The Bioscan 15(1): 023-028, 2020
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

EFFECT OF CHEMICAL TREATMENTS ON QUALITY AND VASE LIFE OF CUT CARNATION (*DIANTHUS CARYOPHYLLUS* L.) CVS. MASTER AND YELLOW CANDY

S. SUGANYA[1]*, M. KALAIMANI[2] AND J. PADMANABAN[3]
[1]Department of Floriculture and Landscape Architecture,Horticultural College and Research Institute,
Tamil Nadu Agricultural University, Coimbatore - 641 003, Tamil Nadu, INDIA
[2]Training Assistant (Horticulture), ICAR Krishi Vigyan Kendra, Tamil Nadu Agricultural University,
Sirugamani, Trichy - 639 115, Tamil Nadu, INDIA
[3]Department of Horticulture, Faculty of Agriculture,
Annamalai University, Annamalai Nagar, Chidambaram - 608 002, Tamil Nadu, INDIA
e-mail: sugunyasambath@gmail.com

KEYWORDS
STS
Salicylic acid
Silver nitrate
Boric acid
Citric acid
Cut carnation

Received on :
14.01.2020

Accepted on :
14.03.2020

***Corresponding author**

ABSTRACT

An experiment was undertaken during 2016-2017 at the laboratory of Department of Horticulture, Annamalai University, to study the effect of different chemicals on quality and vase life of cut carnation flowers Cvs. Master and Yellow Candy. The selected flowers were analysed using Completely Randomized Design and held in different holding solutions containing STS (0.5 mM, 1.0 mM and 1.5 mM), salicylic acid, silver nitrate, boric acid, citric acid (each at 100, 150 and 200 ppm) along with sucrose 5% in all the above holding solutions and control. The water, quality and vase life parameters were observed in both the cultivars. Holding of carnation flowers with citric acid 150 ppm + sucrose 5% resulted in maximum CUW (25.30 and 24.19g flower^{-1}), and minimum CTLW (19.80 and 20.74g flower^{-1} respectively), and STS 1.0 mM + Sucrose 5% resulted in maximum fresh weight (15.56 and 14.64g flower^{-1}), diameter of the flower (7.85 cm and 7.53 cm), slowest stem strength (88.47° and 87.66°), with vase life of (7.76 and 7.34 days) as compared with (5.72 and 4.96 days) in control in both the cultivars. Among different chemicals STS 1.0 mM + Sucrose 5% was found highly effective for longevity of carnation flowers.

INTRODUCTION

Carnations are also commonly referred to by their scientific name, "Dianthus", the name given by the Greek botanist Theopharastus. Carnations got the name Dianthus from two Greek Words - "dios", referring to the god Zeus, and "anthos", meaning flower. Carnations are thus known as the "The Flowers of God". The carnation flowers are among the most sought and popular type of flowers in different parts of the world. This flower also known as Grenadine, is a herbaceous plant that is native to the Mediterranean area. Carnation flowers have become symbolic of mother's love and also of Mother's Day.

Carnation is a climacteric flower that is highly sensitive to ethylene (Pun *et al.*, 1999). Postharvest management is one of the major problems in flower marketing. It is estimated that 30-50 per cent losses of flowers occur due to improper postharvest handling during entire market chain (Singh and Tiwari, 2002; Omar *et al.*, 2014). Hence, addition of chemicals to the cut flowers is recommended to continue its physiological processes so that the longevity of the flowers can be extended by more number of days (Nair *et al.*, 2000).

Two major factors play a dominant role in postharvest physiology of the cut flowers are supply of carbohydrates and water balance in the stem. Sugars are the source of energy for respiration, which maintains turgidity and plays an important role in flower freshness. On other hand, there are different types of chemicals being used to improve the vase life and quality of cut flowers. Preservative solutions can be used for different purposes like pulsing, conditioning and holding. It also controls growth of bacteria and fungi in the vase solution mainly because of their germicidal property (Kader and Rogers, 1986). Vase life termination for many cut flowers is characterized by wilting which is due to loss of water from the cells. (He *et al.*, 2006). Many agents have been used in vase solutions of the cut flowers which extends vase life by improving water uptake. These include silver nitrate (Fujino *et al.*, 1983), aluminium sulphate (Ichimura and Shimizu Yumoto, 2007). Therefore, it is important to use these materials in vase solutions to extend the vase life of Cut flowers.

Keeping of cut flowers in various preservatives has effectively been used from long time to improve their longevity (Gowda and Gowda, 1990; Pal *et al.*, 2003). Pulsing with different chemicals enhancing the longevity of the Cymbidium hybrid' Pine Clash Moon Venus' (Bharathi *et al.*, 2015). Silver thiosulfate increased the longevity of carnation flowers by 8 to 9 days (Aldrufew *et al.*, 1981). So, postharvest management of carnation is very important for successful venture of floriculture industry. The present investigation was undertaken to study the effects of different chemicals on water related attributes and quality and vase life of cut carnation flowers (*Dianthus caryophyllus* L.) Cvs. Master and Yellow Candy.

MATERIALS AND METHODS

An experiment was carried out in the laboratory of Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar during 2016-17. The two 'standard' type cultivars of carnation *viz.,* 'Master' (Red) and 'Yellow Candy' (Yellow) were brought from Gayathiri Farm, Hosur, Tamilnadu. The selected flowers were harvested at paint brush stage. The flowers were carefully brought to the laboratory without causing any damage and the stalks were cut to a uniform length of 30 cm and the basal two pairs of leaves were removed and they were kept in clean water. Practices such as removal of lower leaves, clearing the stalks and re-cutting the base before placing them in the preservative solution were essential (Lemper, 1981). It is generally, preferable to use distilled water as standardized water reduces experimental viability (Rule *et al.,* 1986). Experiment was done in completely randomized design. Solutions were freshly prepared at the beginning of experiment. Holding solutions contains the treatments are as follows T_1-Silver thiosulfate - 0.5 mM + 5% sucrose, T_2-Silver thiosulfate - 1 mM + 5% sucrose, T_3-Silver thiosulfate - 1.5 mM + 5% sucrose, T_4-Salicylic acid -100 ppm + 5% sucrose, T_5-Salicylic acid -150 ppm + 5% sucrose T_6-Salicylic acid -200 ppm + 5% sucrose, T_7-Silver nitrate -100 ppm + 5% sucrose, T_8-Silver nitrate -150 ppm + 5% sucrose, T_9-Silver nitrate -200 ppm + 5% sucrose, T_{10}-Boric acid -100 ppm + 5% sucrose, T_{11}-Boric acid -150 ppm + 5% sucrose, T_{12}-Boric acid -200 ppm + 5% sucrose, T_{13}-Citric acid - 100 ppm + 5% sucrose, T_{14}-Citric acid - 150 ppm + 5% sucrose, T_{15}-Citric acid - 200 ppm + 5% sucrose and T_{16}-Control. Each flower was placed in a 500ml bottle containing 250 ml of distilled water of different holding solutions. Double distilled water was used to minimize experiment error. Solutions were prepared as and when required and used in the experiment. Each treatment consisted of 3 (three) replications where 5 (five) flowers were used per replication. The flowers were held at 80 percent relative humidity in ambient room temperature under 40 W cool white fluorescent lights to maintain 12 hours of photoperiod. Observations were taken on the quality and vase life parameters *viz.,* Cumulative uptake of water (CUW), Cumulative transpirational loss of water (CTLW), Water balance, Fresh weight of cut flower, Cumulative physiological loss in weight (CPLW), Stem strength, Diameter of the flower, Flower discoloration / fading, Freshness of flower, Total soluble solids (TSS), pH of vase solution and Vase life. The data were subjected to statistical analysis as per the procedure outlined by Panse and Sukhatme (1978) and the results were tested at 5 percent level of significance.

RESULTS AND DISCUSSION

The data pertaining to Cumulative uptake of water (CUW), Cumulative transpirational loss of water (CTLW) and Water balance of cut carnation Cvs. Master and Yellow Candy as influenced by chemicals in combination with sucrose 5% are presented in Table 1. Both the cultivars held in vase solution containing citric acid at 150 ppm + sucrose at 5% recorded the maximum cumulative uptake water (25.30 g. flower^{-1} and 24.19 g. flower^{-1}), minimum cumulative transpirational loss of water (19.80 g. flower^{-1} and 20.74 g. flower^{-1}) and maximum water balance (+5.50 g. flower^{-1} and +3.45 g. flower^{-1}) followed by 1 mM of silver thiosulfate + sucrose at 5% which was on par with silver nitrate at 100 ppm + sucrose at 5%. Whereas, control recorded minimum cumulative uptake water (18.26 g. flower^{-1} and 17.38 g. flower^{-1}), maximum cumulative transpirational loss of water (21.78 g. flower^{-1} and 22.28 g. flower^{-1}) and minimum water balance (-3.52 g. flower^{-1} and -4.90 g. flower^{-1}). In both the cultivars, citric acid 150 ppm and optimum concentration of sucrose at 5% prevent the plugging

Table 1: Response of cut carnation to different holding solutions on water related attributes

Treatments	CUW (g. flower^{-1})		CTLW (g. flower^{-1})		Water balance (g. flower^{-1})		CPLW (%)	
	Cv. Master	Cv. Yellow candy	Cv. Master	Cv. Yellow candy	Cv. Master	Cv. Yellow candy	Cv. Master	Cv. Yellow candy
T_1- Silver thiosulfate 0.5 mM+5% Sucrose	21.45	21.95	20.95	21.77	+0.50	+0.18	19.54	26.17
T_2- Silver thiosulfate 1.0 mM+5% Sucrose	24.98	23.89	20.10	21.49	+4.88	+2.40	17.49	21.61
T_3- Silver thiosulfate 1.5 mM+5% Sucrose	21.82	21.60	20.59	21.80	+1.23	-0.20	20.58	29.27
T_4- Salicylic acid 100 ppm+5% Sucrose	21.07	19.19	20.83	22.18	+0.24	-2.99	26.32	24.37
T_5- Salicylic acid 150 ppm+5% Sucrose	19.99	18.08	21.39	22.25	-1.40	-4.17	36.32	24.84
T_6- Salicylic acid 200 ppm+5% Sucrose	23.98	22.94	20.21	21.54	+3.77	+1.40	18.48	23.80
T_7- Silver nitrate 100 ppm+5% Sucrose	24.63	23.59	20.16	21.42	+4.47	+2.17	18.10	22.67
T_8- Silver nitrate 150 ppm+5% Sucrose	20.32	19.58	21.08	22.07	-0.76	-2.49	27.17	26.60
T_9- Silver nitrate 200 ppm+5% Sucrose	22.92	18.81	20.54	22.21	+2.38	-3.26	30.55	31.33
T_{10}- Boric acid 100 ppm+5% Sucrose	19.63	20.58	21.28	21.96	-1.65	-1.38	24.34	27.02
T_{11}- Boric acid 150 ppm+5% Sucrose	22.53	17.74	20.48	22.35	+2.05	-4.61	39.68	27.44
T_{12}- Boric acid 200 ppm+5% Sucrose	18.62	20.25	21.68	22.01	-3.06	-1.76	25.53	27.36
T_{13}- Citric acid 100 ppm+5% Sucrose	23.28	20.92	20.33	21.84	+2.95	-0.92	38.14	32.92
T_{14}- Citric acid 150 ppm+5% Sucrose	25.30	24.19	19.80	20.74	+5.50	+3.45	23.29	36.45
T_{15}- Citric acid 200 ppm+5% Sucrose	18.94	22.27	21.48	21.64	-2.54	+0.63	34.23	34.79
T_{16}- Control	18.26	17.38	21.78	22.28	-3.52	-4.90	44.23	38.03
SED	0.31	0.30	0.08	0.07	-	-	-	-
CD (P=0.05)	0.65	0.63	0.18	0.15	-	-	-	-

Table 2: Response of cut carnation to holding solutions on quality related attributes

Treatments	Stem Strength (degrees)				Flower discoloration (days)		Freshness of flower (days)	
	Cv. Master		Cv. Yellow candy		Cv. Master	Cv. Yellow candy	Cv. Master	Cv. Yellow candy
	3rd day	5th day	3rd day	5th day				
T_1- Silver thiosulfate 0.5 mM+5% Sucrose	86.20	60.03	81.16	54.38	7.28	6.96	6.77	6.44
T_2- Silver thiosulfate 1.0 mM+5% Sucrose	88.47	64.72	87.66	62.71	7.81	7.53	7.85	7.65
T_3- Silver thiosulfate 1.5 mM+5% Sucrose	85.57	59.04	75.35	48.16	7.18	6.86	6.02	5.59
T_4- Salicylic acid 100 ppm+5% Sucrose	82.39	53.84	83.61	57.51	6.68	6.28	7.20	6.90
T_5- Salicylic acid 150 ppm+5% Sucrose	77.22	47.70	82.81	56.45	6.07	5.39	7.05	6.78
T_6- Salicylic acid 200 ppm+5% Sucrose	86.84	60.98	84.96	58.54	7.38	7.07	7.33	7.03
T_7- Silver nitrate 100 ppm+5% Sucrose	87.17	62.87	86.11	60.66	7.58	7.28	7.60	7.35
T_8- Silver nitrate 150 ppm+5% Sucrose	81.78	52.81	80.27	53.32	6.58	6.19	6.67	6.31
T_9- Silver nitrate 200 ppm +5% Sucrose	79.93	50.83	73.45	46.01	6.37	5.90	5.70	5.23
T_{10}- Boric acid 100 ppm+5% Sucrose	83.59	55.91	79.31	52.32	6.87	6.53	6.54	6.21
T_{11}- Boric acid 150 ppm+5% Sucrose	75.37	45.62	78.26	51.31	5.69	5.04	6.44	6.07
T_{12}- Boric acid 200 ppm+5% Sucrose	82.99	54.86	77.17	50.26	6.79	6.41	6.32	5.92
T_{13}- Citric acid 100 ppm+5% Sucrose	76.33	46.68	72.70	44.51	5.92	5.22	5.57	5.11
T_{14}- Citric acid 150 ppm+5% Sucrose	84.22	57.01	71.90	41.39	6.96	6.63	5.35	4.83
T_{15}- Citric acid 200 ppm+5% Sucrose	78.07	48.60	71.20	42.95	6.17	5.55	5.46	4.98
T_{16}- Control	74.39	45.02	70.71	40.00	5.55	4.86	5.22	4.67
SED	0.64	0.85	0.74	0.98	0.11	0.12	0.11	0.14
CD(P=0.05)	1.31	1.75	1.52	2.00	0.24	0.26	0.24	0.29

Table 3: Response of cut carnation to holding solutions on TSS and pH of vase solution

Treatments	TSS (°Brix)			pH of vase solution				
	Cv. Master	Cv. Yellow candy		Cv. Master		Cv. Yellow candy		
	3rd day	5th day	3rd day	5th day	3rd day	5th day	3rd day	5th day
T_1-Silver thiosulfate 0.5 mM+5% Sucrose	11.33	7.30	9.81	6.64	4.49	5.06	5.16	5.79
T_2-Silver thiosulfate 1.0 mM+5% Sucrose	11.78	7.81	10.44	7.39	3.29	4.70	3.69	5.28
T_3--Silver thiosulfate 1.5 mM+5% Sucrose	11.26	7.21	9.38	6.06	4.79	5.14	5.97	6.24
T_4- Salicylic acid 100 ppm+5% Sucrose	10.85	6.76	10.05	6.90	5.69	5.52	4.86	5.67
T_5- Salicylic acid 150 ppm+5% Sucrose	10.27	6.12	9.98	6.83	6.58	6.05	5.01	5.75
T_6- Salicylic acid 200 ppm+5% Sucrose	11.41	7.39	10.14	6.98	3.99	4.91	4.54	5.52
T_7- Silver nitrate 100 ppm+5% Sucrose	11.61	7.61	10.29	7.19	3.59	4.81	4.14	5.40
T_8- Silver nitrate 150 ppm+5% Sucrose	10.78	6.67	9.75	6.54	5.81	5.61	5.50	5.92
T_9-Silver nitrate 200 ppm+5% Sucrose	10.57	6.45	9.20	5.87	5.96	5.70	6.33	6.35
T_{10}- Boric acid 100 ppm+5% Sucrose	11.01	6.90	9.70	6.45	5.41	5.37	5.66	6.01
T_{11}- Boric acid 150 ppm+5% Sucrose	10.06	6.00	9.63	6.36	6.85	6.18	5.81	6.09
T_{12}- Boric acid 200 ppm+5% Sucrose	10.91	6.82	9.54	6.30	5.53	5.45	5.94	6.17
T_{13}- Citric acid 100 ppm+5% Sucrose	10.18	6.04	9.10	5.79	6.71	5.95	6.68	6.45
T_{14}- Citric acid 150 ppm+5% Sucrose	11.08	6.97	8.90	5.68	5.04	5.24	6.97	6.54
T_{15}- Citric acid 200 ppm+5% Sucrose	10.34	6.20	8.99	5.73	6.28	5.83	6.83	6.48
T_{16}- Control	9.93	5.88	8.83	5.58	7.00	6.28	7.12	6.59
SED	0.08	0.10	0.07	0.08	0.16	0.05	0.15	0.05
CD(P=0.05)	0.18	0.21	0.16	0.18	0.33	0.12	0.32	0.11

of vascular bundles improved the water uptake. Marousky (1968) reported that sucrose helped in increasing water uptake and decreased the transpiration loss by decreasing stomatal opening thereby maintaining turgidity of flowers. Volume of water uptake was improved with sucrose to the vase solution (Marwe *et al.,* 1986). Patil and Reddy (1999) registered the maximum water uptake in golden rod which support the usefulness as found in the present study. The transpiration loss may be probably due to maintenance of cell integrity by salt and present in the guard cell might reduce the stomatal operture there by resulting in lower cumulative transpirational loss of water. Hence, it has been proved that vase solution with sugar, salt as well as chemicals are very important to minimize water loss but extend of vase life is different parameter to consider. In this context, only distilled water was used as vase solution in control, had higher transpirational loss of water. Azizi *et al.* (2015) reported the lower transpiration loss in cut lisianthus, which supports the findings of the present study. Positive and greatest influence on water balance by citric acid at 150 ppm + sucrose at 5% toward to prevent the deterioration of textures and guarded cells. These effects may be partially attributed by citric acid and sucrose ability to lower water activity. This can be justified by considering above mentioned parameters such as cumulative uptake of water and cumulative transpirational loss of water values obtained could be treated as responsible for the maximum and minimum water balance. This was in accordance with the results obtained by Durkin (1979) in chrysanthemum.

Cumulative physiological loss in weight of carnation cut flowers Cvs. Master and Yellow Candy were significantly reduced by the treatment 1 mM of STS + sucrose at 5% (17.49 % and 21.61 % respectively) followed by silver nitrate 100 ppm +

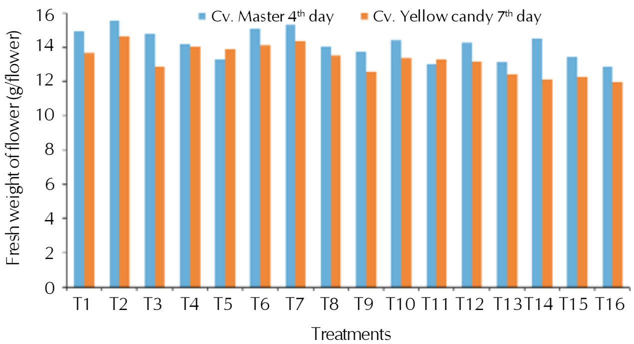

Figure 1: Response of cut carnation to holding solutions on fresh weight of flower

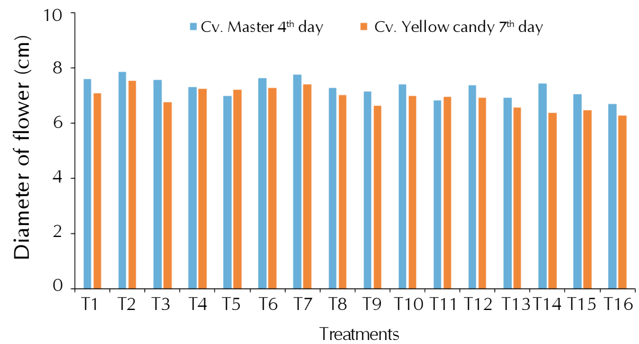

Figure 2: Response of cut carnation to holding solutions on diameter of flower

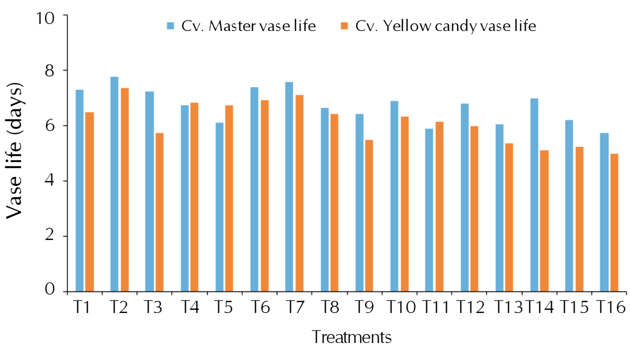

Figure 3: Response of cut carnation to holding solutions on vase life of flower

Figure 4: Best treatments of Cv. Master and Cv. Yellow candy

sucrose 5% (Table 1). The Cumulative physiological loss in weight increased in control (44.23 % and 38.03 % respectively). This might be due to the influence of sucrose and STS on maintenance of mechanical rigidity of flowers by inducing cell wall thickness and lignification of vascular tissues. This was in line with Bharathi *et al.* (2014) in Cymbidium hybrid 'Red Princess'.

Regarding, fresh weight of flower, the stalks of cut carnation Cvs. Master and Yellow Candy held in vase solution containing 1 mM of STS + sucrose at 5% recorded maximum fresh weight on 4th day (15.56 g. flower^{1} and 14.64 g. flower^{1}) followed by silver nitrate 100 ppm + sucrose 5% (15.30 g. flower^{1} and 14.37 g. flower^{1} respectively) while the minimum was recorded by the control T_{16} (5.90 g. flower^{1} and 5.80 g. flower^{1}) at the end of 7th day respectively (Figure 1). The beneficial effect of STS might have acted as antimicrobial agents, apart from STS and sugars acting as an acidifying and anti-ethylene agents resulting in the maximum fresh weight of flower. This findings are in accordance with Chandrashekar and Gopinath (2000), reported that 1 mM of STS + sucrose at 3 % was found to be most effective concentration with respect to maintaining the fresh weight of cut carnation tested.

STS had a positive effect on reducing the percent of flower weight loss in carnation varieties by (Sharma and Bhardwaj, 2015).

The results of investigation presented in Table 2 revealed the stem strength, flower discoloration/fading and freshness of flower were significantly influenced by different holding solutions. The cut carnation Cvs. Master and Yellow Candy held in the vase solution containing 1mM of STS + sucrose at 5% recorded the slowest stem bending on 3rd and 7th day in the treatment T_2 (88.47°and 87.66°); (64.72° and 62.71°), maximum days taken for flower discoloration (7.81 and 7.53 days), maximum days taken for freshness of flower (7.85 and 7.65 days) followed by silver nitrate 100 ppm + sucrose 5% respectively. Whereas, control recorded the fastest stem bending on 3rd and 7th day (74.39° and 70.71°); (45.02° and 40.00°), minimum days taken for flower discoloration (5.55 and 4.86 days), minimum days taken for freshness of flower (5.22 and 4.67 days respectively). In this stem bending context, silver thiosulfate has certain antimicrobial properties, which reduce the degree of vascular blockage, thus allowing for optimum solution uptake and reduced stem bending as well as coupled effect of optimum concentrating of sucrose. These results are in confirmation with Torre and Fjeld (2001) in cut roses. In the flower discoloration context, De *et al.* (1996) reported that optimum concentration of silver thiosulfate along with sucrose in holding solution had beneficial effect on vase life and quality of cut flowers. Pulsing of cut flowers with silver thiosulfate and sucrose inhibited the ethylene synthesis, which has become an essential tool for delaying the senescence of cut flowers and also improves the postharvest quality by Burzo *et al.* (1995) and Wei *et al.* (1997), these results are in confirmation with present investigation. In addition to STS, optimum concentration of sucrose greatly influences on flower freshness by (Khan *et al.,* 2015).

The results of the present study clearly indicated that favourable effect on 1 mM of STS + sucrose at 5% combination was found to extent significant influence in enhancing the diameter of flower up to 4 days and then decrease to certain extend (Figure 2). The greatest diameter (7.85 cm) was exhibited on 4^{th} day after the cut carnation Cv. Master held in vase solution containing 1 mM of STS + sucrose at 5% whereas the lower diameter was exhibited by control (5.98 cm). In this study, we found that increases in diameter during initial period and decreases during later days. The similar trend was found in Cv. Yellow Candy, STS may acted as an antimicrobial agent apart from counteracting the action of ethylene and the same time sucrose might have helped in better uptake of water and served as a source of energy for obtaining greater diameter of cut flowers. Results on flower appearance with the use of silver thiosulphate are in agreement with the findings of LaMasson and Nowak (1981), who observed reduced ethylene synthesis and 'rolling in' and wilting of petals thereby obtained best carnation flower quality. Mineral salts maintained the osmotic pressure of potential of the petal cells thus improving their water balance and quality of cut flower size (Halevy, 1976). The results are also in consonance with the findings by Rezvanypour and Osfoori (2011).

The perusal data pertaining in Table 3 showed that the cut carnation Cvs. Master and Yellow Candy held in vase solution containing 1mM of STS + sucrose at 5% showed maximum total soluble solids (TSS) on 3^{rd} day (11.78 °Brix and 10.44 °Brix respectively) and then gradually decreased on 5^{th} day (7.81 °Brix and 7.39 °Brix respectively). The minimum pH of 3.29 and 3.69 was recorded on 3^{rd} day and then gradually increased on 5^{th} day (4.70 and 5.28). Whereas, minimum total soluble solids (TSS) (9.93 °Brix and 8.83 °Brix) and maximum pH (7.00 and 7.12) was recorded in control on 3^{rd} day. Correlation of sugar starvation and degradation of cellular components is well established. Further, protective and stabilizing influence of STS and sugar in cell membrane may contribute to maintain TSS status in petals by Van Doorn and Woltering (2004), these results are supports the usefulness as found in the present study. This change in pH may be due to specific interaction of vase solution with inherent transport physiology and metabolism of cut flowers. STS act as an antimicrobial agent, which inhibits microbial growth, this might have attributed for low pH which resulted in non-conducive environment for microbial growth.

Cut flowers of both the cultivars *viz.,* Master and Yellow Candy pulsed in 1 mM of STS + sucrose at 5% resulted in obtaining longer vase life (7.76 days and 7.34 days respectively) followed by silver nitrate 100 ppm + sucrose 5% (7.56 days and 7.11 days respectively). Whereas, shorter vase life of cut flowers (5.72 days and 4.96 days respectively) was obtained by control (Figure 3). Prolongation of vase life depended on maintenance of fresh weight, good water balance, improved water uptake and low transpiration loss (Halevy and Mayak, 1981). The ethylene action inhibiting property of STS and sucrose as a source of energy might have helped to get longer vase life of both the cultivars of carnation. Nano silver and sucrose has a positive effect on increasing quality and vase life of cut flowers leaves of Lilium (Vinodh *et al.,* 2013).This result are also in confirmation with Coorts (1973) in cut flowers.

It is concluded that, citric acid at 150 ppm + sucrose at 5% as holding solution significantly influenced on water relation characters *viz.,* cumulative water uptake, cumulative transpirational loss of water and water balance followed by silver thiosulfate 1 mM + sucrose 5% and silver nitrate 100 ppm + sucrose 5%. From the study, we found that influence of water absorbtion characters alone not responsible for the quality improvement and vase life enhancement. The greater importance towards other economic, quality and vase life determining characters. In this context, 1 mM of STS + sucrose at 5% (T_2) showed greatest influences over important characters *viz.,* diameter of flower, fresh weight of flower, cumulative physiological weight in loss and vase life etc, followed by silver nitrate 100 ppm + sucrose 5% (T_7) and salicylic acid 200 ppm + sucrose 5% (T_6) (Figure 4).

REFERENCES

Aldrufew, A., Folch, I. and Canprub, P. 1981. Improving the longevity of bud cut carnations with silver thiosulfate. *Hort. Sci.* **16:** 224-225.

Azizi, S., Onsinejad, R. and Kaviani, B. 2015. Effect of Ascorbic acid on postharvest vase life of cut lisianthus (*Lisianthus grandiflorum* L.) flowers. *ARPN Journal pf agricultural & biological science.* **10(11):** 417-420.

Bharathi, T., Barman, D. and Naik, S. K. 2014. Effect of harvesting stages and chemical preservative on postharvest life of *Cymbidium hybrid* 'Red Princess'. *Society for Plant Research.* **27(1):** 188-194.

Bharathi, T. Usha and Barman, D. 2015. Enhancing the longevity of the Cymbidium Hybrid' Pine Clash moon Venus' through chemical approaches. *The Bioscan.* **10(3):** 973-976.

Burzo, I., Dobrescu, A., Amariujei, A. and Stanica, M. 1995. The exchange of substances between some cut flowers and solutions during vase life. *Acta Horticulturae.* **405:** 101-107.

Chandrashekar, S. Y. and Gopinath, G. 2000. Influence of chemicals on the postharvest quality of carnation cut flowers. *Karnataka J. Agric. Sci.* **14(3):** 791-735.

Coorts, G.D. 1973. Internal metabolic changes in cut flowers. *Hort. Sci.* **8:** 195-198.

De, L. C., Bhattacharjee, S. K. and Misra, R. L. 1996. Postharvest life of pulsed gladiolus spikes as affected by different chemicals. *Journal of Ornamental Hort.* **4:** 18-22.

Durkin, D. J. 1979. Effect of Millipore filteration, citric acid and sucrose on peduncle water potential cut rose flower. *J. Amer. Soc. Hort. Sci.* **104:** 860-863.

Fujino, D. W., Reid, M. S. and Kohl, H. C. 1983. The water relations of maiden hair fronds treated with silvernitrate. *Sci. Hort.* **19:** 349-355.

Gowda, J. V. N. and Gowda, V. N. 1990. Effect of calcium, aluminium and sucrose on vase life of gladiolus. *Crop Res.* **31(1)**:105-106.

Halevy, A. H. and Mayak, S. 1981. Senescence and postharvest physiology of cut Flowers. *Part II. Hort. Rev.* **3**: 59-143.

Halevy, A. H. 1976. Treatment to improve water balance of cut flowers. *Acta. Hort.* **64:** 223-230

He, S., Joyce, D. C., Irving, D. E. and Faragher, J. D. 2006. Stem end blockage in cut Grevillea, Crimso Yullo in inforescences. *Postharvest Biol. Technol.* **41:** 78-84.

Ichimura, K. and Shimizu-Yumoto, H. 2007. Extension of the vase life of cut rose by treatment with sucrose before and during simulates transport. *Bull. Natl. Inst. Flor. Sci.* pp. 17-27.

Khader, A. H. and Rogers, M. N. 1986. Postharvest treatments of Gerbera Jamesonii. Acta Horticulturae, **181:** 169-176.

Khan, P., Shahrin, S., Taufique, T., Mehrj, H. and Uddin, A. F. M. J. 2015. Prolonging vase life of cut rose (*Rosa hybrid* L. Cv. Red pearl) through chemical preservatives. *J, Biosci. Agric. Res.* **5(1):** 10-15.

LaMasson, B. and Nowak, J. 1981. Cut flower life of dry transported carnations as influenced by different silver forms pre-treatments. *Scientia Horticulturae.* **15:** 383-390.

Lemper, J. 1981. Postharvest handling of cut flowers. Land witskammer, Hanover, *German Federal Republic.*

Marousky, F. F. 1968. Influence of 8-HQC and sucrose in extending vase life and improving quality of cut gladiolus. *Proc. Florida State Hort. Sci.* **81:** 409-414.

Marwe, J. J. Vander, Swaradt, G. H. De. and Burge, L. 1986. The effects of sucrose uptake from a vase medium on the starch metabolism of senescing gladiolus inflorescence. *South Agrica J. Bot.* **52(6):** 5415453.

Nair, S. A., Sivasamy, N., Attri, B.L. and Sharma, T. V. R. S. 2000. Effect of natural and chemical floral preservatives on vase life of cut gerbera- a comparative study. *Indian Coconut Journal.* **31(3):** 29-31.

Omar, M. I., Chowdhury, M. M. I., Islam, M. T., Islam, M. R. and Islam, M. 2014. Marketing efficiency and postharvest loss of flower in Bangladesh. *IOSR J. Busi. and Manag.* **16(1):** 45-51.

Panse, U.G. and Sukhatme, P.V. 1978. Statistical methods for agricultural workers. *2nd ed, ICAR, New Delhi.*

Pal, A., Kumar, S. and Srivastava, R. 2003. Effect of floral preservatives on post harvest management in gladiolus spike. *J. Ornamental Hort.* **6(4):** 367-371.

Patil, S. R. and Reddy, S. 1999. Effect of citric acid and vase life on postharvest relations, fresh weight and vase life of golden rod. *Karnataka J. agric. Sci.* **14(2):** 427-430.

Pun, U. K., Rowe, R. N., Rowarth, J., Barnes, M. F., Dawson, C. O. and Heyes, J. A. 1999. Influence of ethanol on Climacteric senescence in five cultivars of carnation. *New Zealand Journal of Crop and Horticultural Science.* **27(1):** 69-77.

Rezvanypour, S. and Osfoori, M. 2011. Effect of chemical treatments and sucrose on vase life of three cut rose cultivars. *Journal of Research in Agricultural Science.* **7(2):** 133-139.

Rule, R. D., Hostead, C. and Past G. 1986. Hydration solution vessels: preservative solutions as pre- shipment in tap and standardized waters. *Acta Hort.* **181:** 195-200.

Sharma, P. and Bhardwaj, S. 2015. Effect of silver thiosulphate, silver nitrate and distilled water on flower quality and vase life of cut carnation flowers. *The Bioscan.* **10(4):** 1483-1487.

Singh, A. K. and Tiwari, A. K. 2002. Effect of pulsing on postharvest life of rose Cv. Doris Rystermann. *South Indian Hort.* **50:** 140-144.

Torre, S. and Fjeld, T. 2001. Water loss and postharvest characteristics of cut roses grown at high or moderate relative air humidity. *Scientia Horticulturae.* **89(3):** 217-226.

Van Doorn, W. G. and Woltering, E. J. 2004. Senescence and programmed cell death: substance or semantics. *J. Exp. Bot.* **55(406):** 2147–2153.

Vinodh, S., Kannan, M. and Jawaharlal, M. 2013. Effect of nano silver and sucrose on post harvest quality of cut Asiatic Lilium Cv. Tresor. *The Bioscan.* **8(3):** 901-904.

Wei, M. G., Zeng, W. and Chen, F. 1997. Regulation of ethylene on senescence of cut chrysanthemum flower. *Journal of Nanjing University.* **20**: 24-29.