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Effect of pulsing with sucrose and silver thiosulphate complex on keeping quality of cut peony (*Paeonia lactiflora* Pall.) cv. "Sarah Bernhardt"

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An experiment was carried out on cut flower Peony cv. "Sarah Bernhardt" to study the effect of pulsing with sucrose and silver thiosulphate on vase life and other parameters. In the trial, sucrose at 3 levels of concentration (0.00, 2.00 and 4.00%) and silverthiosulphate (STS) at 4 levels (0.00, 0.50, 1.00 and 2.00 mm) were tested alone as well as in combination. The experiment was laid out in completely randomized design replicated thrice. The sucrose, 4% and STS 1.0 mm individually recorded higher vase life of 8.93 and 9.36 days respectively. Whereas, their combination (Sucrose 4% × STS 1.0 mm) was significantly superior to the rest of combinations in keeping higher water balance and fresh weight resulting in highest vase life of 10.05 days. This was followed by sucrose 4% × STS 0.50 mm and sucrose 2% × STS 1.0 mm recording 9.57 and 9.18 days of vase life respectively.

Key words: Cut peony, pulsing, vase life, water balance, fresh weight.

INTRODUCTION

Peonies are hardy herbaceous or shrubby perennials belonging to genus *Paeonia* and family Paeoniaceae. There are more than 3,000 cultivars and 30 species of peonies (Klingman, 2002). There are 2 main groups of peony i) herbaceous, ii) shrubby or tree peony, both of which are perennial. Among these 2 types, herbaceous peonies are more popular and bloom each year on new shoots arising from the underground crown and die down during winter. Among many species of herbaceous peonies, only a few are commonly cultivated in garden for their attractive bloom viz. *Paeonia officinalis* (common peony), *Paeonia lactiflora* (Chinese peony), *Paeonia wittmmanniana* and *Paeonia mlokosewithhii*. However, the first 2 species have been mainly used for producing modern commercial cultivars of peony. Peonies are priced for their attractive blooms which are highly fragrant and hence wonderful for indoor arrangements. They are long lived, low maintenance, cold tolerant and thus are excellent cut flowers (Post, 1949). The *P. lactiflora* cv. Sarah Bernhardt is robust herbaceous perennial with erect stems, mid-green leaves, and very large, double, fragrant rose-pink flowers, the inner petals are reffled with silvered margins (Brickell, 1996). Sarah Bernhardt captures about 50% of the total dutch auction sales among different peony hybrids (Pertwee, 2000).

The capability and quality of flowers is decided by its hereditary nature but these critical factors can be manipulated to certain extent by developing improved technologies in harvesting, grading, packaging, preshipping treatment, long distance transportation, long term storage facilities and use of flower preservatives and bud opening solutions. In case of peony different

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Plate 1. Commercial stage of harvesting the peony stems (*P. lactiflora* Pall.) cv. "Sarah Bernhardt".

researchers have worked on its postharvest management. Niklova (1972) reported that vase life of cut peony flowers increased by 10% when held in 1.5% sugar with other floral preservatives incomparison to cut peony flowers held in control. Sim et al. (1994) studied the effect of 7 preservative treatments in extending vase life of the cut peony flowers. The best treatment was silverthosulphate (STS) at 50 ppm which extended vase life to 12.2 to 12.4 days. Gast (1997) concluded from the study conducted on vase life evaluation of *Paceonia lactiflora* cv. Sarah Bernhardt, that maximum total vase life (9.3 days) was observed in cut flowers pulsed by STS 1mM and sucrose 5 per cent. Peony flowers treated with pulse of STS and floral preservatives and stored in polythene bags containing absorbent pad with methyl jasmonate resulted in lowest disease incidence, improved open vase life of the flowers (Gast et al., 2001).

Walton et al. (2010) while working carbohydrate dynamics of the cut peony (*P. lactiflora* Pall. cv. Sarah Bernhardt) examined that the rate of starch hydrolysis in the flower buds was more rapid than in those still attached to the plant and concluded that addition of sugars to the vase water could be beneficial and increase vase life. Since the studies on the postharvest management of peony in India especially in Kashmir are meagre thus the present investigation was carried out.

MATERIALS AND METHODS

The investigation was carried out in the Division of Floriculture, Medicinal and Aromatic Plants, SKUAST-K, Shalimar, Srinagar during 2007 to 2008. For experiment uniform, straight, good looking and healthy stems of length 50 cm were selected of peony cv. 'Sarah Bernhardt' at commercial stage of harvesting (calyx loose with outer petals showing true colour) (Plate 1).

The selected stems were harvested in the late afternoon (15 to16 h). The stems brought from the field were precooled in order to remove the field heat in a refrigerator. The precooled stems were trimmed off leaving 2 to 3 leaves/stem and were given a slanting cut to a uniform stalk length of 40 cm. The recutted stems were weighted individually on a monopan balance, labelled and as per plan placed in the pulsing solutions which were prepared before the first half of the day of harvesting stems. The stems were allowed to stand in pulsing solution for 12 hours as per treatment at ambient temperature. The pulsing solution comprised of sucrose at 3 concentration levels (0, 2 and 4 %) depicted in the experiment by the symbols Suc_0 (Control), Suc_1 and Suc_2 respectively and silverthiosulphate (STS) at 4 concentration levels (0.00, 0.50, 1.00 and 2.00 mM) depicted in the experiment by the symbols as STS_0 (Control), STS_1, STS_2 and STS_3 respectively and their interaction (sucrose × STS) effects. The control stems were placed in distilled water. The treatments and control were replicated thrice. After pulsing stems were transferred to borosil glass cylinders of capacity containing distilled water for recording the observations. The experiment was laid out in the laboratory at room temperature (20 ± 2°C) with a relative humidity of 70 ± 5%. The observations were recorded according to the procedure given by Venkatarayappa et al. (1980). Various postharvest parameters were estimated at every two days interval as under:

Water balance (W_b) = (WU - WL)

Fresh weight changes (F_W) = [C + S + F] - [C + S]

WU = Water uptake (g/stem), C = weight of container (g), S = weight of solution (g), WL = water loss (g/stem), FW = fresh weight.

Vase life (day) of flower, were measured from the day of anthesis of the flower bud to the senescence of flower in days

Table 1. Effect of pulsing with sucrose and STS complex solution on daily water balance (g/stem) of cut peony stems.

Treatment	Days after pulsing					Cumulative water balance (g/stem)
	0*	2	4	6	8	
Sucrose (%)						
Suc_0 : 0.00 (Control)	2.89	3.72	2.21	0.72	0.03	9.57
Suc_1 : 2.00	2.94	3.87	2.52	0.96	0.23	10.54
Suc_2 : 4.00	2.97	4.32	3.00	1.56	0.619	12.46
CD (P = 0.05)	0.03	0.02	0.02	0.02	0.01	0.10
SEm±	0.016	0.013	0.009	0.010	0.007	0.053
Silver thiosulphate (mM)						
STS_0 : 0.00 (Control)	2.89	3.22	1.64	0.34	-0.33	7.76
STS_1 : 0.50	2.95	4.21	2.91	1.33	0.52	11.94
STS_2 : 1.00	2.97	4.30	3.00	1.56	0.73	12.56
STS_3 : 2.00	2.93	4.16	2.76	1.103	0.26	11.21
CD (P = 0.05)	0.04	0.03	0.02	0.02	0.01	0. 12
SEm±	0.018	0.015	0.010	0.011	0.008	0.061
Interaction						
$Suc_0 \times STS_0$ (Control)	2.89	2.97	1.13	0.12	-0.56	6.55
$Suc_0 \times STS_1$	2.89	3.97	2.59	0.94	0.27	10.68
$Suc_0 \times STS_2$	2.92	4.03	2.65	1.15	0.45	11.20
$Suc_0 \times STS_3$	2.88	3.93	2.50	0.69	-0.04	9.96
$Suc_1 \times STS_0$	2.88	3.25	1.76	0.29	-0.42	7.77
$Suc_1 \times STS_1$	2.97	4.07	2.86	1.19	0.45	11.54
$Suc_1 \times STS_2$	2.98	4.15	2.91	1.45	0.70	12.19
$Suc_1 \times STS_3$	2.92	4.04	2.55	0.92	0.20	10.64
$Suc_2 \times STS_0$	2.90	3.44	2.05	0.63	-0.03	8.99
$Suc_2 \times STS_1$	3.00	4.61	3.30	1.86	0.85	13.62
$Suc_2 \times STS_2$	3.01	4.73	3.44	2.08	1.04	14.30
$Suc_2 \times STS_3$	2.98	4.51	3.22	1.70	0.62	13.03
CD (P = 0.05)	N.S	0.05	0.04	0.04	0.03	0.21
SEm±	0.032	0.027	0.018	0.020	0.014	0.106

*Observation taken after 12 h pulsing. N.S. = Non-significant.

(Nowak and Mynett, 1985). Data obtained were tested for critical difference among the various treatments under completely randomized block design (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Data on water balance of cut peony stems pulsed for 12 h with sucrose and STS at various concentrations individually and in combination has been taken at 2 days interval. The data recorded on water balance has been presented in Table 1, whereas, trend is shown in Figure 1. The data presented in Table 1 revealed that among the stems pulsed with only sucrose, high cumulative water balance (12.46 g/stem) was recorded with Suc 4% and minimum in control (9.57 g/stem). Data on effect of different STS concentrations on cumulative water balance of cut peony stems depicted higher cumulative water balance (12.56 g/stem) in case of stems treated with STS 1.00 mM followed by STS 0.50 mM (11.94 g/stem). Whereas, minimum overall water balance (7.76 g/stem) was registered by control. The various sucrose and STS concentration interacted significantly in effecting the cumulative water balance of peony stems. The stems pulsed with $Suc_2 \times STS_1$ combination depicted higher overall water balance of 14.30 g/stem followed by $Suc_2 \times STS_1$, $Suc_2 \times STS_3$, $Suc_1 \times STS_2$ and $Suc_1 \times STS_1$ recording 13.62, 13.03, 12.19 and 11.54 g/stem overall water balance respectively. Whereas, the control recorded minimum cumulative water balance of 6.55 g/stem. The sugars help in maintenance of improved water status in cut stems by improving their ability to absorb water thus maintaining turgidity and thereby increase vase life as was reported in the same viz., *P. lactiflora* cv. Sarah Bernhardt by Walton et al. (2010).

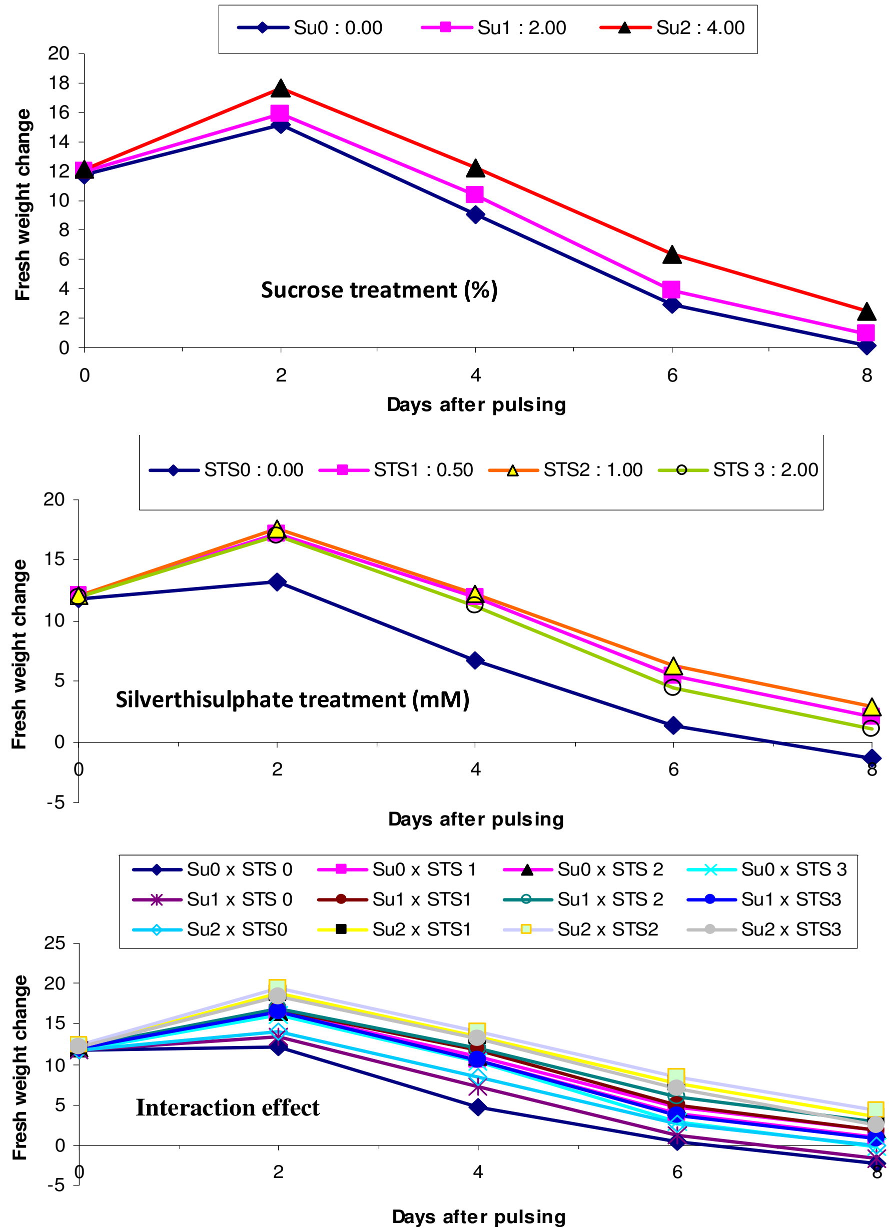

Figure 1. Effect of pulsing with sucrose and STS complex solution on fresh weight change (% of initial FW) of cut peony stems.

STS is ethylene action inhibitor, thus senescence process is delayed and plant metabolism remain in good condition for longer period of time resulting in increased overall water balance (Reid et al., 1980). Sim et al. (1994) and Gast (2001) reported beneficial effects of STS in peony.

The data on fresh weight change of cut peony has been taken at 2 days interval (Table 2) and trend is depicted in Figure 1. The perusal of data revealed that among the stems pulsed with sucrose only higher concentration of sucrose (Suc 4%) maintained superiority in fresh weight gain recording 17.66, 12.28, 6.41 and 2.52 % fresh weight gain of initial fresh weight on 2, 4, 6 and 8 days after pulsing. Data recorded on fresh weight change of the stems treated with STS revealed that STS I mM was most effective in maintaining higher fresh weight followed by STS 0.50 mM and STS 2.00 mM, respectively. The data revealed that STS 1 mM recorded highest fresh weight gain of 17.58, 12.26, 6.35 and 2.97% on 2, 4, 6 and 8 days after pulsing respectively. The data on interaction effect of sucrose and STS on fresh weight gain of cut peony stem revealed that $Suc_2 \times STS_2$ was the most effective treatment combination maintaining superiority throughout the period of

Table 2. Effect of pulsing with sucrose and STS complex solution on fresh weight change (% of initial FW) of cut peony stems.

Treatment	Days after pulsing				
	0*	2	4	6	8
Sucrose (%)					
Suc_0 : 0.00 (Control)	11.81(3.43)	15.22(3.90)	9.07(3.01)	2.95(1.71)	0.12(0.34)
Suc_1 : 2.00	11.98(3.46)	15.85(3.98)	10.31(3.21)	3.92(1.97)	0.94(0.96)
Suc_2 : 4.00	12.12(3.48)	17.66 (4.20)	12.28(3.50)	6.41(2.53)	2.52(1.58)
CD (*P* = 0.05)	0.12	0.10	0.06	0.07	0.06
SEm±	0.060	0.048	0.031	0.036	0.031
Silver thiosulphate (mM)					
STS_0 : 0.00 (Control)	11.80(3.43)	13.17(3.62)	6.75(2.59)	1.41(1.18)	-1.37(-1.37)
STS_1 : 0.50	12.04(3.46)	17.24(4.15)	11.93(3.45)	5.43(2.33)	2.13(1.45)
STS_2 : 1.00	12.11(3.47)	17.58(4.19)	12.26(3.50)	6.35(2.51)	2.97(1.72)
STS_3 : 2.00	11.93(3.45)	16.99(4.12)	11.28(3.35)	4.49(2.11)	1.05(1.02)
CD (*P* = 0.05)	0.14	0.01	0.07	0.09	0.07
SEm±	0.069	0.055	0.036	0.042	0.036
Interaction					
$Suc_0 \times STS_0$ (Control)	11.79(3.43)	12.12(3.48)	4.64(2.15)	0.48(0.69)	-2.27(-2.27)
$Suc_0 \times STS_1$	11.80(3.43)	16.23(4.02)	10.60(3.25)	3.85(1.96)	1.09(1.04)
$Suc_0 \times STS_2$	11.89(3.44)	16.47(4.05)	10.83(3.29)	4.68(2.16)	1.82(1.34)
$Suc_0 \times STS_3$	11.76(3.42)	16.08(4.00)	10.23(3.19)	2.81(1.67)	-0.16(-0.16)
$Suc_1 \times STS_0$	11.77(3.43)	13.32(3.64)	7.21(2.68)	1.19(1.09)	-1.71(-1.71)
$Suc_1 \times STS_1$	12.08(3.47)	16.65(4.08)	11.71(3.42)	4.85(2.20)	1.83(1.35)
$Suc_1 \times STS_2$	12.17(3.48)	16.95(4.11)	11.89(3.44)	5.90(2.42)	2.85(1.68)
$Suc_1 \times STS_3$	11.91(3.45)	16.48(4.05)	10.44(3.23)	3.74(1.93)	0.81(0.90)
$Suc_2 \times STS_0$	11.86(3.44)	14.07(3.75)	8.40(2.89)	2.58(1.60)	-0.13(-0.13)
$Suc_2 \times STS_1$	12.23(3.49)	18.85(4.34)	13.49(3.67)	7.58(2.75)	3.46(1.86)
$Suc_2 \times STS_2$	12.28(3.50)	19.32(4.39)	14.06(3.74)	8.47(2.91)	4.23(2.05)
$Suc_2 \times STS_3$	12.14(3.48)	18.41(4.29)	13.18(3.63)	6.92(2.63)	2.52(1.58)
CD (*P* = 0.05)	N.S	0.20	0.13	0.15	0.13
SEm±	0.121	0.096	0.063	0.073	0.063

*Observation taken after 12 h pulsing.N.S. = Non-significant. Data in parenthesis is square root transformation of original data.

experiment followed $Suc_2 \times STS_1$ and $Suc_1 \times STS_2$, respectively. The $Suc_2 \times STS_2$ combination recorded highest fresh weight gain in whole experiment recording fresh weight gain of 19.32, 14.06, 8.47 and 4.27% on 2, 4, 6 and 8 days after pulsing respectively. The $Suc_0 \times STS_0$ (Control) stems recorded the minimum fresh weight gain in the experiment recording 12.12, 4.64, 0.48 and -2.27 % gain in initial fresh weight on day 2, 4, 6 and 8 days after pulsing. The higher sucrose concentration increase fresh weight in peony in confirmation with the findings of Heuser and Evensen (1986) in herbaceous peony. Gast (1997), Walton et al. (2007, 2010) also reported that elevated levels of sucrose helped to sustain the flowers better in *P. lactiflora* cv. "Sarah Bernhardt" by providing external energy source which gets exhausted after harvesting.

Data recorded on vase life (day) of cut peony stems are presented in Table 3. The perusal of data revealed that among the cut stems pulsed individually with sucrose, higher concentration of sucrose (Suc 4%) was most effective and recorded maximum vase life of 8.93 days followed by Suc 2% (8.01 days). The minimum vase life (7.44 days) was recorded in Suc_0 (Control).

It is quit vivid from the data that all the concentrations of STS proved significantly superior over control in improving vase life of cut peony stems. The higher vase life (9.36 days) was recorded by stems treated with STS 1.00 mM followed by STS 0.50 mM recording vase life of 8.71 days. The minimum vase life (6.53 days) was recorded in STS_0 (control).

The interaction between sucrose and STS was noticed significant in influencing the vase life of cut peony stems. The stems pulsed with Suc 4% × STS 1.00 mM recorded highest vase life of 10.05 days followed by $Suc_2 \times STS_1$

Table 3. Effect of pulsing with sucrose and STS complex solution on vase life (day) of cut peony stems

Treatment	Vase life (day)
Sucrose (%)	
Suc_0 : 0.00 (Control)	7.44
Suc_1 : 2.00	8.01
Suc_2 : 4.00	8.93
CD (P = 0.05)	0.03
SEm±	0.018
Silverthiosulphate (mM)	
STS_0 : 0.00 (Control)	6.53
STS_1 : 0.50	8.71
STS_2 : 1.00	9.36
STS_3 : 2.00	7.91
CD (P = 0.05)	0.04
SEm±	0.021
Interaction	
$Suc_0 \times STS_0$ (Control)	6.17
$Suc_0 \times STS_1$	7.73
$Suc_0 \times STS_2$	8.85
$Suc_0 \times STS_3$	7.02
$Suc_1 \times STS_0$	6.37
$Suc_1 \times STS_1$	8.85
$Suc_1 \times STS_2$	9.18
$Suc_1 \times STS_3$	7.64
$Suc_2 \times STS_0$	7.05
$Suc_2 \times STS_1$	9.57
$Suc_2 \times STS_2$	10.05
$Suc_2 \times STS_3$	9.06
CD (P = 0.05)	0.07
SEm±	0.036

(9.57 days), $Suc_1 \times STS_2$ (9.18 days) and $Suc_2 \times STS_3$ (9.06 dyas). The minimum vase life (6.17 days) was recorded in $Suc_0 \times STS_0$ (Control).

Sindhu et al. (2003) reported that Asiatic lilium hybrid flowers upon pulsing with 10% sucrose and 1.00 mM STS recorded significant increase in vase life. The final stages of lower development on characterized by a decline in the content of carbohydrates and dry weight of petals (Nichols, 1973). Addition of sucrose replaces the depletion of carbohydrates from cut stems and maintains respiratory pool thereby prolongs vase-life (Marousky, 1968). Sim et al. (1994) while working on the cut peony stems of the cultivars Bangerhill and Dakinoyosoumi revealed that pre-treatment with STS extended vase-life of peony stem by reducing the action of ethylene on the flower. The interaction effects combined the positive effects of the sugars and STS in improving vase-life of peony stems as was reported by Gast (1997) in *P. lactiflora* Pall. cv. Sarah Bernhardt which depicted maximum total vase life (9.3 days) in flowers pulsed by STS 1mM and sucrose 5% combination. Elgimabi (2011) also reported positive effects of ethylene action inhibitors and sugars in combination in enhancing vase life of cut roses.It is concluded from the study that the cut peony stems when pulsed with combination of sucrose 4% with STS1.00 mM recorded higher water balance and fresh weight gain resulting in the highest vase life (10.05 days) by the above chemical combination.

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