Asian Journal of Biochemistry

ISSN 1815-9923

Academic
Journals Inc.

www.academicjournals.com

Asian Journal of Biochemistry 7 (3): 171-176, 2012
ISSN 1815-9923 / DOI: 10.3923/ajb.2012.171.176

Effects of Silicon on Antioxidative Defense System and Membrane Lipid Peroxidation in Gerbera Cut Flower

[1]M. Kazemi, [2]M. Gholami and [3]F. Hassanvand
[1]Young Researchers Club, Karaj Branch, Islamic Azad University, Karaj, Iran
[2]Department of Plant Pathology, College of Agriculture, Science and Research Branch of Islamic Azad University, Tehran, Iran
[3]Young Researchers Club, Borujerd Branch, Islamic Azad University, Borujerd, Iran

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

ABSTRACT

To understand the factors that induce floral senescence in gerbera, this study has investigated the effects of various chemical agents on flower senescence. The experiment was carried out to investigate the effect of different concentrations of silicon, acetylsalicylic acid and glutamine on keeping quality and vase life of gerbera cut flowers. The vase were placed in chambers at 19°C, relative humidity about 70% and 14th photoperiod that was maintained using fluorescent lamps (light intensity of 15 μmol m^{-2} sec^{-1}) at the top of the corolla. The recorded traits included Vase life, total chlorophyll content (SPAD reading), anthocyanin leakage, malondialdehyde content, ACC-Oxidase activity and water absorption. The experiments show that: 3 mM silicon had no significant influence but 1 and 2 mM silicon caused an increase on vase life. The results showed that silicon, acetylsalicylic acid and glutamine 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.

Key words: Vase life, gerbera, silicon, acetylsalicylic acid, glutamine

INTRODUCTION

Gerbera (*Gerbera jamesonii*) and its hybrids are well known for their variable shapes and colors and is one of the ten most popular commercial cut flowers in the world (Kazemi *et al*., 2011a). In many flowers, one of the reasons for senescence is closely linked to ethylene evolution (Kazemi *et al*., 2011b). Ethylene promoted flower senescence, increased production of oxygen free radicals (ROS), malondialdehyde (MDA) accumulation, respiratory activity and loss of cell membrane fluidity (Abeles *et al*., 1992; Mittler, 2002; Jaleel *et al*., 2006; Yildirim *et al*., 2008; Chakrabarty *et al*., 2009). Use of preserving substances in vase solution is a widely used method for increasing the vase-life. Ethylene antagonists inhibit the action of ethylene at the molecular level by blocking its receptor site (Khan *et al*., 2003; El-Tayeb *et al*., 2006; Shi and Zhu, 2008; Joseph *et al*., 2010). Two of the preserving agents are ASA and Si that inhibits ethylene synthesis and reduces sensitivity of flowers to ethylene (Epstein, 1994; Fariduddin *et al*., 2003; Waseem *et al*., 2006; Ansari and Misra, 2007; Arfan *et al*., 2007; Mahdavian *et al*., 2007; Mba *et al*., 2007; Canakci, 2008; Karlidag *et al*., 2009; Kazemi *et al*., 2011a-d). Reezi *et al*. (2009) showed that Si could extend the vase life of Rose cut flowers by decreasing ROS, malondialdehyde

content and ethylene. Kazemi *et al.* (2011a-d) reported that a correlation between the antioxidant enzyme activities and SA concentrations. Glutamine is readily metabolized by plants, and cells can metabolize glutamine for energy, so we considered using it as a possible substitute for sucrose (Kovacevic and McGivan, 1983; Kazemi *et al.*, 2011b). Therefore, In this study, the preservative effects of Si, ASA, glutamine and their interaction on the vase life of cut gerbera flowers were studied.

MATERIALS AND METHODS

Plant material and storage conditions: The experiment was started on June 1, 2010 and chlorophyll content, Membrane stability, MDA content and ACC oxidase activity were measured. Gerbera (*Gerbera jamesonii*) 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 four levels of Si (0, 1, 2 and 3 mM), two levels of glutamine (0 and 3 mM), three levels of acetylsalicylic acid (0, 1.5 and 3 mM) were applied on gerbera 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 (ACO) 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).

Microbe population: Test Microbe population were isolated from vase solutions of gerbera by measuring to the method described by Zagory and Reid (1986).

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

According to Table 1, Si and ASA affected Water uptake and fresh weight and microbial population significantly ($p<0.05$). Increasing of ASA and Si levels caused decreases water uptake and fresh weight in vase solution of gerbera cut flowers significantly, while the microbial population decreased with the increase in concentrations of ASA and Si (Table 1). The best treatment in this increase water uptake and decrease the microbial population was 2 mM silicon+3 mM glutamine+1.5 mM ASA. There were no significant ($p<0.05$) difference between 1 mM Si and control. These results are in agreement with those of (Anjum *et al.*, 2001) who found that adding a suitable germicide in vase water can prevent the growth of microbes and increased water uptake. Kazemi *et al.* (2011a) showed that the treatment of salicylic acid reduced microbial population in vase solution of gerbera cut flowers and increased water uptake in carnation cut flowers. Treatment with ASA, Si and glutamine (Table 1) showed remarkable decreases in the anthocyanin leakage and ACO activity as compared with the control ($p = 0.05$). Treatment with 2 mM silicon+1.5 mM ASA higher delayed the climacteric ethylene production, Anthocyanin leakage and extended vase life of the carnation (Table 1), While Treatment with Silicon 3 and 3 mM ASA increased anthocyanin leakage and ACO activity and senescence ($p = 0.05$). These results are in agreement with those of Hussein and Orabi (2008) and Ahmed *et al.* (2010) who found that the treatment of salicylic acid reduced anthocyanin leakage and ACO activity in cut flowers. Similarity, Liu *et al.* (2006) and Kazemi *et al.* (2011c, d) showed that the treatment of salicylic acid reduced anthocyanin leakage and ACO activity in cut flowers.

According to Table 1, Si and ASA affected MDA content and superoxide dismutase activity significantly. Table 1 showed that under the effect of 2 mM silicon+1.5 mM ASA treatment increase SOD activity and decreased accumulation MDA significantly in compared to control ($p<0.05$). The results indicate that the treatment by 2 mM silicon+1.5 mM ASA improved membrane permeability by increasing SOD activity and decrease accumulation MDA in compared to control. This indicates that with silicon and ASA concentration increased, the SOD activity was decreased. Kazemi *et al.* (2011c, d) showed that the treatment of salicylic acid increase SOD activity and decreased accumulation MDA significantly in cut flowers. Similarity, Reezi *et al.* (2009) showed that Si could extend the vase life of Rose cut flowers by decreasing ROS, malondialdehyde content and ethylene. According to Table 1, under the influence of ASA the chlorophyll content greatly increased. Kazemi *et al.* (2011a) observed that chlorophyll biosynthesis increased treatment with SA in the ct flower ($p<0.05$). El-Tayeb *et al.* (2006) found that Chl a, b and carotenoids increased significantly in SA treated plants in comparison to controls of barley plants. SA treatments were increased pigments content of the plants under non salinity and salinity condition (Table 1). The best treatment in this increase chlorophyll content was 2 mM silicon+3 mM glutamine+1.5 mM SA . According to Table 1, significant differences were observed among the different treatments in term vase life ($p<0.05$). Among the different Si and SA concentrations, 2 mM silicon+1.5 mM ASA+3 mM glutamine with average vase life of 16 days was better than other treatments and as compared to the control treatment, it increased the vase life more than 10 days (Table 1). Result our showed that treatment with Si, glutamine and ASA extends the vase life of cut gerbera flowers. Also, Si, glutamine and ASA reduced chlorophyll total degradation and preserved chlorophyll total content. These findings are similar to previous results (Kazemi *et al.*, 2011a, b).

Table 1: Mean comparisons of chlorophyll content, Vase life, MDA, SOD activity, Membrane stability and ACC Oxidase activity in silicon, SA and glutamine treatments and their interaction

Si (mM)	ASA (mM)	Glutamine (mM)	Vase life (day)	Total chlorophyll (SPAD reading)	ACC Oxidase activity (nmol h^{-1} mL^{-1})	Antocyanin leakage (absorption at 525 nm)	MDA (µmol mg^{-1} protein)	Water uptake (mL per flower)	Colony count (cfu mL^{-1})	SOD (U g^{-1} Protein)
0	0	0	6	1	112.1	238.7	141.19	100	601	54.11
		3	8	2	80.02	100	103.3	105	275	60.3
	1.5	0	10	2.39	65.14	60.39	70.14	115	75	103.01
		3	11	3	65.09	59.59	70	120	100	101.06
	3	0	5	0.93	100.9	200.31	164	45	54	21.01
		3	6	1	80.17	176.14	123.08	50	56	30.8
1	0	0	6	1.63	65.8	66.52	100	95	167	64.78
		3	7	2	61.26	62.38	100.31	100	151	64
	1.5	0	10	2.97	61.32	61	82.11	100	114	90.03
		3	11	3.14	61.16	61	83.65	105	106	86.45
	3	0	7	1.01	74.54	98.36	111.1	45	79	46.39
		3	7	1	70.6	88.03	109.35	45	117	50.37
2	0	0	11	3	59	65.45	79.68	120	104	70.06
		3	12	3.47	57.79	65.02	80	125	101	70.39
	1.5	0	13	4.4	25.14	44.03	45.03	135	51	119.23
		3	16	5.6	29	50.43	49.11	155	51	100.07
	3	0	8	2	65.84	61	80.15	110	103	54.18
		3	8	2	63.31	75.65	86.39	100	108	56.89
3	0	0	5	0.93	70.06	84.45	96.3	60	53	29.19
		3	6	1	69.31	84	92.13	65	84	29.29
	1.5	0	6	1	70	86.8	100.23	65	58	65.12
		3	6	1	70.12	85.94	90	65	64	60.16
	3	0	5	0.78	120.32	243.1	161.09	50	60	20.11
		3	6	1.08	96.16	164.65	100.04	60	57	33.89
F-test probabilities										
Si			0	0.02	0.001	0	0.001	0	0.02	0.02
SA			0	0	0.002	0	0	0	0	0
Glutamine			0	0	0.04	0.03	0.04	0	0.03	0.04

CONCLUSION

Based on present study and the previous results, it could be concluded that Si, ASA and GLU treatment had higher benefit effect to improvement of postharvest quality of the cut flowers in comparison with control treatment. Further studies are required, especially to validate some antioxidant enzyme activity, antioxidant capacity and proline concentrations.

REFERENCES

Abeles, F.B., P.W. Morgan and M.E. Saltveit, 1992. Ethylene in Plant Biology. 2nd Edn., Academic Press, New York, USA, Pages: 414.

Ahmed, A.G.A., M.A. Bekheta and S.A. Orabi, 2010. Influence of arginine on growth and productivity of two sorghum cultivars grown under water shortage. Int. J. Acad. Res., 2: 72-80.

Anjum, M.A., F. Naveed, F. Shakeel and S. Amin, 2001. Effect of some chemicals on keeping quality and vase-life of tuberose (*Polianthus tuberosal*) cut flower. J. Res. Sci., 12: 1-7.

Ansari, M.S. and N. Misra, 2007. Miraculous role of salicylic acid in plant and animal system. Am. J. Plant Physiol., 2: 51-58.

Arfan, M., H.R. Athar and M. Ashraf, 2007. Does exogenous application of salicylic acid through the rooting medium modulate growth and photosynthetic capacity in two differently adapted spring wheat cultivars under salt stress? J. Plant Physiol., 164: 685-694.

Beauchamp, C. and I. Fridovich, 1971. Superoxide dismutase: Improved assays and assay applicable to acrylamide gels. Anal. Biochem., 44: 276-287.

Canakci, S., 2008. Effects of salicylic acid on fresh weight change, chlorophyll and protein amounts of radish (*Raphanus sativus* L.) seedlings. J. Biol. Sci., 8: 431-435.

Chakrabarty, D., A.K. Verma and S.K. Datta, 2009. Oxidative stress and antioxidant activity as the basis of senescence in *Hemerocallis* (day lily) flowers. J. Hortic. For., 1: 113-119.

El-Tayeb, M.A., A.E. El-Enany and N.I. Ahmed, 2006. Salicylic acid-induced adaptive response to copper stress in sunflower (*Helianthus annuus* L.). Int. J. Bot., 2: 372-379.

Epstein, E., 1994. The anomaly of silicon in plant biology. Proc. Nat. Acad. Sci., 91: 11-17.

Fariduddin, Q., S. Hayat and A. Ahmad, 2003. Salicylic acid influences net photosynthetic rate, carboxylation efficiency, nitrate reductase activity, and seed yield in *Brassica juncea*. Photosynthetica, 41: 281-284.

Heath, R.L. and L. Packer, 1968. Photoperoxidation in isolated chloroplasts. I. Kinetics and stoichiometry of fatty acid peroxidation. Arch. Biochem. Biophys., 125: 189-198.

Hussein, M.M. and S.A. Orabi, 2008. Growth and antioxidant enzymes activity in onion plants as affected by thiamine and salinity. Proceedings of the CIEC 17th International Symposium on Plant Nutrient Management under Stress Conditions, November 24-27, 2008, Cairo, Egypt, pp: 261-278.

Jaleel, C.A., R. Gopi, G.M.A. Lakshmanan and R. Panneerselvam, 2006. Triadimefon induced changes in the antioxidant metabolism and ajmalicine production in *Catharanthus roseus* (L.) G. Don. Plant Sci., 171: 271-276.

Joseph, B., D. Jini and S. Sujatha, 2010. Insight into the role of exogenous salicylic acid on plants grown under salt environment. Asian J. Crop Sci., 2: 226-235.

Karlidag, H., E. Yildirim and M. Muran, 2009. Salicylic acid ameliorate the adverse effect of salt stress on strawberry. Sci. Agricola, 66: 180-187.

Kazemi, M., E. Hadavi and J. Hekmati, 2011a. Role of salicylic acid in decreases of membrane senescence in cut carnation flowers. Am. J. Plant Physiol., 6: 106-112.

Kazemi, M., M. Aran and S. Zamani, 2011b. Extending the vase life of lisianthus (*Eustoma grandiflorum Mariachii*. cv. blue) with different preservatives. Am. J. Plant Physiol., 6: 167-175.

Kazemi, M., S. Zamani and M. Aran, 2011c. Effect of some treatment chemicals on keeping quality and vase-life of cut flowers. Am. J. Plant Physiol., 6: 99-105.

Kazemi, M., S. Zamani and M. Aran, 2011d. Interaction between glutamin and different chemicals on extending the vase life of cut flowers of Prato lily. Am. J. Plant Physiol., 6: 120-125.

Khan, W., B. Prithiviraj and D.L. Smith, 2003. Photosynthetic response of corn and soybean to foliar application of salicylates. J. Plant Physiol., 160: 485-492.

Kovacevic, Z. and J.D. McGivan, 1983. Mitochondrial metabolism of glutamine and glutamate and its physiological significance. Physiol. Rev., 63: 547-605.

Liu, H.T., Y.Y. Liu, Q.H. Pan, H. Yang, J. Zhan and W.D. Huang, 2006. Novel interrelationship between salicylic acid, abscisic acid, and PIP2-specific phospholipase C in heat acclimation-induced thermotolerance in pea leaves. J. Exp. Bot., 57: 3337-3347.

Mahdavian, K., K.M. Kalantari and M. Ghorbanli, 2007. The effect of different concentrations of salicylic acid on protective enzyme activities of pepper (*Capsicum annuum* L.) plants. Pak. J. Biol. Sci., 10: 3162-3165.

Mba, F.O., X. Zhi-Ting and Q. Hai-Jie, 2007. Salicylic acid alleviates the cadmium toxicity in Chinese cabbages (*Brassica chinensis*). Pak. J. Biol. Sci., 10: 3065-3071.

Mittler, R., 2002. Oxidative stress, antioxidants and stress tolerance. Trends Plant Sci., 7: 405-410.

Moya-Leon, M.A., M. Moya and R. Herrera, 2004. Ripening of mountain papaya (*Vasconcellea pubescens*) and ethylene dependence of some ripening events. Postharvest Biol. Technol., 34: 211-218.

Poovaiah, B.W., 1979. Increased levels of calcium in nutrient solution improves the postharvest life of potted roses. J. Am. Soc. Hort. Sci., 104: 164-166.

Reezi, S., M. Babalar and S. Kalantari, 2009. Silicon alleviates salt stress, decreases malondialdehyde content and affects petal color of salt stressed cut rose (*Rosa xhybrida* L.) Hot Lady. Afr. J. Biotechnol., 8: 1502-1508.

Shi, Q. and Z. Zhu, 2008. Effects of exogenous salicylic acid on manganese toxicity, element contents and antioxidative system in cucumber. Environ. Exp. Bot., 63: 317-326.

Waseem, M., H.U.R. Athar and M. Ashrafi, 2006. Effect of salicylic acid applied through rooting medium on drought tolerance of wheat. Pak. J. Bot., 38: 1127-1136.

Yildirim, B., F. Yasar, T. Ozpay, D. TurkOzu, O. Terzio lu and A. Tamkoc, 2008. Variations in response to salt stress among field pea genotypes (*Pisum sativum* sp. *Arvense* L.). J. Anim. Vet. Adv., 7: 907-910.

Zagory, D. and M.S. Reid, 1986. Role of vase solution microorganisms in the life of cut flowers. J. Am. Soc. Hort. Sci., 111: 154-158.