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Effect of Different Preservatives on Vase Life of Tuberose

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Abstract

This study was carried out to investigate the effect of different preservative solutions to improve the keeping quality of tuberose (*Polianthes tuberosa* cv. Single). These preservative solutions (treatments) were: T_1= 2% sucrose + 200 mg/l $AgNO_3$, T_2= 2% sucrose + 200 mg/l $AgNO_3$ + 25 mg/l citric acid, T_3= 2% sucrose + 300 mg/l HQS, T_4 = 2% sucrose + 300 mg/l HQS+ 25 mg/l citric acid, T_5= 2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS, T_6= 2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS+ 25 mg/l citric acid, T_7= 0.01 % sodium hypochloride, T_8= 0.05 % sodium hypochloride, T_9= 0.10 % sodium hypochloride and T_{10}= tap water (control). The results showed that all treatments had improved the keeping quality and vase life of the cut flowers comparing to control ones. Among all these treatments, 2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS+ 25 mg/l citric acid showed best water uptake, water loss uptake ratio, percentage of maximum increase in fresh weight of the cut flower stem and vase life which was extended up to 10 days. According to the results of this research it is concluded that, 2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS+ 25 mg/l citric acid are suitable for prolongation of tuberose vase life.

Keywords: Citric acid, Keeping quality, *Polianthes tuberosa,* Preservative solution, Sodium hypochloride, Sucrose.

INTRODUCTION

Tuberose (*Polianthes tuberose* L.), a member of Amaryllidaceae family was originated in Mexico and grown on large scale in Asia. It is an important cut flower crop from aesthetic as well as commercial point of view. In Bangladesh, its commercial cultivation was introduced during 1980 by some pioneer and innovative farmers at Panishara union of Jhikorgachathana under Jessore district near the Benapol border (Hoque *et al.,* 1992). Tuberose occupies a very selective and special position to flower loving people. It has agreat economic potential for cut flower trade and essential oil industry. Apart from ornamental value, tuberose is extensively utilized in medicines for headache, diarrhea, rheumatism and allied pains. In Bangladesh, for the last few years,tuberose has become a popular cut flower for its attractive fragrance and beautiful displayin the vase. Now it has high demand in the market and its production is highly profitable (Ara *et al.*, 2009).

Improvement of keeping quality and extend of vase life of cut flowers are important areas in floricultural research. Senescence of cut flowers is induced by several factors e. g. water stress, carbohydrate depletion, microorganism (Gowda, 1990: Van Doorn and Witte, 1991) etc. Accomplishment of the extension of vase life depends on proper harvesting, postharvest handling and a preservative solution for ensuring an ample supply of water, metabolites and regulatory substances to petals and leaves.Water balance is determined by transpiration and water uptake and is the main factor affecting longevity and quality characteristics of cut flowers (Da Silva, 2003). Occlusion at the end of the basal stem is the primary cause of low water uptake by cut flowers (He *et al*., 2006).

Investigations pertaining to extend the vase life of cut flowers by several preservative/ chemicals i.e. silver nitrate, sucrose, HQS, HQC, aluminium sulphate, cobalt sulphate, kinetin, boric acid, citric acid, ascorbic acid after harvest in different formulations and combinations to enhance the vase life of cut flowers have been made with varying success (Van *et al*., 1991; Reddy *et al.,* 1997; Anjum *et al.*, 2001; Saini *et al.*, 1994 and Pruthi *et al.*, 2002) in many countries of the world. But in Bangladesh, a little work has been done in respect of using floral preservative to enhance the vase life of cut flowers. Considering the facts, such research is very important for the greater interest of the scientist as well as the growers and flower shop- keeper of our country. The present study was therefore undertaken to investigate different preservative solutions and determining the best ones which extend vase life and improve the keeping quality of tuberose cut flower.

MATERIALS AND METHODS

This experiment was conducted at the Laboratory of Landscape, Ornamental and Floriculture Division of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during the period from April 2013 to May 2013.

Experimental materials

Spikes of tuberose were selected as experimental material. Fresh tuberose spikes of about 55 cm was harvested from the field of Landscape, Ornamental and Floriculture Division of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur in the morning to avoid excessive heat and immediately the spikes were placed in plastic buckets containing cold water in order to rehydrate the flowers. The spikes were brought to the laboratory within ½ hour after harvest. Spikes were sorted into different groups (based on the size and number of florets per spike) in order to maintain uniformity in thematerial used for experiment. The spikes were again cut to uniform length of 50 centimeter and all the leaves were removed to avoid contact with the solution.

Treatments

The study consisted of ten treatments-

T_1= 2% sucrose + 200 mg/l $AgNO_3$

T_2= 2% sucrose + 200 mg/l $AgNO_3$ + 25 mg/l citric acid

T_3= 2% sucrose + 300 mg/l HQS

T_4 = 2% sucrose + 300 mg/l HQS + 25 mg/l citric acid
T_5= 2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS
T_6= 2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS + 25 mg/l citric acid
T_7= 0.01 % sodium hypochloride
T_8= 0.05 % sodium hypochloride
T_9= 0.10 % sodium hypochloride and
T_{10}= Control (Tap water)

Experimental design

The experiment was laid out in Completely Randomized Design (CRD) with three replications.

Methods

Single spike was used for each bottle. A total number of 30 flowers were used to hold the floral preservatives which were prepared freshly and dispensed into the bottles. Bottles were kept at room temperature (25-35 °C) and relative humidity (RH) of 65-80% with adequate aeration.

Placement of tuberose flower stick in glass bottle.

Preparation of vase solutions

The required concentrations of sugar solution (2%), $AgNO_3$ solution (200 mg/l), HQS solution (300 mg/l), sodium hypochloride solution (0.01-0.05-0.10%) and citric acid (25 mg/l) were prepared by dissolving calculated amount of these chemicals in water. Tap water was used as control solution.

Collection of data

Data were recorded for floret opening (%), floret deterioration (%), total quantity of water uptake, total quantity of water loss, loss uptake ratio, fragrance of the flowers (on 6^{th} day), fresh weight of spike, vase life, incidence of stem rotting etc. Floret opening, recorded from the day when the first floret opened till the spike was discarded and expressed in percentage. Floret deterioration, recorded from the day when the first basal floret became dry and closed and expressed in percentage. The water uptake by the cut spikes was estimated by subtracting the amount of water at the end of experiment from the initial volume and expressed in grams. Water loss is the difference between the initial and final weights of bottle with solution and spike represents the loss of water and expressed in grams.

Statistical analysis

The data recorded on different parameters were statistically analyzed with the help of 'MSTAT'-C software. The difference between treatment means were compared by Duncan's Multiple Range Test (DMRT) according to Steel and Torrie (1960).

RESULTS AND DISCUSSION

Floret opening (%)

Floret opening for a period of 10 days by the spikes differed in case of different vase solution (Fig. 1). Spikes held in T6 (97.76%) recorded the maximum % of floret opening which was statistically similar to T_5 (95.24%) while, the minimum floret openingwas found in control (65.78%). Similar results have been recorded in gladiolus and carnation (Halevy, 1987 and Mayak *et al.,* 1973). When sucrose was present in the holding solution, the activities of sucrose synthetase, sucrose -P- synthase and sucrose -6P- isomerase in the flowers remained high for bud opening. In absence of sucrose, enzyme activity decreased as the flower aged. The decrease in activity appeared to be related to very low protein synthesis (Bose *et al.*, 1999).

Water uptake (g/spike)

Total water uptake for a period of 10 days by the spike differed significantly in case of different vase solutions (Table 1). The spikes held in T_6 (62.0 g) had the highest water absorption compared with the control and other treatments. These may be due to a synergistic effect, which improved water balance by maintaining turgidity. The high absorption of water uptake by T_6, as observed in the present investigation, similar with previous results obtained in tuberose (Anjum *et al.,* 2001).When flowers are detached from the plant, water loss from these continues through transpiration. The ideal flower preservative is that which allows water absorption in flower tissues (Salunkhe *et al*., 1990). Water absorption from the preservative solution maintains a better water balance and flower freshness (Reddy and Singh, 1996) and saves from early wilting resulting inenhanced vase-life.

Water loss (g/spike)

Water loss from the tissue during the experimental period was significantly affected by different vase solutions (Table 1). The spikes held in T_{10} (control) with lower water uptake, recorded the lowest water loss (36.0 g); those held in T6 (2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS

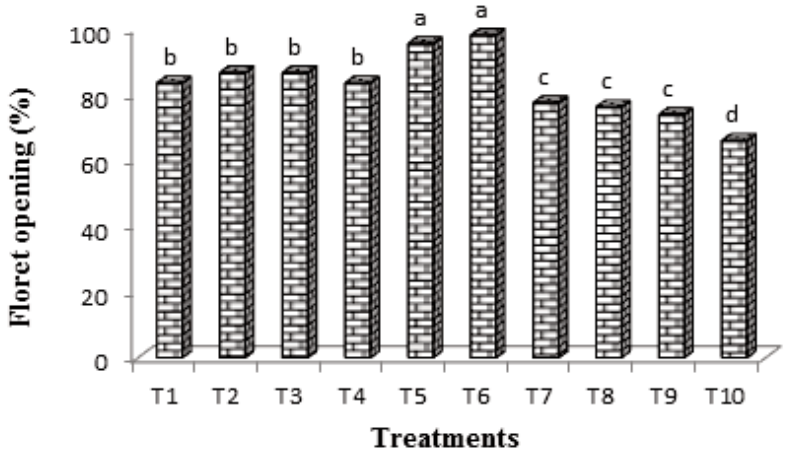

Fig. 1. Effect of preservatives on % floret opening of tuberose.

T_1= 2% sucrose + 200 mg/l $AgNO_3$, T_2= 2% sucrose + 200 mg/l $AgNO_3$ + 25 mg/l citric acid, T_3= 2% sucrose + 300 mg/l HQS, T_4 = 2% sucrose + 300 mg/l HQS+ 25 mg/l citric acid, T_5= 2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS, T_6= 2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS+ 25 mg/l citric acid, T_7= 0.01 % sodium hypochloride, T_8= 0.05 % sodium hypochloride,T_9= 0.10 % sodium hypochloride and T_{10}= Control (tap water)

Table 1. Effect of different preservatives on postharvest physiology of tuberose.

Treatments	Water uptake (g/spike)	Water loss (g/spike)	Water loss uptake ratio	Fragrance of flower	Incidence of stem rotting
2% sucrose + 200 mg/l $AgNO_3$	43.9 cd	44.0 c	1.0 ab	+	-
2% sucrose + 200 mg/l $AgNO_3$ + 25 mg/l citric acid	50.0 bc	49.9 ab	1.0 ab	+	-
2% sucrose + 300 mg/l HQS	47.9 bc	48.0 b	1.0 ab	+	+
2% sucrose + 300 mg/l HQS+ 25 mg/l citric acid	44.9 c	45.0 bc	1.0 ab	+	+
2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS	51.1 b	51.3 ab	1.0 ab	++	-
2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS+ 25 mg/l citric acid	62.0 a	52.5 a	0.8 b	++	-
0.01 % sodium hypochloride	35.6 e	38.0 de	1.1 ab	-	+
0.05 % sodium hypochloride	39.0 d	41.1 d	1.1 ab	-	+
0.10 % sodium hypochloride	32.7 ef	37.0 de	1.1 ab	-	+
Control (tap water)	30.0 f	36.5 e	1.3 a	+	+
CV%	10.0	9.7	4.5	-	-

+ 25 mg/l citric acid) with maximum water uptake, recorded the maximum water loss (57.5 g). These results supported by Reddy *et al.* (1997) in tuberose that an adequate moisture level can be maintained in cut vases given sufficient water uptake or sufficient water retention.

Water loss uptake ratio

This ratio was not significantly affected by different vase solutions (Table 1). However, the minimum water loss and uptake ratio of was recorded in T_6 (0.8) and the ratio was highest for the spikes held in control solution (1.3). According to Kabir *et al.* (2011), the minimum water loss-uptake ratio indicated better relation with flower quality.

Fragrance of flower

The results presented in Table 1. demnostrated that the flowers in T_6 and T_5 were more fragrant other treatments. No fragrance was found in the solution which contains NaOCl (T_7, T_8 T_9) indicating adverse effects of this chemical on fragrance of the flowers. Fragrance is an important quality parameter when flowers are kept for interior decoration, it makes the environment pleasant. Fragrance might be lost due to the fungal attack at stem cut ends; hence if a suitable preservative is added in the vase solution, this may helps in maintain the fragrance of flowers for a longer period. Almost similar result has also been reported by Anjum *et al*. (2001) in tuberose.

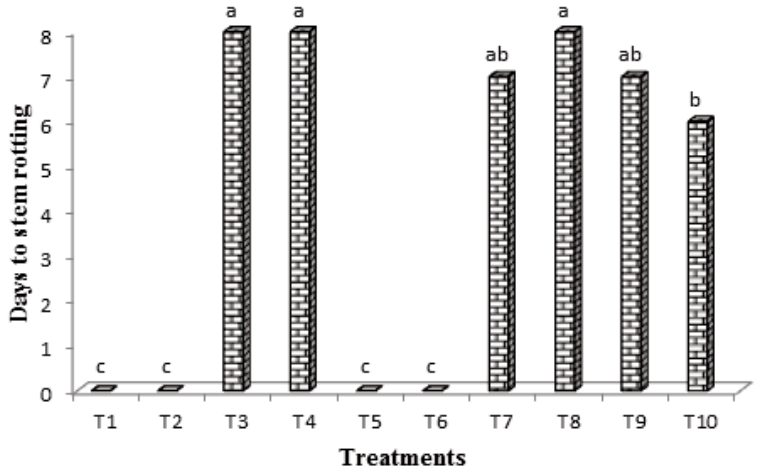

Fig. 2. Stem rotting in different preservative solutions of tuberose.
T_1= 2% sucrose + 200 mg/l $AgNO_3$, T_2= 2% sucrose + 200 mg/l $AgNO_3$ + 25 mg/l citric acid, T_3= 2% sucrose + 300 mg/l HQS, T_4 = 2% sucrose + 300 mg/l HQS+ 25 mg/l citric acid, T_5= 2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS, T_6= 2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS+ 25 mg/l citric acid, T_7= 0.01 % sodium hypochloride, T_8= 0.05 % sodium hypochloride,T_9= 0.10 % sodium hypochloride and T_{10}= Control (tap water)

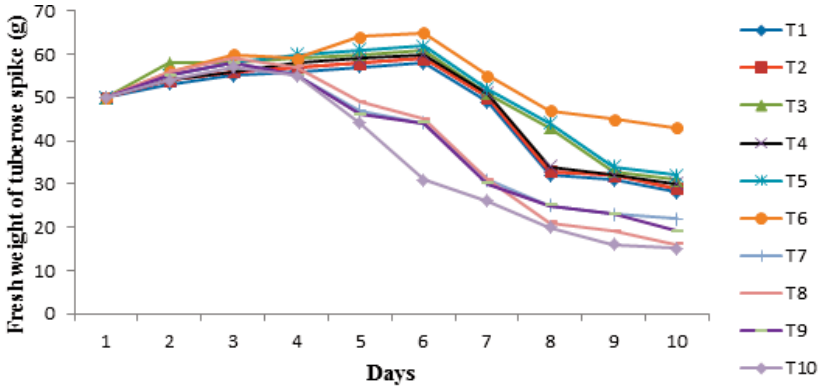

Fig. 3. Changes in fresh weight of tuberose spike held in different preservatives.

T_1= 2% sucrose + 200 mg/l $AgNO_3$, T_2= 2% sucrose + 200 mg/l $AgNO_3$ + 25 mg/l citric acid, T_3= 2% sucrose + 300 mg/l HQS, T_4 = 2% sucrose + 300 mg/l HQS+ 25 mg/l citric acid, T_5= 2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS, T_6= 2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS+ 25 mg/l citric acid, T_7= 0.01 % sodium hypochloride, T_8= 0.05 % sodium hypochloride,T_9= 0.10 % sodium hypochloride and T_{10}= Control (tap water)

Incidence of stem rotting

At first rotting of stick was started in control solution (6th day), then rotting was observed on sticks which held in T_7 (7th day) and T_9 (7th day) (Fig. 2). No stem rotting incidence was found in case of T_1, T_2, T_5 and T_6. This might be due to the fact that the sucrose, $AgNO_3$, HQS and citric acid prevents in the holding solution acted as a biocide inhibiting microbial population that might have resulted in blockage of the vascular tissues.

It was in conformity with the findings of Nagaraja *et al*. (1999) who opined that sucrose, $AgNO_3$, HQS and citric acid prevents microbial occlusion of xylem vessels in tuberose thereby enhancing water uptake and increasing longevity of flowers. The findings of the experiment are further supported by those of Khondakar and Majumdar (1985) in tuberose and Acock and Nichols (1979) in cut carnations.

Changes in fresh weight of spikes

Fig. 3. represent the changes of fresh weight of spikes held in different vase solution up to 10th day at one day interval. It was observed from the graphical presentation that in all treatments including control, a gentle increase in weight of spike was noted up to the 3rd day. There after depletion in weight of spike was observed, those held in tap water and solution containing NaOCl. Increasing trend continued up to 6 days in the spikes held in solution containing sucrose, $AgNO_3$, HQS and their combinations with citric acid. However, the maximum fresh weight of spike was observed in T_6 (65 g). Spikes held in solutions with different concentration of sucrose, $AgNO_3$, HQS and citric acid maintained their weight above the initial one even up to 7th day of vase life, while those held in tap water and solutions free from sucrose, $AgNO_3$, HQS and citric acid gained their weight below their initial weight after 4th day. These results indicated that sucrose, $AgNO_3$, HQS and citric acid help the spike to maintain their weight.

Floret deterioration (%)

Floret deterioration percentage was maximum in T_{10} and minimum in T_6 (Fig. 4). Combination of 2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS + 25 mg/l citric acid inhibited climacteric ethylene synthesis, increased invertase activity in developing buds and significantly reduced floret deterioration.

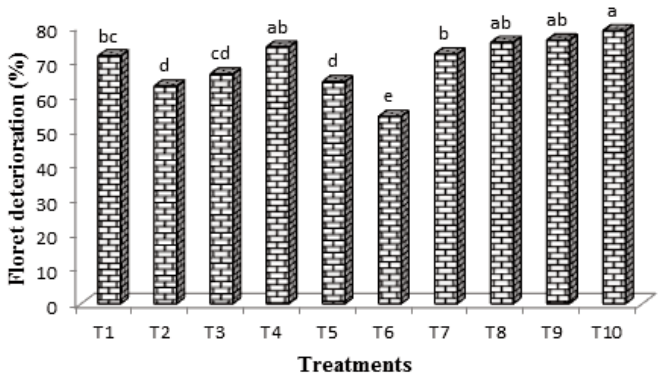

Fig. 4. Effect of preservatives on % floret deterioration in tuberose.
T_1= 2% sucrose + 200 mg/l $AgNO_3$, T_2= 2% sucrose + 200 mg/l $AgNO_3$ + 25 mg/l citric acid, T_3= 2% sucrose + 300 mg/l HQS, T_4 = 2% sucrose + 300 mg/l HQS+ 25 mg/l citric acid, T_5= 2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS, T_6= 2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS+ 25 mg/l citric acid, T_7= 0.01 % sodium hypochloride, T_8= 0.05 % sodium hypochloride,T_9= 0.10 % sodium hypochloride and T_{10}= Control (tap water)

Vase life (days)

From this study it is observed that vase life differed in case of different vase solutions (Fig. 5). Maximum vase life was recorded in T_6 (10 days) followed by T_5 (9 days). The minimum vase-life was noted in control (6 days). Water absorption was greatly influenced by a mixture of sucrose, $AgNO_3$, HQS and citric acid. Tuberose spikes held in T_6 (2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS + 25 mg/l citric acid) had a highest absorption index than other treatments. Sucrose increases the vase life of lisianthus flower compared to control plants (Kiamohammadi and Hashemaabadi, 2011). Sucrose in preservative solution can replaces with the losses carbohydrates and preventsall activity related to senescence (Goszczynska and Rudnicki, 1988). Also, Van doorn (2001) reported that flowers in present of sugar, are resistant to ethylene.

Microorganisms, which grow in vase water, include bacteria, yeasts and molds are harmful to cut flowers through their development in, and their consequent blockage of xylem at cut ends, preventing the water absorption. They also produce ethylene and toxins, which accelerate flower

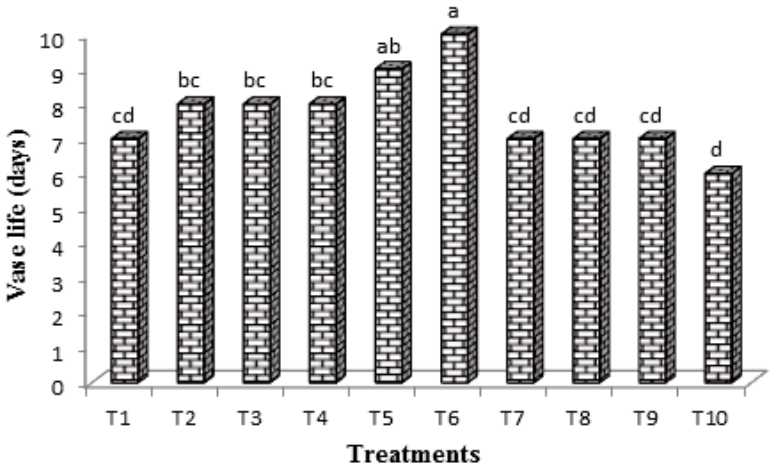

Fig. 5. Effect of preservatives on vase life of tuberose.
T_1= 2% sucrose + 200 mg/l $AgNO_3$, T_2= 2% sucrose + 200 mg/l $AgNO_3$ +25 mg/l citric acid, T_3= 2% sucrose + 300 mg/l HQS, T_4 = 2% sucrose + 300 mg/l HQS+ 25 mg/l citric acid, T_5= 2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS, T_6= 2% sucrose + 200 mg/l $AgNO_3$+ 300 mg/l HQS+ 25 mg/l citric acid, T_7= 0.01 % sodium hypochloride, T_8= 0.05 % sodium hypochloride,T_9= 0.10 % sodium hypochloride and T_{10}= Control (tap water)

senescence and reduce vase life. Adding a suitable germicide in vase water can check the growth of microbes. Silver salts, mainly $AgNO_3$ is an effective bactericide, which is often added in vase water at a concentration of 10-200 mg/l for the extension of vase-life (Singh *et al.*, 2003). Sulphate of hydroxyl quinolene also influenced the vase-life of flowers. Their mode of action is associated with control of microbial activity or control of metabolism in flowers (Singh *et al*., 1994). This might be due to the inhibition of vascular blockage by sucrose + $AgNO_3$ + HQS+ citric acid, as suggested by Pathak (1981) in tuberoses, as well as retardation of microbial growth, as suggested by Reid (2002) in cut flowers. Cut flower longevity has been shown to be associated with maintenance of fresh weight (Gowda and Gowda, 1990). Spike held in 2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS + 25 mg/l citric acid solution maintained their fresh weights above initial weight even up to 7 days of vase life, while those held in tap water and other treatments gained their weight below their initial weight after 4th day.

These results indicated that $AgNO_3$, sucrose, HQS and citric acid helped the spike to maintain their weight. These results are in agreement with previous workers who have reported increased vase-life of tuberose cut flowers when placed in solutions of $AgNO_3$ (Anjum *et al*., 2001) or HQS (Singh *et al.*, 1994). Soaking of tuberose flower stems in 200 mg/l $AgNO_3$ also improved flower longevity by over 50% (Singh *et al.*, 2000).

CONCLUSION

Based on the results of this study, it could be concluded that all chemicals used in this study have improved the vase life of the cut tuberose flower over control. The present study indicates that 2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS + 25 mg/l citric acid treatment has improved tuberose cut flower quality by increasing vase life as measured by number of days, water uptake, maximum increase in fresh weight and inhibiting stem rot incedence. Therefore, 2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS + 25 mg/l citric acid solution has potentiality to be used as a commercial cut flower preservative solution for prolonging vase life and postharvest quality of tuberose cut flowers.

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