? Journal of Research (Science), Bahauddin Zakariya University, Multan, Pakistan.
Vol.12, No.1, June 2001, pp. 01-07 ISSN 1021-1012

EFFECT OF SOME CHEMICALS ON KEEPING QUALITY AND VASE-LIFE OF TUBEROSE (*POLIANTHES TUBEROSA* L.) CUT FLOWERS

Muhammad Akbar Anjum, Farrukh Naveed, Fariha Shakeel and Shazia Amin
Department of Horticulture, University College of Agriculture, Bahauddin Zakariya University, Multan 60800, Pakistan.

Abstract: Cut spikes of tuberose were kept in $CaCl_2.2H_2O$, $AgNO_3$, ascorbic acid and Tri-Miltox Forte (a fungicide) solutions with various concentrations to see their effects on keeping quality and vase–life of the flowers. A control (tap water) and a standard preservative were also included in the experiment. $AgNO_3$, $CaCl_2.2H_2O$ and Tri-Miltox Forte delayed flower opening as compared to ascorbic acid and standard preservative, but stood at par with control. $CaCl_2.2H_2O$ at concentrations of 750 to 1250 ppm and Tri-Miltox Forte at 1500 ppm resulted in minimum flower wilting after six days. $AgNO_3$ was found to have adverse effects on fragrance of the flowers. Water uptake by the spikes was more in those kept in standard preservative and $CaCl_2.2H_2O$ 750 and 1000 ppm solutions. However, $AgNO_3$ 50 and 200 ppm solutions resulted in maximum vase-life (8 days) of cut flowers. Percentages of flowers opened and wilted were significantly negatively correlated with the vase-life. However, vase-life was not correlated with fragrance of the flowers and net water uptake.

Keywords: Ascorbic acid, calcium chloride, cut flower, tuberose preservatives, *Polianthes tuberosa*, post-harvest life, silver nitrate, Tri-Miltox Forte.

INTRODUCTION

The tuberose (*Polianthes tuberosa* L.) is a very popular cut flower of Pakistan. It has white flowers, which are sweet scented. It usually flowers during summer and early autumn, when planted in spring. There are up to 30 flowers in one spike and the length of rachis varies between 14 and 28 cm, depending upon the size of rhizome planted. Besides as a source of essential oils for perfume industry, it is commonly used in bouquets for presenting and in vases for interior decoration. The grading standard for the marketing of tuberose is a disease-free straight stem of about 70 cm and spike with a minimum of 10 pairs of pure white florets [Steenstra and Brundell 1986]. Since it has delicate flowers and sellers and consumers are keen in extending its vase-life, this necessitates to improve its post-harvest life. Keeping quality of the spikes is only 3 days per floret [Rameshwar 1976], and vase-life of the flowers is only few days.

In the earlier times, most of the cut flowers were kept in water but now a day, scientists have introduced many floral preservatives to improve the vase-life of cut flowers. Investigations pertaining to extend the vase-life of tuberose flowers by chemical treatments after harvest have been made with varying success. Several preservatives/chemicals i.e. silver nitrate, aluminium sulphate, cobalt sulphate, 8-hydroxyquinoline sulphate, boric acid, citric acid, ascorbic acid, sucrose etc. have been used in different formulations and combinations to enhance the vase life of tuberose [Saini *et al.* 1994, Reddy *et al.* 1995, Reddy and Singh 1996, Sathyanarayana *et al.* 1996, Reddy *et al.* 1997, De and Barman 1998]. Among the other differently used chemicals of special concern are growth regulators i.e. benzyladenine, gibberellic acid, napthaleneacetic acid, maleic hydazide etc. [Bhaskar and Rao 1998]. Use of floral preservative is the most economical and practicable method for extending the post-harvest life of cut flowers [Salunkhe *et al.* 1990]. Flowers remain fresh longer if they are placed in a suitable floral preservative (Nowak and Rundnicki 1990]. When flowers are kept at room temperature in houses for decoration, flowers dry up due to water loss. If flowers are kept in vase containing water, the main cause of deterioration is stem end rot. Hence, if stem rot at cut end of the stalk is controlled, it may results in enhanced vase-life of the flowers. Calcium salts especially calcium chloride has been reported in literature to delay ripening and senescence in fruits by lowering the respiration rate [Singh *et al.* 1993]. Therefore, in the present study besides silver nitrate ($AgNO_3$) and ascorbic acid, a fungicide (Tri-Miltox Forte) and calcium chloride ($CaCl_2.2H_2O$) were used in different concentrations to investigate their effects on keeping quality and vase-life of tuberose cut flowers. The main objective of the present study was to find out best solutions for enhancing the vase-life of tuberose cut flowers so that the flowers can be kept for longer period for interior decoration.

MATERIALS AND METHODS

The present studies were conducted at University College of Agriculture, Bahauddin Zakariya University, Multan during 1999. The cut flowers were harvested at 6.00 a.m. from Pattuki, transported to Multan, kept overnight with stem ends in water and placed in chemical solutions next morning at 8.00 a.m. The experiment was laid out in a completely randomised design with four replications. The detail of the treatments/chemical solutions used is given below:

T_0 = Control (tap water)	
T_1 = Tri-Miltox Forte	750 ppm
T_2 = Tri-Miltox Forte	1000 ppm
T_3 = Tri-Miltox Forte	1250 ppm
T_4 = Tri-Miltox Forte	1500 ppm
T_5 = $CaCl_2.2H_2O$	750 ppm
T_6 = $CaCl_2.2H_2O$	1000 ppm
T_7 = $CaCl_2.2H_2O$	1250 ppm
T_8 = $CaCl_2.2H_2O$	1500 ppm
T_9 = $AgNO_3$	50 ppm
T_{10} = $AgNO_3$	100 ppm
T_{11} = $AgNO_3$	150 ppm
T_{12} = $AgNO_3$	200 ppm
T_{13} = Ascorbic acid	50 ppm

T_{14} = Ascorbic acid 100 ppm
T_{15} = Ascorbic acid 150 ppm
T_{16} = Ascorbic acid 200 ppm
T_{17} = Standard preservative

The required concentrations of Tri-Miltox Forte (a fungicide containing copper compounds 21% and Mancozeb 20% w/w), calcium chloride ($CaCl_2.2H_2O$), silver nitrate ($AgNO_3$) and ascorbic acid were prepared by dissolving calculated amount of these chemicals in water. Standard preservative was prepared by mixing two tablespoons of fresh lemon juice, one tablespoon of sugar and half tablespoon of household bleach in one litre of water [Howland 1984]. The spikes were placed in glass bottles containing 100 ml of chemical/preservative solution with desired concentration and kept in a laboratory at room temperature. Data were recorded on; percentage of flowers opened (after 24 h), percentage of flowers wilted (on 6^{th} day), fragrance of the flowers (on 6^{th} day), total water uptake by the spikes and vase-life (days). The fragrance of the flowers was evaluated according to the criterion as follows; highly fragrant = 3, moderately fragrant = 2, low fragrant = 1 and no fragrance = 0. The water uptake by the cut spikes was estimated by subtracting the amount of water at the end of experiment from the initial volume. The data collected were analysed statistically using Fisher's analysis of variance technique and Least significant difference test was applied to compare the differences among the treatment means at 5 % probability level. Correlation and regression analysis was made using standard statistical procedures [Petersen 1994].

RESULTS AND DISCUSSION

FLOWER OPENING

Results presented in Table 1 show that the maximum flower opening, after 24 h of placing the spikes in various chemical/ preservative solutions, was recorded in standard preservative followed by ascorbic acid treatments (T_{13} to T_{16}) and all the treatments behaved statistically alike. The minimum flower opening was recorded in $AgNo_3$ and $CaCl_2.2H_2O$ treatments followed by control and Tri-Miltox Forte treatments. All these treatments also stood at par with each other. It is interesting to note that various concentrations of a chemical did not differ significantly with each other, indicating that the chemical is more important and the concentration is the least. In fact, the treatment that delays flower opening is considered better because it results in longer vase-life. These results show that $AgNo_3$, $CaCl_2.2H_2O$, Tri-Miltox Forte treatments and control proved better as compared to other treatments (ascorbic acid treatments and standard preservative).

Table 1: Keeping quality and vase-life of tuberose cut flowers as affected by various chemicals/ preservatives.

Treatments	Flowers opened (%)	Flowers wilted (%)	Fragrance of the flowers	Net water uptake (ml)	Vase-life (days)
T_0	14.21 c*	85.59 abc	0.62 bc	25.75 bc	7.12 abc
T_1	18.79 bc	86.35 abc	1.75 a	21.50 bc	7.00 abc
T_2	23.55 abc	78.18 bcd	1.50 ab	18.75 bc	7.75 ab
T_3	18.71 bc	91.84 ab	1.50 ab	19.50 bc	7.25 abc
T_4	17.41 bc	73.91 cde	1.50 ab	18.00 bc	7.25 abc
T_5	13.84 c	70.76 de	0.50 b	34.00 ab	7.75 ab
T_6	14.84 c	61.29 e	0.50 b	31.25 ab	7.75 ab
T_7	7.92 c	67.56 de	0.50 b	27.50 bc	7.50 ab
T_8	6.08 c	78.37 bcd	0.25 c	22.00 bc	7.50 ab
T_9	7.49 c	81.49 bc	0.00 c	21.25 bc	8.00 a
T_{10}	10.62 c	92.53 a	0.00 c	19.00 bc	7.00 abc
T_{11}	12.59 c	95.66 a	0.00 c	14.00 c	6.50 bcd
T_{12}	8.72 c	81.58 bc	0.00 c	18.75 bc	8.00 a
T_{13}	39.55 a	90.02 ab	0.25 c	23.25 bc	5.00 e
T_{14}	40.75 a	87.68 abc	0.75 abc	13.75 c	6.00 cde
T_{15}	35.19 ab	89.08 ab	0.25 c	12.50 c	5.50 de
T_{16}	34.89 ab	87.73 abc	0.25 c	17.50 bc	6.50 bcd
T_{17}	40.09 a	87.00 abc	1.00 abc	46.25 a	5.50 de

*Figures sharing similar letters in a column are statistically non-significant (Least significant difference test at 5% probability level).

FLOWER WILTING

Data on flower wilting, recorded after six days of placing the spikes in different chemical/preservative solutions, indicate that higher flower wilting percentage was recorded in T_{11} ($AgNO_3$ 150 ppm) and T_{10} ($AgNO_3$ 100 ppm) treatments, followed by T_3, T_{13}, T_{15}, T_{14}, T_{16}, T_{17}, T_1 and T_0 and all these treatments stood at par with each other. The minimum flower wilting was noted in T_6 ($CaCl_2.2H_2O$ 1000 ppm) followed by T_7 ($CaCl_2.2H_2O$ 1250 ppm), T_5 ($CaCl_2.2H_2O$ 750 ppm) and T_4 (Tri-Miltox Forte 1500 ppm), similarly, all these treatments also behaved statistically alike (Table 1). Normally the treatments resulting in less wilting percentage of flowers are considered good because these may result in longer vase-life compared to those showing more wilting. The present study has indicated that $CaCl_2.2H_2O$ is more effective in delaying petal senescence and/or flower wilting. This salt is already known to lower the rate of respiration and is also effective in delaying fruit ripening and senescence in mango [Singh *et al.* 1993].

FRAGRANCE

The results presented in Table 1 demonstrate that the flowers kept in Tri-Miltox Forte 750 ppm (T_1) were more fragrant followed by other Tri-Miltox Forte treatments (T_2, T_3 and T_4), standard preservative (T_{17}) and ascorbic acid 100 ppm (T_{14}) as compared to those kept in other treatments. All these treatments also stood at par with each other. No fragrance was found in $AgNO_3$ treatments (T_9 to T_{12}) 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 fungicide is added in the keeping medium, this may helps in maintaining the fragrance of flowers for a longer period. This has been precisely achieved in the present study. The information regarding the longevity and keeping quality of tuberose flowers is very meager and authors are not aware of any study regarding the improvement of fragrance by a fungicidal treatment.

NET WATER UPTAKE

Results regarding the water uptake by the cut spikes show that maximum water was taken up by the spikes kept in T_{17} (standard preservative) followed by T_5 ($CaCl_2.2H_2O$ 750 ppm) and T_6 ($CaCl_2.2H_2O$ 1000 ppm) and all these treatments differed non-significantly with each other (Table 1). 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 in enhanced vase-life. In standard preservative (T_{17}) ants invaded due to sugar contents taking a significant amount of water and this has also been counted towards water uptake. The standard preservative might be a good vase solution for the area where ants are not a problem but the results of the present study suggest that this is not suitable in our conditions.

VASE-LIFE

It is evident from the data presented in Table 1 that the maximum vase-life (8 days) was recorded in T_9 ($AgNO_3$ 50 ppm), which was at par with T_{12} ($AgNO_3$ 200 ppm), closely followed by $CaCl_2.2H_2O$ and Tri-Miltox Forte treatments and control. Statistically no significant differences existed among these treatments. The minimum vase-life was noted in T_{13} (ascorbic acid 50 ppm) followed by other ascorbic acid treatments and standard preservative. It is interesting that standard preservative only resulted in vase-life of 5.5 days compared to 7.12 days in control.

Microorganisms, which grow in vase water, include bacteria, yeasts and molds. These 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 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 ppm for the extension of vase-life. Salts of calcium also influence the vase-life of flowers. Their mode of action is associated with control of microbial activity or control of metabolism in flowers [Nowak and Rundnicki 1990]. These results are in agreement with previous workers who have reported increased vase-life of tuberose cut flowers when placed in solutions of $AgNO_3$ [Saini *et al*. 1994] or $CaCl_2$ [De and Barman 1998]. Soaking of flower stems of carnation in 1200 ppm $AgNO_3$ for 5 – 20 minutes also improved flower longevity by over 50% [Kofranek and Paul 1972]. Tri-Miltox Forte is a fungicide, which can control fungal growth in vase water, hence, in the present study; Tri-Miltox Forte treatments also resulted in extended vase-life.

CORRELATION BETWEEN VASE-LIFE AND OTHER PARAMETERS

Flower opening was found to be negatively correlated with vase-life of the cut spikes (Table 2). The correlation was highly significant (p = 0.000). This indicates that as the percentage of the flowers opened increased, the vase-life was decreased. Flower wilting was also significantly negatively correlated with the vase life (p = 0.011) indicating the same trend as with flower opening. However, correlation of vase-life with fragrance of the flowers and net water uptake by the cut spikes was found insignificant, i.e. no relationship exists between vase-life and fragrance of the flowers and also between vase-life and net water uptake (Table 2). Net water uptake in relation to vase-life has been used by some workers to determine the quality of flowers. A few workers also reported a significant positive correlation between the amount of water uptake and vase-life [Systema 1975, Buys and Cours 1981]. It is interesting that in the present study no relationship between water uptake and vase-life was found. This might be due to the unusual value of T_{18} (standard preservative) for net water uptake. The unusual value was due to the invasion of ants in solution, the reason already stated.

Table 2. Simple regression lines between the response variable (vase-life) with other variables along with co-efficient of determination (r^2).

Variables	Regression equations	r^2
Vase-life, %age of flowers opened	Vase-life = 8.21 – 0.0628 % flowers opened (0.24) (0.0101)	0.7073
Vase-life, %age of flowers wilted	Vase-life = 11.66 – 0.0572 % flowers wilted (1.65) (0.0199)	0.3399
Vase-life, Fragrance of the flowers	Vase-life = 6.88 + 0.0887 of fragrance (0.33) (0.3883)	0.0032
Vase-life, Net water uptake	Vase-life = 6.91 + 0.0013 ml water uptake (0.66) (0.0278)	0.0001

*The figures in parenthesis underneath the regression coefficients show the standard error of the parameter estimates.

CONCLUSION

From the results of the present study, it can be concluded that $AgNo_3$, $CaCl_2.2H_2O$ and Tri-Miltox Forte treatments delayed flower opening and also resulted in extended vase-life as compared to other treatments (ascorbic acid treatments and standard preservative) but stood at par with control. $CaCl_2.2H_2O$ also proved more effective in delaying petal senescence and/or flower wilting. However, Tri-Miltox Forte treatments maintained the fragrance of flowers for a longer period.

References

Bhaskar, V.V. and Rao, P.V. (**1998**) *Journal of Ornamental Horticulture New Series,* 1, 1-5.

Buys, C.A. and Cours, H.G. (**1981**) *Acta Horticulturae*, 113, 127-130.

De, L.C. and Barman, D. (**1998**) *Journal of Ornamental Horticulture New Series,* 1, 66-68.

De, L.C. and Barman, D. (**1998**) *Orrisa Journal of Horticulture,* 26, 66-69.

Howland, J.E. (**1984**) *Minnesota State Florist Bulletin,* 33, 11-12.

Kofranek, A.M. and Paul, J.L. (**1972**) *Floral Review*, 15, 24.

Nowak, J. and Rundnicki, R.M. (**1990**) "Post-Harvest Handling and Storage of Cut Flowers, Florist Greens and Potted Plants", Chapman and Hall, New York.

Petersen, R.G. (**1994**) "Agricultural Field Experiments – Design and Analysis", Marcel Dekker Inc., New York.

Rameshwar, A. (**1976**) *Indian Horticulture,* 21, 22-23.

Reddy, B.S. and Singh, K. (**1996**) *Journal of Maharashtra Agricultural Universities,* 21, 201-203.

Reddy, B.S., Singh, K., Gangadharappa, P.M., Singh, K., Sathyanarayana, R.B. (**1997**) *Karnatka Journal of Agricultural Sciences,* 10, 1049-1054.

Reddy, B.S., Singh, K., Gupta, A.K., Singh, A., Sathyanarayana, R.B., Singh, K. and Singh, A. (**1995**) *Advances in Agricultural Research in India,* 3, 208-214.

Saini, R.S., Yamdaqni, R. and Sharma S.K. (**1994**) *South Indian Horticulture,* , 42, 376-378.

Salunkhe, D.K., Bhat, N.R. and Desai, B.B. (**1990**) "Post-Harvest Biotechnology of Flowers and Ornamental Plants", Springer-Verlag, Berlin.

Sathyanarayana, R.B., Singh, K., Singh, A. and Saini, A. (**1996**) *Advances in Agricultural Research in India,* 4, 39-45.

Singh, R.P., Tandon, D.K. and Kalra, S.K. (**1993**) *Scientia Horticulturae,* 54, 211-219.

Steenstra, D.R. and Brundell, D.J. (**1986**) "Tuberosa: Cultivation, Cut Flower Production", *Ministry of Agriculture and Fisheries Information Bulletin* 187, Wellington, New Zealand, 3.

Systema, W. (**1975**) *Acta Horticulturae*, 41, 217-220