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Standardization of holding solution to enhance vase life and postharvest quality of cut stem of bird of paradise, *Strelitzia reginae* Ait

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ABSTRACT

Bird of paradise (*Strelitzia reginae* Ait) is one of the most important cut flower crops due to its beautiful appearance. Postharvest treatments of cut stem for colour retention, excellent keeping quality and effective transportation are in vogue to fetch remunerative return. Therefore laboratory experiments were conducted at the Department of Floriculture and Landscape Architecture, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during 2012-13 to assess the affect of different holding treatments on postharvest quality parameters and vase life of cut stem in bird of paradise. The experiment was laid out in completely randomize block design having thirteen holding treatment combinations. Observations were recorded on number of florets opened/stem in vase, vase life (days), amount of pulsing solution consumed (ml/stem), amount of vase solution consumed (ml/stem), reducing sugar content, non-reducing sugar content and per cent weight loss. Significant differences with respect to holding treatment were observed for all the characters under study. Holding treatment of cut stems of bird of paradise comprising of 2 per cent sucrose + 300 ppm $Al_2(SO_4)_3$ was found to be the best for increasing the number of florets opened/stem, maximum vase life, holding and vase solution consumption, reducing and non-reducing sugar contents and minimum per cent loss in weight.

Keywords: Bird of paradise; vase life; holding solution; cut stem; postharvest quality

INTRODUCTION

Bird of paradise (*Strelitzia reginae* Ait) is one of the beautiful cut flowers being grown in many parts of the world for its attractive brilliant colour and remarkable appearance under protected conditions. The flowers have great demand for floral arrangements in bigger cities (Finger et al 1999).

In cut flowers qualitatively and quantitatively about 20-30 per cent loss occurs due to faulty harvesting, handling, packaging, storage, transport and marketing. At the same time there are few problems associated with the cut flowers viz these exhibit irregular and incomplete floret opening and intense browning and wilting of florets usually occurs within a few days after harvest (Finger et al 1999).

Senescence symptoms in bird of paradise include floret desiccation and bract darkening that cause loss of postharvest life which is probably associated with a rapid decline in the water uptake after harvest, possible blockage of the stem vascular tissue and bract senescence (Jaroenkit and Paull 2003). Use of different holding solutions has been reported to be of great value in prolonging vase life, promoting opening and improving the colour and size of petals in cut flowers. Presently most of the biocides used for commercial floriculture industry are not safe for our ecosystem. Due to presence of heavy metals application of few biocides is also banned. Some of these compounds such as silver nitrate and silver thiosulphate have shown environmental risks and health hazards. Moreover only scanty package of practices is available on postharvest handling of bird of paradise.Therefore in order to find an easy to use, non-toxic and inexpensive compound for large scale application the present studies were undertaken on the use of safe biocide for standardization of holding solution to enhance vase life and other postharvest qualities of cut stem of bird of paradise.

MATERIAL and METHODS

The present study was carried out in the experimental laboratory of Department of Floriculture and Landscape Architecture, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during August-September 2012-13. The crop was grown under polyhouse conditions. The soil physico-chemical characteristics of the polyhouse viz pH, EC, organic carbon, available N, available P and available K were studied and the mean values were found to be 6.8, 0.24 ds/m, 0.75 per cent, 272 kg/ha, 45 kg/ha and 198 kg/ha respectively. The cut stems of bird of paradise for the research purpose were harvested from 6 year old plantation of it. The morphological growth parameters of plants were also determined which were number of plants/clump (3.60), number of leaves (30.60), plant height (135.80 cm), leaf length (133.60 cm), leaf breadth (11.40 cm), number of spikes/clump (4.00) and length of spike (114.00 cm).

Uniform superior quality cut flower stems were harvested in the morning (8.00-9.00 am) with the help of sharp secateurs. These cut stems were placed in a bucket containing cool and clean water. As the florets of flower are prone to breakage the stems were harvested a little before the commercial stage of harvest; first orange colour was visible on the upper side of the un-open bract but florets were not opened. After harvesting flowers were taken to the experimental laboratory in a bucket containing water. All the cut stems were kept of 60 cm length and a slanting cut was given 1 to 2 cm above their lower ends by using sharp and sterilized secateurs before putting them in different holding solutions. The cut stems were given different holding treatments viz T_1 (Control, distilled water), T_2 [2% sucrose + 200 ppm 8 citrate of hydroxyquinoline (HQC)], T_3 (2% sucrose + 300 ppm 8HQC), T_4 (2% sucrose + 200 ppm 8HQC + 150 mg/l citric acid), T_5 (2% sucrose + 300 ppm 8HQC + 150 mg/l citric acid), T_6 [2% sucrose + 250 µM thidiazuron (TDZ)], T_7 (2% sucrose + 500 µM TDZ), T_8 (2% sucrose + 250 µM TDZ + 150 mg/l citric acid), T_9 (2% sucrose + 500 µM TDZ + 150 mg/l citric acid, T_{10} [2% sucrose + 200 ppm $Al_2(SO_4)_3$], T_{11} [2% sucrose + 300 ppm $Al_2(SO_4)_3$], T_{12} [2% sucrose + 200 ppm $Al_2(SO_4)_3$ + 150 mg/l citric acid], T_{13} [2 % sucrose + 300 ppm $Al_2(SO_4)_3$ + 150 mg/l citric acid] at ambient room conditions. Amount of holding solution/distilled water consumed was calculated by using the formula suggested by Bravdo et al (1974). Reducing and non-reducing sugars at the end of vase life were estimated on the basis of DNS method (Thimmaiah 1999). The analysis of variance of data was done as per Gomez and Gomez (1984).

RESULTS and DISCUSSION

Effect of different holding treatments on vase life and biochemical and quality parameters of bird of paradise are given in Table 1.

Number of florets opened/stem in vase

Florets of bird of paradise are covered with a hard boat-shaped bract. After harvesting due to lack of continuous source of energy the florets fail to open in vase. An effective flower food or holding solution can extend the life of flowers. In the present study maximum number of florets opened per stem in vase (2.47) was recorded in holding solution comprising 2 per cent sucrose + 300 ppm $Al_2(SO_4)_3$ which was significantly higher than the control. This may be due to the use of sucrose, a respiratory substrate known to be a source of carbohydrate that is utilized by cut flowers when natural carbohydrates are depleted (Paulin 1997). But sugars accelerate the bacterial growth in the vase solution (Sarkka 2005). The proliferation of microbial population in the vase results in vascular plugging. Flow rate of sucrose solution in the vessels becomes slower and water uptake decreases (Sarkka 2005). Aluminum sulfate application acidifies the solution and diminishes bacterial growth (Hassanpour et al 2004). This compound acts as a bacterial filter by forming $Al_2(OH)_3$ sediment on the cut surface of stem (Put et al 1992). However Ichimura and Hisamatsu (1999) reported that sucrose treatment might have increased longevity, floret opening percentage and water balance of bird of paradise cut flowers by delaying senescence throughout one or more of the factors such as promoting bud opening and inhibiting flower senescence thereby increasing sugar concentration and inhibition of ethylene synthesis.

Vase life

Vase life is the period of time the flower remains intact, fresh and presentable and it is one of the most important characteristics of cut flowers. Among the different holding solutions maximum vase life (15.87 days) was recorded when the cut stems were kept in solution comprising 2 per cent sucrose +

Table 1. Effect of different holding treatments on vase life and biochemical and quality parameters of bird of paradise (*Strelitzia reginae* Ait)

Treatment	Number of florets opened/stem in vase	Vase life (days)	Quantity of vase solution consumed (ml/stem)	Reducing sugars (mg/g)	Non-reducing sugars (mg/g)	Weight change/loss (%)
T_1	1.13	7.60	11.67	367.20	87.18	15.50
T_2	1.60	12.20	18.00	369.87	92.08	11.50
T_3	1.60	11.13	20.33	371.67	93.97	10.70
T_4	1.73	11.40	20.67	425.83	91.70	11.20
T_5	2.20	13.20	22.00	389.40	111.59	11.91
T_6	1.53	9.53	17.47	413.67	104.48	10.50
T_7	1.47	9.33	15.00	388.90	111.94	13.00
T_8	1.67	10.80	19.2	396.87	107.34	10.80
T_9	1.53	10.07	15.83	381.03	113.26	10.50
T_{10}	2.27	14.40	23.67	428.37	115.40	9.60
T_{11}	2.47	15.87	25.67	438.40	117.03	7.70
T_{12}	1.67	10.47	22.33	414.67	103.30	9.90
T_{13}	1.80	9.87	23.00	420.10	114.19	10.00
Mean	1.74	11.22	19.60	400.46	104.88	11.22
$CD_{0.05}$	0.31	1.53	2.74	0.77	1.08	1.66

T_1: (Control, distilled water), T_2 [2% sucrose + 200 ppm 8 citrate of hydroxyquinoline (HQC)], T_3 (2% sucrose + 300 ppm 8HQC), T_4 (2% sucrose + 200 ppm 8HQC + 150 mg/l citric acid), T_5 (2% sucrose + 300 ppm 8HQC + 150 mg/l citric acid), T_6 [2% sucrose + 250 µM thidiazuron (TDZ)], T_7 (2% sucrose + 500 µM TDZ), T_8 (2% sucrose + 250 µM TDZ + 150 mg/l citric acid), T_9 (2% sucrose + 500 µM TDZ + 150 mg/l citric acid, T_{10} [2% sucrose + 200 ppm $Al_2(SO_4)_3$], T_{11} [2% sucrose + 300 ppm $Al_2(SO_4)_3$], T_{12} [2% sucrose + 200 ppm $Al_2(SO_4)_3$ + 150 mg/l citric acid], T_{13} [2 % sucrose + 300 ppm $Al_2(SO_4)_3$ + 150 mg/l citric acid]

300 ppm $Al_2(SO_4)_3$. In comparison to this minimum vase life (7.60 days) was observed where no preservatives were added in the holding solution. The increased vase life may be due to the inhibition of vascular blockage and increase in water retention of cut stem. Moreover addition of aluminium sulphate might have reduced the microbial contamination in flowers, stem or vase water and consequently improved water conductance by preventing bacterial growth and reducing occlusion (Amiri et al 2009). The effects of $Al_2(SO_4)_3$ in increasing vase life have also been reported by Karki et al (2004) and Divya et al (2004).

Amount of holding or vase solution consumed

In the present study different holding solutions resulted in significant variation with respect to amount of vase solution consumed by the cut stems. Among the different holding solutions maximum volume of vase solution (25.67 ml/stem) was consumed by the cut stems kept in holding solution containing 2 per cent sucrose + 300 ppm $Al_2(SO_4)_3$. Maximum amount of holding solution was consumed by the cut stem may be attributed to the acidification of the holding solution due to presence of aluminium ion.

Effectiveness of aluminium sulfate application has been proved in cut gladiolus flowers (Gowda and Gowda 1990). Aluminum sulfate (150 mg/l) application enhanced water uptake significantly compared to control in eustoma cut flowers (Liao et al 2001). $Al_2(SO_4)_3$ also reduces bacterial growth and improves water uptake (Halevy and Mayak 1979). On the contrary minimum amount of holding solution consumed may be due to the reduced stem conductivity in distilled water. There are chances of growth of different microorganisms in distilled water which may check/ reduce proper conductivity of water thereby reducing water uptake.

Reducing and non-reducing sugar content

Different holding solutions resulted in significant variation with respect to reducing sugar content in petals after completion of vase life. Maximum reducing sugar content (438.40 mg/g) was recorded when the cut stems were kept in a solution comprising 2 per cent sucrose + 300 ppm $Al_2(SO_4)_3$. All other solutions also showed a significantly higher reducing sugar content over control (367.20 mg/g) which recorded minimum reducing sugar content in petals.

These results are in conformity with the findings of Bhattacharjee (1999) who reported that use of $Al_2(SO_4)_3$ at 300 ppm in holding solution significantly increased the total soluble and reducing sugars in petal tissues of rose cv Queen Elizabeth. Non-reducing sugar content (117.03 mg/g) was observed maximum when the cut stems were kept in control ie distilled water. However maximum reducing sugar content (117.03 mg/g) in petals was found when the cut stems were kept in holding solution containing 2 per cent sucrose + 300 ppm $Al_2(SO_4)_3$. This breakdown of exogenous sugars may be catalyzed by the hydrolytic enzymes produced during the process of senescence (Mayak and Halevy 1980). Availability of exogenous sugars resulted in high content of metabolically utilizable reducing and non-reducing sugars for longer period which might have lead to prolonged vase life.

Change/loss in weight

Maximum weight change (15.50%) was recorded in non-pulsed cut blooms. On the contrary all other holding solutions resulted in less fresh weight loss of cut stems with a minimum of it recorded in cut blooms which were placed in holding solution containing 2 per cent sucrose + 300 ppm $Al_2(SO_4)_3$ (7.70). The minimum loss in weight was found after putting cut stems in holding solution containing 2 per cent sucrose + 300 ppm $Al_2(SO_4)_3$ due to the property of aluminium ions to reduce transpiration and improving water balance.

Aluminium has also been reported to improve water balance in cut roses by inducing stomatal closure (Bhattacharjee 1999). Along with increasing vase life, aluminium sulphate also improved water absorption and resulted in minimum physiological loss in weight (Liao et al 2001, Divya et al 2004).

CONCLUSION

Holding treatment in cut stems of bird of paradise containing 2 per cent sucrose + 300 ppm $Al_2(SO4)_3$ may be recommended for increasing the number of florets opened/stem, vase life and other postharvest characters.

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