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Effect of Cobalt, Silicon, Acetylsalicylic Acid and Sucrose as Novel Agents to Improve Vase-life of *Argyranthemum* Flowers

M. Kazemi
Young Researchers Club, Karaj Branch, Islamic Azad University, Karaj, Iran

ABSTRACT

This experiment revealed significant influence of cobalt (Co), silicon (Si), Acetylsalicylic Acid (ASA) and Sucrose (SUC) at different concentrations on the vase life of *Argyranthemum* cut flowers. In this study three levels of cobalt (0, 1 and 2 mM), three levels of silicon (0, 1.5 and 3 mM), three levels ASA (0, 1.5 and 3 mM) and two levels of SUC (0 and 2.5% w/v) were applied in a factorial arrangement, carried out in a complete randomized design on 324 *Argyranthemum* cut flowers. The recorded traits included Vase life, total chlorophyll content (SPAD reading), anthocyanin leakage, Malondialdehyde (MDA) content, ACC-oxidase (ACO) activity and water absorption. Results show that solution containing 2 mM cobalt, 1.5 mM silicon, 1.5 mM ASA and 2.5% w/v SUC could increase flower longevity in compared to control. Vase life in solution containing 3 mM silicon, 3 mM ASA and their combination didn't have significantly difference than control. The results showed that silicon and ASA treatments increased cut-flower water absorption, fresh weight and vase life, while decreasing MDA content, ACC-oxidase activity and membrane premeability together with total delay of senescence and peroxidation of lipids our results suggest the application of silicon, ASA and cobalt in preservative solutions for *Argyranthemum* flowers maintained the vase life of flowers for a longer period.

Key words: Vase life, *Argyranthemum*, cut flowers, chemical treatments, cobalt, silicon, acetylsalicylic acid, sucrose

INTRODUCTION

Argyranthemum is a summer flowering that is native to Spain and belongs to the Compositae family. The flower of *Argyranthemum* is highly ethylene sensitive and the longevity of the cut flower is very short. The cut flower industry is a US$ 2 billion industry and is important revenue for some of the major cut flower producers in the world (Yamada *et al.*, 2003; Chandran *et al.*, 2006). Senescence in the cut flower is affected by three main parameters: the water balance, the supply of carbohydrates and susceptibility to ethylene, ethylene leads to flower senescence, shortening of life (Reid and Wu, 1992; Jiang, 2000). The onset of flower senescence can delay by Treatment of flowers with inhibitors of ethylene biosynthesis or inhibitors of ethylene action.

Three of the preserving agents are Co, Si and ASA that inhibits ethylene synthesis and reduces sensitivity of flowers to ethylene (Epstein, 1994; Ansari and Misra, 2007; Mahdavian *et al.*, 2007; Mba *et al.*, 2007; Canakci, 2008; Shi and Zhu, 2008; Karlidag *et al.*, 2009; Joseph *et al.*, 2010). Reezi *et al.* (2009) showed that Si could extend the vase life of Rose cut flowers by decreasing ROS, malondialdehyde content and ethylene. Jamali and Rahemi (2011) reported that treatment with Co significantly extends the vase life carnation. Kazemi *et al.* (2011a, b, c, d) reported that addition of SA and SUC in the preserving solution increased the vase-life of cut flowers. SUC is another organic molecule known to delay senescence and prevents up-regulation of senescence-associated genes in carnation petals (Han, 2003; Kazemi and Shokri, 2011). In the present study, we test the hypothesis whether treatment with Co, Si, ASA and SUC or their combination extended the vase life of cut flowers by reduce senescence of cut flowers.

MATERIALS AND METHODS

Plant material and storage conditions: The experiment was started on August 1, 2011 and chlorophyll content, Membrane stability, MDA content and ACC Oxidase activity were measured. *Argyranthemum* were obtained from local commercial greenhouses (Pakdasht, Tehran, Iran). Following harvest and transport to the laboratory, the stems were recut to 40 cm in length. In this study three levels of Co (0, 1, 2 mM), three levels of Si (0, 1.5, 3 mM), SUC (0 and 2.5% w/v), three levels of ASA (0, 1.5 and 3 mM) were applied on *Argyranthemum* 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 leaves 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 (ACO) activity was assayed by measuring to the method described by Moya-Leon and John (1994).

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.

Superoxide dismutase: The activity of superoxide dismutase was measured based on the method described by Beauchamp and Fridovich (1971).

Experimental design and statistical analysis: Experiment was arranged in a factorial test with complete randomized design with four 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 analysis in the same software ($p = 0.05$).

RESULTS AND DISCUSSION

Anthocyanin leakage and ACO activity: Significant decrease in anthocyanin leakage and ACO activity was observed after treated cut flowers with ASA, Co, Si and SUC (Table 1). Table 1

Table 1: Mean comparisons of chlorophyll content, vase life, MDA, SOD activity, membrane stability and ACC oxidase activity in Co, Si, ASA and SUC treatments and their interaction

Co (mM)	Si (mM)	ASA (mM)	SUC (v/w)	vase life (day)	Total chlorophyll (SPAD reading) (nmol h^{-1} mL^{-1})	ACC oxidase activity (at 525 nm)	Anthocyanin leakage (Absorption protein)	MDA (µmol mg^{-1})	Water uptake (mL^{-1} flower)	SOD (U g^{-1} protein)
0	0	0	0	4	0.87	68.23	111.14	203.45	55	55.14
			2.5	5	0.94	69	90.36	167.84	55	59.41
		1.5	0	6	1	25.11	45.65	50.18	60	120.3
		3	0	3	0.37	75.42	156.34	231.7	35	33.4
	1.5	0	0	5	1	33.65	80	100	50	60.14
		1.5	0	6	1	25	40.12	78.6	50	78.9
			2.5	6	1	29.65	41.23	92.5	50	80.3
1	0	0	0	6	0.95	65.11	94.15	90.36	65	70.25
			2.5	6	1	65	92.14	94.54	65	70
		1.5	0	6	1.02	64.15	75.18	84.6	55	84.12
			2.5	6	1.3	63.11	76.14	86.2	50	85.09
	1.5	0	0	6	1	60.14	75.14	85.5	45	80.17
			2.5	6	1	62.35	74.65	87.86	50	79.8
		1.5	0	7	1.4	60.7	66.33	70.48	50	97.11
			2.5	7	0.99	55.45	66	73.45	65	95.99
		3	0	4	0.71	70.32	89.14	96.8	45	46.14
			2.5	4	0.79	69.35	90.56	90.4	45	46.07
2	0	0	0	6	1.01	45.12	55.65	70.5	55	90.35
			2.5	6	1.11	44.69	56.89	70.12	60	87.78
	1.5	0	0	6	1	33.56	50.12	64.7	60	90.59
			2.5	6	0.86	31.9	50.36	65.5	60	86.45
		1.5	0	7	1.5	20.14	35.11	41.7	75	132.17
			2.5	9	3.12	25.05	40.16	52.01	85	100
	3	1.5	0	4	0.9	60.17	59.64	74.1	45	64.15
			2.5	5	1	58.69	60.23	75.12	50	63.18
		3	0	4	1	70.12	84.56	168.9	40	40.07
			2.5	4	1	69.78	89.3	170.87	55	49
F-test probabilities										
Co				0.05	0.06	0.05	0.04	0.04	0.05	0.02
Si				0.05	0.07	0.05	0.04	0.03	0.5	0.03
ASA				0.001	0.02	0.01	0.001	0.01	0.3	0.002
SUC				0.04	0.04	0.08	0.1	0.2	0.1	0.1

shows that significant decreases in anthocyanin leakage and ACO activity were recorded in Co (2 mM) treatments followed by the low concentration of ASA and Si (1.5 mM) ($p<0.05$). The results indicate that the treatment by 2 mM Co+1.5 mM ASA+1.5 mM Si improved membrane permeability by decreasing anthocyanin leakage and ACO activity in compared to control ($p<0.05$). These findings are in agreement with those reported by Lamikanra and Watson (2001, 2002), Kazemi and Shokri (2011), Kazemi *et al.* (2011a, b, c, d). Similarity, Zhang *et al.* (2003) showed that pretreatment with SA decreased the level of anthocyanin leakage and ACO activity.

MDA content and superoxide dismutase activity: The results from Table 1 showed that the MDA content and superoxide dismutase activity gradually decreased and increased (respectively) during vase life ($p<0.05$). Flower-treated with ASA and Si at level 1.5 and 1.5 mM, (respectively) significant decrease and increase malondialdehyde (MDA) content and superoxide dismutase activity in cut flowers. Co did not affect superoxide dismutase activity in cut flowers. As Zhang *et al.* (2003) reported, application of SA on kiwifruit increased superoxide free radical and enzyme antioxidant activity. A similar finding in a previous reported by Kazemi *et al.* (2011a) found that application of SA on cut flower increased enzyme antioxidant activity.

Water uptake, fresh weight and chlorophyll content: The results indicated that Co had no effect to the water uptake and fresh weight in during vase life (Table 1). Both treating with Si at level 1.5 mM and ASA at level 1.5 mM stimulated the highest Water uptake and fresh weight after storage ($p<0.05$). *Argyranthemum* flower showed a sharp increase the wilting incidence after storage. The results showed that flower treated with 1.5 mM Si+ 1.5 mM ASA appeared the least bract wilting, when compared to control ($p = 0.05$). The total chlorophyll content of the flower increased with ASA and SUC treated cut flowers (Table 1). Chlorophyll content was not affected by Co treatment. These results are in agreement with those of Kazemi *et al.* (2011b, c) who found that adding ASA and GLU in vase water increased chlorophyll content cut flowers. Similarity, Canakci (2008) reported that treatment with salicylic acid significantly extends the vase life with increases chlorophyll content.

Vase life: The results showed that in comparison to the control, all concentrations of Co prolonged the vase life cut flowers. There were no significant ($p<0.01$) differences between 1.5 mM Co and control. Vase life of cut flowers held in distilled water received to 4 days (Table 1). Holding *Argyranthemum* cut flowers in vase solutions containing 2 mM Co+1.5 mM Si+1.5 mM ASA+2.5 v/w SUC significantly increased their vase life and delayed flower senescence compared to flowers either held in 3 mM ASA, 3 mM Si or distilled water (Table 1).

CONCLUSION

The improvement of vase life of *Argyranthemum* by the use of Co, Si, ASA and SUC remained approximately for 5 days more compared with control (simple distilled water), which suggests that an extensive research work should be carried out to reach in a final conclusion for using such chemicals to enhance the vase life in *Argyranthemum*.

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