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Postharvest Physiology and Vase Life of Rose (*Rosa hybrid* L. cv. Grand Prix) Cut Flowers as Influenced by Using Sucrose and some Chemical Treatments

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ABSTRACT

Studies were conducted to determine the effects of preservative solutions of potassium chloride , aluminium sulfate ($Al_2(SO_4)_3$)and 8- hydroxyquinoline sulfate (8-HQS) on rose cut flowers. Potassium chloride at 100, 200 or 300 ppm, aluminium sulfate at 50, 100 or 200 ppm and 8- hydroxyquinoline sulfate at 125, 250 or 500 ppm as well as control (tap water) were investigated. Sucrose 5% was added with all chemical treatments. All the solutions increased vase life compared with tap water. Aluminium sulfate at different concentrations + sucrose 5% significantly prolonged the vase life of rose cut flowers. Vase life ranged from 10.83days with control to 14.50 days with 200 ppm $Al_2(SO_4)_3$ + 5% sucrose. Also, relative fresh weight and solution uptake were the highest values with 200 ppm $Al_2(SO_4)_3$ + 5% sucrose. Soluble sugars content in leaves and petals total anthocyanins were increased by using 50 ppm $Al_2(SO_4)_3$ + 5% sucrose. Leaf water content of 50 ppm $Al_2(SO_4)_3$ + 5% sucrose treated flowers during the vase-life period were higher than in flowers treated with tap water or preservative solutions. Leaf water content was the highest in a solution containing 125 ppm 8- hydroxyquinoline sulfate + 5% sucrose.

Kew words: Rose, cut flowers, vase life, potassium chloride, aluminium sulfate, 8- HQS.

Introduction

Roses, the "Queen of the Flowers," have been enjoyed for thousands of years. Roses belong to family Rosaceae are found all over the world. It is hard to imagine a garden without roses. Many investigators mentioned that some substances play an important role, in extend vase life and maintaining the quality of cut flowers, when added to preservative solutions. Use of aluminium sulphate as a germicide in floral preservation is recommended by Nowak and Rudnicki (1990) reported that the colour, form and longevity were more in aluminium treated flowers. Singh *et al*. 2004 indicated that sucrose at (1.5 per cent) in combination with aluminium sulphate (300 ppm) considered as suitable treatment for improving vase life of *Rosa hybrid* Cv. First Red. Effect of $Al_2(SO_4)_3$ is apparently due to its biocidal nature and also improved water balance of cut roses. Divya *et al*., 2004 reported that use the holding solution with sucrose (1.5 %) + aluminium sulphate (300ppm) extended the vase life cut rose, *Rosa hybrid* Cv. First Red and recorded the highest values for the quality character viz., flower diameter , water uptake, carotenoid content and freshness recorded lowest physiological loss in weight. Bhattacharjee (1999a) found that the longest vase life of cut roses, maximum water uptake, increasing flower diameter as well as improving in fresh weight of cut flowers were recorded with $Al_2(SO_4)_3$ at 300 ppm. Bhattacharjee and Palanikumar (2002) treated cut rose cv. Raktaganha flowers with 300 ppm aluminium sulphate + sucrose (1.5 %) recorded the greatest water uptake.

Elgimabi and Sliai (2013) showed that the vase life of Taif rose cut flowers was prolonged by all (8-HQS) treatments. The results indicated that, the best concentration was 200 ppm and the effect was better when combined with 7% sucrose, which recorded the best vase life compared to other concentrations of sucrose. Elhindi, (2012) suggested that pulse treatment with HQS plus sucrose for 12 h is the most effective for improving pigmentation and use as a commercial cut flower preservative solution to delay flower senescence, enhance quality, and prolong the vase life of sweet pea. Hassan, 2009 reported that applying 8-HQS and sucrose treatments in both seasons improved the vase life and floret longevity of *Hippeastrum vittatum* cut flowers. Dineshbabu *et al.* (2002) reported that holding solutions containing 8-HQS + sucrose extended the vase life of dendrobium flowers and improved flower quality.

The aims of this study were to determine the effectiveness of various concentrations of potassium chloride (KCl); aluminium sulfate ($Al_2(SO_4)_3$) and 8- hydroxyquinoline sulfate (8-HQS) in combination with sucrose on postharvest physiology and vase life of rose (*Rosa hybrid* L. cv. Grand Prix) cut flowers.

Materials and Methods

Two laboratory trials were carried out to study the effect of preservative chemicals on vase life of rose cut-flowers. Flowering stems of rose cultivar "Grand prix "were harvested on the first week on December 2012

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and 2013 at a commercial farm in Giza, Egypt. The flower stems were cut to a length of 45-50 cm then placed in tap water and pre-cooled at 2 °C for 24 hrs. The flower stems were received within 1 hr. to the Ornamental Laboratory at the Department of Ornamental Plants and Woody Trees, National Research Centre, Cairo, Egypt.

The flower stems were re-cut under water to avoid air embolism. Eight rose cut-flowers were used for each treatment in four replicates. The flower stems were placed in glass vases containing potassium chloride at 100,200 or 300 ppm, aluminium sulfate at 50, 100 or 200 ppm and 8- hydroxyquinoline sulfate at 125, 250 or 500 ppm as well as control (tap water) were investigated. Sucrose 5% was added to all chemical treatments. The vases were arranged in a completely randomized design with 4 replicates. Trials were carried out in a laboratory at an ambient temperature of 21±2ºC and 30-40% RH and continuous lighting with fluorescent lamps 1000 lux.

The following data were recorded: The vase life (days) was the period between harvest and the time when either the petals lost turgor or at least one petal had abscised, relative fresh weight % (including stem, leaves and flower head) and solution uptake (ml g^{-1} fresh weight) after 3, 6, 9, 11, 12, 13. 14 and 15 days during the shelf life period. After a week from the start of the trial, leaf water content (g g^{-1} dry weight), chlorophyll content according to Saric *et al.,* (1967) ,leaves total soluble sugars according to Dubois *et al.,* (1956) and total anthocyanins of petals (mg/ 100g fresh weight) according to Husia *et al.* (1965) were recorded.

The obtained data were statistically analyzed by using combined analysis of variance by LSD test according to Steel and Torrie (1980).

Results and Discussion

The vase life (days)

All the preservative solutions increased vase life compared with tap water. Holding rose cut flowers in vase solutions containing 200 ppm aluminium sulphate + 5% sucrose significantly increased their vase life and delayed flower senescence compared to flowers either held in other treatments or tap water (Table 1). Vase life ranged from 10.83days with control to 14.50 days with 200 ppm $Al_2(SO_4)_3$ + 5% sucrose. Jowkar, *et al* (2012) reported that aluminum sulfate treatment significantly increased vase life of cut 'Cherry Brandy' roses and improved postharvest visual quality of this cultivar by retaining leave freshness even at the end of vase life. Treatments of potassium chloride and 8- HQS were to have the same positive impact on increasing the period of stay in the vase. Reddy *et al.,* (1995), reported that using 8-HQS and %4 sucrose caused to increase flower longevity by 16 days and improve water retention and water uptake by tuberose flowers. Marousky (1972) considered that while 8-HQ compounds could help prevent microbial occlusion, their ability to reduce vascular blockage can be due to their ability to inactivate enzyme systems through pH adjustment. HQS, an effective germistat, inhibits vascular occlusion and extends the vase life of cut rose flowers (Ichimura *et al.* 1999). Use of aluminum sulfate was the best influential of potassium chloride and 8 -HQS.

Table 1. Vase life and leaf water content of rose cut flowers as affected by preservative solutions of potassium chloride (KCl), aluminium sulfate (Al2(SO4)3) and 8- hydroxyquinoline sulfate (8-HQS).

Treatments	Vase life (days)	Water content of leaf (g g^{-1} D.W.)
KCl 100 ppm +Sucrose 5%	11.83	1.640
KCl 200 ppm + Sucrose 5%	12.17	1.577
KCl 300 ppm + Sucrose 5%	12.00	1.558
$Al_2(SO_4)_3$ 50 ppm + Sucrose 5%	14.17	1.747
$Al_2(SO_4)_3$ 100 ppm + Sucrose 5%	14.33	1.715
$Al_2(SO_4)_3$ 200 ppm + Sucrose 5%	14.50	1.679
8-HQS 125 ppm + Sucrose 5%	12.33	2.235
8-HQS 250 ppm + Sucrose 5%	12.83	1.610
8-HQS 500 ppm + Sucrose 5%	12.17	1.461
Control	10.83	0.939
L S D 5%	1.08	0.145

Leaf water content:

Regarding the data shown in Table 2, after a week of vase life, leaf water content of all treatments showed a significant increase compared with the control. Leaf water content of flowers placed in 8-HQS 125 ppm + sucrose 5% (2.235 g g^{-1} D.W.) holding solution was significantly higher than the control and the other treatments. There were no significant differences among Aluminium sulphate treatments and also potassium chloride treatments. Mohammadi, *et al.* (2012) on tuberose, reported that aluminum sulfate with concentration of 100 mg l-1 had the maximum vase life, solution absorption, protein and pigments content and least fresh weight loss.

Relative fresh weight %:

Data in Table 2 showed that flowers treated with 200 ppm aluminium sulphate + 5% sucrose in third day recorded the highest relative fresh weight (118.2%) among all treatments. Beginning of the senescence phase in cut flowers is characterized by decrease in fresh weight (Adachi *et al*., 2000; Ichimura and Goto, 2002). Aluminium sulphate treatments increased the relative fresh weight followed by 8- hydroxyquinoline sulfate then potassium chloride. 8- HQS promotes stomatal closure in addition to having biocidal activity (Burge *et al*., 1996). Maximum relative fresh weight was related to 200 ppm $Al_2(SO_4)_3$ + 5% sucrose in all days compared to control and all other treatments. Comparing to the control at the 11th day and chemical treatments, it could be stated that 200,100 and 50 ppm $Al_2(SO_4)_3$ + 5% sucrose presented the highest rose cut flowers fresh weight 37.92, 33.24 and 30.45%, respectively. $Al_2(SO4)_3$ had positive effect on water uptake rate and raising fresh weight (Liao *et al.,* 2001). On the other hand, flowers treated with 100 ppm KCl + 5% sucrose produced the lowest percentage of fresh weight (16.98 %). The effective role of 8-HQS could be explained also by maintaining leaves turgidity, by keeping fresh weight.

Table 2. Relative fresh weight % of rose cut flowers as affected by preservative solutions of potassium chloride (KCl), aluminium sulfate ($Al_2(SO_4)_3$) and 8- hydroxyquinoline sulfate (8-HQS).

Treatments	Relative Fresh Weight %								
	0 day	3 days	6 days	9 days	11 days	12 days	13 days	14 days	15 days
KCl 100 ppm + Sucrose 5%	100	96.6	91.1	88.4	79.9	77.2	0	0	0
KCl 200 ppm + Sucrose 5%	100	102.3	97.6	90.9	81.8	78.1	75.8	0	0
KCl 300 ppm + Sucrose 5%	100	103.8	98.2	93.7	84.5	79.3	0	0	0
$Al_2(SO_4)_3$ 50 ppm +Sucrose 5%	100	112.6	103.9	95.6	89.1	82.4	79.8	77.6	74.5
$Al_2(SO_4)_3$100ppm +Sucrose 5%	100	114.4	105.6	98.1	91	83.7	78.9	76.3	72.4
$Al_2(SO_4)_3$ 200ppm +Sucrose 5%	100	118.2	109.7	100.5	94.2	85.4	83.1	80.3	78.6
8-HQS 125 ppm + Sucrose 5%	100	101.9	96.5	89.3	84.1	79.3	73.7	0	0
8-HQS 250 ppm + Sucrose 5%	100	104.7	97.1	91.7	85.2	81.8	76.3	0	0
8-HQS 500 ppm + Sucrose 5%	100	103.5	99.4	90.5	83.7	77.4	73.3	0	0
Control	100	89.8	82.2	74.6	68.3	0	0	0	0

Solution uptake:

All treatments levels solution uptake by flower stems increased at the 3rd and 6th day then diminished until the end of experiment (Table 3). Cut rose flowers treated with 300 ppm KCl + 5% sucrose had more solution uptake compare to control and other treatments on 3rd and 6th day. From the 9th day until the end of evaluations flowers treated with 200 ppm $Al_2(SO_4)_3$ + 5% sucrose showed more solution uptake compare to control and other treatments. Our results are agreed with the report of Kiamohammadi and Hashemaabadi (2011). They observed that with $Al2(SO4)_3$, water uptake in cut lisianthus was increased. $Al2(SO4)_3$ is the most important bactericide which as same as citric acid have positive effect water uptake rate and consequence in anthesis (Liao *et al.,* 2001).

Table 3. Solution uptake (ml g^{-1} fresh weight) of rose cut flowers as affected by preservative solutions of potassium chloride (KCl), aluminium sulfate ($Al_2(SO_4)_3$) and 8- hydroxyquinoline sulfate (8-HQS).

Treatments	Solution uptake(ml g^{-1} fresh weight) after:							
	3 days	6 days	9 days	11 days	12 days	13 days	14 days	15 days
KCl 100 ppm + Sucrose 5%	1.18	1.10	0.51	0.32	0.23	0.00	0.00	0.00
KCl 200 ppm + Sucrose 5%	0.82	0.78	0.44	0.31	0.37	0.33	0.00	0.00
KCl 300 ppm + Sucrose 5%	1.29	1.20	0.58	0.42	0.56	0.43	0.00	0.00
$Al_2(SO_4)_3$ 50 ppm +Sucrose 5%	1.07	0.99	0.57	0.37	0.55	0.47	0.41	0.31
$Al_2(SO_4)_3$100ppm +Sucrose 5%	1.19	1.09	0.66	0.47	0.60	0.56	0.44	0.37
$Al_2(SO_4)_3$ 200ppm +Sucrose 5%	1.08	1.16	0.73	0.51	0.64	0.57	0.48	0.40
8-HQS 125 ppm + Sucrose 5%	0.99	0.72	0.37	0.17	0.26	0.22	0.00	0.00
8-HQS 250 ppm + Sucrose 5%	1.05	0.92	0.47	0.25	0.41	0.29	0.00	0.00
8-HQS 500 ppm + Sucrose 5%	1.25	1.03	0.48	0.18	0.36	0.27	0.00	0.00
Control	1.23	1.11	0.47	0.24	0.00	0.00	0.00	0.00

Pigments content:

Data presented in Table 4 shows that all preservative solutions treatments significantly increased chlorophyll a+b and carotenoids content over the control. The highest contents of chlorophyll a+b and carotenoids (2.356 and 0.488 mg/g F.W., respectively) were found in the leaves of rose cut flowers treated with $Al_2(SO_4)_3$100ppm +sucrose 5%. These findings were in agreement with Jowkar *et al* (2012) on rose cut flowers (Chery Brandy). They reported that aluminum sulfate increased leaf chlorophyll content. Divya *et al.* (2004)

reported that holding solution with sucrose (1.5%) + aluminium sulphate (300 ppm) extended the vase life of cut rose and recorded the highest value of carotenoid content.

Soluble sugars %:

The data in Table (4) indicate that the maximum leaves soluble sugars % of rose cut flowers (17.86 %) was related to $Al_2(SO_4)_3$ 50 ppm +sucrose 5% followed by 8-HQS 500 ppm + sucrose 5% (15.35 %). Soluble sugars percentages in the leaves of rose cut flowers decreased gradually with increasing the concentration of aluminum sulfate preservative solutions, while the opposite has happened with both of potassium chloride and8-hydroxyquinoline sulfate. Using the first and second levels of potassium chloride and8- hydroxyquinoline sulfate resulted in significant decrease in leaves soluble sugars %.

Anthocyanins content:

From recorded in Table (4), it can be concluded that for petals of rose cut flowers when held in different preservative solutions, the highest content of total anthocyanins (498.9mg/ 100g F.W.) was recorded with 50 ppm $Al_2(SO_4)_3$ + 5% sucrose. Aluminium sulphate (50 to 100 ppm) has been used in many preservative formulations of roses (Halevy *et al*. 1979) attributed the effect of aluminium to lowering the pH of rose petals and stabilizing the anthocyanins, thereby improving the keeping quality of rose cut flowers. Treatment with sucrose increased the anthocyanin concentration in petals as well as extended the vase life of *Eustoma* flowers, and sucrose may therefore be involved in the anthocyanin biosynthesis gene expression (Ichimura, 1998).

Table 4. Pigments content (mg/g F.W.), leaves soluble sugars % and petals total anthocyanins of rose cut flowers as affected by preservative solutions of potassium chloride (KCl), aluminium sulfate ($Al_2(SO_4)_3$)and 8- hydroxyquinoline sulfate (8-HQS).

Treatments	Chlorophyll (a+b)	Carotenoids	Soluble sugars %	Total anthocyanins (mg/ 100g F.W.)
KCl 100 ppm + Sucrose 5%	1.292	0.295	9.58	329.1
KCl 200 ppm + Sucrose 5%	1.324	0.241	10.73	367.8
KCl 300 ppm + Sucrose 5%	1.593	0.345	12.66	400.0
$Al_2(SO_4)_3$ 50 ppm +Sucrose 5%	1.968	0.395	17.86	498.9
$Al_2(SO_4)_3$100ppm +Sucrose 5%	2.356	0.488	14.59	466.8
$Al_2(SO_4)_3$ 200ppm +Sucrose 5%	2.042	0.432	12.50	425.3
8-HQS 125 ppm + Sucrose 5%	1.798	0.394	9.82	391.4
8-HQS 250 ppm + Sucrose 5%	1.955	0.379	10.11	412.2
8-HQS 500 ppm + Sucrose 5%	1.289	0.332	15.35	434.6
Control	1.219	0.228	12.55	385.3
LSD 5%	0.037	0.016	1.79	----

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