Influence of Malic Acid in Extension of Vase Life of Cut *Eustoma grandiflorum* Flowers

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Abstract

In this study, effect of foliar application of 5-sulfosalicylic acid and malic acid in extending the vase-life of *Eustoma grandiflorum Mariachii. cv. white* flowers was investigated. The treatments included malic acid at three levels (1.5, 3 and 5 mM) and 5-sulfosalicylic acid at three levels (0.5, 1 and 1.5 mM) and distilled water as a control. Results showed 5-sulfosalicylic acid and malic acid increased chlorophyll and carbohydrate content, while descreasing ACC-oxidase activity and delay of senescence and peroxidation of lipids. In general, spraying 5-sulfosalicylic acid and malic acid at level of 1.5 and 5 mMare recommended for increasing of vase life of cut *Eustoma grandiflorum* flowers.

Keywords:5-mulfosalicylic acid, malic acid, *Eustoma grandiflorum*, preservative solution

Introduction

Salicylic acid is the most readily accessible plant growth regulators which are effective in other forms of acetyl salicylic acid and methyl salicylate in plant as well (Raskin et al. 1992). Salicylic acid could induce the alternative oxidase enzyme activity in mitochondria which is involved in stress alleviation mechanism and enhancing or reduction in specific secondary metabolites of plants is reported (Raskin et al., 1992; Kiddle et al., 1994; Prithiviraj et al., 2005; D'onofrio et al., 2009). Salicylic acid and its derivatives are widely in use to enhance fruits postharvest life by controlling their firmness (Kazemi et al., 2011). Salicylic acid has been documented to enhance flesh firmness of harvested peaches during storage and banana fruits during ripening (Wang et al., 2007).

Malic acid is the organic acid which plants could metabolize it by reaction of malic enzyme in mitochondria which could be considered as ability limited to plant. Malate is a common reserve anion acting as a counter ion for K and Ca in plant vacuoles, especially in nitrate dependent plants (Day, 1977). In this study, effects of 5-sulfosalicylic acid and malic acid on the vase life of cut *Eustoma grandiflorum Mariachii. cv. white* flowers was reported.

Materials and Methods

The treatments included malic acid at three levels (1.5, 3 and 5 mM) and 5-sulfosalicylic acid at three levels (0.5, 1 and 1.5 mM) and distilled water as a control, in a factorial test with complete randomized design with 5 replications. The vase life of the inflorescence was considered terminated when 50% of the open flowers had wilted. 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. ACC-Oxidase (ACO) was measured based on the method of Moya-Leon and Herrera (2004). Oxidative damage to lipids was measured based on the method of Heath and Packer (1968). Carbohydrates were measured based on the method of Hassan (2005). 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.

Results and Discussion

As result has shown 5-sulfosalicylic acid and malic acid increased chlorophyll and carbohydrate content, while decreasing ACC-oxidase activity and delay of senescence and peroxidation of lipids. (Table 1). The results indicate that 1.5 mM 5-sulfosalicylic acid caused a significant increase in chlorophyll content and vase life, while reduced ACO and MDA. On the other hands, malic acid has effective significantly ($p<0.05$) (Table1).

Carbohydrate contents in petals decreased rapidly in present cut flowers in solutions containing control while flowers in the solutions containing 5 and 1.5 mM malic acid and 5-sulfosalicylic showed the minimum decrease in carbohydrate contents of the end of day 11 ($p\leq0.05$) (Table 2). In agreement with our result, Kazemi et al. (2010) found that application of MA on cut flower increased vase life and enzyme antioxidant activity. Kazemi et al. (2011) reported that treatment with malic acid and salicylic acid significantly extends the vase life with reduced the anthocyanin leakage and ACO activity.

The application of nano-malate as preservative in solutions *E. grandiflorum* flowers maintained the vase life of flowers for a longer period. It is suggested that because SA has anti-senescence influence on plant organs, vegetative growth may be prolonged following its application consequently leading to higher leaf area. Martin-Mex et al. (2005) also reported that SA treatment was able to increase root fresh weight of African violet. In general, spraying 5-sulfosalicylic acid and malic acid at level at 1.5 and 5 mM is recommended for increasing of vase life of cut *Eustoma grandiflorum* flowers.

Table 1 Mean comparisons of chlorophyll content, vase life, MDA and ACC oxidase activity in malic acid and 5-sulfosalicylic treatments.

Treatment		Vase life (day)	Chlorophyll total (a+b) content (spad reading)	ACC Oxidase activity (nmol gFW^{-1} h^{-1})	MDA (µmol mg^{-1} protein)
Control	0	4	1.02	56.14	112.021
5-sulfosalicylic (mM)	0.5	6	1.21	50.14	108.41
	1	10	1.89	41.25	78.35
	1.5	14	3.14	22.01	52.03
Malic acid (mM)	1.5	7	1.68	52.14	100.02
	3	9	2.04	40.21	92.41
	5	11	3	29.03	87.65
F-test	5-sulfosalicylic	0.000	0.001	0.001	0.001
	Malic acid	0.000	0.000	0.04	0.05

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

Table 2 Effect of malic acid and 5-sulfosalicylic on carbohydrate content (mg^{-1} dry weight) for petals of cut flowers

Treatment	Petals								
	1st day			4th day			11th day		
	Fructose	Glucose	Sucrose	Fructose	Glucose	Sucrose	Fructose	Glucose	Sucrose
Control (0)	0.39	1.42	1.81	0.28	0.51	0.65	-------	-------	-------
5-Sulfosalicylic 0.5 mM	0.42	1.4	1.8	1.48	0.69	0.74	-------	-------	-------
5-Sulfosalicylic 1 mM	0.42	1.42	1.82	1.49	0.98	0.86	------	-------	-------
5-Sulfosalicylic 1.5 mM	0.42	1.4	1.8	2.35	1.98	1.79	3.35	2.51	3.25
Malic acid 1.5 mM	0.41	1.4	1.84	1.65	0.65	0.71	--------	-------	-------
Malic acid 3 mM	0.43	1.43	1.81	1.87	0.89	0.95	-------	-------	-------
Malic acid 5 mM	0.43	1.4	1.82	2.28	1.86	1.61	3.21	2.14	3.11

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