Zagazig J. Agric. Res., Vol. 42 No. (4) 2015
http:/www.journals.zu.edu.eg/journalDisplay.aspx?JournalId=1&queryType=Master

IMPROVING THE KEEPING QUALITY OF SWEET PEA CUT FLOWERS BY NANO SILVER AND SOME OTHER PRESERVATIVE SOLUTIONS

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ABSTRACT

This research was carried out at Hort. Res. Inst. During 2012 and 2013 seasons.The aim of this study was to investigate the effect of some chemical preservatives (STS, Nano Ag^+, Neem and Norbornadiene) solutions on each of improve keeping quality,enhance water uptake, delay leaf wilting and extend the shelf life period of sweet pea flowers. Mostly, treatments under this study, improved flowers quality and increased vase life of sweet pea cut flowers as compared to control treatment. The longest vase life (13 and 13.67 days, in both seasons) of sweet pea cut flowers was obtained by pulsing flowers in Nano Ag^+ ($8x10^3$) at 10 ml/l for 1 hr., then transfered to hold in vase solution (5% sucrose + 200 ppm 8-HQS + 150 ppm citric acid) to complete their shelf life duration. Moreover, this treatment recorded higher rate for daily fresh weight (%), daily solution uptake (g/flower), total chlorophyll (mg/g f.w.) and reduced sugars (%). In this regard, treatments can be arranged in descending order *i.e.*, Nano Ag^+ ($8x10^3$) at 10, 5 and 1 ml/L > STS for 15,10 and 5 min > Norbornadiene (NBD) at 2,5 and 10 ml/l > Neem at 2, 5 and 10 ml/l. The fresh weight was gradually increased up to the 6^{th} day then decreased. However, water uptake increased up to the 3^{rd} day then gradually decreased. The flower opening (%) increased with extending their shelf life periods up to 12^{th} day. Dipping flowers in Neem (azal /t 5% Azedirachtin) at 2 and 5cm/l for 1hr., then holding in vase solution recorded high level of flower opening (%) and carotenoids in leaves of sweet pea cut flowers.

Key words: Sweet pea, nano Ag^+, vase life, norbornadiene.

INTRODUCTION

Sweet pea (*Lathyrus odoratus* L.) is a native to Sicily. It is an annual climbing plant. The flowers are very variable in color in the many cultivars. It is important cut flowers, prized for their aroma and range of colors and exceptional fragrance.

Sweet peas should have five flowers per stem and only one flower open at the time of purchase. Sweet peas are traditionally harvested when the last bud on the stem is about half open. "Bud-stage" flowers are harvested when the petals on the first bud are colored and near full size, but have not yet opened. Avoid bunches with wilting flowers or where buds or flowers have fallen. Sweet peas benefit substantially from anti-ethylene pre- treatments, combined with a sugar pulse, treatment with STS or 1-MCP enables these delicate flowers to be harvested at an earlier stage when the flowers are less susceptible to damage, and to give as much as a week of display life (Reid, 2013). However, cut flowers of sweet pea have short longevity, and so preservatives such as silver thiosulfate complex (STS) have to be used immediately after cutting. Ikeura *et al.* (2012) reported that treatment with STS in combination with sucrose is more effective in improving postharvest life than with either STS or sucrose alone. Many studies have mentioned the

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important of Nano silver (Ag^+) particles as an anti-bacterial agent, (Alt *et al.*, 2004; Lok *et al.*, 2007). The anti-bacterial activities of NS are related to their size with higher surface to volume ratio and increased percentage of atoms at the grain boundaries (Raffi *et al.*, 2008). But little is known about their physiological effect on plants. Lu *et al* (2010) mentioned that cut rose cv "Movie Star" pulse solution treatments for 1hr., with 50-100 mg/l NS solutions extended vase life and suppressed reduction in fresh weight during the vase period. The amounts of water uptake and water loss by the cut flowers decreased due to NS treatment. Norbornadiene behaves as a competitive inhibitor of ethylene action (Bleecker *et al.*, 1987). Also, Sisler and Yang (1984) reported that NBD at 2,000 µ11l doubled the vase life of the carnation cut flowers. Neem azal at 2% extend the vase life, water uptake and good maintenance of fresh weight of carnation cut flower (Chandrashekhar and Gopinath, 2004). Adding chemical preservatives to the holding solution is recommended to extend the shelf life period of cut flowers. All holding solutions must contain essentially sugar and germicides such as 8-hydroxyquinoline sulfate (8-HQS) (Nowak and Rudnicki, 1990)

The aim of this study was to investigate the effect of some chemical preservatives as STS, Nano Silver, Neem and Norbornadiene solutions on each of improve keeping quality, enhance water uptake delay leaf yellowing and wilting and extend the shelf life period of sweet pea (*Lathyrus odoratus* L.) flowers.

MATERIALS AND METHODS

The experiment was conducted in the lab of post-harvest of Ornamental Plants and Garden Design Dept., Hort. Res. Inst., ARC, Egypt, during the two successive seasons of 2012 and 2013.

Plant Material

Sweet pea (*Lathyrus odoratus* L.) belongs to family: Fabaceae. Sweet pea cut flowers were obtained from nurse of Ornamental Plant and Garden Design Dept. Uniform flowers were cut in the early morning. The flowers were cut at the same buds stage with puffy buds 2-3 leaves and 40-45 cm length. The flowers were pre-cooled by placing them in cold distilled water for 30 min to remove the field heat. After that, flowers were re-cut 3 cm from the end of stem. The leaves on the lower third part of the stem were removed also.

Preservative Solutions Treatments

1. Control distilled water (D.W)
2. STS at 1:4 mM for 5, 10 and 15 min
3. Nano silver ($8x10^3$) at 1, 5 and 10 ml/l for 1 hr.
4. Neem (azal /t 5% Azedirachtin) 2, 5 and 10 cm/l for 1 hr.
5. 2,5-Norbornadiene(NBD) at 2, 5 and 10 ml/l for 1hr.
6. All pulsing solution treatments were transferred to holding solution containing 5% sucrose + 200 ppm 8-HQS + 150 ppm citric acid to complete their shelf life duration.

Preparation of silver thiosulphate (STS) solution

STS stocks solutions were prepared according to Gorin *et al.* (1985) as follows: (1) dissolving of 0.079 g. ($AgNO_3$) in 500 ml distilled water [solution 1]. (2) Dissolving of 0.462 g [$Na_2S_2O_3.5H_2O$] in 500 ml distilled water [solution 2], and (3) Solution 1 was gently poured into solution 2 with magnetic stirrer. The final concentration of silver was 0.463 mM.

Preparation of Nano silver

Silver nitrate (Sigma) and trisodium citrate (Sigma) of analytical grade purity were used as starting materials without further purification. The silver colloid was synthesized using a chemical reduction method. All solutions of reacting materials were prepared in distilled water. Silver nanoparticles (12 nm ± 1.2) were prepared by chemical reduction of 3×10^{-3} M of silver nitrate solution using ice-cold 0.1 M of sodium tetra-hydridoborate solution in the presence of polyvinyl pyrrolidone (4%, *W/V*) as a capping agent to prevent particles from aggregation and further growth. The pH of the nanoparticles formed was 7.2 (Amin *et al.*, 2009).

Neem Azal /T (5% Azedirachtin) is formulation natural and biological extracts from neem oil which is found in neem Kernels. Its produced by Trifolio-M-GumbH, Germany.

Experimental design

Thirteen treatments in the present work were arranged in a simple experiment in complete randomized block design. Each treatment had three replicates and each replicate had three flowers. (13 treatments × 3 replicates × 3 flowers/ replicate = 117 flowers. Each flower was placed in graduated cylinder 100 cm holding solution. Flowers were kept under lab conditions for 24 hours, lighted with fluorescent lamps (1000 Lux) at 19 ± 2°C and 60 ± 5% RH (relative humidity).

The following data were recorded:

1. The vase life (days) was determined by the appearance changing color of flowers and wilting of leaves.
2. Flower opening (%) were recorded at 3, 6, 9 and 12 days during the shelf life duration
3. The change in fresh weight (%) of cut flowers after 3, 6, 9 and 12 days during the shelf life duration
4. Solution uptake (cm^3/flower) were recorded at 3, 6, 9 and 12 days, during the shelf life periods.

Chemical determinations

Chemical constituents were determined when control flowers started to show wilting symptoms as will as at the end of the shelf life duration.

1. Reducing sugars (%) in flowers and leaves were recorded after six days from the treatments and at the end of the shelf life periods according to Smith *et al.* (1956).
2. Chlorophyll A and B (mg/g F.W.) in leaves were calorimetrically recorded at the end of the shelf life periods according to the method described by Wettstein (1957).

Statistical Analysis

Collected data were subjected to the statistical analysis according to Thomas and Hill (1978). The treatments means were compared using the least significant difference (LSD) at 5 and 1% levels.

Correlations

The correlations coefficient between the post-harvest characters under this study were done according to Guler *et al.* (2001).The values under 0.4 means weak relationships, and the values between 0.4 and 0.7 means average relationship, but above 0.7 mean strong relationships.

RESULTS AND DISCUSSION

The Vase Life (Days)

Table 1 show that Nano Ag^+ treatments had the highest significant effect on sweet pea cut flower vase life, when compared to the control treatment. The highest Nano Ag^+ concentration (10ml/l) caused the highest significant increase of longevity followed by the lowest one. Nano Ag^+ treatment increased vase life and did not result in any evidential side effects on cut flowers. These results agreed with that obtained by Basiri *et al.* (2011), Chaman *et al.* (2013) on cut carnation, Mortazavi *et al.* (2011), Hatami *et al.* (2013), Jowkar *et al.* (2013) on cut rose flower, Beni *et al.* (2013) on tuberose cut flower and Nemati *et al.* (2013) on lilum cut flower. STS pulsing solution treatments came after Nano Ag^+ treatments, with significant difference when the lower concentration was used, and insignificant effect by using the higher concentration. The pulse application of (STS) was effective in maintaining the vase life of sweet pea cut flowers as was reported by El-Saka (2002) on snapdragon flowers. Pulsing solution containing Norbornadiene at the low concentration (2 ml/l) walk behind all Nano Ag+ and STS treatments. On the opposite side, neem oil treatments was the lower effect. In spite of that, neem oil treatments designated higher effects as compared to the control treatment.

Table 1. Effect of preservative solution treatments on vase life (days) of sweet pea cut flowers in the two seasons, 2012 and 2013

Treatments		1st season	2nd season
Control	(D.W)	7.66 e	8.22 h
STS* for	5 min	11.78 bc	12.11 cd
STS for	10min	11.89 bc	12.55 bc
STS for	15min	12.55 ab	13.22 ab
Nano Ag^+ at	1 ml/l	12.33 ab	12.67 bc
Nano Ag^+ at	5 ml/l	12.33 ab	12.56 bc
Nano Ag^+ at	10ml/l	13.00 a	13.67 a
Neem at	2ml/l	9.78 d	11.11 ef
Neem at	5ml/l	9.78 d	10.44 fg
Neem at	10ml/l	9.33 d	9.78 g
NBD** at	2 ml/l	11.78 bc	12.11 cd
NBD at	5 ml/l	11.22 c	11.56 de
NBD at	10 ml/l	9.78 d	10.44 fg
LSD at	5%	1.01	0.91
LSD at	1%	1.37	1.23

D.W : Distilled water STS*: Silver thiosulphate NBD** : Norbornadeine

The Change in Fresh Weight (%)

Data in Table 2 and Fig. 1 clearly indicate that Nano Ag^+ (10ml/l) recorded the highly significant increase in fresh weight (%). The results were in the same line with Wani *et al.* (2009) on *Asiatic lilium* flowers, Zargarani *et al.* (2012) on gerbera, Beni *et al.* (2013) on tuberose cut flower, Hatami *et al.* (2013) on rose cut flowers. STS, treatments came after Nano Ag^+ treatments, in general. Whereas, Norbornadiene treatments came in the 3rd station after STS and Nano Ag^+. Over and above, Neem oil treatments came late, especially with the highest concentration. In spite of that, Neem oil treatments designated higher effects, as compared to the control treatment.

The Flower Opening (%)

Data in Table 3 and Fig. 2 clearly indicate that flower opening (%) was increased by increasing the time in pulsing solution, to reach the maximum after 12 days. The higher concentration of Nano Ag^+ and the lower of Neem oil (10 ml/l) as well increased the average flower opening percentage when compared to the control and all other treatments .The lower concentration of Neem oil produced the highest flower opening percentage, especially after12 days. These results are in line with those stated by Diab (2007) who indicated that the higher concentrations 2 ml/l. and 3ml/l. neem oil was the more early effective. Nano Ag^+ commonly gave the highest effect when compared to the other two lower concentrations in flower opening (%). STS treatments mostly supervened Nano Ag^+ and lowest neem oil concentration effects on flower opening percentage of sweet pea. These results agreed with the results reported by Ichimura and Hiraya (1999) on cut sweet pea cv "Diana", El-Saka (2002) on cut tuberose Qadri *et al.* (2000) on Dutch iris (*Iris hollandica*), Zhang *et al.* (2001) on cut gentian (*Gentiana triflora*) flowers, and Jowkar and Mohsen (2005) on cut *Narcissus tazetta*.

Norbornadene pulsing treatments at the higher concentration (10ml/l) was more effective in flower opening percentage as compared to the lower concentration .Control treatments gave rise to the lowest level, when compared to all other treatments.

Table 2. Effect of preservative solution treatments on the change of fresh weight (%) of sweet pea cut flowers during the shelf life period (day) on the two seasons(2012 and 2013)

Treatments	The shelf life period (day)							
	1st season				2nd season			
	3rd day	6th day	9th day	12th day	3rd day	6th day	9th day	12th day
Control (D.W)	0.53 g	7.56 f	-1.89 h	-5.4 i	0.60 h	8.73 i	-1.27 e	-4.85 Jh
STS* for 5 min	3.91 a-c	17.34 bc	4.03 b	0.89 cd	4.17 b-d	20.84 bc	4.38 b	1.20 c
STS for 10min	3.99 a-c	17.35 bc	4.08 b	2.13 bc	4.74 bc	21.01 bc	4.41 b	3.20 b
STS for 15min	4.12 ab	18.00 ab	4.17 b	3.47 ab	5.25 ab	21.83 ab	4.55 b	3.93 b
Nano Ag^+at 1 ml/l	2.37 d-f	15.51 c	2.07 cd	-1.80 g	3.04 d-f	17.67 de	3.85 b	-.88 f
NanoAg+ at 5 ml/l	2.88 ef	15.70 c	2.78 de	-2.82 gh	3.25 d-f	18.37 ef	4.00 b	-0.71 g
NanoAg+ at 10ml/l	4.49 a	19.47 a	5.63 a	4.49 a	6.39 a	23.47 a	5.73 a	5.27 a
Neem at 2ml/l	2.21 f	13.28 d	0.99 f	-4.45 hi	2.68 e-g	15.11 g	1.95 cd	-2.56 hi
Neem at 5ml/l	0.73 g	10.05 e	0.77 g	-4.51 i	2.07 fg	12.05 h	1.51 d	-3.60 ij
Neem at 10ml/l	0.76 g	9.33 ef	0.450 gh	-5.11 i	1.41 gh	10.83 hi	1.467 d	-4.85 j
NBD** at 2 ml/l	3.48 b-d	17.04 bc	3.26 c	-1.53 ef	3.70 c-e	20.04 Bd	4.16 b	-.99 de
NBD at 5 ml/l	3.24 c-e	17.01 bc	2.96 c	-1.78 f	3.31 d-f	19.17 ce	4.00 b	-.34 e
NBD at 10 ml/l	2.26 f	13.40 d	1.70 ef	-3.95 hi	2.79 ef	15.40 fg	2.49 c	-2.08 h
LSD at 5%	0.87	1.90	0.71	1.67	0.87	1.90	0.71	1.25
LSD at 1%	1.18	2.57	0.96	2.27	1.18	2.57	0.96	1.70

D.W : Distilled water STS*: Silver thiosulphate NBD** : Norbornadeine

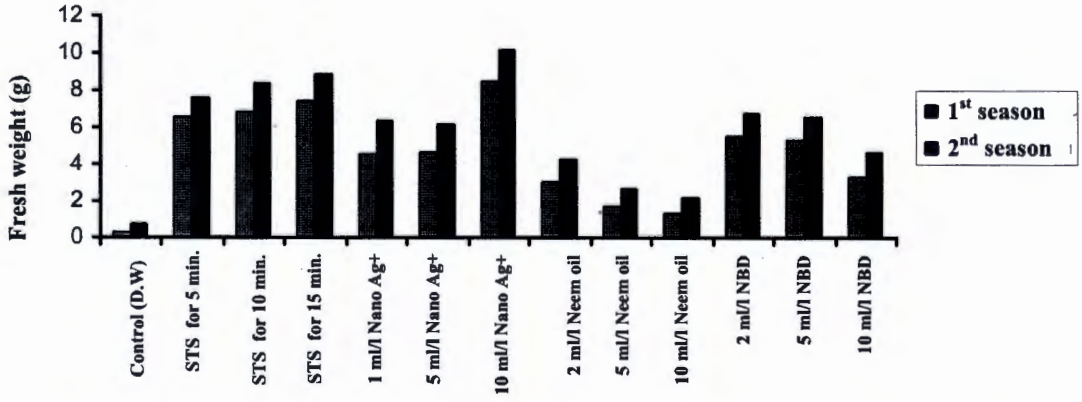

Fig. 1. Effect of preservative solution treatments on the means of the change of fresh weight (%) of sweet pea cut flowers during the shelf life period (days) in the two seasons (2012 and 2013)

Table 3. Effect of preservative solution treatments on flower opening (%) of sweet pea cut flowers during the shelf life period (days) on the two seasons (2012 and 2013)

Treatments		The shelf life period (days)							
		1st season				2nd season			
		3rd day	6th day	9th day	12th day	3rd day	6th day	9th day	12th day
Control	(D.W)	15.00	20.83	40.58	50.28	18.24	21.48	48.52	55.56
STS* for	5 min	17.59	22.5	48.58	73.98	20.83	25.56	52.38	76.67
STS for	10min	18.25	23.61	53.24	74.07	23.61	26.19	55.56	81.76
STS for	15min	20.59	23.61	55.15	80.09	25.56	28.33	60.15	83.80
Nano Ag* at	1 ml/l	15.5	21.48	79.17	82.61	20.83	25.56	83.8	86.63
Nano Ag^+ at	5 ml/l	15.59	21.48	81.76	86.92	23.33	31.11	87.76	87.76
NanoAg^+ at	10ml/l	26.58	41.67	86.8	89.93	31.11	47.62	91.67	96.93
Neem at	2ml/l	29.89	39.01	91.67	91.67	36.89	46.01	93.92	97.5
Neem at	5ml/l	27.55	34.60	86.92	88.19	34.55	41.6	91.67	91.67
Neem at	10ml/l	18.24	20.83	48.72	55.56	21.48	23.33	51.44	57.56
NBD** at	2 ml/l	18.24	31.11	73.11	79.17	21.48	26.19	76.67	84.72
NBD at	5 ml/l	18.24	23.33	72.14	72.14	20.83	26.19	76.22	76.67
NBD at	10ml/l	15.25	21.48	69.64	69.64	20.83	25.56	71.85	72.14

D.W : Distilled water STS*: Silver thiosulphate NBD** : Norbornadeine

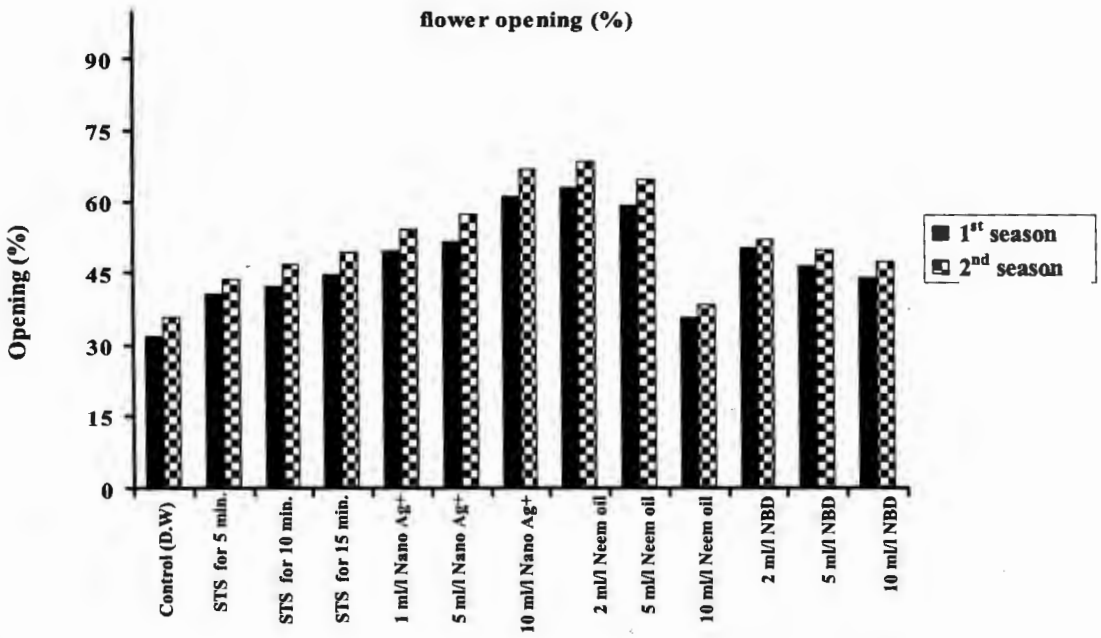

Fig. 2. Effect of preservative solution treatments on the means of flower opening (%)of sweet pea cut flowers on the two seasons (2012 and 2013)

Solution Uptake (Cm^3/Flower)

Data in Table 4 and Fig. 3 clearly indicate that Nano Ag^+ (10/ml/l) recorded the highly significant incremental in solution uptake. In addition, Nano Ag^+ added to vase solutions efficiently prevented vase solution microbial proliferation (Jowkar *et al.*, 2013) on rose cut flowers. Obtained results in this study were in the same line with Wani *et al.* (2009) on *Asiatic lilium* cv, "Elite", Basiri *et al.* (2011) on carnation (*Dianthus caryophyllus*), Zargarani *et al.* (2012), Nazari *et al.* (2011) on gerbera cut flower, Beni *et al.* (2013) on Tuberose cut flower and Hatami *et al.* (2013) on cut rose, indicated that Nano silver treatments improved solution uptake and STS treatment came after Nano Ag^+ treatments. Generally, Norbornadiene treatment came in the 3rd station after STS and Nano Ag^+. Based on the obtained results it is thought that senescence and vase life of cut flowers is closely correlated with solution uptake.

Total Chlorophyll (mg/g f.w.)

Data in Table 5 show that Nano Ag^+ at 10ml/l showed the most effective treatment follow the lower dose walk behind the highest one .STS at the higher dose followed Nano Ag^+ treatments with lesser effects .

Neem oil at the lower dose exhibited the third maen, but with opposite trend. Norbornadiene was the lowest in comparison with all pulsing preservative solution treatments.

Reducing Sugars (%)

The data under discussion in sugars (Table 6) exhibit the effect of pulsing solution treatments *i.e.*, STS (1:4) mM for 5, 10, 15 min ,and Nano Ag^+ at (1, 5, 10) ml/l, neem oil azal., at (2,5,10) ml/l, and Norbornadiene (2, 5, 10) ml/l. on reducing sugars in petal of sweet pea cut flowers. Generally, all pulsing solution treatments increased reducing sugars in flower of sweet pea cut flowers when compared to control after six days from the treatment and at the end of longevity in the two seasons. The pulsing treatments with Nano Ag^+ at 10ml/l, and STS 1:4 mM for 15 min increased reducing sugars in sweet pea petals compared to control and all treatments in the two seasons after 6 days from the treatment and at the end of longevity in the two seasons. These results agreed with that reported by Zargarani *et al.* (2012) on gerbera cut flowers. STS treatments recorded an increase after Nano Ag^+ 10m/l treatment in reducing sugars in sweet pea cut flowers petals compared to control after six days from the treatment and at the end of longevity during two seasons. Pulsing solution in Norbornadiene treatment came after Nano Ag^+ and STS treatments but increased reducing sugar in petals of sweet pea cut flowers when compared to control after six days from the treatment and at the end of longevity during the two seasons. Neem oil treatments came later but also, increased reducing sugar in petals of sweet pea cut flowers when compared to control after six days from the treatment and at the end of longevity during the two seasons. In general, most of pulsing solution treatments increased reducing sugar in the flowers of sweet pea cut after six days from the treatment and at the end of longevity compared to control in the two seasons.

Correlation Coefficients

. The correlation coefficients between vase life, fresh weight, water uptake, flower opening, reducing sugars and total chlorophyll were positively significant (Table 7), which indicated that the increase in water uptake and fresh weight were accompanied by increasing vase life of sweet pea cut flowers under the effect of pulsing solutions that have been used in this study.

Table 4. Effect of pulsing solution treatments on solution uptake (cm^3/flower) of sweet pea cut flowers during the shelf life period (days) on the two seasons, 2012 and 2013

Treatments	The shelf life period (day)							
	1st season				2nd season			
	3rd day	6th day	9th day	12th day	3rd day	6th day	9th day	12th day
Control (D.W)	16.87 g	9.23 f	6.83 f	5.52 e	18.57 de	10.93 g	8.53 h	8.23g
STS* for 5 min	32.12 a-c	16.34 bc	12.24 cd	10.90 c	39.96 bc	22.84 b	19.74 cd	17.73d
STS for 10min	32.71 ac	17.03 bc	13.79bc	12.88 b	41.37 ac	23.69 b	22.13 bc	20.88c
STS for 15min	32.92 ab	18.00 ab	15.38 ab	13.38 ab	42.43 ab	27.17 a	24.54 ab	23.55b
Nano Ag^+ at 1 ml/l	29.34 bc	15.24 c	11.35 d	9.67 cd	36.29 ce	20.83 bc	16.36 ef	12.67e
NanoAg^+ at 5 ml/l	30.96 bc	15.50 cd	11.3 d	9.07d	33.84 de	19.74 cd	16.36 ef	12.02 ef
Nano Ag^+ at 10ml/l	35.877 a	19.47 a	15.52 a	14.91a	46.21 a	29.47 a	25.52 a	25.91 a
Neem at 2ml/l	24.62 de	12.94 e	8.61 e	6.683 e	28.12 fg	16.44e	12.11 g	10.18 fg
Neem at 5ml/l	21.31 ef	10.05 e	7.36 ef	5.25 e	24.31 gh	15.30 ef	10.36 gh	8.25 g
Neem at 10ml/l	18.77 fg	10.03 f	7.36 ef	5.45e	21.27 hi	13.05 fg	9.86 gh	8.52 g
NBD** at 2 ml/l	32.01 ac	15.71 c	11.92 d	10.84 c	9.01 b-d	22.71 bc	18.59 de	16.84 d
NBD at 5 ml/l	31.11 bc	15.67 c	11.53 d	10.62 cd	37.27 b-e	21.84 bc	17.37d-f	16.12d
NBD at 10 ml/l	28.59 cd	13.24 de	11.23 d	7.00 e	2.59 ef	17.23de	15.230 f	11.00 ef
LSD at 5%	4.13	2.08	1.66	1.76	5.23	3.05	2.67	2.07
LSD at 1%	5.59	2.82	2.25	2.38	2.24	7.08	4.33	3.62

D.W : Distilled water STS*: Silver thiosulphate NBD** : Norbornadeine

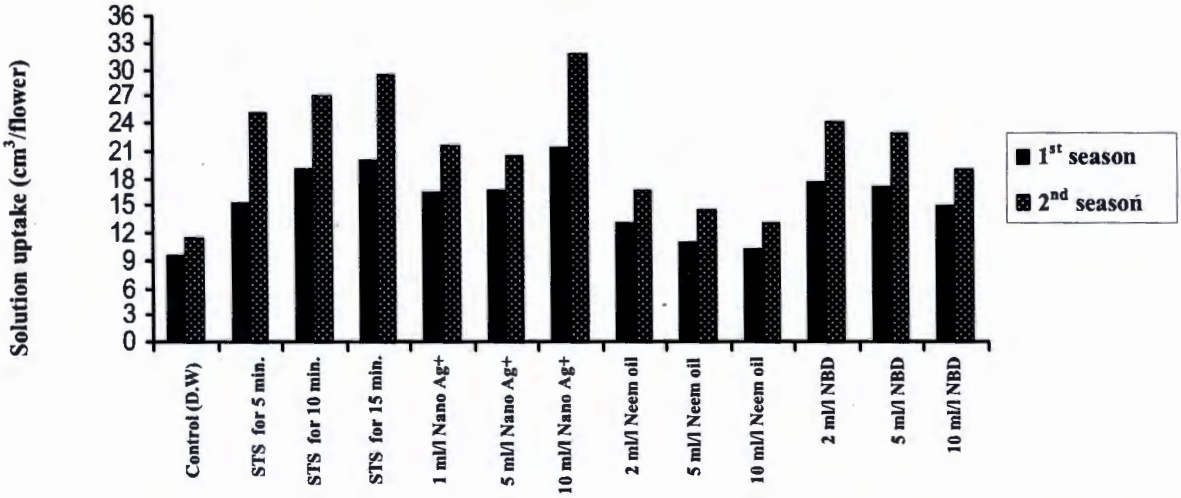

Fig. 3. Effect of preservative solution treatments on solution uptake (cm^3/ flower) during the shelf life period in the two seasons (2012 and 2013)

Table 5. Effect of preservative solution treatments on natural pigment concentration (mg/g f.w.) in leaves of cut flowers sweet pea at the end of longevity in the two season (2012 and 2013)

Treatments		1st season		2nd season	
		Total Chlorophyll	Caro.	Total chl.	Caro.
Control	(W.D)	2.12	1.65	0.82	1.39
STS* for	5 min	2.66	0.80	0.62	0.66
STS for	10min	2.78	0.56	1.87	0.41
STS for	15min	5.17	0.48	4.38	0.09
Nano Ag^+ at	1 ml/l	1.88	2.38	1.24	2.23
NanoAg^+ at	5 ml/l	2.34	2.54	1.60	1.85
Nano Ag^+ at	10ml/l	5.17	0.24	4.39	0.88
Neem at	2ml/l	4.41	1.92	3.62	1.52
Neem at	5ml/l	4.05	0.54	3.26	1.59
Neem at	10ml/l	1.09	2.65	0.43	2.16
NBD* at	2 ml/l	4.45	1.35	2.37	1.55
NBD* at	5 ml/l	1.95	0.30	1.11	1.55
NBD* at	10 ml/l	1.53	0.68	0.04	1.76

D.W : Distilled water STS*: Silver thiosulphate NBD** : Norbornadeine

Table 6. Effect of pulsing solution treatments on reducing sugars(%) in petal of sweet pea cut flowers after 6 days from the treatment and at the end of shelf life in the two seasons (2013 and 2014)

Treatments		1st season		2nd season	
		After 6 days	At the end	After 6 days	At the end
Control	(D.W)	0.22	0.15	0.57	0.18
STS for	5 min	1.12	1.47	1.90	1.62
STS for	10min	2.65	1.37	2.35	1.67
STS* for	15min	2.90	2.017	3.65	2.52
Nano Ag^+ at	1 ml/l	1.57	0.51	1.32	0.72
Nano Ag^+ at	5 ml/l	1.62	0.92	1.92	1.30
Nano Ag^+ at	10ml/l	3.95	2.32	4.77	2.60
Neem at	2ml/l	0.58	0.22	0.57	0.35
Neem at	5ml/l	0.57	0.12	0.47	0.17
Neem at	10ml/l	0.35	0.22	0.47	0.22
NBD* at	2 ml/l	2.85	0.55	1.15	0.72
NBD at	5 ml/l	2.80	0.92	1.10	1.30
NBD at	10 ml/l	1.88	0.15	1.05	0.20

D.W : Distilled water STS*: Silver thiosulphate NBD** : Norbornadeine

Table 7. The correlation coefficient between post harvest characters of sweet pea cut flowers under effect of pulsing solution treatments, on the two seasons (2013 and 2014)

Characters	1st season						2nd season					
	Vase life	Fresh weight	Open flower	Solution uptake	Red. Sugars.	Total Chl.	Vase life	Fresh weight	Open flower	Solution uptake	Red. sugars	Total Chl.
Vase life	------						------					
Fresh weight	0.89	---					0.94	----				
Opening flower	0.26	0.04	--				0.39	0.23	----			
Solution uptake	0.85	0.90	0.19	---			0.90	0.99	0.18	----		
Reducing sugars	0.78	0.79	0.29	0.84	--		0.81	0.85	0.26	0.85	---	
Total Chl.	0.43	0.33	0.74	0.30	0.49	----	0.54	0.40	0.78	0.41	0.15	---

The values< 0.4 means weak relationships , the values between 0.4 : 0.7 mean average relationship and the values > 0.7 mean strong relationships between the different characters.

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تحسين جودة أزهار البسلة المقطوفة باستخدام نانو فضة وبعض محاليل الحفظ الأخرى

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أجرى هذا البحث فى معهد بحوث البساتين خلال عامى ٢٠١٢ و٢٠١٣ بهدف إطالة وحفظ جودة أزهار البسلة المقطوفة لأطول فتره ممكنة، وكان الهدف من هذا البحث هو دراسة تأثير استخدام ثيوسلفات الفضة STS ونانو فضة ومستخلص زيت النيم وكذلك مادة النوربونادين وذلك للحفاظ على جودة الأزهار وإطالة عمرها وتتلخص أهم النتائج فى: زيادة عمر أزهار البسلة المقطوفة ١٣ و١٣,٦٧ يوماً خلال الموسميين ٢٠١٢ و ٢٠١٣ وذلك بالمعاملة بمحلول نانوا فضه ٨x ١٠$^{-٣}$ بمعدل١٠ مل/لتر لمدة ساعة ثم نقلها إلى محلول الفازة (٥% سكروز + ٢٠٠ جزء فى مليون هيدروكسى كينولين سلفات +١٥٠ جزء فى مليون حمض ستريك)، هذه المعاملة سجلت زيادة فى النسبة المئوية للوزن الطازج للأزهار، زيادة فى معدل الامتصاص اليومى للمحلول (جم/زهره)، زيادة الكلورفيل الكلى فى الأوراق، كذلك زيادة النسبة المئوية للسكريات المختزلة، وكان ترتيب المعاملات بالمحاليل كالآتى: نانو فضة ٨ ×١٠ وذلك بمعدل ١و٥ و١٠ مل/لتر، يليها الغمس فى ثيوسلفات الفضة لمدة ٥ و١٠ و١٥ دقيقه، يليها نوربورناديين بمعدل٢و ٥ و١٠ مل /لتر، يليها مستخلص زيت النيم بمعدل ٢ و ٥ و١٠ مل/لتر، كما أظهرت النتائج بصفه عامه زيادة في الوزن الطازج للأزهار بالتدرج حتى اليوم السادس ثم بعد ذلك بداء يتناقص و كذلك زيادة فى حجم المحلول الممتص يوميا حتى اليوم الثالث ثم بداء يتناقص مع زيادة النسبة المئوية للتفتح فى الأزهار حتى اليوم الثانى عشر، غمس الأزهار في النيم بتركيز ٢و٥ مل/لتر لمدة ساعة ثم نقلها إلى محلول الفازة قد حقق زيادة معنوية بمعدل تفتح الأزهار مع زيادة نسبة الكاروتين فى أوراق البسلة المقطوفة.

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