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EFFECT OF SILVER THIOSULPHATE, SILVER NITRATE AND DISTILLED WATER ON FLOWER QUALITY AND VASE LIFE OF CUT CARNATION FLOWERS

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ABSTRACT

The present investigation was undertaken during the years 2006-07 and 2007-08 at Model Floriculture Centre, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (Uttarakhand) with carnation genotypes. 16 carnation genotypes were planted in completely randomized block design under low cost polyhouse. These genotypes were also selected for post harvest analysis by using completely randomized block design with treatments as factorial combination of 16 cultivars and 3 levels of different holding solutions (STS, $AgNo_3$ and distilled water). Ferada and Sunrise in distilled water had highest value of days taken to bud opening (5.12 days) whereas Keyar in STS solution (2.63 days) was recorded with minimum value. Flower diameter was found to be maximum (6.41 cm.) with Liberty which exhibited significantly higher diameter than all the genotypes in different holding solutions, while minimum (2.94 cm.) was recorded with Salaya which was at par with Dubesco Rubesco (3.11 cm.). Minimum Percent of flower weight loss was found with Ferato (13.26%) in STS solution which was at par with Tabour, Dark Randevous, Master, Ferada, Liberty, Tabour while maximum percent of weight loss was recorded in Parado Fansi (47.19%) which was at par with Sunrise (44.43%) in distilled water. Maximum amount of solution uptake was recorded with Tabour (36.56 ml) when kept in solution and minimum (11.07 ml) amount of solution was consumed by Sunrise when kept in distilled water. Maximum Vase life was recorded with Ferato(13.90 days) in STS solution which was at par with Tabour (13.64 days) while minimum (5.88 days) vase life was recorded with Cv. Lavender lace in distilled water, which was significantly lesser than all the genotypes in different holding solutions.

INTRODUCTION

Cut flower industry in India is at its nascent stage. Large commercial floriculture units have come up in areas near Bangalore, Pune and Delhi. Carnation (*Dianthus caryophyllus* L.) a member of family Caryophyllaceae is native to the Mediterranean region. Carnation ranks next to Rose and Chrysanthemum in cut flower trade in the world. In India, it is mainly cultivated in the polyhouses or greenhouses. There is a great scope for growing carnations in India for the production of quality cut flowers. Cut flowers, in general, are highly perishable and carnations are no exception. The high perishability of flower renders them vulnerable to considerable post-harvest losses (Bhattacharjee, 1999). Ethylene is mainly responsible for flower senescence, which leads to the death of tissue (Mayak *et al.,* 1977). Hence, to preserve the quality of cut flowers after harvest and to make them resistant to fluctuations in environmental conditions, it is very important to give special treatments to cut flowers after harvest to improve their post harvest quality and vase life. Flower preservatives form a mixture of chemicals which came under categories like sugars, germicides, salt, growth regulators, ethylene inhibitors etc., are mainly recommended. 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 & Barman, 2015). 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.The present investigation was undertaken with following objectives:

Post-harvest behavior of carnation varieties as influenced by chemicals.

Post-harvest evaluation of carnation germplasm on the basis of different chemical solutions

MATERIALS AND METHODS

The present investigation was conducted at post-harvest lab of Department of Horticulture, G. B. Pant University of Agriculture and Technology, Pantnagar. The experiment was subjected to analysis of variance, used Completely Randomized Design (Gomez and Gomez, 1976) with treatments as factorial combination of 16 types of cultivars and 3 levels of different holding solutions with 3 replication and 1 cut stem per replication. The experimental material for the present investigation comprised of 16 carnation varieties (Table 1) which form the part of germplasm collection. These cultivars were procured from Department of Floriculture and Landscaping, University of Horticulture and Floriculture, Nauni, Solan. The harvesting of superior quality of cut blooms at their proper harvesting stage (paint brush stage) was done in the morning hours (8 to 9 a.m.) with the help of secateur. The cut blooms were immediately placed in a bucket, containing water, which was used to bring the flowers to the laboratory. Observation was recorded by keeping the harvested flowers at paint brush stage in holding solution at room temperature. Days taken to bud opening was measured from the day when the cut flower was kept into the holding solution to the stage when flower fully opened were recorded. The equatorial diameter of flower, at two places after maximum opening, was recorded and average of two values was calculated. Volume of solution consumed was calculated by using the formula suggested by Bravo *et al.* (1974).

Volume of solution consumed (ml) = Initial Volume of solution – Final volume of solution at the end of Vase life determination

The percent weight loss was calculated by using the formula

$$\text{Percent fresh weight loss} = \frac{\text{Initial weight - Final weight}}{\text{Initial weight}} \text{X } 100$$

The vase life of cut flower was recorded as per the method suggested by Nowak and Mynett (1979.) The experiment was terminated when the cut flowers showed sign of initial wilting or curling of petals or rolling (Sleepiness) of petals.

The details of treatments are as follows

STS (1mM) + Sugar (40%) + citric acid (200ppm)

$AgNO_3$ (1mM) + Sugar (40%) + citric acid (200ppm)

Distilled water (control)

RESULTS AND DISCUSSION

Data pertaining to pooled over two year (Table 2) showed that irrespective of vase solutions maximum days taken to bud opening was found in Ferada (4.23 days) which was at par with Piax Dover (4.05 days), Sunrise (4.00 days), Verna (3.9 days), Salaya (3.98 days), Deasio (3.92 days) and Sesagri (3.91 days) and minimum with Keyar. Among different holding solutions irrespective of varieties, maximum days (4.55 days) taken to bud opening was in distilled water followed by $AgNO_3$ (3.84 days) and minimum in STS (3.08 days) solution.

A perusal of data pertaining to interaction between holding solutions and varieties presented in Table 2 showed that Ferada and Sunrise in distilled water had highest value for days taken to bud opening (5.12 days) followed by Salaya (4.88 days), Verna and Piax Dover (4.83 days) in distilled water whereas, Keyar in STS solution (2.63 days) was recorded with minimum value (2.63 days). This clearly reveals that minimum days taken to bud opening was found in STS solution and maximum days taken to bud opening was found in distilled water when no preservatives were added. This might be due to the fact that sucrose provides energy for growth and accelerated the opening of flower bud. Sugar content in opening solutions accelerated the opening of carnation flower, resulting in longer flower (Basemer, 1971 and Farnham *et al.*, 1972). Rameshwar (1974) had reported the beneficial effect of sucrose with combination of flower preservatives like 8-HQC. These findings are in conformity with the reports of Halevy and Mayak (1981) and Bravda *et al.* (1974). Lukaszewska (1978) reported that solution containing sucrose (5%), antiseptic (8-HQC) improves gladiolus flower opening. Rameshwar (1974) suggested that aluminium sulphate acts as a better substitute to 8-HQC salt in increasing percentage of bud opening. Opening of gladiolus florets enhanced by 8-HQC and sucrose was also reported by Reddy *et al.* (1993), Suneetha and Kumar (1998) and Singh *et al.* (2000). A perusal of data presented in Table 2 revealed that the maximum flower diameter irrespective of vase solutions was found in Liberty (5.26 cm) which was at par with Dark Randevous (5.14 cm) and Tabour (5.16 cm), while rest of genotypes had significantly lower flower diameter than Liberty, whereas irrespective of varieties, flower diameter was found to be maximum in STS solution (5.46 cm) followed by solutions (5.17 cm). However, flowers kept in distilled water attained lowest flower diameter

Table 1: List of genotypes

S. No.	Cultivars	Colour	Source of procurement
1.	Dubesco Rubesco	Pink	Department of FLS, UHF, Nauni, Solan
2	Verna	Light orange	,,
3.	Salaya	Orange	,,
4.	Ferada	Light yellow with dark pink strips	,,
5.	Piax Dover	Light pink	,,
6.	Lavender Lace	Purple	,,
7.	Sesagri	Light pink	,,
8.	Sunrise	Yellow	,,
9.	Liberty	Yellow	,,
10.	Parado Fansi	Pink	,,
11.	Dark Randevous	Purplish pink with dark pink stripes	,,
12.	Master	Red	,,
13.	Deasio	Pink	,,
14.	Keyar	Pink	,,
15.	Firato	Red	,,
16.	Tabour	Light purple with dark purple strips	,,

Table 2: Effect on days taken to bud opening (days), Flower diameter and amount of solution consumed due to different holding solution (ml) of carnation varieties during pooled over two years

Genotypes	Days taken to bud opening (Days)				Flower diameter (cm)				Amount of solution consumed (ml)			
	D.W.	$AgNO_3$	STS	Mean	D.W.	$AgNO_3$	STS	Mean	D.W.	$AgNO_3$	STS	Mean
Dubesco Rubesco	4.68	3.63	3.02	3.78	3.11	5.00	5.18	4.43	11.57	26.86	24.00	20.81
Verna	4.83	3.79	3.36	3.99	3.25	4.84	5.16	4.42	11.58	26.16	22.63	20.12
Salaya	4.88	3.80	3.27	3.98	2.94	4.99	5.34	4.42	12.04	26.39	22.18	20.21
Ferada	5.12	3.74	3.83	4.23	3.34	5.32	6.01	4.89	12.82	33.30	25.08	23.73
Piax Dover	4.83	4.09	3.24	4.05	3.40	4.81	5.35	4.52	12.57	23.66	21.00	19.07
Lavender Lace	4.44	3.69	2.75	3.62	3.25	4.75	4.80	4.27	12.65	29.41	23.63	21.90
Sesagri	4.60	3.61	3.52	3.91	3.25	5.17	5.19	4.54	12.16	24.01	22.08	19.42
Sunrise	5.12	3.80	3.7	4.00	3.74	5.31	5.37	4.80	11.07	24.63	21.55	19.08
Liberty	4.62	4.02	2.80	3.81	3.96	5.42	6.41	5.26	13.03	34.13	25.58	24.25
Parado Fansi	4.16	4.16	2.83	3.78	3.28	5.10	5.33	4.57	12.87	31.18	26.02	23.36
Dark Randevous	3.91	4.02	2.80	3.57	3.88	5.63	5.92	5.14	12.46	36.30	26.79	25.19
Master	4.10	3.99	3.41	3.83	3.76	5.40	5.85	5.01	11.39	32.98	25.00	23.12
Deasio	4.50	4.06	3.19	3.92	3.83	5.00	4.80	4.54	12.59	25.52	23.83	20.65
Keyar	3.91	3.55	2.63	3.36	3.84	5.07	4.92	4.61	12.16	24.43	21.41	19.33
Ferato	4.55	3.53	2.88	3.65	4.01	5.22	5.85	5.02	12.02	33.21	27.69	24.31
Tabour	4.60	3.92	2.69	3.74	3.90	5.69	5.88	5.16	12.61	36.56	26.92	25.36
Mean	4.55	3.84	3.08	3.82	3.54	5.17	5.46	4.72	12.22	29.30	24.09	21.87
CD (5%)												
Genotype (A)	0.150				0.113				0.44			
Holding solution (B)	0.340				0.262				1.02			
A × B	0.602				0.450				1.77			

Table 3: Effect of different holding solution on flower weight loss (%) and Vase life of carnation varieties during pooled over two years

Genotypes	Flower weight loss (%)				Vase life (Days)			
	D.W.	A_gNo_3	STS	Mean	D.W.	A_gNo_3	STS	Mean
Dubesco Rubesco	31.87 (34.34)	18.30 (25.30)	17.54 (24.75)	22.57 (28.17)	7.89	10.55	12.86	10.43
Verna	27.18 (31.42)	19.83 (26.41)	20.51 (26.92)	22.57 (28.25)	7.24	10.19	11.69	9.71
Salaya	25.42 (30.26)	19.19 (25.98)	18.56 (25.51)	21.05 (27.25)	6.92	9.02	10.41	8.78
Ferada	24.08 (29.30)	14.51 (22.36)	14.12 (22.07)	17.57 (24.57)	8.7	11.3	12.08	10.69
Piax Dover	40.71 (39.63)	19.06 (25.87)	18.19 (25.24)	25.99 (30.24)	7.79	9.27	10.49	9.18
Lavender Lace	35.54 (36.56)	18.85 (25.72)	18.32 (25.32)	24.23 (29.20)	5.88	8.58	10.03	8.16
Sesagri	33.72 (35.29)	19.40 (26.12)	17.89 (24.98)	23.67 (28.80)	8.16	9.97	11.5	9.88
Sunrise	41.79 (44.43)	18.36 (25.37)	18.84 (25.72)	27.21 (30.96)	8.39	10.58	11.67	10.21
Liberty	29.54 (32.88)	15.47 (23.16)	15.98 (23.55)	20.33 (26.53)	8.96	11.8	13.67	11.48
Parado Fansi	47.19 (43.38)	18.36 (25.35)	18.48 (25.45)	28.01 (31.39)	7.44	9.36	11.02	9.27
Dark Randevous	25.90 (30.58)	15.48 (23.16)	14.80 (22.62)	18.73 (25.45)	9.16	12.27	13.93	11.79
Master	29.24 (32.66)	14.48 (22.35)	14.92 (22.70)	19.55 (25.91)	9.22	11.13	13.12	11.16
Deasio	34.99 (36.25)	19.37 (26.10)	18.45 (25.42)	24.27 (29.26)	7.7	9.05	11.11	9.28
Keyar	40.21 (39.35)	20.22 (26.70)	19.28 (26.04)	26.57 (30.70)	7	8.61	10.45	8.69
Ferato	29.49 (32.89)	14.95 (22.74)	13.26 (21.35)	19.24 (25.66)	8.97	12.13	13.94	11.68
Tabour	24.06 (29.28)	15.41 (23.10)	13.84 (21.83)	17.77 (24.74)	9.41	12.75	13.69	11.95
Mean	32.72 (34.74)	17.38 (24.74)	17.06 (24.34)	22.45 (27.94)	8.05	10.41	11.98	10.15
CD (5%)								
Genotype (A)	1.17 (0.76)				0.2			
Holding solution (B)	2.72 (1.75)				0.47			
A × B	4.71 (3.04)				0.81			

*Figure in parenthesis is angular transformed value

(3.54 cm).

The interaction effect of holding solutions and varieties was found to be maximum (6.41 cm) with Liberty which exhibited significantly higher diameter than all the genotypes in different holding solutions, while minimum (2.94 cm) was recorded with Salaya which was at par with Dubesco Rubesco (3.11 cm) and significantly lower than rest of genotypes in different vase solutions. Greater diameter of flowers was observed in STS solutions for cv. Liberty, Dark Randevous and Tabour while lowest diameter of flower was recorded in distilled water for cv. Salaya, Dubesco Rubesco, Lavender Lace and Sesagri. 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 beneficial effects of cobalt (Gowda and Gowda, 1990; Murali and Reddy, 1990; Gowda and Murthy, 1993), (Venkatarayappa *et al.*, 1981; Murali and Reddy, 1990 and Gupta *et al.,* 1993 ;) and 8-HQC (Larsan and Scholes, 1966; Marousky, 1969; Lal *et al.,* 1990 and Singh *et al.,* 2000) was also reported on floret size of gladiolus.

A study (Table 2) revealed that maximum uptake of solution was found in cultivar Tabour (25.36 ml) irrespective of vase solutions, followed by Dark Randevous (25.19 ml) while minimum uptake of solution was found in var. Piax Dover (19.07 ml) followed by Keyar (19.33 ml). Among different vase solutions irrespective of varieties maximum (29.30 ml) solution was consumed by flowers when kept in $AgNO_3$ solutions and minimum (12.22 ml) in distilled water.

The interaction effect of vase solutions and cultivars was found that maximum amount of solution uptake was recorded with Tabour (36.56 ml) when kept in solution which was significantly higher than all the genotypes, kept in different holding solutions. Minimum (11.07 ml) amount of solution was consumed by Sunrise when kept in distilled water which was at par with Master (11.39 ml), Dubesco Rubesco (11.57 ml), Verna (11.58 ml), Ferato (12.02 ml), Salaya (12.04 ml), Sesagri (12.16 ml), Dark Randevous (12.46 ml), Tabour (12.61 ml), Deasio (12.59 ml), Piax Dover (12.57 ml) and Lavender Lace (12.65 mL) in distilled water. The present study revealed that maximum uptake of solutions was found in cv. Tabour in solution whereas it was the minimum in distilled water. Variation in solution uptake might be due to disturbance in transpiration pool, bacterial and fungal species gaining predominance in vase solution (Destigter and Broekhuysen, 1986a). 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). Beneficial effect of partial closure of stomata has also been reported with aluminium (Schnable, 1976) and cobalt (Reddy and Nagarajaiah, 1988; Venkatarayappa *et al.,* 1981) and which could be the main reason for retaining water and increasing water uptake. The pooled analysis over two years (Table 3) revealed that lowest per cent weight loss irrespective of vase solutions was found in Ferada (17.57%) which was at par with Tabour (17.77%), Dark Randevous (18.73%) and Ferato (19.24%). Among different holding solutions and irrespective of varieties highest degree of per cent weight loss was found in distilled water (32.72%) and lowest degree in STS solution (17.06%).

A perusal of interaction between vase solutions and genotypes presented in Table 3 revealed that minimum per cent of flower weight loss was found with Ferato (13.26%) in STS solution which was at par with Tabour (13.84%), Dark Randevous (14.80%), Master (14.92%), Ferada (14.12%), Liberty (15.98%), Tabour (15.41%), Liberty (15.47%) and Dark Rendevous (15.48%) in solutions, while maximum per cent of weight loss was recorded in Parado Fansi (47.19%) which was at par with Sunrise (44.43%) in distilled water and significantly higher than rest of varieties in different vase solutions. The decrease in fresh weight at petal senescence might be due to the reduced level of starch, cell wall polysaccharides, proteins and nucleic acid (Matile and Winkenbach, 1971). Ethylene induces rapid hydrolysis of storage materials due to which heavy weight loss during senescence was noticed in cut flowers held in distilled water, whereas, antiethylene solution significantly reduced the weight loss during senescence by checking ethylene induced hydrolysis. Halevy and Mayak (1981) observed more weight loss in vase water, having no preservative. They opined that it might be due to very low concentration of macromolecules in water as compared to the preservative solutions with added sugars, which not only retarded the fresh weight losses, but also increased longevity of cut flowers. Since, vascular blockage is an enzymatic phenomenon, STS and might act as enzyme inhibitor in reducing physiological plugging. The data presented in Table 3 showed that cut blooms of 'Tabour' irrespective of holding solutions lasted for longer duration (11.95 days) in the vases, which was at par with Ferato (11.68 days), Liberty (11.48 days) and Dark Randevous (11.79 days). Among different holding solutions, irrespective of varieties, maximum vase life was observed with STS solution (11.98 days) followed by solution (10.41 days), whereas, minimum (8.05 days) vase life was recorded in control (distilled water).

It is evident from interaction between different holding solutions and genotypes (Table 3) that maximum vase life was recorded with Ferato (13.94 days) in STS solution which was at par with Tabour (13.69 days), Dark Randevous (13.93 days), Liberty (13.67 days) and Master (13.12 days) in STS solution while minimum (5.88 days) vase life was recorded with cv. Lavender Lace in distilled water, which was significantly lesser than all the genotypes in different holding solutions. Beyer (1976) suggested that the ability of silver to block specifically the action of ethylene was due to silver substitution for copper, a metallic receptor site for ethylene. Silver applied as silver thiosulphate complex, completely blocked the ethylene surge normally preceding the onset of senescence in carnation (Veen, 1979a). By blocking the ethylene action, the silver inhibited the ACC content (Veen and Kwakkenbos, 1983) and rise in respiration of carnation flowers (Veen, 1979b). Since silver nitrate is relatively immobile in stems of flowers (Veen and Van de Geijn, 1978). It could increase longevity of cut flower only by reducing bacterial contamination or to some extent by acting as an antiethylene agent in the wound response on the cut stem surface whereas silver chelated to anionic silverthiosulphate complex is very mobile in plant tissue. It moves very quickly to the floral parts, which are source of high ethylene production (Veen and Van de Geijn, 1978) due to which there was longer vase life of flowers held in STS solution than those held in silver nitrate solution. Nano silver and sucrose has a positive effect on increasing quality and vase life of cut flowers leaves of Lilium. (Vinodh *et al.,* 2013). In general, cut stem held in distilled water experienced water stress early, which might be due to disruption of water column in the flower stem (Rogers, 1973).

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