.73	1.26	5.00^{c}	0.24^{d}	2.99^{cd}	4.26	-1.27	Yellowing, drying
Sucrose 4%+ $Al_2(SO_4)_3$ @100ppm	3.73	0.60	5.70^{bc}	0.30^{c}	6.00^{ab}	6.20	-0.20	Yellowing from base, drying
Sucrose 4%+ $Al_2(SO_4)_3$ @200ppm	4.13	1.13	7.00^{ab}	0.48^{b}	4.99^{ab}	6.12	-1.13	Yellowing and slight drying
Sucrose 4%+Disprin 1 tablet	3.80	0.18	8.33^{a}	0.55^{a}	7.64^{a}	7.46	0.18	Yellowing from petiole towards midrib
Sucrose 4%+Disprin 2 tablets	3.86	0.26	0.26^{d}	0.06^{f}	1.13^{e}	1.39	-0.26	Drying and blackening

*Note: *Figures bearing same superscripts did not differ significantly*

to control (11 days) while higher strength of $Al_2(SO_4)_3$ failed. On the contrary, both the concentration of aluminum sulfate with sucrose 4% and sucrose 4% alone extraordinarily extended *A. commutatum macculatum*'s longevity to 29.70, 29 and 26 days respectively. Silver nitrate and aluminum sulfate improve post harvest life possibly due to their antimicrobial and anti-respiratory properties (Nair *et al*., 2003). Use of sucrose along with biocides possibly enrich the solution for respiration with lower amount of microbial activity thus leading to increased vase-life (Singh and Tiwari, 2003; Darras *et al*., 2010; Elgimabi, 2011). On *N. cordifolia* and *A. plumosus* combined impact of afore named chemicals were really noteworthy (Table 1).

Collaterally, contribution of disprin tablets on magnification of vase-life was less significant as apparent from table 1 but unpredictably the durability of *Spathiphyllum* × *clevelandii* become doubled in contrast to control (4.33 days) by sucrose 4% + 1 disprin tablet (490 mg) treatment. Disprin contains acetylsalicylic acid @ 350mg, calcium carbonate @105mg and anhydrous citric acid @ 35mg might be the reason for this enhancement of vase-life. Improved vase-life by citric acid like other organic acid was also observed by Singh and Singh (2002) in *Asparagus* sp. as it's the source of both carbon and energy for cells and are used in the respiratory cycle and some other biochemical pathway (Dasilva, 2003). Additionally, it's only the mobile forms of iron in plants, thus plays vital role in iron transport (Darandeh and Hadavi, 2012) while it also impairs bacterial population in vase solution and increases the water conductance in xylem of cut flowers (Van Doorn, 1997).

Increase in solution uptake irrespective of all samples upto 96 hrs. was evident from table 1 but deterioration as compare to control after the pulsing treatment was profound in all except in *C. terminalis* and *A. plumosus*. Here, solution uptake exhibited a positive correlation with the prolongation of vase-life. In case of *C. terminalis* and *A. plumosus* utmost total water uptake were perceived (Table 1) in combination treatment of $Al_2(SO_4)_3$ and $AgNO_3$ with sucrose 4%. The rate of total water uptake (ml) and transpiration loss (ml) corroborated a positive connection with the vase-life regarding the latter one while due to high rate of transpiration loss, 100ppm of aluminum sulfate was unsuccessful to extend the former ones longevity although fair amount of solution uptake was evinced. Halevy and Mayak, 1981; Van doorn, 1997; Van doorn *et al*., 2011 and Jowkar *et al*., 2012 suggested that maximum weight gain and solution uptake are correlated, and subsequently, both are correlated with longer vase life of cut foliages. Regarding several water relation

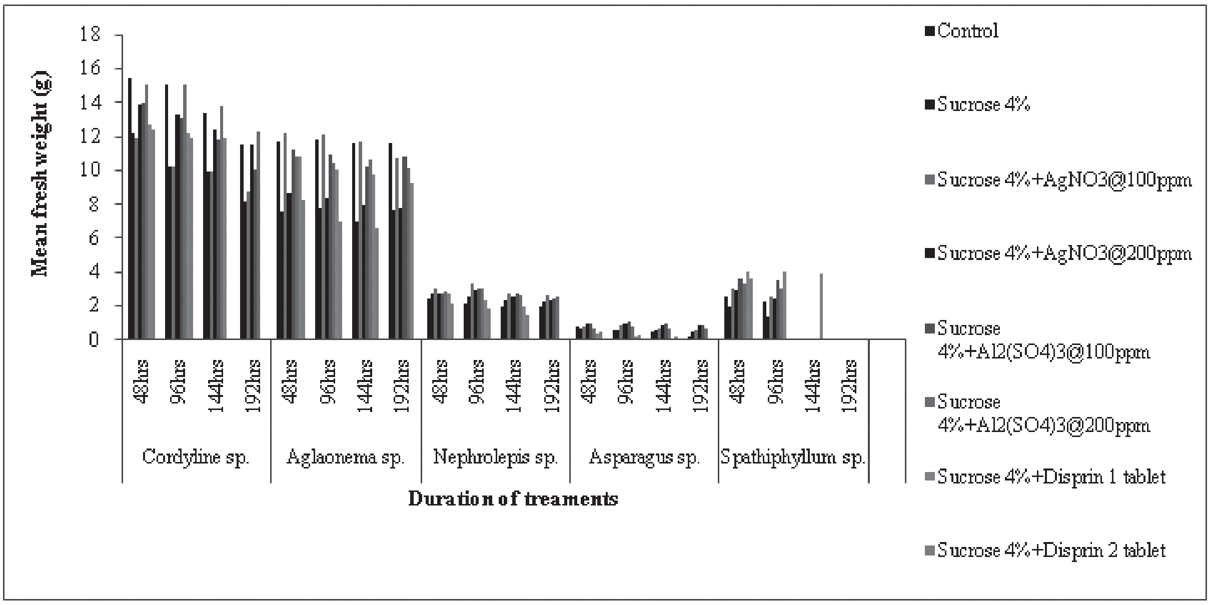

Fig. 1: Mean fresh weight of utilized cut foliages affected by different chemical treatments

parameters in *A. commutatum macculatum*, uptake of total solution was at par irrespective of different treatments as per the statistical analysis, however water uptake was negatively correlated to its foliage's durability. Foliages under control treatment depicted highest uptake (4.12 ml.) along with utmost amount of transpiration loss (4.45ml) causing a negative water balance. Trend of water uptake was also alike while sucrose along with disprin yielded disappointed output from the very beginning in *N. cordifolia* (Table 1). Normal vase-life of this species in distilled water was found 8 days whereas sucrose treated fronds enhanced it by 2 days along with 7.58 and 5.38ml of water loss respectively thus depicting no relation b/w water uptake and vase-life exists in this species which agrees with Stamps and Nell (1987) observation. Maximum amount of solution uptake facilitated the vase-life in *Spathiphyllum* × *Clevelandii*.

Hues are the supreme indication of foliages' physiology. Protracted vase-life was found to be associated with higher pigment content in all specimens. Both concentrations of $Al_2(SO_4)_3$ maintained chlorophyll level in *A. commutatum macculatum* while severe degradation was noted with disprin treated plants (0.15-0.16mg g^{-1}) followed by $AgNO_3$@100ppm (0.19mg g^{-1}). Our observations are in accordance with the findings of Pinto *et al.*, (2007). Loss of chlorophyll takes place owing to chloroplast degradation; the key index for the inception of senescence process instigated by external factors like temperature, relative humidity, pathogens and also by internal factors like ethylene and abscisic acid (ABA) (Weaver *et al.*, 1998). Treated fronds of *A. plumosus* by sucrose 4% + $AgNO_3$ @ 100ppm revealed minimum pigment degradation which also resulted in maximum vase-life of 13 days. These sequels are in correspondence with the observations of Mandal (2008) and Ferrante *et al.*, 2002. Defensive capacity of sucrose aids to shield the ultrastructure of chromoplast from damage and thus ensure the pigment retention (Singh *et al.*, 2008). Disprin treatment potentially preserved the chlorophyll content (0.55mg g^{-1}) in contrast to initial chlorophyll content (0.80mg g^{-1}) concerning *Spathiphyllum* × *Clevelandii*. Anthocyanin content of *C. terminalis* was estimated during the senescence period and a positive correlation with the enhancement of vase-life was manifested. Significant retrogression of red color due to anthocyanin leakage by holding solution of salicylic acid + sucrose in carnation was also found (Kazemi *et al.*, 2011). Blackening of leaf margin, tip drying, wrinkled lamina, loss of turgidity and yellowing of leaves in all species along with falling of cladodes in *A. plumosus* were perceived at 75 per cent senescence level irrespective of treatments.

From the present investigation it can be recommended that for *C. terminalis*, *Asparagus plumosus* and *Nephrolepis cordifolia* the use of both biocides at both concentrations *viz*. sucrose 4% along with $AgNO_3$ and $Al_2(SO_4)_3$ @100 and 200ppm would significantly magnify the durability. For *Aglaonema commutatum macculatum*, $Al_2(SO_4)_3$ at both concentrations should be used. In case of *Spathiphyllum* × *Clevelandii*, sucrose in combination with disprin 1tablet would to be useful in enhancing the vase life.

Thus, the use of chemicals along with sucrose solution was more helpful in enhancing the vase life of such ornamental cut foliages. Perhaps, other cultivars of these species may react differently, so obtained results call for further studies.

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