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INFLUENCE OF LILIUMS AND ROSES INTERACTION ON POST-HARVEST QUALITY OF THE CUT FLOWERS AS AFFECTED BY PULSING SOLUTION AND PACKAGING MATERIALS

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Abstract

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Rose and Lilium are the most important and marketable cut flowers in the world. However, a relatively limited vase life reduces its marketability. This study was performed to evaluate the effect of interaction of packaging flowers together in a preservative solution under exogenous ethylene and anti-ethylene treatments on their post harvest characteristics. The experiment consisted of pre-treating the flowers with silver thiosulfate 0.5 mM STS for 2 h at room temperature placed in pulsing solutions containing 8-hydroxyquinoline sulphate (8HQS) and packed (two packaging type, glass and polyethyleneamid) under exogenous ethylene treatment at 0.1, 10 and 100 $\mu l\, l^{-1}$. Treatments were arranged in a completely randomized design with three replications. The results showed protein content, ethylene production and also fresh and dry weight rose and lilium (phythochemical charters affect on the flowers vase life) were changed significantly. Therefore based on the experiment results packaging type and concentration of exogenous ethylene treatment indicated the most important factors influencing on vase life.

Key words: packaging materials rose flower, Lilium flower, vase life, exogenous ethylene, preservative solutions

Introduction

Currently, the cut flower industry in Ethiopia is facing an increasing total fresh loss of about 20% due to poor post-harvest handling. Cut flowers need to last longer in a vase or flower arrangement with their aesthetic qualities, fragrance and appearance maintained in order to get consumer's acceptance. Under ordinary conditions, the flowers could be a source of beauty and attraction for only two to three days. Since most of the people like to enjoy the scenery of flowers for a longer period of time, so keeping in view the socioeconomic value of flowers is very important. Also some countries are fortunate to have all types of climates and can produce fresh flowers round the year with little efforts, mechanization and proper post-harvest handling and can export them to the international market. Ornamental cut flowers and potted flowering and foliage plants are showing great trade potential for export in Persian Gulf and European countries that do not have suitable condition for producing fresh flowers round the year. After harvest flowers are cut off from their mother plants, and get detached, their ageing processes accelerate. To delay their ageing processes and subsequently increase their vase life, post- harvest treatment is crucial. This is because flowers take up about 80% of their water requirement within the first two hours after harvest (Roskam, 2010; Tsegaw et al., 2011). Decreasing the rate of deterioration extends the quality and maintains the natural appearances of cut flowers to attract wholesalers, retailers, and finally consumers' attention (Chapman and Austin-brown, 2007).

With increasing demand in different parts of the world, there is a need to transport the flowers to long distances in an attractive condition which requires good transportation facilities and using suitable packing materials, for decreasing and environmental factors' effects on vase life. Preservative chemicals physiological functions vary actively even after harvest, and the beginning of the flowers senescence al-

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ways depends on ethylene. A rise in ethylene production that accelerates senescence has been found in cut carnations and roses (Halevy and Mayak, 1981; Mayak and Halevy, 1980; Quesada and Valpuesta, 2000).

The use of preservative solution is considered a common practice for the storage of floral stems. These treatments allow to control ethylene synthesis, pathogen development, maintenance of hydric and respiration balance, to contribute in color conservation, floral induction and latter to complete their development (Arboleda, 1993; Halevy and Mayak, 1981). For these reasons, many floral preservative contain germicides, ethylene synthesis inhibitors, growth regulators, some mineral compounds, and carbohydrates that are essential to extend the vase life of cut flowers (Halevy and Mayak, 1981).

Using preservative materials for pulsing is seemed to prolong flower longevity. 8-hydroxy quinoline sulphate (8-HQS) as a germicide prevented growth of microorganisms in xylem and thus maintained water uptake by flower stems (Reid et al., 2001), so delayed flowers senescence (Abdelkader, 1987; Gendy and Hamad, 2011). Packaging materials also affect the vase life and quality of flowers. Different packaging materials can be used in packaging cut flowers.

Therefore, it needs to address post-harvest handling researches of cut rose flowers and study the combined effects of packaging preservatives and preservative materials for increasing florets longevity and vase life of cut flowers. Ichimura and Hiraya (1999) and Sexton et al. (1995) indicated that a pulse treatment of sucrose and/or silver thiosulfate (STS) was effective in maintaining the vase life of cut sweet pea flowers. Meir et al. (1995) reported that mini-gladiolus cut spikes, together with sucrose plus STS pulsing, offered potential advantages of extending their vase life and maintaining flower's quality. Moreover, Han (1998) also reported that the post-harvest quality of cut *Heuchera sanguinea* was significantly improved and its vase life significantly increased by pulsing the inflorescence with STS for 4 h followed by placing the stems in a sucrose solution containing cntdotl^{-1} 8-hydroxyquino-line citrate. However, relatively few studies have been reported on the effects of the pulse treatment of sucrose and/or STS on improving the vase life of cut rose flowers. Moreover, silver thiosulphate (STS) was reported as most effective bactericide and inhibitor of ethylene production and action, (Nowak and Rudnicki, 1990).

Thus, this research was initiated to investigate the effect of pulsing solution, and packaging type on the vase life and quality of cut flowers and also the interaction impact of preserving different flowers together on each other's post harvesting physiological changes (Bayleyegn et al., 2012).

Materials and Methods

Experiment was conducted to study the vase life of cut rose flower Cv. Amada and *Lilium oriental* with preservative materials used as pulsing solution, containing 8-hydroxyquinoline sulphate (8HQS) and silver thiosulfate (STS) under room conditions (23 ± 1C) with normal day light and natural ventilation at the post harvest research laboratory, Department of plant production, Imam Khomeini higher educational center Karaj, Iran during the year 2012. Flowers cultivars Amada and lilium were obtained from commercial greenhouse located 70 km away from university campus (sharifabad). Cut roses at tight bud stages were picked and brought immediately to the post-harvest laboratory in a cold room (4°C) and lilium flowers were harvested in half-open stage and in the same way transported with appropriate cover to the post-harvest laboratory in a cold room (4°C) immediately. Stem ends were recut under water to remove air emboli and then placed into vases containing 8-hydroxyquinoline sulphate and distilled water.

Experimental design and treatments: Each experimental unit consisted of five stems of each type of flowers (rose and lilium separately and rose and lilium together) with three replication for 48 h. In studying the effect of different pulsing solutions on the vase life of cut flower stems, the packages of flowers were divided into two groups. The first group, flowers treated with ethylene at [1, 10 and 100 µl l^{-1} for 48 h at 24°C preserved solution contained 8HQS (200 mg^{-1}) while in the second group flowers treated with ethylene, pulse- treated with 0.5 mM STS for 2 h at room temperature (24°C) and preserved solution contained 8HQS. Two separate sets of experiments were conducted in a completely randomized design. In the first set, the flowers were sealed in 30×30×34 cm (30 l volume) glass chambers and in the second set, the flowers were sealed in 30×30×34 cm (30 l volume) polyethyleneamid chambers.

Measuring ethylene production: Ethylene production was measured enclosing flowers detached daily after treatment in airtight containers (30 ml). Two ml gas samples were taken from the headspace of the containers with a hypodermic syringe at room temperature. The ethylene concentration in the sample was measured by gas chromatograph (HP 5890, Hewlett-Packard, Menlo Park, CA) using a flame ionization detector (FID), a stainless steel column (150 × 0,4 cm packed with Hysep T), column and detector temperatures of 70 and 350°C, respectively, and nitrogen carrier gas at a flow rate of 30 ml min^{-1}. Quantification was performed against an external standard and results were expressed on a fresh weight basis (plh^{-1}).

Determination of protein content: Determination of protein content in the leaves was made with the help of Brad-

ford's (1976) method. 2 ml of a solution of Coomassie Brilliant Blue G-250 (CBB) in 85% orthophosphoric acid was added to 100 µl of a diluted extract, with the extraction in a phosphorate-potassium buffer (pH 7.0). After 10 minutes the absorbance was measured at a wavelength of 595 nm. Protein content was determined from a curve plotted for albumin (Janowska and Stanecka, 2011).

Relative fresh weight and dry weight: The sample cut flowers were weighed every two days until the end of vase life. Samples of flowers were taken out of water for a very short time of 20 to 30 s. The fresh weight of each flower was measured using analytical balance. The fresh weight was expressed relative to the initial weight of sample flowers (Joyce and Jones, 1992). The volume of solution uptake was calculated by subtracting the volume of water evaporated from a flask of the same volume without cut flowers that of the total volume of water lost from the flask with cut flower sample (Chamani et al., 2005). The volume of water lost was calculated by subtracting the increase in fresh weight from the water uptake volume. 15 g of petals were taken for the determination of total dry weight by an oven at 70°C for 48 h (Bayleyegn et al., 2012).

Statistical analysis: In all experiments, flowers were arranged by using a completely randomized design (CRD) in a controlled environment vase life room. For the experiment with ethylene, 10 replications were used for each treatment and data were analyzed by one way ANOVA using Minitab® Release 13.2 (Minitab Inc.). Following ANOVA, the least significant difference (LSD) test at P = 0.05 was used to separate treatment means. For the experiment with STS, three replications were used for each treatment and all data were analyzed by the general linear model ANOVA of Minitab® Release 13.2 (Minitab Inc.). Following ANOVA, treatment means were compared using the LSD test at P = 0.05.

Statistical procedures were performed using the PCSAS software package. Differences between means were determined using orthogonal comparisons or Student T-test.

Results

Cut flowers depending on their species, cultivar, harvesting stage, cultivation conditions and kind of flowers that are preserved together displaying various post-harvest longevity reactions. The vase life of flowers is one of the criteria in assessing their quality.

In this study stems of rose and lilium lonely and together were put in a pulse solution content 8HQS in the glass chambers compared with flowers that were covered by polyethyleneamid for the packaging type and especially the different flowers effects on each other vase-life was studied. The effects of cover of chamber, STS and exogenous ethylene treatment on ethylene production, protein content and fresh and dry weight were studied in order to explore their effect on the flower vase life.

Protein content, ethylene production and also fresh and dry weight of rose and lilium have shown significantly difference (Table 1a). The flower kind showed significant effect on protein content, ethylene production and fresh and dry weight ($p < 0.01$).The packaging type had significant effect on protein content ($p < 0.05$), ethylene production, fresh and dry weight ($p < 0.01$) (Table 1a).

Senescence in plant parts is accompanied by organized disassembling of polysaccharides, proteins, lipids, and nucleic acids. The disassembly results in production of sugars and amides are transported to other plant parts. It is still unknown how the onset of these senescence-associated degradation processes is regulated (Van Door et al., 2004).

Proteolysis, the degradation of proteins, results in the tissue senescence process. Any controlling factor that causes to decrease this process, can positively affect on vase life of cut flowers (Janowska and Stanecka, 2011). Furthermore, eth-

Table 1a
Analysis of variance for Rose and Lilium studied characters under different treatments when they placed separate

		Studied characters	
Source of Changes	**df**	Protein content	Dry weight
Plant type	1	.201**	165.92**
Coverage type	1	.073*	7.23**
STS	1	.031^{ns}	10.67**
Et	3	.032^{ns}	5.69**
Plant Type*Coverage	1	0.031	7.12**
Plant Type*STS	1	.518**	11.46**
Plant Type*Et	3	.117**	6.59**
Coverage Type*STS	1	.029^{ns}	11.59**
Coverage Type*ET	3	.077**	1.80**
STS*ET	3	.013^{ns}	1.44**
Plant*Coverage*STS	1	.043^{ns}	9.97**
Plant*Coverage*ET	3	.009^{ns}	1.84**
Plant Type*STS*Et	3	.044^{ns}	1.43**
Coverage*STS*ET	3	.084**	1.41**
Plant*Coverage*STS*Et	3	.006^{ns}	2.11**
Error	64	0.012	0.14
CV		5.3	9.3

*=P<0.05, **=P<0.01, ns=not significant, Eta=ethylene internal

ylene treatment could effectively increase ethylene production and so reduce the fresh and dry weight which results in progressing of tissue senescence of cut flowers. Here, results have shown that unlike higher protein content in glass chamber (2.07), the ethylene production was higher (723.9), and fresh weight (16.5) and dry weight (4.26) in comparison with the polyethyleneamid chamber were higher. Therefore, the glass chamber seems more supportive than polyethyleneamid chamber to increase the vase life (Table 2a).

To understand the effect of ethylene treatment on vase life longevity, pulsing solution with STS (anti-ethylene treatment) has been studied. The protein content was not significantly changed, while, the other related characters were significantly affected by anti-ethylene treatment ($P < 0.01$) (Table 1b). Comparison of STS pre-treatment showed less characters level comparing with un-treated samples. Though, they showed significant ethylene production, fresh and dry weight significantly was influenced by STS treatment (Table 3a).

HQS is a well known germicide that has little effect in extending the vase life of cut flowers. Here we found that, the pulse treatment with only HQS solution in comparison with compare to HQS together with antiethylene (STS) showed higher level of parameters (Table 3). Ichimura et al. (1999) also indicated that using HQS has little effect on the vase life or climacteric ethylene production of cut flowers. Therefore, the effect of HQS on ethylene production was ignored, and the vase life of the rose and lilium cut flowers was attributed to packaging type, STS and also their interaction (Table 4a). This combination has not detectable effect on vase life and flower quality in cut rose in comparison with lilium flower when they placed together in a vase under the same condition (Table 4a). STS and 8-HQS combined treatment had effect on protein content without significant effect on ethylene production contrary to when they are used lonely. The treatment had not noticeable effect on rose and lilium fresh weight; it also reduced dry weight of rose and increased dry weight of lilium that can be related to different treatments effects on the flowers even when they are in the same condition. However the results showed that in the lilium condition the quality of flowers was better than rose's, when they placed lonely in the chamber (Table 1b).

Ethylene treatment with its increasing concentrations (1, 10 and 100 μl^{-1}) had no significant effect on protein content; when the flowers were lonely (Table 1a). However its effect on protein content, ethylene production, fresh and dry weight is significant, when the flowers put together (Table 1a, 1b) in a vase. This results indicate that exogenous ethylene lonely and together with STS increases ethylene production and its increasing depends on concentration of ethylene treatment therefore with $100\mu l^{-1}$ concentration external ethylene ($P < 0.01$) (Table 1a, 2b, Figures 1, 2, 3, 4). But protein content, fresh and dry weight and the flowers reaction in a the same condition, under definite external ethylene, are not equal and depend on rose cut flower, under 10 µl ethylene treatment and lilium under 0 and 1 µl ethylene treatment showed higher fresh and dry weight (Table 2b). When

Table 2a
Effects of packaging type on Rose and Lilium studied characters when they placed separate

	Studied characters	
Packaging type	Eta	Dry weight
Glass	723.9a	4.26a
Polyethylenamid	456.7b	3.71b

Table 1b
Analysis of variance for Rose and Lilium studied characters under different treatments when they placed together

		Studied Characters						
Sorce of changes		Protein Content		Eta	Rose Weight		Lilium Weight	
	df	Rose	Lilium		Fresh	Dry	Fresh	Dry
Coverage Type	1	.778**	.521**	492480.1**	3.606**	.009**	1.065ns	.239**
STS	1	.210**	5.732**	6440.3ns	.004ns	.178*	22.100**	.278**
ET	3	.223**	.422**	6986439.7**	.813*	.223**	12.468*	.043^{ns}
Coverage Type*STS	1	.652**	.253ns	5461.3ns	.003ns	.008ns	44.10**	.162**
Coverage Type*ET	3	.142*	.104ns	176912.5**	.623*	.077ns	1.874ns	.094**
STS*ET	3	.125^{ns}	.064^{ns}	2313.9^{ns}	.530*	.131*	10.382*	.021^{ns}
CoverageType*STS*Et	3	117^{ns}	.156^{ns}	930.4^{ns}	.270ns	.123*	5.763ns	.057*
Error	32	0.96	0.181	11639.3	0.225	0.043	3.409	0.016
CV		13.9	2.4	12.7	5.4	9.9	11.7	9.7

*=P<0.05, **=P<0.01, ns=not significant, Eta=ethylene internal

Table 3a
Effects of different treatment on Rose and Lilium Studied characters when they placed separate

Plant Type	Et	Studied Characters		
		STS	Eta	Dry weight
Rose	Et0	ST0	264.7hi	11.3j
		ST1	168.3kl	10.0j
		ST0	225.7jjk	10.2j
		ST1	139.0l	10.8j
	Et1	ST0	254.0ij	10.0j
		ST1	191.4jkl	10.2j
		ST0	254.3ij	10.1j
		ST1	177.3kl	10.1j
	Et10	ST0	253.3ij	10.0j
		ST1	361.2f	10.5j
		ST0	227.0ijk	10.1j
		ST1	334.8fg	10.5j
	Et100	ST0	1927.0c	10.0j
		ST1	2414.2a	10.2j
		ST0	854.7e	10.1j
		ST1	1633.2d	10.2j
Lilium	Et0	ST0	229.3ijk	18.9f
		ST1	152.1 l	15.8gh
		ST0	221.7ijk	16.7g
		ST1	125.0 l	13.3i
	Et1	ST0	271.3ghi	32.1b
		ST1	160.3kl	17.3g
		ST0	230.7ijk	28.8c
		ST1	128.4 l	22.0de
	Et10	ST0	267.7ghi	33.9a
		ST1	363.6f	20.2fg
		ST0	249.0ij	14.5hi
		ST1	280.3ghi	20.5ef
	Et100	ST0	2144.0b	27.6c
		ST1	2159.2b	15.8gh
		ST0	331.7fgh	13.1i
		ST1	1894.0c	15.8gh

Table 4a
Effects of plant type on Rose and Lilium studied characters when they placed separate

Plant type	Studied characters	
	Eta	Fresh weight
Rose	512.9b	10.3b
Lilium	667.7a	20.4a

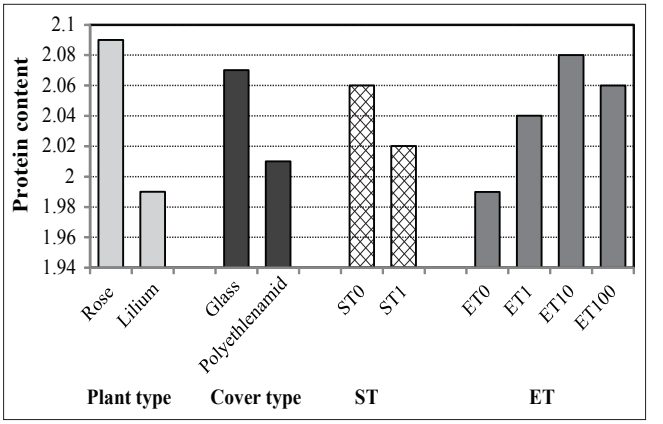

Fig. 1. Effects of the treatments on rose and lilium protein content (g/dry weight) when they placed together

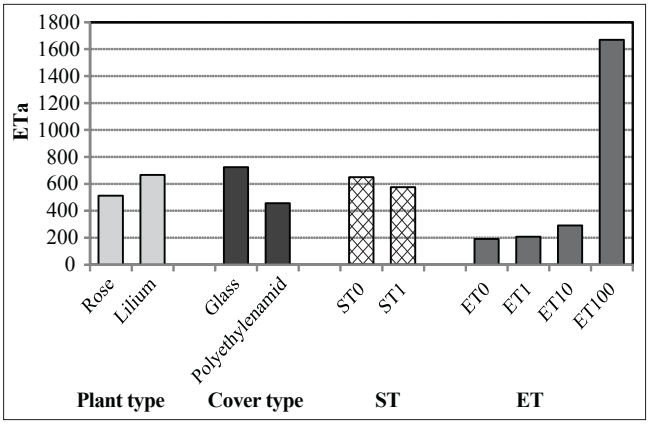

Fig. 2. Effects of the treatments on rose and lilium internal ethylene (µll^{-1}) weight when they placed together

they placed lonely they did not show noticeable difference in this character, however lilium compared with rose product had higher ethylene (Table 4a). There was significant increasing protein content (Table 2b). Therefore rose under 100µl^{-1} and lilium under1µl^{-1} indicated higher level of protein content. When they are placed lonely, the concentration is a little different (Table 2a). So it seems that between factors affecting on vase life and flower quality regarded in this study, the highest influencing factors when the flower placed in a vase under a package were packaging type and STS treatment for lilium, polyethyleneamid with STS treatment and for rose, glass with STS treatment. But if we want to determine a definite condition that is sufficient for both of them, glass chamber without treatment showed higher vase life and quality. On the other hand when we kept rose lonely in glass package

Table 2b
Effects of different treatment on Rose and Lilium Studied characters when they placed together

			Studied Characters				
Packaging type	STS		Proteincontent			Lilium weight	
			Rose	Lilium	Eta	Fresh	Dry
Glass	ST0	ET0	1.95k	1.81cd	243.3ef	18.42ab	1.39ab
		ET1	1.99jk	1.82cd	424.3de	17.33ab	1.26ab
		ET10	2.00jk	1.79cd	903.7c	16.82bc	1.25ab
		ET100	2.03ij	1.65d	2218.3a	16.58cd	1.13ab
	ST1	ET0	2.06hi	2.19bc	216.0f	15.55cd	1.34ab
		ET1	2.08hi	2.76a	485.7d	15.70cd	1.25ab
		ET10	2.11gh	2.38ab	905.3c	12.08e	1.08b
		ET100	2.15fg	2.15bc	2190.0a	12.69e	1.21ab
Polyethynelamid	ST0	ET0	2.18ef	1.57d	219.3f	15.53cd	1.38ab
		ET1	2.21e	1.86cd	320.0ef	15.00d	1.43ab
		ET10	2.23de	1.67d	724.1c	15.06d	1.41ab
		ET100	2.28cd	1.73cd	1630.7b	17.05ab	1.83a
	ST1	ET0	2.31bc	2.57ab	240.2ef	18.79a	1.33ab
		ET1	2.34bc	2.42ab	372.7de	16.60cd	1.21ab
		ET10	2.37b	2.65a	791.0c	16.17cd	1.15ab
		ET100	2.52a	2.44ab	1668.3b	13.34e	1.29ab

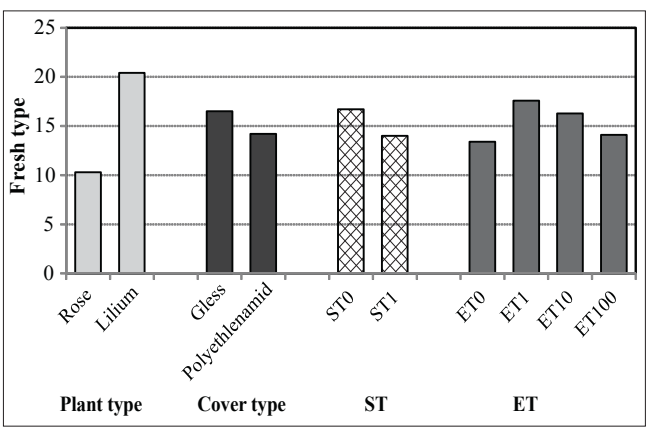

Fig. 3. Effects of the treatments on rose and lilium fresh weight(g) when they placed together

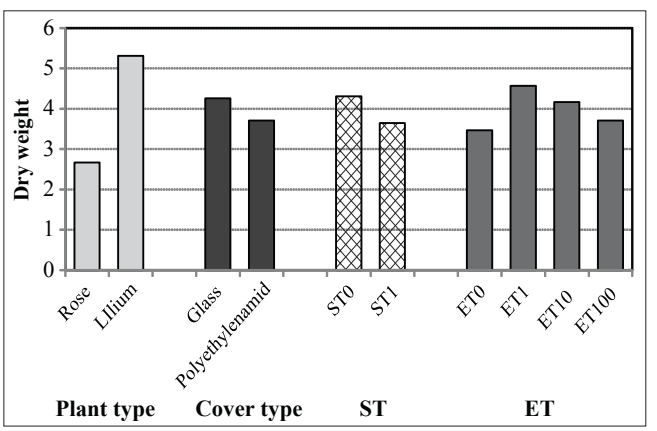

Fig. 4. Effects of the treatments on rose and lilium dry weight (g) when they placed together

without treatment and lilium glass chamber with 10 µl external ethylene, they showed higher vase life and quality.

Discussion

Prashanth and Chandrasekar (2010) found significant differences among different packaging treatments in response to pulsing solution in storage condition at room temperature and subsequent vase life period of cut gerberas. The study results indicated that the less vase life was in glass chamber by flowers STS pre-treated under $100\mu l^{-1}$ exogenouse ethylene after that by flowers without pretreatment under $100\mu l^{-1}$exogenouse ethylene were put in glass chamber. Following them were the flowers that were put in polyethylenamid chamber with STS

pre-treatment under 100 μl^{-1} exogenous ethylene and polyethylenamid chamber without STS pre-treatment under 100 μl^{-1} exogenous ethylene respectively, against them the greatest vase life respectively were indicated in glass chamber without anyone of treatments and in polyethylenamid chamber with STS pre-treated without exogenous ethylene treatment and then without STS pre-treatment with 1 μl^{-1}exogenouse ethylene. Therefore based on the study results packaging type and concentration of exogenous ethylene treatment were the most important factors influenced on vase life.

Conclusion

The potential of rose for protein production comparing with lilium, and potential of lilium for ethylene production comparing with rose are higher when the flowers placed beside each other. Potential production and patterns affect protein content, ethylene product, fresh and dry weight under coverage type, STS treatment and external ethylene. Especially in the case of rose of course ethylene production change pattern was not noticeable and lilium changes in quantity and pattern characters are moderate comparing with rose. Therefore rose and lilium affected each other vase life under different conditions, but different conditions did not have the same effect and it seemed that rose have positive effect on lilium vase life and its quality after harvesting. However lilium's effect on rose vase life was not detectable even in the same condition. It seemed that lilium decreased the rose quality during vase life; however the rose vase life was longer than lilium in this experiment.

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