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PHYSIOLOGICAL STUDIES ON POST HARVEST OF *Chrysanthemum morifolium*, L. CV "FLYER" CUT FLOWERS

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ABSTRACT

Chrysanthemum (*Chrysanthemum morifolium,* L.) is one of the most the important cut flower. The aim of this study to investigate the effect of some chemical preservative solutions to improve keeping quality ,enhancing water uptake, delaing leaf wilting and leaf yellowing and extending the shelf life period of cut chrysanthemum flowers .The flowers were held in the vase solution containing silver nitrate at 75ppm + citric acid at 150ppm + sucrose at 3%(T2) or silver nitrate at 75ppm + citric acid at 150ppm + sucrose at 5% (T3) was increased significant vase life (19.5 and 17.2 days, respectively), flower diameter, water uptake ,total soluble sugars % and reducing sugars in leaves , decreased chlorophyll "a" and "b**",** pectin in flowers and leaves and reduced the number of bacteria in the vase solution to zero . Super blue green at1cm/L +Sucrose at 3 or 5% (T 6 &T7) increased vase life in 2nd season . On the other hand, benzyl adenine + citric acid + sucrose (T8, T9 , T10 & T11) treatments didnot enhance vase life and recorded the largest number of bacteria (1163×10^{6}) in vase solution. All holding vase solution treatments gradually increased flower diameter and decreased water uptake with extended shelf life periods. Concerning water balance in treatments T2 ; T3 ; T6 ; T 11 and Potassium Nitrate +150 ppm citric acid + sucrose (T12 , T 13, T14 & T 15) had petter vase life with respect to water balance during the shelf life periods as compared with control and other holding solutions under study. All holding vase solutions recorded gradual decreases in total soluble sugars % in flowers with extending shelf life periods.. In most cases, reducing sugars% gradually increased up to 8th day then decreased after wards.

INTRODUCTION

Chrysanthemum (*Chrysanthemum morifolium*, L.) The new scientific name Dendranthema grandiflora Family :Asteraceae (formerly Compositae), Chrysanthemum is the important cut flower after rose among the ornamental plants trade in the global flower market. Nowak and Rudnicki (1999) mentioned that cut flowers deteriorate for one or more reasons. The most common reasons for early senescence are carbohydrate depletion in respiration, attack by bacteria and fungi, inability of stems to absorb water due to blockage, excessive water loss from the cut flower, flactuating temperatures during storage and transit, color change, accumulation of ethylene and poor water quality. Short vase life is one of the most important reasons for the inability of florists to develop any apprecibale market in Egypt. However, with flowers and foliage that are in good condition, ideal care given to them by the retailer and the customer can easily double their vase life. Flowers which were held in sucrose solutions with 8-hydroxyquinoline sulfate, citric acid and aluminum sulfate recorded the greatest water uptake.

Solutions with 8-hydroxyquinoline sulfate allowed the maintenance of higher rates of fresh weight over a longer period than solutions without. All treatments significantly prolonged vase life(**Patil *et al* ,2001)**. Plant growth regulators are effective on extending flowers´ vase life, by delaying the onset of petal, fading and wilting(**Eason ,2003)** .Salicylic acid and malic acid treatments increased cut flower water absorption, fresh weight and vase life, while decreasing the malondialdehyde content, ACC oxides activity and membrane permeability together with a total delay of senescence and peroxidation of lipids. A direct relationship between vase life and, increasing of fresh weight and water uptake was observed **(Zamani *et al* 2011)**.The longevity of cut flowers was determined from flowering to senescence. The chrysanthemum flower is non- climacteric and therefore ethylene does not appear to play a role in flower senescence, during which only minor changes in both the protein content and the proportion of the major polypeptides were observed. This apparent stability of the protein may contribute to the long postharvest life of chrysanthemum flowers **(Willioms *et al* ,1995**)

The aim of this study to investigate the effect of some chemical preservative solutions to improve keeping quality ,enhancing water uptake and extending the shelf life period of cut chrysanthemum flowers by treatments as holding solutions which may improve flower quality during shelf life. A studying the effects of these treatments on post harvest characters, water relations, some chemical compositions and bacterial counts in vase solution.

MATERIALS AND METHODS

The experiment was conducted in the Lab of Ornamental Plants Hort. Dep., Fac. of Agri., Mansoura Univ., Egypt, during the two successive seasons from2010 -2012. The aim of this study was to investigate the effect of some chemical preservatives solutions on the improving keeping quality ,enhancing water uptake, delaying leaf wilting and leaf yellowing and extending the shelf life period of chrysanthemum flowers

1. Plant material : *Chrysanthemum morifolium*, L. cv " Flyer " family Asteraceae.

Chrysanthemum cut flowers were obtained from a well known commercial orchard at El Mansora, Giza. Uniform flowers were cut in the early morning. The flowers were cut as ¾ of the flowers are fully developed and 80cm length . The flowers were pre-cooled by placing them in acold distilled water for 30 min to remove field heat. After that, flowers were wrapped in wax paper then were transported in ice box to the laboratory during the three hours. After that, were re-cut 5cm from the end of stem. The leaves on the lower third part of the stems were also removed**.**

2. Chemical preservative component:

T.1)Holding flowers in distilled water as control treatment (pH 6.5).

T.2) Holding flowers in75 ppm silver nitrate +150 ppm Citric acid + 3% Sucrose (PH 3.6).

T.3) Holding flowers in 75 ppm silver nitrate +150 ppm Citric acid+5% Sucrose (PH 3.6).

T.4) Holding flowers In 0.5 cm /L Super blue green *+3 % sucrose (pH 5.2).

T.5) Holding flowers in 0.5 cm /L Super blue green* +5 % sucrose (pH 5.2).
T.6) Holding flowers in 1 cm /L Super blue green* +3 % sucrose (pH 5.2).
T.7) Holding flowers in 1 cm /L Super blue green* +5 % sucrose (pH 5.2).
T.8) Holding flowers in 5 ppm benzyl Adenine +150 ppm citric acid + 3 % sucrose (pH 3.6).
T.9) Holding flowers in 5 ppm benzyl adenine +150 ppm citric acid + 5 % sucrose. (pH 3.6).
T.10) Holding flowers in 1 ppm benzyl adenine +150 ppm citric acid +3 % sucrose (pH 3.6).
T.11) Holding flowers in 1 ppm benzyl adenine +150 ppm citric acid +5 % sucrose (pH 3.6).
T.12) Holding flowers in 0.5 g/l potassium nitrate +150 ppm citric acid +3 % sucrose (pH3.6).
T.13) Holding flowers in 0.5 g/l potassium nitrate +150 ppm citric acid+ 5 % sucrose (pH 3.6).
T.14) Holding flowers in 1g/l potassium nitrate +150 ppm citric acid + 3 % sucrose (pH 3.6).
T.15) Holding flowers in1g/l potassium nitrate +150 ppm citric acid + 5 % sucrose (pH 3.6).
T.16) Holding flowers in 150 ppm salicylic acid + 3 % sucrose (pH 4.2).
T.17) Holding flowers in 150 ppm salicylic acid + 5 % sucrose (pH 4.2).

Super blue green ***** :Largest groups of amino acids +organic acid + vitamins + auxines produced from Algae to activate biosynthesis in plant.

The experimental design:

Seventeen 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 four flowers.

17 Treatments × 3 replicates × 4 flowers / replicate = 204 flowers

Each flower was placed in graduated cylinder of 100 cm holding solution. Flowers were kept in different vase solutions under lab conditions for 24 hours, lighted with fluorescent lamps (1500 Lux) at 22 ± 2°C and 60 ± % 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 diameter (cm) as the mean distance between the furthermost circumference petals
3. Water uptake (g / flower) was recorded at 3^{th} , 7^{th} , 11^{th} … days, during the shelf life periods.
4. Water loss (g / flower) calculated as the difference between change in fresh weight of flowers was recorded at 3^{th} , 7^{th} , 11^{th} … days during the shelf life periods.

5. Water balance (water uptake – water loss) was recorded at 3^{th} , 7^{th} , 11^{th} … days, during the shelf life periods.
6. Total, reducing and non-reducing sugars (%) in flowers and leaves was recorded every four days during the shelf life periods according to James (1995).
7. Chlorophyll a and b(_mg/g fw weight) in leaves was recorded every four days during the shelf life periods calorimetrically as described by Morania (1982).
8. Pectin (%): in flowers and leaves was recorded every four days during the shelf life periods was calorimetrically method as described by Ravganna (1979).
9. Bacterial counts (colonies/ml) in vase solution at the end of shelf life periods.

Statistical analysis:

Collected data were subjected to the statistical analysis according to Gomes and Gomes (1984). The treatments means were compared using the least significant difference (L.S.D) at 5 and 1% levels.

Results And Descussion

1. Vase life (days):

The effect of preservative treatments on vase life (days) *of Chrysanthemum morifolium,* L. cv "Flyer" are presented in Table (1). In the 1^{st} season, the vase life was increased highly significant when chrysanthemum cut flower were held in the vase solution containing $AgNO_3$ at 75ppm + citric acid at 150ppm + sucrose at 3%(T2) or $AgNO_3$ at 75ppm + citric acid at 150ppm + sucrose at 5%(T3) (19.5 and 19.7 days, respectively) compared to control (17.2 days) and other holding solutions. In the 2^{nd} season, the cut flowers hold in the vase solution containing Super blue green at 1cm/L+ sucrose at 3% (T6) or Super blue green at 1cm/l+ sucrose at 5% (T7) highly significant increased the vase life (20.5 and 19.7days) respectively compared to control (16.8 days) and other holding solutions . In both seasons conducted that BA + citric acid + sucrose (T8, T9,T10 and T11) treatments didnot enhance vase life of chrysanthemum cut flowers . However, **Eason (2003)** stated that the plant growth regulator is effective on extending Sandersonia vase life, by delaying the onset of petal, fading and wilting. Also, **Hutchinson *et al* (2003)** found that the addition of BA at low concentration (25-50 mg/l) improved the vase life of cut tuberose. Adding $KN0_3$ at 0.5 or 1 g/l to the holding solution containing citric acid at 150 ppm + sucrose at 3 or 5% (T12, T13,T14 & T15) recorded less significance in vase life of chrysanthemum cut flowers as compared to control and other holding solution treatments. Adding salicylic acid to the holding vase solution containing sucrose at 3 or 5%(T16 and T17) didnot extend the vase life, in the 2^{nd} season. Citric acid was most widely used to decrease the pH of vase solution. Citric acid showed a positive effect on increasing the longevity of cut flowers, especially when combined with other chemicals such as sucrose and $AgNo_3$ (**EL-Saka *et al*, 1994 and 2002**). Citric acid was found to be very effective on chrysanthemum cut flowers(**Kofranek and Halevy, 1972**) and pot-marigold and Zinnia cut flowers (**Awad *et al,* 1986)**.

2. Flower Diameter (cm):

Data presentable in Table (1) clearly indicated that all holding vase solution treatments gradually increased flower diameter (cm) with extending the shelf life periods up to 7th day . *Chrysanthemum morifolium* cv " Flyer " hold in vase solution containing $AgNo_3$ at 75 ppm + citric acid at 150 ppm + sucrose acid at 150 ppm + sucrose at 5% (T3) showed significantly increased with flower diameter(cm) during the shelf life periods in both seasons. This result agree **Gendy (2000**) on gladiolus cut flowers .

3. Water uptake, water loss and water balance (g /Flower):

Table (2) shows that flowers hold in vase solution containing , $Ag\ No_3$ at 75 ppm + citric acid at 150 ppm + sucrose at 3% (T2) ; $Ag\ No_3$ at 75 ppm + citric acid at 150ppm + sucrose at 5% (T3) ; KNo_3 at 0.5 g /l + citric acid at 150 ppm + sucrose 3% (T12) ; KNo_3 at 0.5 g /l + citric acid at 150 ppm + sucrose at 5% (T13) ; $K\ No_3$ at 1g/l + citric acid at 150 ppm + sucrose at 3% (T14) and KNo_3 at 1 g/l + citric acid at 150 ppm + sucrose at 5% (T 15) were significantly improved water uptake during the shelf life periods compared to control and other holding solution treatments.

Meanwhile, Table (3) show that the water loss recorded a lower value than water uptake value (up to 7^{th} day) during the shelf life period, then decreased after that day in most cases. Concerning the effect of holding solution treatments on water balance data recorded in Table (4) indicated that holding vase solution treatments T2 ; T3 ; T6 ; T 11 T12 , T 13, T14 & T 15 had better vase life with respect to water balance during the shelf life periods as compared with control and other holding solutions under study . Enhancing water uptake is one of the most factors for extending vase life of cut flowers. Increased water uptake with reduced water transpiration led to the increased in flower fresh weight resulting to improve water balance. **Halevy and Mayak(1979 and 1981)** mentioned that flower turgidity results from the balance between the rate of water uptake and water loss also gains in flower fresh weight that can occur only when the rate of water uptake is greater than the transpiration .

4. Total soluble sugars and reducing sugars (%) **in flowers and leaves:**

Data presented in Table (5) indicated that all holding vase solutions and control treatments recorded gradually decreases in total soluble sugars, reducing sugars % and in petals of chrysanthemum cut flowers with extending shelf life periods. This might be due to their consumption in respiration processes. On the other hand, the data show that no clear trend for total soluble sugars % in petals could be observed between treatments under study.

The effect of preservative vase solution treatments on total soluble sugars % in leaves of *Chrysanthemum morifolium* L. cv " Flyer "is shown (5) . Total soluble sugars % in leaves was significantly increased when cut flowers were held in solution containing $Ag\ No_3$ at 75 ppm + citric acid at 150 ppm + sucrose at 3% (T2) and

$AgNo_3$ at 75 ppm + citric acid at 150 ppm + sucrose at 5% (T3) as compared to control and other holding solution treatments, during the shelf life periods. However, the total soluble sugars gradually decreased in all treatments with extending the shelf life periods .

It was clear from data recorded in Table (5) that cut flowers were held in the vase solution containing Ag No_3 at 75 ppm + citric acid at 150 ppm + sucrose at 5% (T3) recorded a higher significant increase in reducing sugars in leaves compared to control and other holding solutions under this study. In most cases, reducing sugars% gradually increased up to 8^{th} day then decreased after that. The result under discussion pointed out that, a direct relationship occurred between extending vase life of flowers and decreased total and reducing sugars in each of petals and leaves of chrysanthemum . **Paulin (1986)** mentioned that, cut flowers supplied with water die rapidly , since rapid consumption of the reserve sugars exhausts their energetic substrates which are necessary for vital biosynthesis. A supply of exogenous sugar delays the onset of senescence. Exogenous glucose delays proteolysis and promotes protein and amide synthesis. The sugar supply preserves the enzymatic activities.

Furthermore, **Hussain *et al* (2002)** stated that the amount of soluble carbohydrates present in single florets of cut gladiolus increased with floret opening and gradually decreased with senescence; pulsing with 20% sucrose significantly increased the amount of soluble carbohydrates and soluble proteins. **Pandya and Saxena (2003)** found that correlation between carbohydrate content and vase life of chrysanthemum flowers were growing under various light intensities. The total chlorophyll content of leaves increased, whereas the starch content decreased with the reduction in light intensity. The rate of photosynthesis was lower at the flowering stages. The carbohydrate content was higher at the reproductive stage than at the vegetative stage. The total sugar content decreased in all parts of the plants at low temperature. The incorporation of 6% sucrose or glucose solutions improved the quality and vase life of cut flowers. Supplementation with carbohydrate improved the color of petals, increased bud opening, strengthened the pedicels, and extended inflorescence longevity by up to 9 days.

5. Chlorophyll a and b (mg/ g fw) in leaves:

The data described in Table (6) showed that chlorophyll "a" and "b" decreased in leaves of chrysanthemum cut flowers with the advancement of age to be the minimum at 12^{th} day . Flowers in BA +Citric acid +Sucrose(T 8) or KNo_3+ Citric acid +Sucrose (T12) delayed the loss of chlorophyll a & b as compared to other holding solution. This results agree with **Reyes *et al* (2000)** on chrysanthemum, who reported that sucrose (1%) and BA 50 mg/L delayed the loss of chlorophyll in " Tara" (cultivar) and had no effect on " Boaldi" (cultivar)

6. Pectin (%) in flowers and leaves:

It was quite clear from the data in Table (7) that pectin percentage in flowers and leaves of *Chrysanthemum morifolium* , L. cv " Flyer " cut flowers was significantly decreased with extending the shelf life periods , when flowers were treated with Ag No_3 at 75 ppm citric acid at 150 ppm + sucrose at 3% (

T2) and $AgNo_3$ at 75 ppm + citric acid at 150 ppm + sucrose at 5% (T3) compared to control and other treatments .**Gomes *et al* (2010)** stared that the pectin polymers are major components of primary cell walls having a high water-binding ability. Pectin levels and solubility were quantified in stems and petals of rose, chrysanthemum, carnation, and snapdragon and related to the rate of solution uptake and to the rate of fresh weight increase during the vase life of these cut flowers.

7. Bacteria number (cfu) in vase solution:

The results under discussion in Table (8) revealed that *Chrysanthemum morifolium* cut flowers tereated with $AgNo_3$ at 75 ppm + citric acid at 150ppm + sucrose at 3%(T2) and $AgNo_3$ at 75 ppm + citric acid at 150ppm + sucrose at 5%(T3) reduced the number of bacteria to zero in the vase solution as compared to other treatments and control . This is due to enhancing water uptake and vase life of cut flowers. Silver nitrate ($AgNo_3$) can act an antimicrobial .Also, **El.Saka (2002)** mentioned that adding $AgNo_3$ to the holding solution reduced the growth of microbes in a vase and base of the stem. This is due to effect of $AgNo_3$ as a bactericide and negative effect on the growth of microorganisms in vase solution .. BA at 5 ppm + citric acid at 150ppm + sucrose at 3% (T8) recorded the largest number of bacteria (1163×10^6) in the vase solution as compared to other treatments and control. **Macnish *et al*(2008)** stated that, the accumulation of bacteria in vase water was associated with premature senescence in many cut flower species

Table (8): Effect of preservative solutions on bacterial number (cfu) in vase solution at the end of Shelf life periods of *Chrysanthemum morifolium, L*.cv "Flyer " in the second season (2012).

No	Treatments	Bacterial No
T1	Control	730×10^5
T2	75ppm $AgNo_3$+ 15 0 ppm citric acid+3% sucrose	0.0
T3	75ppm $AgNo_3$+ 150 ppm citric acid+5% sucrose	0.0
T4	0.5 cm\L Super blue green +3% sucrose	340×10^6
T6	1 cm\L Super blue green +3% sucrose	630×10^6
T8	5 ppm BA+150 ppm citric acid+3% sucrose	1163×10^6
T12	0.5 g/L KNO_3+150 ppm citric acid+3% sucrose	472×10^6
T16	150ppm Salicylic acid+3% sucrose	583×10^6

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دراسات فسيولوجية على معاملات ما بعد الحصاد لأزها ر الأراولا المقطوفة
" صنف فلير"

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اجرى هذا البحث فى معمل نباتات الزينة بقسم البساتين –كلية الزراعة –جامعة المنصورة خلال عامى ٢٠١١& ٢٠١٢ على أزهار الأراولا المقطوفة ¾ تفتح ومتماثلة فى الحجم والشكل والطول وعدد الأوراق من أحد المزارع التجارية بالمنصورية - محافظة الجيزة .
وكان الهدف من البحث: حفظ و تحسين جودة أزهارالأراولا بعد القطف بإستخدام بعد المواد الكيماوية
1-نترات الفضة (٧٥ جزء/المليون)
٢- سوبر بلو جرين(١ , ٥و ٠ سم/لتر)
٣- بنزيل أدنين(٢,٥ , ٥ جزء/المليون)
٤- نترات البوتاسيوم (١ , ٥و٠ سم/لتر)
٥- حمض الستريك (١٥٠ جزء/المليون)
٦-حمض السالسيلك (١٥٠ جزء/المليون)
٧- السكروز (٣% , ٥ %).
وقد أدت المعاملة بنترات الفضة ٧٥ جزء/المليون + حمض الستريك ١٥٠جزء/المليون + السكروز ٣% أو ٥ % الى زيادة معنوية فى عمر الأزهار بعد القطف وقطر الأزهار حجم الماء الممتص والسكريات الكلية والمختزلة فى الأوراق والأزهار ونقص فى حجم الماء المفقود و الكلوروفيل أ,ب والبكتين فى الأوراق والأزهار وأختزال عدد البكتريا فى محلول الفازة الى الصفر
بالمقارنة بالكنترول ومعظم المعاملات الأخرى .
أدت معاملة السوبر بلو جرين الى اطالة عمر الأزهار فى الموسم الثانى.
أدت معاملات كل من البنزيل أدنين ونترات البوتاسيوم وحمض السلسيلك كان لها تأثير سلبى على معظم الصفات تحت الدراسة ما عدا الكلوروفيل أ,ب مقارنة بالكنترول.
بصفة عامة كان هناك زيادة تدريجية فى قطر الأزهار وحجم الماء الممتص حتى اليوم السابع ثم حدث نقص تدريجى بعد ذلك . كان هناك نقص تدريجى فى السكريات الكلية % وزيادة تدريجية فى السكريات المختزلة % حتى اليوم الثامن فى الأوراق والأزهار.

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Table (1): Effect of preservative solutions on vase life (days) and flower diameter (cm) of *Chrysanthemum morifolium,* L cv " Flyer" during the shelf shelf life periods (days) in the two seasons .

No	Treatments	Vase life (days)		Flower diameter (cm)				
				Shelf life periods (days)				
				1st season			2nd seas	
		1ST season	2nd season	3rd	7th	11th	3rd	7th
T1	Control	17.2	16.8	6.6	7.7	7.3	4.7	6.9
T2	75 ppm $AgNo_3$+ 150ppm citric acid+3% sucrose	19.5	14.5	8.2	7.7	8.3	4.7	6.9
T3	75 ppm $AgNo_3$+ 150ppm citric acid+5% sucrose	19.7	15.7	7.3	8.4	7.9	5.0	6.9
T4	0.5 cm\L Super blue green+3% sucrose	15.1	14.2	7.4	7.7	7.6	4.3	6.6
T5	0.5 cm\L Super blue green +5% sucrose	14.8	15.1	7.2	7.5	7.4	4.5	6.7
T6	1 cm\L Super blue green +3% sucrose	13.2	20.5	6.5	7.5	7.6	4.4	6.6
T7	1 cm\L Super blue green +5% sucrose	13.3	19.7	7.4	6.5	7.5	4.7	6.5
T8	5 ppm BA+150 ppm citric acid+3% sucrose	16.3	17.8	7.4	7.4	7.6	4.5	6.9
T9	5 ppm BA+150 ppm citric acid+5% sucros	17.8	17.2	7.4	7.8	8.1	4.6	6.7
T10	2.5 ppm BA+150 ppm citric acid+3% sucrose	15.2	16.5	7.0	7.5	7.6	4.5	6.7
T11	2.5 ppm BA+150 ppm citric acid+5% sucrose	15.5	16.3	7.1	7.6	7.6	4.7	6.7
T12	0.5 g/L KNO_3+150 ppm citric acid+3% sucrose	12.3	10.5	7.4	7.5	7.9	4.2	6.4
T13	0.5 g/L KNO_3+150 ppm citric acid+5% sucrose	13.0	13.0	6.7	7.5	7.5	4.5	6.4
T14	1 g/L KNO_3+150 ppm citric acid+3% sucrose	11.2	13.3	7.7	7.7	8.2	4.6	6.4

T15	1 g/L KNO_3+150 ppm citric acid+5% sucrose	12.1	14.0	7.3	7.5	7.6	4.5	6.6
T16	150 ppm Salicylic acid+3% sucrose	-	15.2	0.44	0.38	0.39	4.5	6.6
T17	150 ppm Salicylic acid+5% sucrose	-	16.3	0.60	0.51	0.52	4.7	6.7
L.S.D at 5%		1.5	1.8	-	-	-	0.29	0.26
L.S.D at 1%		2.01	2.2	-	-	-	0.39	0.35

Table (2): Effect of preservative solutions on water uptake (g /flower) of *Chrysanthemum morifolium*, L cv " Flyer" during the shelf life periods (days) in the two seasons .

No	Treatments	Shelf life periods (days)					
		1st season			2nd season		
		3rd	7th	11th	3rd	7th	11th
T1	Control	21.3	23.7	24.3	20.3	15.0	12.7
T2	75 ppm $AgNo_3$+ 150ppm citric acid+3% sucrose	31.0	32.3	26.0	18.3	16.7	13.3
T3	75 ppm $AgNo_3$+ 150ppm citric acid+5% sucrose	28.7	27.3	23.3	18.7	17.0	14.3
T4	0.5 cm\L Super blue green+3% sucrose	21.0	13.3	21.0	9.0	15.3	11.3
T5	0.5 cm\L Super blue green +5% sucrose	16.7	15.7	17.3	18.7	5.7	4.7
T6	1 cm\L Super blue green +3% sucrose	29.3	17.0	34.0	19.0	12.0	11.7
T7	1 cm\L Super blue green +5% sucrose	20.7	15.3	16.0	25.3	15.3	14.0
T8	5 ppm BA+150 ppm citric acid+3% sucrose	32.7	24.7	28.7	29.3	21.7	19.0
T9	5 ppm BA+150 ppm citric acid+5% sucros	24.7	20.7	36.0	26.7	26.0	16.7
T10	2.5 ppm BA+150 ppm citric acid+3% sucrose	24.7	17.7	23.0	23.3	30.3	23.3
T11	2.5 ppm BA+150 ppm citric acid+5% sucrose	25.0	18.3	26.7	9.3	18.0	15.7
T12	0.5 g/L KNO_3+150 ppm citric acid+3% sucrose	31.7	31.7	32.3	12.7	6.0	5.0
T13	0.5 g/L KNO_3+150 ppm citric acid+5% sucrose	33.0	22.3	31.0	17.0	10.3	7.3
T14	1 g/L KNO_3+150 ppm citric acid+3% sucrose	33.0	21.3	26.3	7.0	10.3	13.0
T15	1 g/L KNO_3+150 ppm citric acid+5% sucrose	25.3	21.7	24.7	9.3	5.0	4.0

T16	150 ppm Salicylic acid+3% sucrose	-	-	-	15.3	11.3	8.7
T17	150 ppm Salicylic acid+5% sucrose	-	-	-	13.3	9.3	8.0
L.S.D	at 5%	4.48	3.15	6.47	3.55	4.07	2.94
L.S.D	at 1%	6.03	4.25	8.71	4.76	5.47	3.96

Table (3): Effect of preservative solutions on water loss (g /flower) of *Chrysanthemum morifolium*, L. cv " Flyer" during the shelf life periods (days) in the two seasons .

No	Treatments	Shelf life periods (days)					
		1st season			2nd season		
		3rd	7th	11th	3rd	7th	11th
T1	Control	24.8	20.9	22.3	6.1	8.3	8.8
T2	75 ppm $AgNo_3$+ 150ppm citric acid+3% sucrose	32.2	38.7	23.0	14.4	14.1	11.9
T3	75 ppm $AgNo_3$+ 150ppm citric acid+5% sucrose	30.7	32.7	18.3	14.0	14.4	11.5
T4	0.5 cm\L Super blue green+3% sucrose	16.2	22.8	23.9	3.6	8.8	8.8
T5	0.5 cm\L Super blue green +5% sucrose	34.9	32.2	17.8	12.3	13.2	12.7
T6	1 cm\L Super blue green +3% sucrose	6.5	26.0	10.4	12.3	18.2	8.8
T7	1 cm\L Super blue green +5% sucrose	29.3	26.0	31.5	5.8	5.3	5.0
T8	5 ppm BA+150 ppm citric acid+3% sucrose	14.8	15.4	13.8	5.0	5.6	2.5
T9	5 ppm BA+150 ppm citric acid+5% sucros	8.6	14.5	8.8	0.6	0.3	4.9
T10	2.5 ppm BA+150 ppm citric acid+3% sucrose	19.7	14.1	21.4	3.6	0.2	2.4
T11	2.5 ppm BA+150 ppm citric acid+5% sucrose	23.6	32.0	10.4	1.8	3.3	2.1
T12	0.5 g/L KNO_3+150 ppm citric acid+3% sucrose	16.8	25.8	12.0	13.1	13.3	10.8
T13	0.5 g/L KNO_3+150 ppm citric acid+5% sucrose	22.1	15.9	17.3	9.6	7.3	7.5
T14	1 g/L KNO_3+150 ppm citric acid+3% sucrose	21.8	12.8	20.3	9.3	10.6	3.6
T15	1 g/L KNO_3+150 ppm citric acid+5% sucrose	33.4	30.6	31.8	13.6	12.2	10.3
T16	150 ppm Salicylic acid+3% sucrose	-	-	-	5.4	6.9	7.8
T17	150 ppm Salicylic acid+5% sucrose	-	-	-	9.1	11.5	9.4
L.S.D	at 5%	N.S	N.S	N.S	N.S	N.S	N.S
L.S.D	at 1%	N.S	N.S	N.S	N.S	N.S	N.S

Table (4): Effect of preservative solutions on water balance (g /flower) of *Chrysanthemum morifolium*, L. cv " Flyer" during the shelf life periods (days) in the two seasons.

No	Treatments	Water balance (g /flower) during shelf life periods (days)					
		1st season			2nd season		
		3rd	7th	11th	3rd	7th	11th
T1	Control	-3.5	+2.8	+2	+14.3	+6.7	+3.8
T2	75 ppm $AgNo_3$+ 150ppm citric acid+3% sucrose	-1.2	-6.4	+3.0	+3.9	+1.9	+1.4
T3	75 ppm $AgNo_3$+ 150ppm citric acid+5% sucrose	-2	-5.4	+5.0	+4.7	+2.6	+2.8
T4	0.5 cm\L Super blue green+3% sucrose	+4.8	-9.5	-2.9	+15.1	+6.6	+2.5
T5	0.5 cm\L Super blue green +5% sucrose	-18.2	-16.6	-0.5	-3.3	-7.6	-8.0
T6	1 cm\L Super blue green +3% sucrose	+22.8	-9.0	+23.6	+6.4	-6.2	+2.8
T7	1 cm\L Super blue green +5% sucrose	-8.6	-10.7	-15.5	+13.2	+10.0	+9.0
T8	5 ppm BA+150 ppm citric acid+3% sucrose	+17.9	+9.3	+10.2	+20.3	+16.1	+16.5
T9	5 ppm BA+150 ppm citric acid+5% sucros	+16.1	+6.2	+27.2	+28.8	+26.3	+11.8
T10	2.5 ppm BA+150 ppm citric acid+3% sucrose	+5.0	+3.5	+1.6	+23.1	+30.2	+25.8
T11	2.5 ppm BA+150 ppm citric acid+5% sucrose	+1.4	-13.7	+16.3	+21.6	+14.7	+13.6
T12	0.5 g/L KNO_3+150 ppm citric acid+3% sucrose	+14.8	+5.9	+20.4	-3.7	-7.3	-5.8

No	Treatments	Water balance (g /flower) during shelf life periods (days)					
		1st season			2nd season		
		3rd	7th	11th	3rd	7th	11th
T13	0.5 g/L KNO_3+150 ppm citric acid+5% sucrose	+10.9	+6.4	+13.7	+3.1	+3.0	-0.2
T14	1 g/L KNO_3+150 ppm citric acid+3% sucrose	+11.2	+8.5	+8.0	+7.7	-0.3	+9.4
T15	1 g/L KNO_3+150 ppm citric acid+5% sucrose	-8.0	-8.9	-7.1	-6.6	-7.2	-6.3
T16	150 ppm Salicylic acid+3% sucrose	-	-	-	+9.9	+4.4	+0.8
T17	150 ppm Salicylic acid+5% sucrose	-	-	-	+4.3	-2.2	-1.4

Table (5): Effect of preservative solutions on total and reducing sugar (%) in flowers and leaves *Chrysanthemu morifolium*, L.
cv " Flyer" during the shelf life periods (days), in the second season (2012).

No	Treatments	Total sugar			Reducing sugar %		
		Flowers					
		Shelf life periods (days)					
		4^{th}	8^{th}	12^{th}	4^{th}	8^{th}	12^{th}
T1	Control	1.23	1.05	0.73	0.33	0.32	0.25
T2	75ppm $AgNo_3$+ 15 0 ppm citric acid+3% sucrose	1.19	1.27	0.67	0.41	0.41	0.22
T3	75ppm $AgNo_3$+ 150 ppm citric acid+5% sucrose	1.20	1.31	0.83	0.41	0.45	0.25
T4	0.5 cm\L Super blue green +3% sucrose	1.25	1.25	0.75	0.45	0.48	0.22
T6	1 cm\L Super blue green +3% Sucrose	1.20	1.04	1.06	0.33	0.33	0.39
T8	5 ppm BA+150 ppm Citric acid+3% sucrose	1.21	1.05	1.09	0.42	0.41	0.31
T12	0.5 g/L KNO_3+150 ppm Citric acid+3% sucrose	1.25	1.11	1.10	0.37	0.40	0.34
T16	150 ppm Salicylic acid+3% sucrose	1.23	0.97	0.91	0.32	0.30	0.25
L.S.D	at 5%	0.04	0.07	0.09	0.08	0.05	0.07
L.S.D	at 1%	0.06	0.10	0.13	0.11	0.07	0.10
		Leaves					
T1	Control	0.83	0.78	0.61	0.18	0.22	0.18
T2	75ppm $AgNo_3$+ 15 0 ppm citric acid+3% sucrose	1.02	1.04	0.98	0.22	0.22	0.20
T3	75ppm $AgNo_3$+ 150 ppm citric acid+5% sucrose	1.06	1.10	1.12	0.29	0.24	0.30
T4	0.5 cm\L Super blue green +3% sucrose	0.89	0.69	0.65	0.17	0.19	0.21
T6	1 cm\L Super blue green +3% sucrose	1.02	0.82	0.84	0.20	0.22	0.20
T8	5 ppm BA+150 ppm citric acid+3% sucrose	1.06	0.90	0.91	0.19	0.24	0.21
T12	0.5 g/L KNO_3+150 ppm citric acid+3% sucrose	0.96	0.89	1.01	0.22	0.28	0.21
T16	150 ppm Salicylic acid +3% Sucrose	0.72	0.72	0.77	0.18	0.20	0.21
L.S.D	at 5%	0.09	0.06	0.07	0.04	0.04	0.03
L.S.D	at 1%	0.11	0.08	0.10	0.05	0.05	0.05

Table (6): Effect of preservative solution on chlorophyll a & b (mg/g fw) in leaves of *Chrysanthemum morifolium*, L. cv "Flyer" during
the shelf life periods (days) in the two seasons.

No	Treatments	Chlorophyll a mg/g fresh weight			chlorophyll b		
		Shelf life periods (days)					
		4^{th}	8^{th}	12^{th}	4^{th}	8^{th}	12^{th}
T1	Control	0.719	0.619	0.384	0.356	0.348	0.302
T2	75ppm $AgNo_3$+ 15 0 ppm citric acid+3% sucrose	0.666	0.604	0.427	0.366	0.314	0.295
T3	75ppm $AgNo_3$+ 150 ppm citric acid+5% sucrose	0.738	0.673	0.447	0.383	0.379	0.319
T4	0.5 cm\L Super blue green +3% sucrose	0.663	0.564	0.437	0.349	0.338	0.301
T6	1 cm\L Super blue green +3% sucrose	0.718	0.616	0.424	0.342	0.342	0.309
T8	5 ppm BA+150 ppm citric acid+3% sucrose	0.738	0.627	0.418	0.354	0.345	0.333
T12	0.5 g/L KNO_3+150 ppm citric acid+3% sucrose	0.800	0.636	0.421	0.367	0.360	0.344
T16	150ppm Salicylic acid+3% sucrose	0.705	0.607	0.345	0.342	0.324	0.277
L.S.D	at 5%	0.033	0.024	0.021	0.013	0.011	0.011
L.S.D	at 1%	0.046	0.033	0.029	0.018	0.015	0.014

Table (7): Effect of preservative solutions on pectin(%) in flowers and leaves of *Chrysanthemum morifolium*, L. cv " Flyer"
during the shelf life periods (days) in the two seasons

No	Treatments	Pectin(%) in Flowers			Pectin(%) in Leaves		
		Shelf life periods (days)					
		4^{th}	8^{th}	12^{th}	4^{th}	8^{th}	12^{th}

T1	Control	0.45	0.60	0.93	0.50	0.82	1.11
T2	75ppm $AgNo_3$+ 15 0 ppm citric acid+3% Sucrose	0.51	0.42	0.40	0.57	0.51	0.45
T3	75ppm $AgNo_3$+ 150 ppm citric acid+5% Sucrose	0.50	0.44	0.42	0.55	0.55	0.50
T4	0.5 cm\L Super blue green +3% sucrose	0.47	0.78	0.80	0.58	0.66	1.00
T6	1 cm\L Super blue green +3% sucrose	0.43	0.74	0.70	0.44	0.90	0.84
T8	5 ppm BA+150 ppm citric acid+3% sucrose	0.41	0.62	0.65	0.40	0.77	0.81
T12	0.5 g/L KNO_3+150 ppm citric acid+3% sucrose	0.39	0.55	0.57	0.41	0.71	0.71
T16	150 ppm Salicylic acid+3% Sucrose	0.48	0.73	0.74	0.55	0.90	0.96
L.S.D	at 5%	0.03	0.05	0.04	0.03	N.S	0.04
L.S.D	at 1%	0.04	0.07	0.06	0.05	N.S	0.06

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