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Full Length Research Paper

Effects of nanosilver and sucrose on vase life of cut Rose flower (*Rosa hybrid* cv. 'Royal')

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In cut flowers increasing of quality and duration of storage and minimizing wastes after harvest is very important. Silver thiosulphate (STS) is one of the materials that in this connection is used, but because of environmental pollutant, its application has been limited. Recent study evaluated the possibility of replacing nanosilver instead of STS. In this study, experimental design was factorial with two factors, including sucrose and several types of chemicals such as nanosilver, hydroxyquinoline citrate (HQC), copper nitrate and STS with three replications that were performed on the cut Rose flower cultivar royal using pulsed method. During the experiment, traits such as vase-life of flower, electrolyte leakage (EL), relative water content (RWC), leaf and flower qualitative traits and percentage of flowers opening were evaluated. Analysis of variance showed that between traits among treatments, there are significant differences. Mean comparisons showed that the use of STS in combination with 8 percent sucrose had the most effect on traits, so that vase-life of cut Rose flowers has increased up to 67.15 days. Application of nanosilver using concentration of 5 ppm in combination with 4 percent sucrose also could, to reach the vase-life of flowers to 67.13 days that it seems to bring effective treatment to increase the vase- life of cut Rose flowers. Use of STS in combination with different concentrations of sucrose and 15 ppm nanosilver with 4 percent sucrose had also a significant difference in maintaining of quality and vase-life of flowers other than chemical treatments.

Key words: Sucrose, silver thiosulphate (STS), hydroxyquinoline citrate (HQC), copper nitrate, nanosilver, Rose cultivar royal.

INTRODUCTION

Use of nano materials including nanosilver has recently increased in the world. Nanosilver due to antibacterial properties has found wide applications. Some of the reasons are as follows: properties like high durability, simple and easy to use and lack of side effects than other anti-bacterial materials (Champion, 1381). In cut flowers, even if provided appropriate conditions, vase-life of flowers is less than when they are on the mother stocks that hormonal imbalances and creating of water stress are two factors involved (Van Doorm, 1997). Burdett (1970) tests showed that vascular blockage factor is related to the proliferation of bacteria. According to Marvsky (1971), HQC has strong effect against fungi and yeasts, but its most effect is in preventing of bacteria activities. Durkin (1979) has known that entering of air into stem is one of the causes of vascular blockage. Halvey (1976) in his research stated that wilting and not fully opening of flowers are due to water stress and reduced water conductivity is because of imbalanced water. He expressed high concentration of sucrose (50 to 40%) causes an increasing in osmotic potential of petal cells. Ayz et al (1986) stated that the production of ethylene and abscisic acid in the tissues of Rose petals occurs in parallel with aging. Reid et al. (1989) reported that the effect of external ethylene treatment can be neutralized by primary treatment of flowers with 0.5 µM of STS. Experiments show that pulsed treatment with citric acid, salicylic acid, sucrose, calcium sulfate and STS causes reducing of damages resulted from botrytis.

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Duran and Van Prayk (1990) studied the effects of HQC and decreasing of pH in preventing of vascular blockage by reducing the number of bacteria in Rose stems. The results showed that the use of HQC or buffer solution (citrate phosphate) with pH = 3 reduce the number of bacteria in Rose stems. He stated the proliferation of microorganisms in the water container causes xylems blockage, water stress and consequently decreases postharvest vase-life of cut flowers. Sryk and Reed (1993) mentioned that STS increases the vase-life in some species of flowers by preventing of ethylene action. Ichimura et al. (1998) in an experiment studied the effects of sucrose with hydroxyquinoline sulfate (HQS) on longevity and the emergence of petal color in several cultivars of cut Lisianthus. Studies showed that use of 200 mg/L HQS with 20 g/L of sucrose during storage causes increasing of florets opening and vase-life of flowers. Ichimura et al. (1999) found that treatment with HQS and HQC in combination with sucrose; both increased the vase-life of cut Rose flowers in all temperatures. Van Meetereu et al. (2001) suggested that it must be used a combination of calcium chloride, sodium carbonate and copper sulfate solution as a basic standard for the preservative solution.

The results of Liao et al. (2000) research showed that when the cut Rose flowers were treated by 120 g/L of sucrose in combination with 0.2 mM of STS for 2 h, the highest vase-life of flowers is obtained. Researches of Sun et al (2003) about the effects of pulsed treatment with silver nitrate and STS on cut Rose cultivar Red Sandra showed that treatment with STS increases the vase-life of flowers so that the longevity of flowers in three hours pulsed treatment with silver nitrate and STS (both in concentration of 1 mM) without re-cutting, in control was 8.3 days, in treated with silver nitrate was 10.8 days and in treated with STS was 11.1 days, respectively, because ions of silver prevent the action of ethylene. On the other hand, the effect of re-cutting in absorption of silver ions was very effective so that in treatment with silver nitrate, the silver ion was only at the end of the stem, while in treatment with STS, silver ions in all parts of the plant were observed. Also, if the act of re-cutting be done and 5 cm below stem be cut off, there will not a significant difference between the use of silver nitrate (vase-life of 9.4 days) and STS (vase-life of 8.9 days). Ichimura et al. (2005) stated that vascular blockage and reduced soluble carbohydrates are responsible for reduction of flower longevity in cut Rose cultivar Sonia. They were also said although all treatments increase longevity of flowers, but sucrose is more effective than HQS. Studies of Khalighi and Shafiee (2000) about the effect of chemical treatments on cut carnation showed that STS in concentration of 500 mg/L and HQC in concentrations of 600 mg/L with 1% sucrose increase the vase-life of flower. Fakhraee (2001) stated that presence of sucrose in preservative solution decreases concentration of anthocyanins in the petals.

Ajamgard et al. (2001) studies about the effects of STS and HQC on the longevity of cut Rose cultivar Bakarya showed that a solution containing 200 ppm STS has the greatest effect on cut flowers and increases their longevity up to 5.5 days after harvest. In this study application of 200 ppm HQC increased the vase-life of cut flowers about 2.1 days. Jokar et al. (2002) studied the effects of harvest stage, HQC, STS and silver nitrate on the vase-life of cut Shirazian narcissus (*Narcissus tazetta*) that was used in all treatments from 2 percent sucrose. In this study flowers were treated with STS (20 min) and with silver nitrate and HQC (nine hours) and results showed that silver nitrate and STS in addition to increasing of longevity after harvest, improves the appearance of wilted flowers in the clusters and prevents them from browning. Fakhraee (2003) in an experiment studied the effects of different levels of sucrose with a fungicide and HQC in a concentration of 100 ppm on cut Rose cultivar first red. The results showed that sucrose has significantly increased the vase-life of cut Rose flowers. In solutions containing sucrose without fungicide, water absorption was less and vascular blockage has been further in the lowest part of cut flower. Reduction of water absorption has also a direct relationship with bud opening of cut Rose flower and less water absorption causes lower carbohydrate absorption and thus vase-life of cut flowers decreases. On the other hand, lower opening of flower depends on the available carbohydrates of petals. Faraji et al. (2005) studied the effects of various chemical treatments to increase the longevity of cut Rose flower cultivar Maroussia. They stated that combined treatment of 8% sucrose without spraying mid HQC and treatment of 8% sucrose without spraying mid aluminum sulfate were followed the most vase-life by flowers. Also the highest percentage of flowers opening achieved in combined treatment of 8% sucrose without spraying mid aluminum sulfate or HQC, and treatment of 8 percent sucrose without spraying mid HQC had the greatest effects on the quality of flowers. He stated that sucrose in concentration of 8% has the most effect on the vase-life of flowers, flower's diameter and flowers opening. Idrisi et al. (2006) researches about the effect of preservative solutions on increasing the flower's longevity after harvest and flower opening of pink carnation showed that treatment of flowers with 300 ppm copper sulfate had the greatest effect on the two desired traits.

MATERIALS AND METHODS

This Study was conducted in the research center of flowers and plants of Mahallat (Markazy province, Iran).The statistical design used was factorial with two factors including sucrose in three levels (0, 4 and 8%) and several types of chemicals such as nanosilver in four levels (0, 5, 10 and 15 ppm), HQC 600 ppm, copper nitrate 300 ppm and silver thiosulphate 1mM with three replications that each one consisted of four cut Rose flower cultivar royal. Flowers isolated at bud stage (bud tip was opened a little) to 60 cm length

Table 1. Square means of effects of experimental treatments on evaluated traits.

S.O.V	df	MS					
		Vase-life (day)	Flower quality	Flower opening	Leaf quality	RWC (%)	EL (%)
R	2	7.64*	176036^{ns}	2.42^{ns}	584.48*	0^{ns}	0.003^{ns}
Sucrose (A)	2	7.64	609.48**	7.22**	691.98*	0.001^{ns}	0.081**
Chemical treatments (B)	2	5.81*	208.26*	3.92*	549.38*	0.002^{ns}	0.009^{ns}
Interaction of A*B	6	7.77***	378.41***	5.65***	820.02***	0.002^{ns}	0.018^{ns}
Error	40	1.99	88.82	1.195	169.01	0.001	0.013
CV%	-	11.77	12.78	20.18	13.58	4.28	23.42

*, **, ***: Significant at 0.05, 0.01 and 0.001 probability levels, respectively. - ns: non significant

from the mother stock and transferred to the laboratory. Chemical solutions with above mentioned concentrations were prepared and transferred into the glass containers with volume of 330 ml (2 times sterilized by autoclave in temperature of 121℃). Afte r locating flowers into the containers for 4 h, they transferred into the glass containers containing distilled water, where with controlled conditions (mean temperature 20℃ and relative humid ity 60%) with 1800 Lux light intensity during total time of experiment. During the experiment traits such as vase-life, percentage of flowers opening, quality of leaves, flower quality, relative water content (RWC), electrolyte leakage (EL) were evaluated. Analysis of variance and comparison of data were performed by using of MSTAT-C and SPSS soft wares and Duncan test, respectively.

RESULTS AND DISCUSSION

Analysis of variance resulted from the effects of sucrose factors, chemical treatments and interaction between sucrose and chemical treatments (Table 1) on vase-life of flowers, showed that treated flowers with sucrose or chemicals at level of 5% and interaction between sucrose and chemical treatments at the level of 0.1% are significant. Results confirmed Marousky (1969) findings about the role of sugars in improving of water balance in plant, involving in the regulation of stomata action, the accumulation of sucrose in plant tissues, increasing of osmotic pressure and water absorption capacity and maintaining the cell turgidity. Table 2 showed that the best treatment for increasing the vase-life of flowers is use of STS with concentration of 1 mM in combination with 8% sucrose, which vase-life of flowers in this treatment was 15.67 days. Liaves et al. (2000) experiments on Rose cultivar Diana showed that when sucrose is used with the STS, the highest longevity of flower can be achieved. The results showed that there is no significant difference among the use of 15 ppm Nanosilver and 4% sucrose, HQC and 4% sucrose and STS in combination with different concentrations of sucrose. According to Table 1, effects of sucrose and different chemical treatments on flowers opening were significant at 1 and 5% levels, respectively. Also the interaction between different concentrations of sucrose and chemical treatments on flowers opening was significant at 0.1% level. Van duran (1997) reports also indicated that some cut flowers to opening need to a carbohydrate source. Halo and Mayak (1974) stated that some sugars affecting metabolism (metabolic sugars) except manitol, because water potential reduction of Gladiole flowers and their negative water potential improve water movement in the stems. Results showed that use of sucrose in preservative solutions (rate of 10 to 25%) with bactericides cause to reach their maximum in growth, development and opening of flowers. According to Table 2 there is no significant difference among the use of STS in combination with different concentrations of sucrose, 15 ppm nanosilver and 4% sucrose at 5% level and the highest percentage of flower opening is resulted by using of STS and 8% sucrose so that about 75.053% of flowers opening have been observed.

According to Table 1, effects of sucrose and different treatments of chemicals on maintaining of flowers quality were significant at 1 and 5% levels, respectively. Also interaction between different concentrations of sucrose and chemical treatments were significant at 0.1% level. According to Table 2 use of STS in combination with various concentrations of sucrose, 15 ppm nanosilver and 4% sucrose had significant difference than other chemical treatments. Variance resulting from the effects of sucrose, chemical treatments factors and interaction between them (Table 1) shows effect of sucrose on electrolyte leakage percent at 1 percent level. In other words, different concentrations of sucrose reduced the leakage of cellular materials to the intercellular spaces and plant would be in the best turgidity, but there is no significant difference between use of 4 and 8% sucrose at 5% level. Also based on Table 2, interaction between sucrose and chemical treatments on electrolyte leakage is not significant.

Regarding to Table 1, effects of sucrose and chemical treatments to maintaining quality of leaves are significant. The interaction between different concentrations of sucrose and chemical treatments on maintaining quality of leaves is also significant at 0.1% level. Considering the data in Table 2, use of 15 ppm nanosilver and 4% sucrose, HQC and 4% sucrose and STS with 4 and 8% sucrose have shown significant difference in comparison with other chemical treatments to maintain quality of leaves, although between the use of these treatments

Table 2. Interaction effects of sucrose and chemical treatments on evaluated traits.

Treatment levels	Vase-life (day)	Flower quality	Flower opening	Leaf quality	RWC (%)	EL (%)
a_1b_1	11^{CDE}	69^{CDEF}	19.360^{FG}	84.33^{DEF}	ns	ns
a_1b_2	12^{BCD}	72.03^{BCDEF}	26.610^{EFG}	97.5^{BCDE}	ns	ns
a_1b_3	12^{BCD}	72.78^{BCDEF}	27.003^{CDEFG}	96^{BCDE}	ns	ns
a_1b_4	12.23^{BCD}	79.42^{BCDE}	37.390^{BCDEF}	102.8^{BCDE}	ns	ns
a_2b_1	9^{E}	56.33^{F}	10.87^{G}	70^{F}	ns	ns
a_2b_2	11.33^{BCDE}	64.03^{EF}	22.723^{DEFG}	86.83^{CDEF}	ns	ns
a_2b_3	11.33^{BCDE}	66.08^{EF}	21.553^{DEFG}	86.64^{CDEF}	ns	ns
a_2b_4	13.67^{ABC}	86.39^{ABCD}	51.110^{ABC}	113.7^{AB}	ns	ns
a_3b_1	10.67^{DE}	63.97^{EF}	20.223^{EFG}	83.39^{DEF}	ns	ns
a_3b_2	11.33^{BCDE}	65.81^{EF}	19.307^{EFG}	90.19^{BCDEF}	ns	ns
a_3b_3	11.33^{BCDE}	68.39^{DEF}	25.697^{DEFG}	91.94^{BCDEF}	ns	ns
a_3b_4	12.67^{BCD}	79.72^{BCDE}	43.500^{BCDE}	101.3^{BCDE}	ns	ns
a_1b_5	12^{BCD}	70.03^{CDEF}	30.167^{BCDEF}	94.17^{BCDEF}	ns	ns
a_2b_5	13.67^{ABC}	79.36^{BCDE}	45.637^{ABCD}	114.3^{AB}	ns	ns
a_3b_5	10.33^{DE}	70.11^{CDEF}	21.117^{EFG}	77.19^{DEF}	ns	ns
a_1b_6	11^{BCD}	67.03^{EF}	25.307^{DEFG}	86.78^{CDEF}	ns	ns
a_2b_6	12.33^{BCD}	73.64^{BCDEF}	28.640^{BCDEFG}	95.56^{BCDEF}	ns	ns
a_3b_6	10^{DE}	65.30^{EF}	16.280^{FG}	77.08^{EF}	ns	ns
a_1b_7	14^{AB}	87.16^{ABC}	45.690^{ABCD}	111^{BC}	ns	ns
a_2b_7	13.67^{ABC}	88.61^{AB}	56.253^{AB}	114.7^{AB}	ns	ns
a_3b_7	15.67^{A}	103.1^{A}	75.053^{A}	135.3^{A}	ns	ns
F Test	***	***	***	***	ns	ns

- Means followed by the same letter (letters) symbols in each column (according to Duncan's multiple range test) are not significantly different from each other.

have not observed significant difference at 5% level. Also the best quality of leaves has been resulted from STS treatment with 8% sucrose.

Based on Tables 1 and 2 effects of different concentrations of sucrose, nanosilver and other chemical treatments and interaction between them on relative water content (RWC) are not significant.

Conclusion

The results showed that only use of sucrose has a positive effect on the more evaluated traits, so that it has caused an increasing in vase-life of flowers, flowers opening, maintaining quality of flowers and leaves and reducing the electrolyte leakage, and it only has not followed a positive effect on relative water content. Among chemical treatments, although STS has more effects on traits such as vase-life increasing, flowers opening and maintaining quality of leaves and flowers, but it's application have to be avoided due to environmental risks, because in long-term should be paid more costs to eliminate the frequency of pollution created by these materials, so although the effects of materials application such as copper nitrate, HQC and nanosilver are not same silver thiosulphate, but their application is a way for protection of natural resources and environment.

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