

**STUDIES ON SOME FACTORS AFFECTING THE VASE LIFE AND QUALITY OF THE CUT FLOWERS OF CARNATION (*Dianthus caryophyllus* L.) AND ROSE (*Rosa hybrida* L.).**

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**ABSTRACT**

Two experiments were carried out on "White Sim" standard carnation and "Dallas" roses, in order to study the effects of ethanol, as an anti-ethylene agent, in comparison to silver salts on the vase life and quality of the cut flowers in the presence or absence of external ethylene source. The experiments were conducted at the Dept. of Plant Production, College of Agric., King Saud University, Saudi Arabia during the two successive seasons 1995 and 1996. Within each season, carnation experiment was conducted twice on 1<sup>st</sup> of March and 1<sup>st</sup> of April, and rose experiment on 1<sup>st</sup> of May and 1<sup>st</sup> of June in each year. Flowers were placed in either deionized distilled water, 4% ethanol, 6% ethanol, 1mM silver nitrate, and 1mM silver thiosulfate (STS) solutions containing zero or 50 ppm ethephon. Flowers were placed inside fully controlled growth chambers under standard conditions of 20°C, 16 hours of 2000 lux fluorescent light, 60 - 70 % relative humidity, and continuous air circulation of low velocity. Data were collected on vase life, fresh weight gain, and average daily solution uptake of the flower.

The results showed that, in the absence of ethephon from the solution, all chemicals improved vase life and quality of both carnation and roses compared with the DI water. In the absence of ethephon, silver nitrate solution gave best results of vase life, maximum weight gain, and solution uptake for both carnation and roses. STS solution ranked second, followed by 6% ethanol, while 4% ethanol ranked fourth in descending order for all previous measurements.

The results also showed that the presence of ethephon in the solution reduced vase life and quality of both carnation and roses, and it was observed that carnation was more affected by ethephon than roses. In the presence of 50 ppm ethephon in the solution, all chemicals improved vase life of cut roses in comparison with DI water containing ethephon, while STS and 6% ethanol were the only two chemicals that improved vase life of cut carnation. In addition, in the presence of ethephon in the solution, STS was the best chemical, followed by 6% ethanol for both "White Sim" carnation and "Dallas" roses.

In this respect, it was concluded that in the absence of external ethylene, at least a part of cut carnation and rose senescence is caused by the effect of internal ethylene produced by the flower tissue. Ethanol is a promising chemical that could be used in flower preservative solutions as an anti-ethylene agent, but further studies are needed before giving recommendations for optimum concentration that could be used for different cut flowers.

## INTRODUCTION

Ethylene causes great losses in vase life and quality of many cut flowers (Halevy and Mayak, 1981; Celikel and Reid, 2002; Ming *et al.*, 1997; Reid *et al.*, 1989). Roses and carnations are two of the most important cut flowers in Egypt as well as in the world. Carnation flowers are very susceptible to ethylene, showing "sleepiness" when exposed to very low concentrations of ethylene in the ambient atmosphere (Baker, 1983). On the other hand, ethylene was involved in postharvest life of cut roses, only when it was present as an atmosphere pollutant, or when its synthesis was stimulated by stress (Reid *et al.*, 1989).

Ethylene may accumulate in the atmosphere surrounding cut flowers as a result of endogenous ethylene or as a consequence of air pollution (Sherman, 1985). One approach to reduce ethylene damage is the use of chemicals that block ethylene synthesis or action (Halevy and Mayak, 1981). Silver ions inhibited ethylene action in plant tissues and thereby reduced senescence and abscission processes induced by ethylene (Veen, 1986). Silver nitrate was very beneficial for air and truck-shipped cut carnations (Halevy *et al.*, 1978). Silver thiosulfate (STS) was used to prevent ethylene-induced senescence and action in carnations and roses (Mor *et al.*, 1981; Mor *et al.*, 1989; Reid *et al.*, 1980; Reid *et al.*, 1989; Serek, 1993; Serek and Reid, 1993; Tjosvold *et al.*, 1994). STS is expensive, relatively difficult to prepare, and potentially harmful heavy-metal environmental contaminant (Altman and Solomos, 1993). Since silver ion was considered environmentally unacceptable, the environmental concerns related to STS need to be addressed, first by care in application and disposal of used material, and second by searching for effective alternatives (Serek and Andersen, 1993; Serek and Reid, 1993). The effect of several chemicals other than silver salts on ethylene have been tested (Altman and Solomos, 1993; Baker *et al.*, 1985; Mor *et al.*, 1989; Naderi *et al.*, 2000; Serek and Andersen, 1993; Serek and Reid, 1993; Weibo *et al.*, 1997). Heins, (1980) reported that ethanol (0.5 % to 4 % v/v), in the holding solution, inhibited climacteric ethylene synthesis and delayed senescence in carnation flowers. In addition, ethanol vapour inhibited conversion of ACC to ethylene in tomato slices (Saltveit and Mencarelli, 1988). The aim of this study was to evaluate the effect of ethanol versus silver nitrate and silver thiosulfate (STS) on vase life and quality of "White Sim" standard carnation and "Dallas" cut roses in the presence and absence of an external ethylene source.

## MATERIALS AND METHODS

Two separate experiments were conducted on the cut flowers of "White Sim" standard carnation and "Dallas" roses. Each experiment was conducted twice within each of the two successive seasons of 1995 and 1996 at the Department of Plant Production, College of Agriculture, King Saud University-Riyadh, Kingdom of Saudi Arabia.

### **Canation**

Freshly harvested carnation flowers *Dianthus caryophyllus* L. cv. "White Sim", produced using standard horticultural practices were obtained from the experimental station greenhouse, King Saud University. Flowers were cut early in the morning, when the centred petals have extended out of the calyx and the outer ones have started to unfold. Flowers were moved quickly to the laboratory where they were kept dry inside black plastic bags over night in the refrigerator at 7° C. In the second morning, flowers were graded according to the size of the flower, appearance, and stem thickness and length. The two lower nodes were stripped of the leaves, and flowers were cut under distilled water at 25 cm length from the flower neck. Flowers were weighed and each flower was placed individually in 200 ml graduated cylinder filled with the designated solution.

Flowers were observed daily, and vase life of carnation flower was terminated when it either lost 5% of its maximum fresh weight; its petals wilted, or showed symptoms of sleepiness.

### **Roses:**

Uniform cut flowers of *Rosa hybrida* L. cv. "Dallas" were obtained from a major greenhouse (Astra) in the Kingdom of Saudi Arabia. Flowers of uniform size and appearance were cut at the commercial stage of cutting (when their sepals started to reflex) and were transported at the same day to the retailer in Riyadh by air according to standard procedures; inside insulated boxes with ice. Flowers were kept overnight in a refrigerator at 4 C, and in the second morning, flowers were received at the laboratory. Upon arrival, flowers were unpacked and did not need any further grading since they were uniform. The leaves of the lower part of the flower stem were stripped leaving only the three uppermost five-leaflet leaves on each stem. The basal part of the stem was cut under DI water at 25 cm length from the flower neck. Flower weight was recorded as the initial fresh weight and each flower was placed individually in a 100 ml graduated cylinder filled with the designated solution. Flowers were observed daily, and vase life of the flower was terminated when the flower showed bent neck, petal bluing or abscission, or when permanently wilted.

The following solutions were freshly prepared for both experiments:

- 1- distilled water (control)
- 2- 4% (v/v) ethanol solution.
- 3- 6% (v/v) ethanol solution.
- 4- 1 mM Silver nitrate.
- 5- 1 mM Silver thiosulfate (STS).

The pre-mentioned solutions were divided into two groups of solutions containing either zero or 50 ppm ethephon. All solutions were prepared using autoclaved distilled water. Silver thiosulfate complex (STS) was prepared according to Reid *et al.*, (1980).

Each group of flowers (plus ethephon or without ethephon) was placed in a separate fully controlled growth chamber. The two chambers had continuous air circulation of low velocity and were set at 20°C, 16 hours of 2000 lux fluorescent light, and 60 - 70 % relative humidity according to Halevy and Mayak, (1979). Additional 5 graduated cylinders filled with water only were added in each growth chamber in order to measure the average daily

evaporation value from the graduated cylinder. The fresh weight and solution uptake was recorded daily for each single flower. Solution uptake was recorded as the daily decrease in the solution level of the graduated cylinder minus the average daily evaporation value. Maximum fresh weight gain % was measured as the difference between the maximum fresh weight and the initial fresh weight of the flower at the beginning of the experiment, then divided by the initial fresh weight and multiplied by 100.

Each treatment in carnation experiment contained 8 flowers placed individually in 200 ml graduated cylinder. In case of roses, each treatment included 6 flowers placed individually in 100 ml graduated cylinders. Each single flower was considered as a replicate and each experiment was repeated twice in any single season. Within each season of the two successive seasons, carnation experiment was carried out on 1<sup>st</sup> of March and 1<sup>st</sup> of April, and rose experiment on 1<sup>st</sup> of May and 1<sup>st</sup> of June. The two experiments were analysed as a split plot design using SAS computer software program (SAS Institute, 1985). The main plot was ethephon treatment, and the sub-plot was the solutions treatments. Treatment differences were determined by analysis of variance procedure, while means separation was by a test for least significant difference (LSD), (probability 5 %).

## **RESULTS AND DISCUSSION**

### **I. Carnation:**

Carnation flowers placed in solutions containing 50 ppm ethephon had shorter vase life and less weight gain than those placed in corresponding solutions with no ethephon added (Table 1). The vase life of cut carnation placed in DI water containing 50 ppm ethephon was reduced by 5.1 and 5.4 days in both seasons compared with those placed in DI water without ethephon. Ethephon is an ethylene releasing compound had been used to study the effects of exogenous ethylene on cut flowers (DeStigter, 1981; Ming *et al.*, 1997; Serek, 1993). The adverse effect of ethylene on cut carnation flowers is well-established (Baker, 1983; Halevy and Mayak, 1981).

In the absence of ethephon from the solution, all treatments increased vase life and quality of cut carnation, while in the presence of ethephon, STS and 6% ethanol were the only solutions that improved vase life of the flowers.

Among solutions containing ethephon, flowers placed in 1mM STS solution had more than double the vase life of those placed in 1mM silver nitrate, in 4% ethanol, or in DI water. STS has been successfully used to extend vase life of standard and spray carnations (Halevy and Mayak, 1981; Mor *et al.*, 1981; Reid *et al.*, 1980). STS delays senescence by inhibiting ethylene action (Beyer, 1976; Celikel and Reid, 2002), and is very effective because it moves readily in the stem of carnation flowers (Halevy and Mayak, 1981). Ming *et al.*, (1997) reported that STS antagonised the effect of ethephon in cut mums. Results of table 1 also showed that, in the presence of ethephon, 6% ethanol increased vase life of cut carnation flowers by about 4 days more than those placed in silver nitrate and those placed in 4% ethanol. Ethanol was reported to increase vase life of cut flowers by inhibiting ethylene production (Podd and Staden, 1998; Pun *et al.*, 2001). Suk and Kim (1999) reported that

6% ethanol decreased ethylene evolution and extended vase life of "White Sim" carnation 2.4 times the control. In this experiment, ethanol at 6% increased vase life of cut carnation in the presence of ethephon, but had no effect on vase life when was used at 4%. It seems that 50 ppm ethephon was too high a concentration to be overcome by 4% ethanol. This view is supported by Pun *et al*, (2001) who reported that, in the presence of ACC (ethylene precursor), 4% ethanol failed to inhibit ethylene production in cut carnation flowers. Although silver ion inhibited the action of ethylene and delayed senescence in carnation flowers (Halevy *et al*, 1978), silver nitrate did not improve vase life of cut carnation in the presence of 50 ppm ethephon in the solution in this experiment. In this concern, Eyini *et al*, (1996) reported that STS was more effective than silver nitrate in deferring senescence and increasing vase life of cut sunflower c.v. Japanese Miniature.

**Table 1: Effects of different chemicals on vase life, maximum fresh weight gain, and average daily solution uptake of "White Sim" cut carnation in the presence or absence of 50 ppm ethephon during 1995 and 1996 seasons\***

Treatments (Solutions)		Vase life (days)	Maximum fresh weight gain (% of original fresh weight)				Average solution uptake (ml/flower/day)	
			1995	1996	1995	1996	1995	1996
No Ethrel added	Distilled water	12	12.6	17.7	17.5	2.03	2.13	
	Ethanol (4%)	13.8	13.8	18.4	17	2.18	2.27	
	Ethanol (6%)	18.9	18	21	19.5	2.36	2.48	
	Silver nitrate (1Mm)	24	23.4	33.2	40.8	2.94	3.14	
	STS(1mM)	22.3	21	28.1	26.7	2.2	2.33	
50 ppm Ethrel added	Distilled water	6.9	7.2	18.1	16	2.08	2.16	
	Ethanol (4%)	7.4	8.4	22.8	18.2	2.39	2.53	
	Ethanol (6%)	12.1	11	23.5	21	2.52	2.5	
	Silver nitrate (1mM)	7.9	8.4	23.3	23.6	2.4	2.47	
	STS(1mM)	15.9	17	21.2	24	2.29	2.28	
L.S.D. 5%		1.2	1.3	2.6	3.2	0.27	0.32	

\* Data represented in each season is a result of two consecutive experiments carried out on 1<sup>st</sup> of March and 1<sup>st</sup> of April.

In the absence of ethephon from the solution, all solutions improved vase life of cut carnation compared with the control. Silver nitrate was the most effective compound to extending vase life of cut carnations (24 & 23.4 days) and had best quality measured as the maximum weight gain percentage (33.2 and 40.8) in both seasons. This might be due to the strong antimicrobial effect of silver nitrate since the average daily solution uptake was highest (2.94 and 3.14 ml/flower). Flowers placed in STS ranked second after silver nitrate, followed by 6% ethanol, while 4% ethanol ranked fourth. These results lead to the conclusion that, at least a part of carnation senescence problem, even in the absence of external ethylene, could be related to the internal ethylene produced by the flower tissues at minimum amounts.

**Table 2: Effects of different chemicals on vase life, maximum fresh weight gain, and average daily solution uptake of "Dallas" cut roses in the presence or absence of 50 ppm ethephon during 1995 and 1996 seasons\***

Treatments (Solutions)		Vase life (days)		Maximum fresh weight gain (% of original fresh weight)		Average solution uptake (ml/flower/day)	
		1995	1996	1995	1996	1995	1996
No Ethrel added	Distilled water	9.9	10.4	11.9	12	5.28	5.33
	Ethanol (4%)	10.7	11	12.8	13.1	5.56	5.74
	Ethanol (6%)	12.3	12.7	13.8	14.5	5.8	5.78
	Silver nitrate (1mM)	15	17	16.6	18.2	7.89	8.3
	STS(1mM)	14	13.2	15.8	15.6	6.67	7.2
50 ppm Ethrel	Distilled water	8.9	8.5	12	12.1	4.86	5.1
	Ethanol (4%)	10.3	10.7	13	13.2	5.08	5.21
	Ethanol (6%)	11.3	12	13.9	12.8	5.6	5.76
	Silver nitrate (1mM)	10.4	11.2	13.8	15	5.74	5.74
	STS(-1mM)	12.4	13	15.7	14.9	6.92	7.24
L.S.D. 5%		0.9	1.0	1.3	1.5	0.49	0.47

Data represented in each season is a result of two consecutive experiments carried out on 1<sup>st</sup> of Ma; and 1<sup>st</sup> of June.

## II. Roses

The presence of 50 ppm ethephon in the solution reduced vase life and quality of cut roses. The vase life of cut roses placed in DI water containing 50 ppm ethephon was significantly reduced by 1 and 1.9 days in both seasons compared with those placed in DI water without ethephon (Table 2). Similarly, high concentrations of exogenous ethylene were reported to reduce postharvest life of cut roses (Mor *et al*, 1989; Serek, 1993; Tjosvold *et al*, 1994).

In the absence of ethephon from the solution, silver nitrate, STS, and 6% ethanol significantly improved vase life of cut roses. On the other hand, 4% ethanol was slightly (but not significantly) better than the control. Flowers placed in silver nitrate solution had longest vase life (15 & 17 days), highest daily solution uptake (7.89 & 8.3 ml/flower), and highest weight gain percentage (16.6 & 18.2 %) in both seasons respectively. Flowers placed in STS solution ranked second followed by those placed in 6% ethanol in all three measurements. STS increased vase life of cold stored roses and affected bud opening of cut roses (Reid *et al*, 1989). In addition, ethanol increased vase life of cyclamen flowers (Naderi *et al*, 2000), and limited weight loss and increased chlorophyll content in leaves and vase life of cut mums (Petridou *et al*, 2001).

In the presence of ethephon in the solution, all solutions improved vase life of cut roses compared with the DI water plus ethephon. Among solutions containing 50 ppm ethephon, flowers placed in STS solution had longest vase life (12.4 & 13 days), highest daily solution uptake (5.74 & 5.74 ml/flower), and highest weight gain percentage (13.8 & 15 %) in both seasons respectively. In this concern, STS was reported to increase longevity (Serek and Andersen, 1993) and to antagonise the effect of ethephon (Serek, 1993) in 'Victory Parade' pot roses. Flowers placed in 6% ethanol solution ranked second and had significantly longer vase life than those placed in 4% ethanol. Podd and Staden, (1998) reported that ethanol affected respiration, ethylene production,

and caused damage to the binding site, where ethylene action was suspected to be. Ethanol at 4-6% inhibited ethylene production in cut carnations (Podd and Staden, 1999). Flowers placed in silver nitrate solution were intermediate between flowers of the ethanol solutions, and their vase life was not significantly different from both. The fresh weight gain and daily solution uptake were relatively in favour to flowers placed in silver nitrate and 6% ethanol compared with those placed in 4% ethanol.

## CONCLUSIONS

In the absence of external ethylene source, silver nitrate was the most effective compound that improved vase life of both cut flowers. Silver nitrate is a strong antimicrobial agent, promoting more solution uptake by the flower, and thus allowing favourable water balance within the flower leading to improved vase life and quality of the flower. In addition, silver ion is a potent competitive inhibitor of ethylene responses (Reid *et al*, 1989). Also, in the absence of ethephon, STS (an inhibitor of ethylene action) and ethanol (an inhibitor of ethylene synthesis) at 6% or 4% also improved vase life of cut carnation and roses. This leads to the conclusion that, at least a part of normal senescence of roses and carnation (in the absence of external ethylene) is the internal ethylene produced by the cut flower tissues. This view is supported by Celikel and Reid, (2002) who reported that STS inhibited ethylene action in *Mathiola incana*, even in the absence of external ethylene, and that reduced vase life of long stored roses was associated with ethylene production (Reid *et al*, 1989).

The results also showed that, in the presence of ethephon, STS and 6% ethanol were the only two solutions that improved vase life of "White Sim" cut carnation, while silver nitrate and 4% ethanol also improved vase life of "Dallas" cut roses. On general basis, carnation flowers are more sensitive to ethylene than cut roses (Reid *et al*, 1989). In addition, in the presence of ethephon, STS was the best compound to improve vase life of both carnation and roses. STS is an anionic silver complex (Serek and Reid, 1993), and moves readily in the stem to the corolla and inhibit ethylene action, while silver nitrate is relatively immobile and travels only a short distance in the stem (Halevy and Mayak, 1981). The results also showed that 6% ethanol gave the best results next to STS for both cut flowers of roses and carnation in the presence of ethephon. Also, ethanol at 4% was less effective than 6% on roses, and did not improve vase life of carnation in the presence of ethephon. The effect of ethanol on vase life of cut flowers depended on species, cultivar, the presence or absence of external ethylene, and the concentration of both ethanol and external ethylene (Naderi *et al*, 2000; Petridou *et al*, 2001; Pun *et al*, 1999; Pun *et al*, 2001; Podd and Staden, 1998). Ethanol is a promising chemical and need to be tested in the future as a substitute to, the environmentally pollutant and expensive, STS. However, ethanol needs to be tested at different concentrations, alone or in combination with inhibitors of ethylene action, on a wide range of cut flowers.

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دراسات على بعض العوامل التي تؤثر على عمر و جودة الزهور المقطوفة  
للقرنفل (*Dianthus caryophyllus L.*) و الورد (*Rosa hybrida L.*)  
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تم إجراء تجربتين على كل من القرنفل صنف 'White Sim' و الورد صنف 'Dallas' لدراسة تأثير الإيثانول كعامل مضاد للإيثيلين بالمقارنة مع نترات الفضة و ثيوكبريتات الفضة (STS) على عمر و جودة الزهور المقطوفة في وجود أو غياب مصدر خارجي للإيثيلين. تم إجراء التجربتين في قسم الإنتاج النباتي بكلية الزراعة جامعة الملك سعود بالعربية السعودية خلال الموسمين المتتاليين ١٩٩٥ و ١٩٩٦، و في كل موسم تم إجراء تجربة القرنفل مرتين في أول مارس و أول إبريل و الورد في أول مايو و أول يونيو من كل عام. و لقد تم وضع الزهور في محاليل ماء مقطر و ٤% إيثانول و ٦% إيثانول و ١ ملليمولر نترات الفضة و ١ ملليمولر ثيوكبريتات الفضة (STS) بحيث تحتوى المحاليل على صفر أو ٥٠ جزء/مليون إيثيفون. و تم وضع الزهور في غرف نمو متحكم فيها تحت ظروف قياسية ٢٠ درجة مئوية و ١٦ ساعة ضوء فلورسنت بقوة ٢٠٠٠ لوكس و رطوبة نسبية من ٦٠-٧٠% و تيار هواء مستمر قليل السرعة. و تم تقدير عمر الزهور و التغير في الوزن الطازج و متوسط الإمتصاص اليومي للزهرة. و أظهرت النتائج أنه في غياب الإيثيفون أدت جميع الكيماويات المستخدمة إلى زيادة عمر و جودة زهور كل من القرنفل و الورد بالمقارنة مع الماء المقطر. و في غياب الإيثيفون أعطى محلول نترات الفضة أفضل النتائج من حيث عمر الزهور و أقصى زيادة في الوزن الطازج و أعلى متوسط إمتصاص يومي لزهور كل من القرنفل و الورد، و كان مركب ثيوكبريتات الفضة (STS) في المرتبة الثانية و تلاه الإيثانول ٦% ثم أتى الإيثانول ٤% في المرتبة الرابعة تنازليا بالنسبة لكل القياسات السابقة. أظهرت النتائج أيضا أن وجود الإيثيفون في المحلول أدى لنقص عمر و تقليل جودة زهور كل من القرنفل و الورد و أن القرنفل كان أكثر تأثرا بالإيثيفون من الورد، و في وجود ٥٠ جزء/مليون إيثيفون في المحلول أدت جميع الكيماويات إلى تحسين عمر زهور الورد بالمقارنة بالماء المحتوي على الإيثيفون فسي حين أن ثيوكبريتات الفضة (STS) و الإيثانول ٦% كانا المركبان الوحيديين اللذان أديا إلى تحسين عمر زهور القرنفل. و في وجود الإيثيفون في المحلول أعطى مركب (STS) أفضل النتائج و تلاه في الترتيب ٦% إيثانول و ذلك بالنسبة لكل من القرنفل و الورد. و قد تم استنتاج أنه في غياب مصدر خارجي للإيثيلين فإنه على الأقل جزء من شيوخة زهور القرنفل و الورد يرجع إلى تأثير الإيثيلين الداخلي الذي تنتجه أنسجة الزهرة، و الإيثانول يعتبر مركبا كيمائيا مبشرا للإستخدام في محاليل حفظ الزهور كعامل مضاد للإيثيلين، إلا أنه يحتاج إلى دراسات مستقبلية قبل إعطاء توصيات بالتركيزات المثلى لإستخدامه على زهور القطف المختلفة.