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# Efficiency of Silicon, Nickel and Acetylsalicylic Acid Reduced Senescence and Extended Vase Life of Cut Rose Flowers

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## ABSTRACT

Short postharvest vase life is one of the most important problems on the cut flowers. The aim of this study was to evaluate the efficacy of silicon, nickel and acetylsalicylic acid and their interaction on extending the vase life, total chlorophyll content, ACC-oxidase (Aminocyclopropanecarboxylate oxidase, ACO) activity, anthocyanin leakage, membrane stability and malondialdehyde (MDA) content of Cut rose flowers. The treatments were distilled water, silicon (0, 1.5, 2.5 mM), acetylsalicylic acid (0, 1,1.5 mM) and nickel (0, 1, 2 mM). Vase life in solution containing 1.5 mM silicon and 1 mM acetylsalicylic acid didn't have significant difference than control. The results showed that silicon, acetylsalicylic acid and nickel treatments increased cut flower water absorption, fresh weight and vase life, while decreasing malondialdehyde content, ACC-oxidase activity and membrane premeability together with total delay of senescence and peroxidation of lipids. Our results suggest the application of silicon, acetylsalicylic acid and nickel in preservative solutions for rose flowers maintained the vase life of flowers for a longer period.

**Key words:** Cut flower, silicon, acetylsalicylic acid, nickel

## INTRODUCTION

Cut rose flowers are usually short and senescence of the rose petals increase with ethylene production during postharvest life (Elgimabi and Ahmed, 2009). Ethylene promoted flower senescence, increased production of oxygen free radicals (ROS), malondialdehyde (MDA) accumulation, respiratory activity and loss of cell membrane fluidity (Mayak *et al*., 1977; Liu *et al*., 1987; Witte and van Doom, 1991; Epstein, 1994; Sankat and Mujaffar, 1994; Khan *et al*., 2003; Shi and Zhu, 2008; Karlidag *et al*., 2009; Reezi *et al*., 2009; Kazemi *et al*., 2010; Kazemi and Shokri, 2011; Kazemi *et al*., 2011a-d). Ethylene antagonists inhibit the action of ethylene at the molecular level by blocking its receptor site (Kazemi *et al*., 2011a-d). Three of the preserving agents are ASA, Ni and Si that inhibits ethylene synthesis and reduces sensitivity of flowers to ethylene. (Reezi *et al*., 2009) showed that Si could extend the vase life of rose cut flowers by decreasing ROS, malondialdehyde content and ethylene. SA has been identified as an important signaling element involved in establishing local and systematic disease resistance responses of plants after pathogen attack (Janda *et al*., 1999; Ananieva *et al*., 2002; Metwally *et al*., 2003; Ansari and Misra, 2007; Mahdavian *et al*., 2007; Mba *et al*., 2007; Canakci, 2008; Karlidag *et al*., 2009; Zheng *et al*., 2006),

Wood and Reilly (2007) and Fan *et al.* (2008) reported that addition of SA and sucrose in the preserving solution increased the vase-life of cut flowers. Therefore in this study, the preservative effects of Si and ASA with Ni on the vase life of cut rose flowers was compared with emphasis on the possibility of Si and SA with Ni effect on antioxidative indicators of cut flower.

## MATERIALS AND METHODS

**Plant material and storage conditions:** The experiment was started on August 6, 2011 and chlorophyll content, Membrane stability, MDA content and ACC oxidase activity were measured. Roses were obtained from local commercial greenhouses (Pakdasht, Tehran, Iran). Following harvest and transport to the laboratory, the stems were recut to 40 cm length. In this study three levels of Si (0, 1.5, 2.5 mM), three levels of Ni (0, 1, 2 mM), three levels of acetylsalicylic acid (0, 1, 1.5 mM) were applied on rose cut flowers. After recording the fresh weight, each flower was placed in a 250 mL bottle containing preservative solutions.

**Vase life:** Vase life was determined as the number of days to wilting of flowers.

**Chlorophyll content measurement:** Total chlorophyll (a+b) content was measured by chlorophyll meter (SPAD-502, Minolta Co. Japan) which is presented by SPAD value. Average of 3 measurements from different spots of a single leaves was considered.

**Determination of anthocyanin leakage:** Anthocyanin leakage was measured based on the method of Poovaiah (1979).

**Determination of ACC-oxidase activity:** ACC oxidase activity was assayed by measuring to the method described by Moya-Leon *et al.* (2004).

**Assays of MDA content (lipid peroxidation):** Lipid peroxidation rates were determined by measuring the malondialdehyde equivalents according to Heath and Packer (1968).

**Water uptake and fresh weight:** The volume of water uptake was calculated by subtracting the volume of water evaporated from a control bottle without cut flowers from the amount of water decreased in bottles containing flowers. The fresh weight of the cut flowers also measured in initial day and terminal day of experiment.

**Experimental design and statistical analysis:** Experiment was arranged in a factorial test with complete randomized design with six replications. Analysis of variance was performed on the data collected using the General Linear Model (GLM) procedure of the SPSS software (Version 16, IBM Inc.). The mean separation was conducted by Tukey's analysis in the same software ($p = 0.05$).

## RESULTS AND DISCUSSION

**Vase life:** The results of showed that in comparison to the control, concentrations of Ni, ASA and Si prolonged the vase life of cut rose flowers. There were no significant ($p<0.05$) differences between 1 mM (ASA and Ni), 1.5 mM Si and control. Vase life of cut flowers held in 2.5 mM Si+ 1.5 mM Ni+1.5 mM ASA received to 12 days (Table 1). Jamali and Rahemi (2011) reported that treatment with Ni and Si significantly extends the vase life carnation. Ions of Ni, have an inhibitory effect on ACC oxidase by forming an enzyme-metal complex.On the other hand the

Table 1: Mean comparisons of chlorophyll content, vase life, MDA, Membrane stability and ACC oxidase activity in Ni, Si and ASA treatments and their interaction

| Si (mM) | ASA (mM) | Ni (mM) | Vase life (day) | Total chlorophyll (SPAD reading) | ACC oxidase activity (nmol $h^{-1}$ m $L^{-1}$) | MDA (μM $mg^{-1}$ protein) | Anthocyanin leakage (absorption at 525 nm) | Water uptake ($mL^{-1}$ flower) |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 7 | 1.34 | 76.32 | 231.14 | 165.41 | 65 |
| | | 1 | 7 | 1.87 | 75.12 | 200.10 | 160.40 | 60 |
| | | 2 | 8 | 1.00 | 46.11 | 123.04 | 100.01 | 60 |
| | 1 | 0 | 7 | 0.97 | 73.65 | 186.78 | 154.11 | 60 |
| | | 1 | 7 | 1.90 | 75.69 | 180.12 | 160.23 | 60 |
| | | 2 | 8 | 2.03 | 50.12 | 120.89 | 140.35 | 65 |
| | 1.5 | 0 | 9 | 2.74 | 45.13 | 120.03 | 30.41 | 75 |
| | | 1 | 8 | 1.56 | 49.33 | 116.98 | 77.90 | 70 |
| | | 2 | 9 | 2.00 | 40.12 | 78.68 | 65.47 | 75 |
| 1.5 | 0 | 0 | 9 | 2.11 | 89.11 | 176.14 | 56.44 | 70 |
| | | 1 | 9 | 1.67 | 84.56 | 87.56 | 58.47 | 70 |
| | | 2 | 10 | 3.41 | 55.14 | 70.15 | 51.00 | 75 |
| | 1 | 0 | 9 | 2.70 | 76.45 | 90.36 | 57.45 | 75 |
| | | 1 | 8 | 1.80 | 76.00 | 100.08 | 58.11 | 75 |
| | | 2 | 9 | 2.00 | 51.08 | 61.07 | 50.24 | 75 |
| | 1.5 | 0 | 10 | 3.70 | 55.23 | 73.12 | 45.57 | 80 |
| | | 1 | 9 | 2.45 | 57.90 | 70.12 | 50.12 | 75 |
| | | 2 | 10 | 3.00 | 50.11 | 70.00 | 43.12 | 85 |
| 2.5 | 0 | 0 | 10 | 2.68 | 68.14 | 65.14 | 41.20 | 90 |
| | | 1 | 9 | 1.96 | 64.12 | 69.06 | 54.36 | 90 |
| | | 2 | 10 | 3.70 | 50.78 | 61.54 | 41.00 | 100 |
| | 1 | 0 | 10 | 2.80 | 70.12 | 65.78 | 42.36 | 90 |
| | | 1 | 10 | 2.91 | 71.05 | 68.45 | 41.09 | 95 |
| | | 2 | 10 | 3.09 | 60.15 | 63.11 | 41.00 | 100 |
| | 1.5 | 0 | 11 | 4.00 | 50.12 | 64.14 | 39.87 | 125 |
| | | 1 | 11 | 4.01 | 50.00 | 60.37 | 35.14 | 110 |
| | | 2 | 12 | 5.12 | 40.39 | 51.12 | 26.78 | 135 |
| **F-test probabilities** | | | | | | | | |
| Si | | | 0.01 | 0.400 | 0.030 | 0.010 | 0.002 | 0.04 |
| ASA | | | 0 | 0.001 | 0.001 | 0.001 | 0 | 0.001 |
| Ni | | | 0.03 | 0.040 | 0.001 | 0.001 | 0 | 0.03 |

Means in each column followed by similar letters are not significantly different at 5% level

nitrogen cycle within plants can be affected by Ni (Bai *et al*., 2006) and this element have beneficial influence on rigidity of protein structures (Wood and Reilly, 2007) which might increase the total resistance of plants against senescence (Jamali and Rahemi, 2011). Similarity, Fan *et al*. (2008) found that application of SA on cut flowers increased vase life and enzyme antioxidant activity.

**Water uptake and fresh weight loss:** Water uptake rate increased at the first days of experiment in all treatments tested and then decreased ($p<0.05$). Uptake rate decreased rapidly in control and 1 mM (ASA and Ni) and 1.5 mM Si, while flowers that were treated by 2.5 mM Si+1.5 mM Ni+1.5 mM ASA showed the minimum decrease to day 12 (Table 1). These findings are in agreement with those reported by Lamikanra and Watson (2001, 2002), Fan *et al*. (2008), Kazemi and Shokri (2011) and Kazemi *et al*. (2011a-d).

**Chlorophyll content and anthocyanin leakage:** The application of different Ni, ASA and Si concentrations delayed the chlorophyll degradation and decreased anthocyanin leakage in comparison to control. The best treatment in this regards was 2.5 mM Si+1.5 mM Ni+1.5 mM ASA

and 1.5 mM ASA. There were no significant ($p<0.05$) difference between 1 mM (ASA and Ni), 1.5 mM Si and control. Hodson and Sangster (1988) reported that accumulated monosilicic acid polymerizes into polysilicic acid and then transforms to amorphous silica which forms a thickened silicone-cellulose membrane, by this means, a double cuticular layer protects and mechanically strengthens plants. Si might also form complexes with organic compounds in the cell walls of epidermal cells, therefore increasing their resistance to degrading enzymes (Snyder *et al*., 2007).

**ACO activity and MDA content:** ACO activity and MDA content in the cut flower decreased with increased ASA, Si and Ni concentrations treatments. ACO activity and MDA content in the cut flower, ASA, Si and Ni treatments significantly decreased the anthocyanin in the floret cut flower when compared to control ($p<0.05$). The results indicate that the treatment by 2.5 mM Si+1.5 mM ASA+1.5 mM Ni improved membrane permeability by decreasing Anthocyanin leakage and ACO activity in compared to control ($p<0.05$). Nickel (Ni) as an essential element, plays different roles in completion of plant life cycle (Wood and Reilly, 2007). It has been demonstrated that this element has anti-ethylene features and can impede its production (Zheng *et al*., 2006). Similarity, Kazemi *et al*. (2011a) showed that treatment with SA decreased the level of Anthocyanin leakage and ACO activity.

## CONCLUSION

The results showed that in comparison to the control, high concentrations of ASA, Si and Ni prolonged the vase life cut flowers. Holding rose cut flowers in vase solutions containing 2.5 mM Si+1.5 mM Ni+1.5 mM ASA significantly increased their vase life and delayed flower senescence compared to flowers of distilled water. This could suggest that the protection mechanism had helped the plants to increase their tolerance against ASA, Si and Ni.

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