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Effect of pre harvest spray and vase solutions under different growing environment on the vase life of cut foliage *Dracaena* (*D. reflexa*)

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Abstract
An experiment was carried out at the Department of Floriculture and Landscape Architecture, HC& RI, TNAU, Coimbatore from December 2019 to March 2020 to study the effect of pre harvest spray and vase solutions of cut stalks of *Dracaena* plants grown under different growing environments, *viz.,* open and shade. Six pre harvest foliar sprays of GA_3 at different concentrations, *viz.,* 250 ppm, 300 ppm and 350 ppm were given at every fortnight interval to the foliage plants grown under open and shade conditions. The cut stalks of Dracaena were placed in different vase solutions *viz.,* Distilled water (control), 2% $CaCl_2$, 1 mM Salicylic acid, 4% Sucrose, 2% $CaCl_2$ + 1 mM Salicylic acid, 2% $CaCl_2$ + Sucrose 4%, 1 mM Salicylic acid+ Sucrose 4%, Sucrose 4% + 1 mM Salicylic acid + 2% $CaCl_2$ *etc.,* to investigate the efficacy in extending the post-harvest life of cut stalks of Dracaena. The physical and physiological parameters like the number of dried leaves, physiological loss in weight, vase life, relative fresh weight (RFW) and vase solution uptake were measured at every 5 days as indicators of cut stem quality. The vase solution of calcium chloride (2%) along with sucrose (4%) showed increased vase life of 21.13 days when compared with control (distilled water) with 17.38 days.

Keywords: song of India, vase life, calcium chloride, sucrose, gibberellic acid

Introduction
Foliage plants includes all the plants grown primarily for their attractive foliage used in the interior landscaping, interior decoration and landscaping purposes as a focal point and as specimen plant (Conover). *Dracaena reflexa* is a popular ornamental foliage plant valued and cultivated mainly for its richly variegated leaves. It occupies a major place in landscaping purposes and as well as a household plant. It is commonly called as Song of India. It belongs to the family Agavaceae. With increased needs in the event management and decorations for the flowers and foliage, the attractive greens play a vital role in making decorations, a complete fuelling demand for greenery. The foliage quality and increase in vase life characters are essential in any economically important cut foliage.
Generally, leaf yellowing is associated with early senescence and is a major problem in many tropical cut foliage plants used for cut decorations. Likewise, wilting and colour change of dracaena leaves are major post-harvest problems in exportation. To export, the important quality is to retain the freshness and green colour of leaves for longer period. The vase life of dracaena cut stalks is terminated by various external factors such as temperature, moisture content, gases, radiation and pathogens, while internal factors related to senescence are regulated mainly by two phytohormones, ethylene and abscisic acid (ABA) (Weaver *et al*., 1998) [12]. The growth conditions of the plant before harvest would affect the quality of the cut foliage. Further, it is also known that gibberellins delay senescence by preventing the loss of chlorophylls and degradation of RNA and proteins in cut foliage. Therefore, the focus of this research is to study the effect of different vase solution treatments on keeping quality and vase life of Song of India cut stalks and also to conclude the effects of pre harvest spray of gibberellic acid on the post-harvest life extension of dracaena plants.

Materials and Methods
The present investigation was carried out at the laboratory in the Department of Floriculture and Landscape Architecture, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore from December 2019 to March 2020. The methodology adopted and the materials used in the experiment are furnished below as follows. The experiment was carried out in Factorial Completely Randomized design (FCRD) with 8 treatments and four replications with one cut stalk per replication. The number of factors involved in this experiment were three factors. Factor 1 is the growing environment with two levels, *i.e.,* the stalks harvested from the plants grown in open and shade conditions.

Factor two is the eight treatments of the vase solution and is furnished in Table 1. In factor 3, vase solution uptake (g stem^{-1} day $^{-1}$) and relative fresh weight (%) were recorded at 5 days i.e., 5, 10, 15, 20, 21 days interval from the beginning day of experiment. The plants were grown in open and shade environment under shade net to standardize the growing conditions and pre-harvest foliar sprays of GA_3 with different concentrations of (250, 300 & 350 ppm) were applied at fortnight intervals with distilled water as control.

Table 1: Treatment combinations of vase solutions

T_1	**Distilled water (control)**
T_2	2% $CaCl_2$
T_3	1 mM Salicylic acid
T_4	4% Sucrose
T_5	2% $CaCl_2$ + 1 mM Salicylic acid
T_6	2% $CaCl_2$ + Sucrose 4%
T_7	1 mM Salicylic acid + Sucrose 4%
T_8	Sucrose 4% + 1 mM Salicylic acid + 2% $CaCl_2$

The number of replications taken for research study is four replications. Each stalk was placed inside the prepared solutions in conical flask by giving a slant cut to the stem of the harvested cut foliage. The same design and treatment combination were followed for the plants grown from both the open and shade environment. The plants were given with pre harvest spray of Gibberellic acid. The cut foliage stalks were harvested from the plants and the stalks were placed in the proposed combination of vase solutions. The physical and physiological parameters *viz.*, number of dried leaves cut stalk $^{-1}$, physiological loss in weight (%), vase life (days), vase solution uptake (g stem^{-1} day^{-1}), relative fresh weight (%) were recorded and the data were analysed as per the standard procedures of SAS software.

Results and Discussion

The results of the experiment are furnished below.

Table 2: ANOVA table for the effect of growing environments, vase solutions and the interaction between the growing environments and vase solutions on cut stalks of *Dracaena*

Traits	Growing environments	Vase solutions	Growing environments × Vase solutions
Number of dried leaves cut stem $^{-1}$	NS	***	NS
Physiological loss in weight (%)	***	***	***
Vase life (days)	NS	***	NS
Vase solution uptake (g stem^{-1} day^{-1})	NS	***	NS
Relative fresh weight (%)	NS	***	***

Table 3: Effect of growing environment on the physical and physiological parameters of the cut stalks of song of India

Traits	Growing environments		
	Open	**Shade**	**LSD**
Number of dried leaves (numbers)	0.32^{a}	0.30^{a}	NS
Physiological loss in weight (%)	13.00^{a}	1.00^{b}	0.0495
Relative fresh weight (%)	110.43 ^{a}	109.64 ^{a}	NS
Vase solution uptake (g stem^{-1} day^{-1})	1.16^{a}	1.19^{a}	NS
Vase life (days)	17.45^{b}	18.18^{a}	0.3655

The effect of growing environment on drying of leaves was on par between the stalk collected from open and shade with 0.32 and 0.30 numbers respectively. With regard to the physiological loss in weight (%), the cut stalks from shade environment performed better with less physiological loss in weight of 1% whereas under the open environment, the physiological loss in weight was 13%. Similarly, the relative fresh weight was on par between the open and shade environment stalks with about 110.43% and 109.64% respectively. The vase solution uptake in g stem^{-1} day^{-1} by the cut stalks did not show significant variations between the open and shade environment with 1.16 g stem^{-1} day^{-1} and 1.19 g stem^{-1} day^{-1} respectively whereas, the vase life significantly varied between the growing environment conditions with 17.45 days and 18.18 days in open and shade respectively.

Table 4: Effect of different treatments of vase solutions on the physical and physiological parameters of cut stems of song of India

Treatments	Traits				
	Number of dried leaves (numbers)	**PLW (%)**	**RFW (%)**	**Vase solution uptake (g stem^{-1} day^{-1})**	**Vase life (days)**
T_1	0.31^{c}	14.25^{a}	105.33^{e}	0.88^{bc}	17.75^{b}
T_2	0.37^{cb}	19.75^{a}	109.05^{d}	1.18^{b}	16.38 ^{c}
T_3	0.47^{a}	21.75 ^{a}	99.20^{f}	0.70^{c}	16.46 ^{c}
T_4	0.40^{ab}	17.86 ^{a}	106.22^{e}	1.05^{b}	17.00 ^{c}
T_5	0.37^{cb}	17.25 ^{a}	104.27^{e}	0.98^{bc}	16.62^{c}
T_6	0.04^{e}	-33.25^{c}	130.04^{a}	2.63^{a}	20.25^{a}
T_7	0.30^{cd}	20.00^{b}	111.82^{c}	0.93^{bc}	18.39^{b}
T_8	0.23^{d}	-1.13^{b}	114.34^{b}	1.10^{b}	19.69^{a}
LSD	0.0753	0.099	2.4484	0.3046	0.731

The influence of the treatments on the cut stalks are furnished in the table 4. The drying of leaves was minimum in T_6 (2% $CaCl_2$ + Sucrose 4%) with 0.04 while the highest being observed in T_3, (1 mM Salicylic acid) with 0.47. The physiological loss in weight was lowest in T_6 (2% $CaCl_2$ + Sucrose 4%) with -0.33 whereas it was highest in T_3 (1 mM Salicylic acid) with 0.22. The relative fresh weight in % was maximum in T_6, (2% $CaCl_2$ + Sucrose 4%) with 130.04% and the minimum relative fresh weight was recorded in T_3 (1 mM Salicylic acid) with 99.20 %. The vase solution uptake () was significantly higher in T_6, (2% $CaCl_2$ + Sucrose 4%) with 2.63 g stem^{-1} day^{-1} and it was lowest in T_3 1 mM Salicylic acid with 0.70 g stem^{-1} day^{-1}. The vase life was maximum in T_6, (2% $CaCl_2$ + Sucrose 4%) with 20.25 days whereas it was noted minimum in T_2, (2% $CaCl_2$) with 16.38 days.

Table 5: Interaction effect of growing environment and the vase life solutions treatments on number of dried leaves and vase solution uptake of song of India

Traits	Number of dried leaves stalk $^{-1}$		PLW (%)	
Growing environments / Treatments	Open	Shade	Open	Shade
T_1	0.32	0.31	20.00	8.50
T_2	0.38	0.37	32.50	7.00
T_3	0.47	0.46	30.25	13.25
T_4	0.41	0.40	24.25	11.50
T_5	0.38	0.36	25.25	9.25
T_6	0.05	0.03	-59.00	-7.50
T_7	0.32	0.29	15.75	-11.75
T_8	0.24	0.23	14.25	-16.50
LSD	0.0753		0.099	

The data for the effect of different pre-harvest spray of Gibberellic acid and different vase solutions on number of dried leaves and physiological loss in weight are furnished in Table 4. From the data provided, there has been a significant difference in the number of dried leaves in the cut stalks. Among the treatments of the cut stalks from open environment, the minimum number of dried leaves was observed in T_6 (2% $CaCl_2$ + Sucrose 4%) with 0.05 followed by T_8 Sucrose 4% + 1 mM Salicylic acid + 2% $CaCl_2$ with 0.24 and the maximum number of dried leaves was noted in T_3 (1 mM Salicylic acid) with 0.47 which was similar to the reports by (H. A. Akintoye *et al*.,) in *Heliconia* spp. Among the treatments, the stems collected from shade environment showed the minimum drying of leaves in T_6 for 2% $CaCl_2$ + Sucrose 4%) with 0.03 numbers followed by T_8 Sucrose 4% + 1 mM Salicylic acid + 2% $CaCl_2$ with 0.23 numbers and the maximum drying of leaves was noted in T_3 (1 mM Salicylic acid) with 0.46 numbers. This was similar to the reports of H.A. Akintoye *et al.*, in *Heliconia* spp, where no wilted and dried sepals were recorded in treatment combination of $CaCl_2$. $2H_20$ + Sucrose. The physiological loss in weight showed significant differences among the growing environment with lowest value in T_6 (2% $CaCl_2$ + Sucrose 4%) with -59.00% and the highest PLW recorded in T_2, 2% $CaCl_2$ with 33.00% in the open environment stalks whereas among the cut foliage stalks of song of India from the shade condition, showed lowest PLW in T_8 Sucrose 4% + 1 mM Salicylic acid + 2% $CaCl_2$ with -17.00% and the highest value was recorded in T_3 (1 mM Salicylic acid) with 13.00%.

Table 6: Interaction effect of growing environment and the vase life solutions treatments on vase life, vase solution uptake and relative fresh weight of *Dracaena*

Traits	Vase life (d)		Vase solution uptake (g stem^{-1} day^{-1})		Relative fresh weight (%)	
Growing environments / Treatments	Open	Shade	Open	Shade	Open	Shade
T_1	17.38	18.13	0.85	0.90	106.56	104.09
T_2	16.00	16.75	1.25	1.10	112.34	105.77
T_3	16.18	16.75	0.60	0.80	97.00	101.40
T_4	16.75	17.25	1.00	1.10	106.34	106.10
T_5	16.25	17.00	0.90	1.05	102.33	106.20
T_6	19.25	21.25	2.75	2.50	131.99	128.10
T_7	18.20	18.58	0.85	1.00	112.35	111.28
T_8	19.63	19.75	1.10	1.10	114.54	114.14
LSD	0.731		0.3046		2.4484	

The data pertaining to the vase life, vase solution uptake and relative fresh weight of Song of India is furnished in the table 5. The vase life was maximum in T_8 (Sucrose 4% + 1 mM Salicylic acid + 2% $CaCl_2$) with 19.63 days, whereas it was minimum in T_2, 2% $CaCl_2$ with 16.00 days in the open environment. Among the treatments of the stalks from shade environment, the maximum vase life (days) was observed in T_6 (2% $CaCl_2$ + Sucrose 4%) with 21.25 days followed by T_8 Sucrose 4% + 1 mM Salicylic acid + 2% $CaCl_2$ with 19.63 days and the minimum vase life was recorded in T_2 2% $CaCl_2$ and T_3 (1 mM Salicylic acid) with 16.75 and 16.75 days respectively. The pre harvest spray of gibberellins helps extend the vase life of foliage by reducing the abscission process. This may be due to the decrease in the rate of respiration that delayed senescence. Sucrose on its own or in combination with citric acid did not improve vase life significantly, instead sucrose in combination with calcium chloride increased the vase life of the cut stems by prolonging withering of leaves and maintaining the freshness and retaining the greenness (H. A. Akintoye *et al.*, 2018) [9].

The vase solution uptake was maximum in T_6 (2% $CaCl_2$ + Sucrose 4%) with 2.75 g stem^{-1} day^{-1} and the minimum vase solution uptake was recorded in T_1 control distilled water and T_7, 1 mM Salicylic acid+ Sucrose 4% with 0.85 and 0.85 g stem^{-1} day^{-1} respectively in the open environment stalks. Among the stalks from shade, the vase solution uptake was maximum in T_6 (2% $CaCl_2$ + Sucrose 4%) with 2.50 g stem^{-1} day^{-1} and the minimum vase solution uptake was recorded T_3 (1 mM Salicylic acid) with 0.80 g stem^{-1} day^{-1}. This signifies that pre-harvest treatment with Gibberellic acid improves uptake of vase solution, thereby increasing the keeping quality and vase life of cut stalks. Sucrose helps in maintaining the water balance and turgidity. Hence, addition of sucrose to holding solution might have led to increased uptake of holding solution (Rogers, 1973).

The relative fresh weight (%) showed significant differences between the treatments with the highest value being noted in T_6 (2% $CaCl_2$ + Sucrose 4%) with 131.99% and the lowest was noted in T_3 (1 mM Salicylic acid) with 97% in the open stalks whereas among the shade stalks, the maximum relative

fresh weight was found in T_6 (2% $CaCl_2$ + Sucrose 4%) with 128.10 % and the least value was observed in T_3, 1 mM Salicylic acid with 101.40 %. The increase in relative fresh weight may be due to the uptake of the vase solution by the cut foliage stalks. After 20th day, the relative fresh weight decreased significantly till the end of vase life of the foliage.

Table 7: Effect of vase solutions on uptake of vase solution by cut stems of song of India

Growing environments / Treatments	Vase solution uptake				
	Day 5	Day 10	Day 15	Day 20	Day 21
T_1	0.50	2.13	1.38	0.38	0.00
T_2	1.75	1.75	2.25	0.00	0.13
T_3	0.63	1.13	1.63	0.00	0.13
T_4	0.88	1.50	2.25	0.38	0.25
T_5	1.63	1.25	1.63	0.13	0.25
T_6	2.38	2.13	3.00	3.25	2.38
T_7	0.75	1.63	1.63	0.50	0.13
T_8	1.75	1.25	1.75	0.75	0.00
LSD	0.2408				

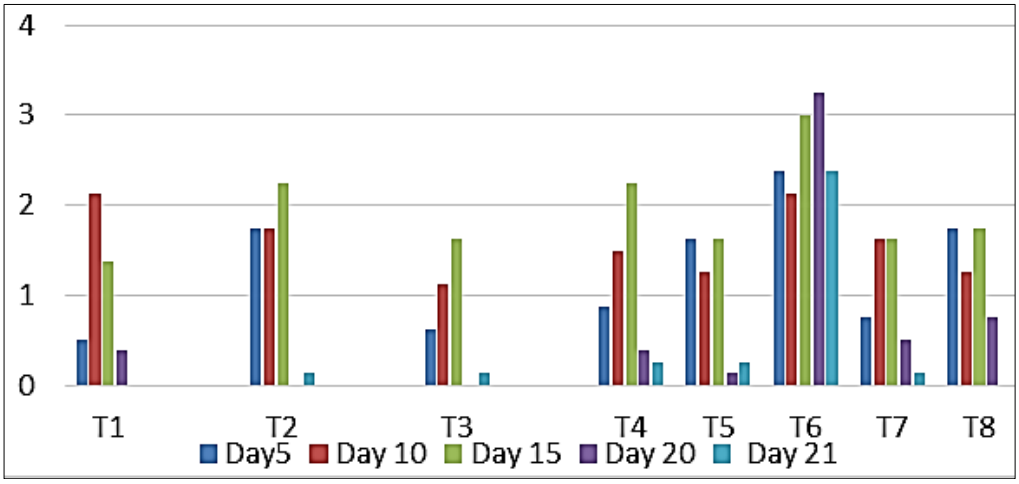

Fig 1: Bar chart showing the vase solution uptake of song of India noted on day 5, 10, 15, 20 and 21 of different treatments

Table 8: Effect of vase solutions on relative fresh weight of cut stalks of song of India

Growing environments / Treatments	Relative fresh weight				
	Day 5	Day 10	Day 15	Day 20	Day 21
T_1	102.05	110.87	116.50	102.49	94.72
T_2	106.69	113.97	122.21	105.82	96.61
T_3	102.41	106.74	112.69	90.39	83.78
T_4	103.09	108.17	118.83	108.43	92.59
T_5	105.38	110.21	115.19	100.74	89.83
T_6	110.67	119.50	129.64	140.48	149.92
T_7	102.66	109.06	115.26	118.24	113.86
T_8	106.29	110.93	117.57	120.12	116.81
LSD	1.9357				

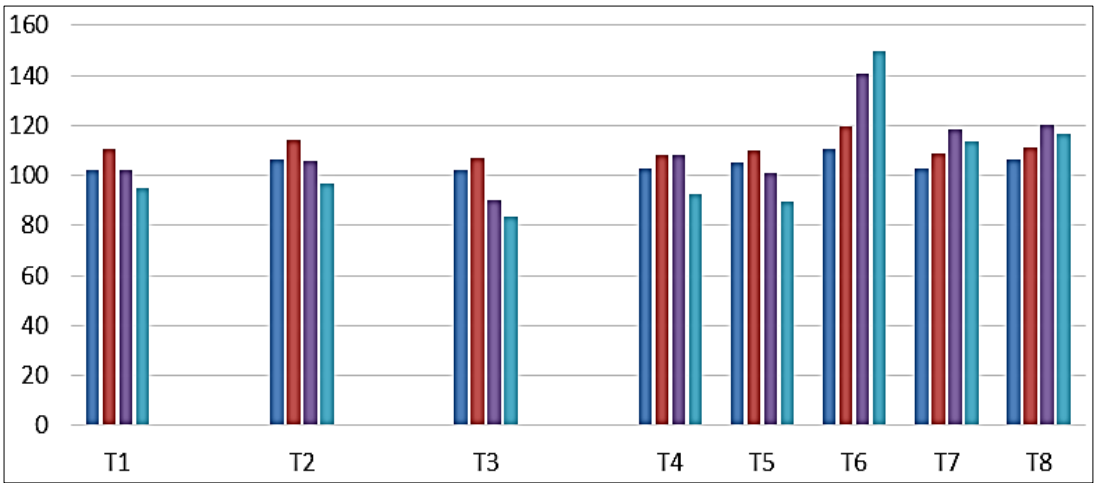

Fig 2: Bar chart showing the relative fresh weight of song of India noted on day 5, 10, 15, 20 and 21 of different treatments

Conclusion

The results of the experiment showed that the growing environment varyingly affects the physical and physiological parameters of the vase life of Song of India cut stalks. The pre harvest spray of Gibberellins had slight differences in the vase life of the cut stalks. Rekha *et al.*, (2001) [13] mentioned that these preservative solutions exerted a dual effect in delaying senescence of schefflera leaves by increasing water uptake and reducing water loss, thereby improving water balance. The effect of Calcium chloride (2%) along with sucrose (4%) was shown to be superior in increasing the vase life for 21.13 days as compared with distilled water as control (17.38 days). Among the different vase solution treatment combinations studied, T_6, (2% $CaCl_2$ + Sucrose 4%) was found best influencing all parameters. Similar findings were reported by by Merwe *et al.* (1986) [11] in gladiolus inflorescences and the sucrose uptake from vase solution replenished the intercellular respirable carbohydrates leading to high respirable rate and prolonged vase life and from the decreased moisture stress and improved water balance (Gowda and Gowda, 1990) [10]. The sucrose acts as a food source or respiratory substrate and helps in delaying the proteins degradation. Sucrose alone tends to promote the microbial growth. Hence, the combination of sugars with biocides will extent the vase life of cut foliage. This were with accordance with the reports of H. A. Akintoye *et al.*, in *Heliconia* spp, where the longest vase life was achieved with the use of vase solution combination of calcium chloride and sucrose combination. Calcium chloride increased the cut foliage vase life, while decreased the microbial count with total delay of senescence which were in accordance with Ali Salehi Sardoei, 2014 reports in *Narcissus tazetta*. Hence, the use of sugars with biocides would be more beneficial in improving the foliage attributes and vase life of Song of India cut stalks.

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