Journal of Ornamental Plants
Available online on: www.jornamental.iaurasht.ac.ir
ISSN (Print): 2251-6433 ISSN (Online): 2251-6441

Effects of Different Preservative Solutions on Vase Life of *Narcissus tazetta* Cut Flowers

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Received: 07 May 2017 Accepted: 19 October 2017
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Abstract

The main aim of this study was to evaluate the effects of silicon (Si), ethanol (Et), ascorbic acid (AA), and citric acid (CA) on the vase life of *Narcissus tazetta* L. cv. 'Shahla' cut flowers. For this purpose, an experiment based on a completely randomized design was conducted with Si (5, 10 and 20 mM), Et (2 and 4%), AA (100, 200 and 300 mg L^{-1}), CA (100, 200 and 300 mg L^{-1}) and control (distilled water) with three replications and three samples (individual flowers) for each replicate. The results showed that the addition of all preservatives to vase solutions significantly increased relative fresh weight, water uptake, and vase life of cut flowers in comparison to control. Relative fresh weight of the cut flowers treated with Si (5 mM) was higher than that of other treatments during all days of experiment and this treatment increased relative fresh weight and total water uptake by 16 and 27% compared to control (day 7 of the experiment), respectively. Silicon (5 mM) also increased fresh weight of control flower (excluding stem) from 0.185 to 0.259 g (40% increases). The highest dry weight of flower (0.057 g) was obtained from 300 mg L^{-1} AA. It was 32% higher than that of control flower. The application of Si (5 mM) extended the vase life of cut flowers by 2.66 days in comparison to control. According to the results of this experiment, Si, Et, AA and CA are safe and cheap compounds that are suitable for extending the vase life of *N. tazetta* cut flowers.

Keywords: Ascorbic acid, Citric acid, Ethanol, Silicon, Total soluble carbohydrate.

INTRODUCTION

The genus *Narcissus* spp. belongs to the Amaryllidaceae family and comprises about 50 species, classified into 12 divisions (Hanks, 1993; Dole and Wilkins, 2005). *Narcissus tazetta* is the most extensive species of the genus *Narcissus* spreading from Spain, Iran, Kashmir to China and Japan (Coats, 1971; Dole and Wilkins, 2005). Narcissuses are popular ornamental flowers worldwide and are widely cultivated in different regions of Iran. They have a strong fragrance that is highly valued in the fragrance industry (van Dort *et al*., 1993; Chen *et al*., 2013).

Cut flowers exhibit longer vase life when acidifier compounds like citric acid (CA) and ascorbic acid (AA) are used as preservative compounds which act through adjusting water pH and decreasing the incidence of microorganisms in the vase solution (Vahdati Mashhadian *et al*., 2012; Sheikh *et al*., 2014). Ethanol (Et) is another preservative agent that inhibits ethylene synthesis and reduces the sensitivity of flowers to ethylene (Wu *et al*., 1992; van Doorn, 1998). In carnation (*Dianthus caryophyllus* cv. 'Yellow Candy'), the addition of Et 4% in the preservative solution increased the vase life of carnation cut flowers (Bayat *et al*., 2011). In another experiment, pulse and continuous use of Et (2% and 4%) in preservative solution increased the vase life of chrysanthemum cut flowers (Petridou *et al*., 2001). Silicon (Si) is the second most abundant element on the earth ground. The application of Si has several beneficial effects on different aspects of the plant growth such as root development, fruit formation, crop yield, and postharvest quality parameters (Epstein, 1994; Kazemi *et al*., 2012). Jamali and Rahemi (2011) and Kazemi *et al.* (2012) reported that the treatment with Si significantly extended the vase life of cut carnation flowers by reducing ethylene biosynthesis. Therefore, the aim of this study was to evaluate the effects of Si, Et, AA and CA on vase life, water uptake, and total soluble carbohydrate of *N. tazetta* cut flowers.

MATERIALS AND METHODS

Experimental material

Cut *Narcissus tazetta* L. cv. 'Shahla' were obtained from a local farm in Khusf city (32° 48′ 11″ N and 58° 54′ 14″ E), South Khorasan Province, Iran, in December 2016. Plants were grown under natural conditions. The cut flowers were picked up in the early morning (when the first flower opened) and immediately moved to the laboratory in proper packages. Stems were trimmed to 30 cm and placed in the glass vials containing 300 ml of the test solutions. The experiment was carried out at 23±1°C and 70% relative humidity under 10 µmol m^{-2} s^{-1} fluorescent light with 12/12 hours of light/darkness regime (Ichimura and Goto, 2002).

Postharvest treatments

Postharvest treatments were Si (5, 10 and 20 mM), Et (2 and 4%), AA (100, 200 and 300 mg. L^{-1}), CA (100, 200 and 300 mg. L^{-1}), or distilled water as the control. The source of silicon was nano silicon with <100 nm particle size and higher 98% trace metals basis (Sigma-Aldrich Co, Germany).

Measured traits

Vase life of spike was determined as the time from harvest to wilting of the last floret (Ichimura and Goto, 2002). Fresh weights of cut flowers were measured every day until day 7. To measure relative fresh weight, the following formula was used (Sairam *et al*., 2002):

$$R.F.W.\ (\%) = (W_t/W_0) \times 100$$

where Wt represents the fresh weight in first seven days of experiment and W0 denotes the initial fresh weight at the beginning of the experiment. The opening of each vase was covered in order to limit evaporation loss of vase solution and to allow determination of the solution uptake by cut flowers (Sairam *et al.*, 2002). Total soluble carbohydrate content was determined by the Anthron method (Carrol *et al*., 1956). At the end of the experiment, dry and fresh weights of flowers

(without stem) were measured. For this purpose, flowers from all replications and each sample were weighed as fresh weight and then, they were dried at 70°C for 48 h to estimate the dry weight (Sairam *et al.*, 2002).

Experimental design and data analysis

The experiment was carried out on the basis of a completely randomized design. Each treatment comprised three replicates and three samples (individual flowers) for each replication. Statistical significance between mean values was assessed using analysis of variance (ANOVA) and LSD Test at $P < 0.05$ using the JMP8 statistical software.

RESULTS

The results of variance analysis showed significant effects ($P<0.01$) of preservative treatments on all measured traits of N. tazetta cut flowers (Table 1).

Table 1. Variance analysis of the effect of preservative treatments on measured traits of *N. tazetta* cv. 'Shahla' cut flowers

S.o.V	df	MS				
		Total water uptake	Fresh weight of flower (without stem)	Dry weight of flower (without stem)	Total soluble carbohydrate	Vase life
Treatment	11	38.73**	0.002**	0.0005**	1085.31**	3.94**
Error	24	2.25	0.0004	0.00006	180.49	1.24
CV (%)	-	5.05	8.19	14.23	8.46	10.12

* * significant at 1% probability level.

Total water uptake

All preservative treatments significantly increased total water uptake of cut flowers over control. At day 7, Si treatment (5 mM) increased total water uptake by 27% when compared to control (Table 2). Moreover, daily water uptake of cut flowers was depicted in Fig. 1 until day 7 of the experiment. Between days 4 to 7, the highest water uptake was obtained from cut flowers treated with Si (5 mM).

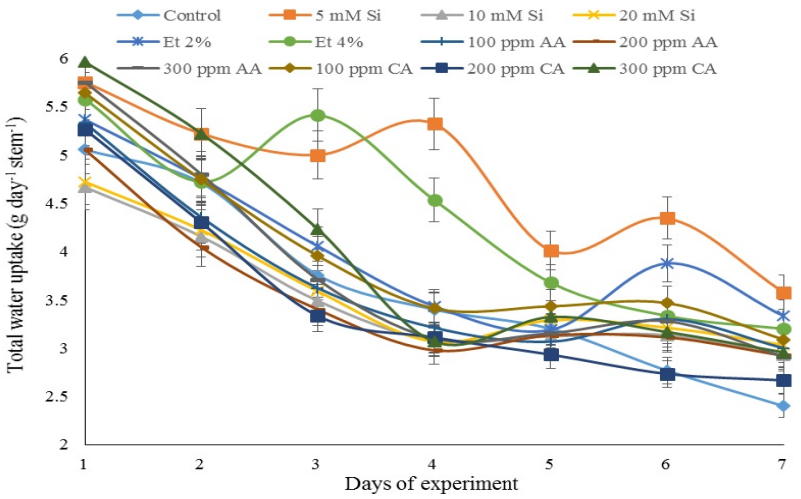

Fig. 1. Effects of different concentrations of Si, Et, AA and CA on daily water uptake of *N. tazetta* cv. Shahla cut flowers on the first seven days of the experiment. Si: Silicon; Et: Ethanol; AA: Ascorbic acid, CA: Citric acid.

Relative fresh weight

Based on the results of Fig. 2, there were significant differences in relative fresh weight of treated cut flowers during days 1 to 7. Relative fresh weight of Si (5 mM) treatment was higher than other treatments during all days of the experiment. On day 7, Si (5 mM) increased relative fresh weight by 16% as compared to control.

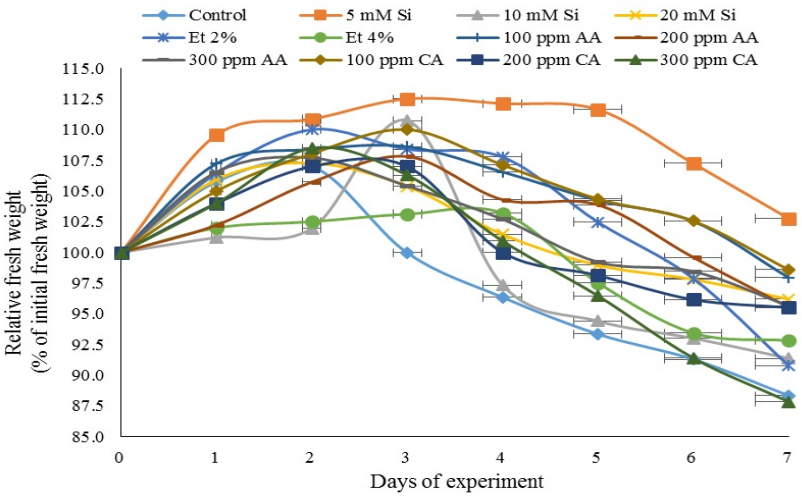

Fig. 2. Effects of different concentrations of Si, Et, AA and CA on relative fresh weight of *N. tazetta* cv. 'Shahla' cut flowers on the first 7 days of the experiment. Si: Silicon; Et: Ethanol; AA: Ascorbic acid, CA: Citric acid.

Fresh and dry weight of flower

According to the results in Table 2, placement of narcissus cut flowers in vase solutions containing Si, Et, AA and CA significantly improved fresh and dry weight of flowers (without stem) as compared to control (Table 1). Fresh weight of control flower was increased from 0.185 to 0.259 g with Si was applied at 5 mM rate. The highest dry weight of flower (0.057 g) was obtained from 300 mg L^{-1} AA. It was 32% higher than that of control flower.

Total soluble carbohydrate

Total soluble carbohydrate of cut flowers treated with preservative treatments was significantly decreased in comparison to control. The highest (127.74 mg g^{-1} DW) and lowest (89.08 mg g^{-1} DW) total soluble carbohydrate were obtained from control and 5 mM Si-treated plants, respectively (Table 2).

Table 2. Effects of different concentrations of Si, Et, AA and CA on total water uptake, dry and fresh weight of flower (without stem), and total soluble carbohydrate of *N. tazetta* cv. 'Shahla' cut flowers

Treatment	Total water uptake (g stem -1 day -1)	Fresh weight of flower (g)	Dry weight of flower (g)	Total soluble carbohydrate (mg g-1 DW)
Control	20.11 c	0.185 e [ŧ]	0.043cd	127.74a
Si (mM)				
5	25.88 a	0.259 a	0.039 d	89.08d
10	20.97 bc	0.237 b-d	0.047 bc	104.07c
20	20.41 c	0.221 d	0.048 bc	114.57b
Et (%)				
2	21.01bc	0.250 a- c	0.048 bc	118.66b
4	25.4 a	0.252 ab	0.040cd	91.11cd
AA (mg L^{-1})				
100	20.30 c	0.223 cd	0.043 cd	96.33c
200	21.85 b	0.256 ab	0.054 ab	110.59bc
300	20.95 bc	0.239 a-d	0.057 a	107.57bc
CA (mg L^{-1})				
100	22.10 b	0.258 ab	0.040 cd	96.48c
200	25.01 a	0.244 a-d	0.047 bc	110.16bc
300	21.96 b	0.245 a-d	0.046 cd	118.36b

[ŧ] Means followed with same letter(s) are not significantly different at 5% probability level using LSD test. Si: Silicon; Et: Ethanol; AA: Ascorbic acid, CA: Citric acid.

Vase life

The results showed that Si, Et, AA and CA at all rates significantly increased the vase life of narcissus cut flowers vis-à-vis control (Fig. 3). The highest (11.37 days) and lowest (8.71 days) vase lives were observed in 5 mM Si-treated plants and control plants, respectively (Fig. 3).

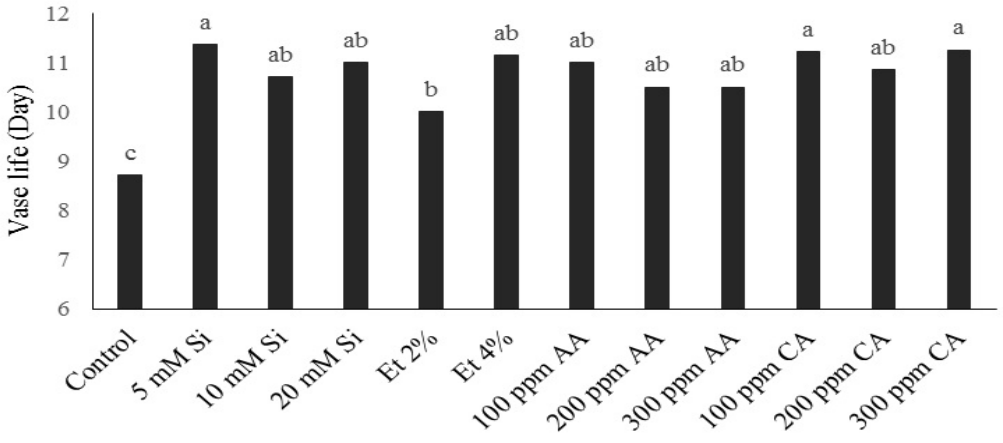

Fig 3. Effects of different concentrations of Si, Et, AA and CA on vase life of *N. tazetta* cv. 'Shahla' cut flowers. Si: Silicon; Et: Ethanol; AA: Ascorbic acid, CA: Citric acid.

DISCUSSION

After cutting, the fresh weight of cut flowers decreases due to the loss of water uptake and increasing water loss through transpiration (Borochov *et al.*, 1995; Rattanawisalanon *et al*., 2003; Liao *et al*., 2012; Mansouri, 2012). The present results showed that all preservative treatments (Si, Et, AA and CA) significantly increased water uptake, relative fresh weight, and fresh weight of flowers as compared to control. Vahdati Mashhadian *et al*. (2012) reported that the application of CA increased relative fresh weight of chrysanthemum cut flowers in comparison to control. Sheikh *et al.* (2014) showed that the addition of AA and CA as a preservative to vase solutions of lisianthus enhanced water uptake and relative fresh weight of cut flowers in agreement with the present results. Acidifier compounds like AA and CA reduce pH and prevent the proliferation and accumulation of bacteria in the vase solution and improve the normal flow of water (Alaey *et al.*, 2011; Mansouri, 2012). Moreover, it is reported that the addition of CA and AA to vase solution caused low latex flow from the cut stem surface and delay in the closure of xylem (Imsabai *et al.*, 2013). Kazemi *et al*. (2012) in carnation and Farokhzad *et al*. (2005) in lisianthus also reported that the addition of Si and Et to vase solution increased water uptake and fresh weight of cut flowers. Silicon and Et act as germicide agents and inhibit microbial growth and vascular blockage, resulting in keeping water turgidity and balance in cut flowers (Balestra *et al.*, 2005; Kazemi *et al.*, 2012). In this study, total soluble carbohydrate was decreased in treated cut flowers in comparison to control. Similar results were reported by Jamali and Rahemi (2011) for cut carnations. Lower total soluble carbohydrate observed in the present study is an indication of a delay in senescence of the treated flowers in comparison to control flowers. These treatments improved the postharvest characteristics (less ethylene production and better flow of water) and postponed the senescence, so internal reservoir structures like starch would maintain for longer period and this can be responsible for lower carbohydrates and higher dry weight of the treated flowers (Jamali and Rahemi, 2011).

The application of Si, Et, AA and CA significantly extended the vase life of narcissus cut flowers compared to control. Hasanpour Asil and Hasani (2012) reported that CA increased vase life of gladiolus flowers. Moreover, extending the vase life of cut flowers by the application of Si, Et, AA and CA has been reported in previous studies (Jamali and Rahemi, 2011; Bayat *et al*., 2011; Vahdati Mashhadian et al., 2012; Sheikh *et al*., 2014). Vase life of cut flowers is mainly influenced by two factors – ethylene which accelerates the senescence of many flowers and microorganisms that cause vascular blockage and thereby decrease the vase life (Van Doorn *et al*., 1994; Zencirkiran, 2005; Zencirkiran, 2010). It has been demonstrated that narcissus flowers are sensitive to ethylene (Hunter *et al.*, 2004). Farokhzad *et al.* (2005) in lisianthus and Kazemi *et al.* (2012) and Bayat *et al.* (2011) in carnation reported that Et and Si increased vase life by inhibiting ethylene synthesis and sensitivity to ethylene action. These substances inhibit the conversion of ACC into ethylene. It has also been proposed that ethanol acts by providing a readily available carbon source and by limiting carbon loss by photorespiration in C3 plants (Petridou et al., 2001).

Moreover, van Doorn (1998) showed that narcissus flowers were sensitive to high populations of bacteria in vase solution and that the presence of the bacteria caused vascular blockage, preventing water uptake and consequently resulting in vase life shortening. Ethanol, CA and AA as disinfective agents inhibit bacterial growth in the solution, thereby extending flower vase life. Moreover, numerous studies have demonstrated that the vase life of cut flowers is modulated by antioxidants (Baker *et al.*, 1978), suggesting the contribution of reactive oxygen species (ROS) in senescence. Reactive oxygen species-mediated lipid peroxidation is considered the most damaging process in living organisms (Gill and Tuteja, 2010). Kazemi (2012) reported that Si extended the vase life of *Argyranthemum* cut flowers by increasing antioxidant enzyme activity like superoxide dismutase and decreasing the concentration of malondialdehyde, the end-product of membrane lipid peroxidation.

CONCLUSION

The results showed that the application of Si, Et, AA and CA in preservative solutions significantly increased vase life, water uptake, and relative fresh weight of *N. tazetta* cut flowers in comparison to control. Among all treatments, the optimum result was obtained from the application of 5 mM Si that is advisable.

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How to cite this article:
Bayat, H. and Aminifard, M. 2018. Effects of Different Preservative Solutions on Vase Life of *Narcissus tazetta* Cut Flowers. *Journal of Ornamental Plants, 8(1), 13-21.*
URL: **http://jornamental.iaurasht.ac.ir/article_538642.html**