Journal of Applied Horticulture, 10(2): 149-153, July-December, 2008

Influence of ethanol on the longevity and delayed senescence of bougainvillea flower

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Abstract

The study was carried out to investigate the effect of ethanol (ET) at different concentrations on longevity and senescence delay in bougainvillea flowers. The treatments were water (control), 2, 4, 8, 10, 20, 30, 40, 50 and 70% ET. Positive response was found in case of 4, 8 and 10% of ET after a certain period of treatment application. Dry weight was higher in lower concentrations of ethanol and lower in higher concentrations. Flower longevity was 2 days longer in 4, 8 and 10% ET than in water control and other concentrations of ethanol. Petal wilting and abscission occurred 2 days later in 4, 8 and 10% ET than in control. Perianth abscission also appeared 2 days later in 4, 8 and 10% ET than in control. However, petal discoloration (color change) was later in control, 2, 4, 8 and 10% than in 20, 30, 40, 50 and 70% ET. The results showed that flower vase life was significantly affected by ethanol concentrations as well as longevity was longer in 4, 8 and 10% ET than in water control and other concentrations.

Key words: Bougainvillea flower, vase life, senescence, ethanol

Introduction

Bougainvilleas are popular ornamental plants and are used as decorative flowers in most areas with warm climates, including Australia, India, Malaysia, the Mediterranean region, Mexico, South Africa, Taiwan, and Arizona, California, Florida, Hawaii, and southern Texas in the United States. Bougainvilleas are used to decorate fences and arbors with explosion of color in the house corridor, office and play ground. A bougainvillea tree can make guarding the entry or framing a window. Bougainvillea is a great vine for large containers to decorate hot patios and plazas. Bougainvillea is also used to create beautiful flowering bonsai specimens. Bougainvillea flower are dropped having a short vase life. Cameron (1981) reported that bougainvillea bracteoles were attractive at the end of a 6-day observations period but 32.2% dropped in treated with STS (0.5 oz/Gallon) whilst, 100% dropped in the control.

Pun *et al.* (1999) reported that vase life of carnation flowers increased with treatment of 4 and 6% ethanol and cultivars showed variable response to ethanol treatment with regards to vase life increment, and delay in bud opening. They also mentioned that treatment with 4% ethanol inhibited ethylene production as well as sensitivity to ethylene.The effectiveness of ethanol in extending vase life correlated closely with the longevity, ethylene production and sensitivity.

Longevity of vase life is an important factor in consumer preference and considerable research has been carried out on the causes of carnation senescence (Menguc and Usta, 1994; Reid *et al.,* 1980, 1983). Senescence of cut flowers is induced by several factors, *e.g.*, water stress (Sankat and Mujaffar, 1994), carbohydrate depletion (Ketsa, 1989), micro-organisms (Witte and Van Doom, 1991), and ethylene effects (Wu *et al.,* 1991). Climacteric senescence can be prevented, and hence longevity of the flowers increased, with the use of various chemicals (Staby *et al.,* 1993) as a pre-treatment or in the vase solution (Reid *et al.,* 1980), resulting in inhibition of either ethylene biosynthesis or ethylene action or both. Of the available chemicals, silver thiosulphate (STS) is the most effective and widely-used commercial postharvest treatment for carnation cut flowers (Reid *et al.,* 1980). Ethanol has been found to be effective in increasing the vase life of carnation flowers by inhibiting ethylene biosynthesis (Heins and Blakely, 1980; Wu *et al.,* 1992) as well as its action (Wu *et al.,* 1992). The concentration of ethanol effective in increasing vase life of carnation flowers ranges from 2% for an unknown cultivar (Heins and Blakely, 1980) to 8% (Wu *et al.,* 1992).

Podd and Staden (2004) stated that acetaldehyde and ethanol, when applied at low concentration in holding solutions both extended the vase life of cut carnation flowers by inhibiting the action of ACC synthase. Treatment of cut carnation flowers with low concentrations of ethanol increases their vase life significantly (Heins, 1980; Podd and Staden, 1998; Wu *et al.,* 1992). The aims of this project are to develop develop techniques for retaining bougainvillea flower quality (color development, longevity, expansions and delay senescence) by applying different ethanol concentrations.

Materials and methods

Plant material: Three-year-old bougainvillea plants were used in this experiment for collecting flower sample. Bougainvillea flowers (purple) were collected from nursery, University of Malaya campus. The plant was 0.75 m of height and canopy length was 1.0 m. The plant consisted of 4 branches. Flowers were harvested from each branch randomly.

Flower harvesting and measurement: The flowers were harvested on January 18, 2007. Flowers were weighed immediately after harvest and used for setting treatments.

Treatment setting: Treatments were set following Complete Randomized Block design. Each treatment was replicated 4 times. Total 40 flowers of 4 branches were collected for 10 treatments. The treatments were water (control), 2, 4, 8, 10, 20, 30, 40, 50 and 70% ethanol (ET). Flower stems (petiole) were placed individually in distilled water immediately after cutting and sprayed to the petal and perianth with different concentrations of ethanol solutions. The samples were placed at 28 °C of room temperature.

Response characters determination: Response characters were observed. Positive (+) indicates freshness of flower just before wilting. Negative (-) was considered as wilting of flower.

Vase life, petal wilting, scar (color changed) and senescence evaluation: Vase life was observed by counting day. Flower status was observed everyday. Percent petal wilting was calculated by taking the total petal area divided by wilted petal area multiplying by 100. Color changing (petal scar) was determined by visual observation. After wilting phase, petal senescence was evaluated by observing petal abscised position.

Fresh and dry weight measurements: Fresh weight was measured immediately after harvest on 18th January, 2007. Dry weight was measured after all flowers were abscised.

SPAD measurement: SPAD value was measured by SPAD-502, Minolta Co. Japan. The petal was inserted into the meter and SPAD value measured 5 times from different parts of a single petal.

Petal abscission measurement: Flowers were forced with air using a fan. The flowers were kept in front of a table fan for 5 min. Petal abscission was calculated by counting the percentage of petal drop.

Statistical analysis: Mean seperations were done by Duncan`s multiple range test (DMRT).

Results

Response to ethanol was positive (before wilting) from 12 h-6 days after treatment (DAT) and afterwards negative in case of all treatments (Table 1). The highest positive response (6d) was found at 8 and 10% ET treated flower and the lowest (1st day) was found at 70% ET treated flower. In case of water (control), wilting occurrence was observed on 5th day, while it occured at 7 DAT for 8 and 10% ET treated flower (Fig. 1). The wilting occurred from 1 DAT for 50 and 70% ET, 2 DAT for 30 and 40 % ET, 3 DAT for 20 % ET, 6 DAT for 4% ET, 5 DAT for 2 % ET and water (control), 7 DAT for 8 and 10 % ET treated trees (Fig. 1). In case of water control 100% wilting was observed on 7 DAT, while it was found in 9 DAT for 8 and 10% ET treated flower. Percent petal abscission was earlier for water control, 2% ET than 4, 8 and 10% ET (Fig. 2). The petal abscission range was 3-12 days in different concentrations of ethanol.

The abscission order was 70< 50 < 30 < 20 < control and 2 <4, <8 and 10% ET. The similar trend was found for percent perianth abscission (Fig, 3). But the perianth abscission was 1 day later than petal abscission. The 100% perianth abscission was found for 8 and 10% ET on 12th day while, on 11th day for water control, 2, 4 and 20% ET treated flower. Percent petal discoloration was earlier in water, 2, 4 20, 30, 40, 50 and 70% ET than 4, 8 and 10% ET (Fig, 4). The similar increasing (day) trend was found in case of all ET treated flowers. Petal discoloration started 4 DAT for water contol and completed (100%) 11 DAT, whereas, it started 5 DAT and completed (100%) 11 DAT for 8 and 10% ET treated flowers.

Vase life was extended 1 day with 4% ET and 2 days with 8 and 10% ET than control and 2% ET treated flowers (Table 2). The vase life gradually decreased as 6, 5, 4, 2, 1 and 0.5 day following the order of 8 and 10> 4>water control and 2 > 20 > 30 and 40> 50 and 70% ET. Fresh weight (before wilting) was measured and there was no significant difference among all treatments (Table1). Dry weight was measured after abscission. Dry weight significantly reduced in case of all treatment but more significantly reduced at 40, 50 and 70% ET treated flower. Fresh and dry weight ratio was lower at 2, 4, 8 and 10% ET than control, 20, 30, 40, 50 and 70% ET (Table 1). Thirty three per cent petals shed at 4, 8 and 10% ET, 66.6% at water control, 2 and 20% and 100% at 30, 40, 50 and 70% ET.

Initially SPAD value was almost same in different treatments. However, finally it was higher in 8 and 10% ET than all other treatments. Fig. 5 shows the different flower structures and color changes after treatment application at different stages.

Discussion

The results showed that ethanol was effective as ethylene inhibiting component in bougainvillea flower. It was observed that the most effective ethanol concentrations were 8 and 10% ethanol. Results indicated that sensitivity to ethylene developed several

Table 1. Response of bougainvillea flower as affected by different concentrations of ethanol

Treatment	Response										
	12h	1d	2d	3d	4d	5d	6d	7d	8d	9d	10d
Water	+	+	+	+	+	-(W)	-(W)	-(W)	-(A)	-(A)	-(A)
2 % Ethanol	+	+	+	+	+	-(W)	-(W)	-(W)	-(A)	-(A)	-(A)
4 % Ethanol	+	+	+	+	+	+	-(W)	-(W)	-(W)	-(A)	-(A)
8 % Ethanol	+	+	+	+	+	+	+	-(W)	-(W)	-(W)	-(A)
10 % Ethanol	+	+	+	+	+	+	+	-(W)	-(W)	-(W)	-(A)
20 % Ethanol	+	+	+	-(W)	-(W)	-(W)	-(W)	-(A)	-(A)	-(A)	-(A)
30 % Ethanol	+	+	-(W)	-(W)	-(W)	-(W)	-(A)	-(A)	-(A)	-(A)	-(A)
40 % Ethanol	+	+	-(W)	-(W)	-(W)	-(A)	-(A)	-(A)	-(A)	-(A)	-(A)
50 % Ethanol	+	-(W)	-(W)	-(A)	-(A)	-(A)	-(A)	-(A)	-(A)	-(A)	-(A)
70 % Ethanol	+	-(W)	-(A)	-(A)	-(A)	-(A)	-(A)	-(A)	-(A)	-(A)	-(A)

+ : positive (before wilting symptom), -: negative (wilting symptom just appeared), W: wilting, A: abscission, d: day

Table 2. Fresh and dry weight of bougainvillea flower as affected by different concentrations of ethanol

Treatments	Initial fresh weight (g)	Dry weight after senescence (g)	Ratio (FW/DW)	Vase life (Day)	Petal drop (%)	SPAD value)	
						Initial	Final
Water	0.57±0.10a	0.301±0.05b	1.89±0.20a	4.5±0.32c	66.3±5.8b	3.8±0.5a	0.3±0.02b
2 % Ethanol	0.62±0.12a	0.345±0.06c	1.79±0.11a	4.5±0.34c	66.3± 5.6b	3.6±0.4a	0.3±0.02b
4 % Ethanol	0.48±0.09a	0.261±0.05b	1.83±0.13a	5.5±0.33d	33.3±3.8a	3.7±0.3a	0.2±0.01a
8 % Ethanol	0.66±0.08a	0.395±0.05c	1.67±0.12a	6.5±0.45d	33.3±3.3a	3.7±0.3a	0.5±0.02c
10 % Ethanol	0.62±0.11a	0.393±0.05c	1.57±0.15a	6.5±0.38d	33.3±3.3a	8.0±0.3a	0.6±0.02c
20 % Ethanol	0.51±0.06a	0.275±0.04b	1.85±0.16a	2.5±0.27b	66.3± 00b	3.6±0.4a	0.2 ±0.01a
30 % Ethanol	0.60±0.11a	0.310±0.04b	1.93±0.23a	1.5±0.22a	100± 00c	3.8±0.3a	0.2±0.01a
40 % Ethanol	0.67±0.10a	0.181±0.04a	3.70±0.28b	1.5±0.12a	100±00c	3.6±0.4a	0.2±0.01a
50 % Ethanol	0.55±0.08a	0.132±0.03a	4.16±0.37c	0.5±0.04a	100±00c	3.7±0.5a	0.1±0. 005a
70 % Ethanol	0.64±0.09a	0.097±0.02a	6.60±0.51d	0.5±0.04a	100±00c	3.8±0.5a	0.05±0.005a

Mean±SE (n =4). FW: Fresh weight, DW: Dry weight, Means followed by the same letters in column are not significantly different at the 5% level by Duncan`s multiple range test(DMRT).

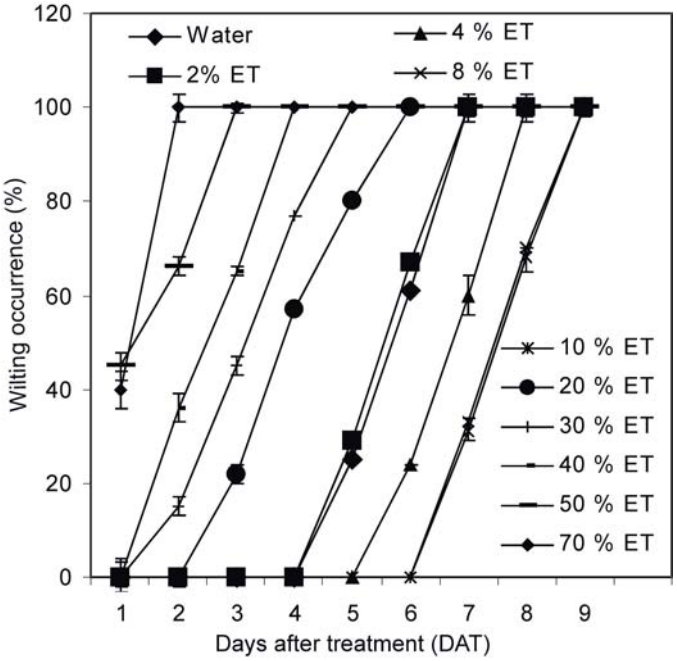

Fig.1. Wilting occurrence at different days after treatment at different ethanol concentrations. Bars represent SE.

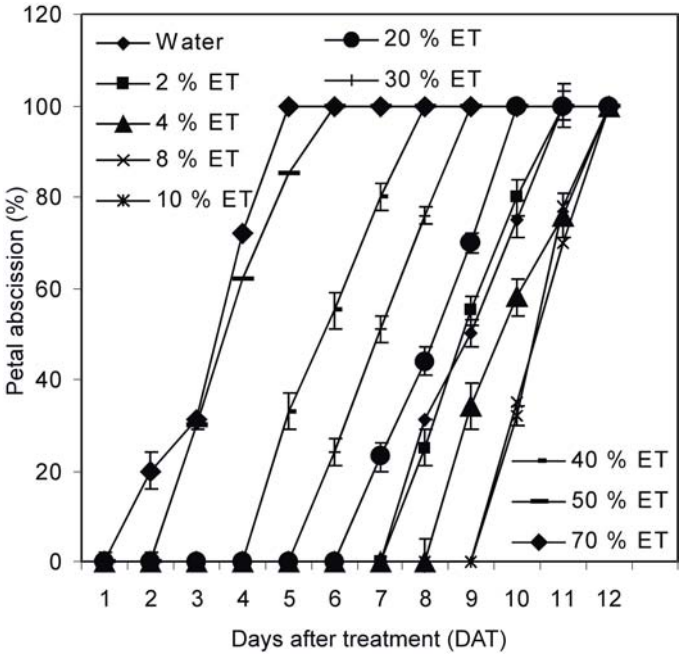

Fig. 2. Petal abscission at different days after treatment at different ethanol concentrations. Bars represent SE.

days after flower opening that ethanol only had a limited ability to delay vase life as well as petal abscission. It was reported that ethylene was the major coordinator of senescence in many flowers (Nickols, 1968). Podd and Staden (2004) stated that ethanol, when applied at low concentration in holding solutions, extended the vase life of cut carnation flowers. They also mentioned that low concentration of ethanol apparently decreased the formation of ethylene by inhibiting the action of ACC synthase. Ethanol has been found to be effective in increasing the vase life of carnation flowers by inhibiting ethylene biosynthesis (Heins and Blakely, 1980) as well as its action (Wu *et al.,* 1992).

In our results we found ethanol most effective in case of 8 and 10%. The concentration of ethanol effective in increasing vase life of carnation flowers ranged from 2% (Heins and Blakely, 1980) to 8% (Wu *et al.,* 1992) for the different cultivars. This variation in response could be due to differences in cultivar sensitivity to ethylene (Mayak and Triosh, 1993; Serrano *et al.,* 1991).

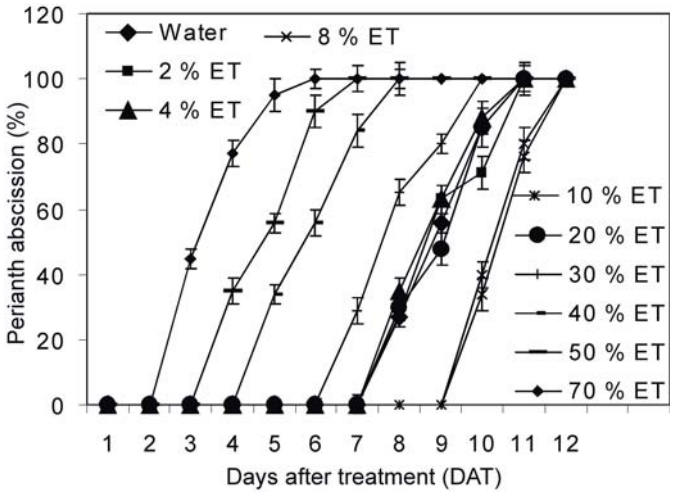

Fig. 3. Perianth abscission at different days after treatment at different ethanol concentrations. Bars represent SE.

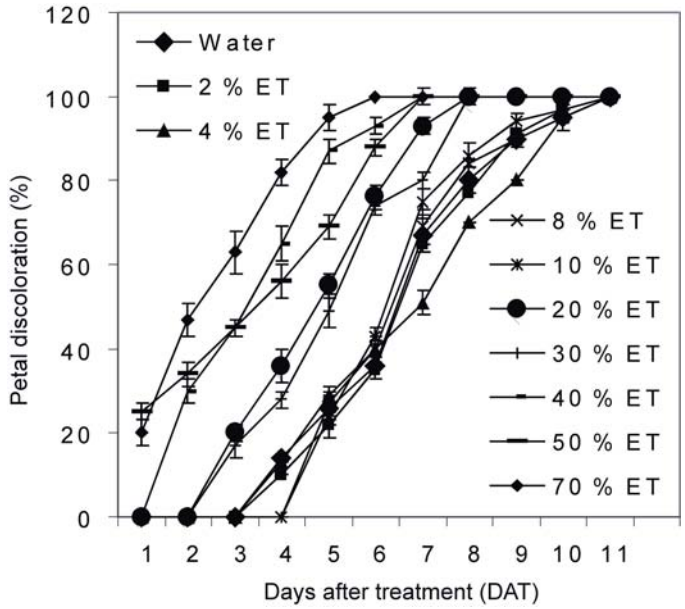

Fig. 4. Petal discoloration followed by days after treatment at different ethanol concentrations. Bars represent SE.

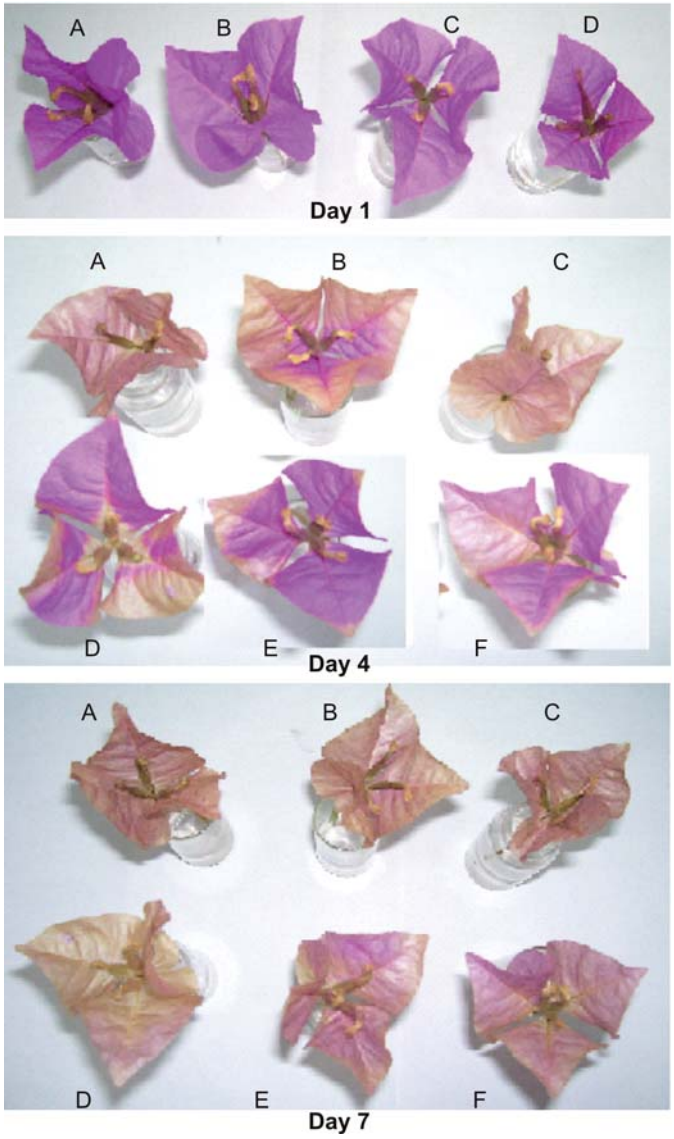

Fig. 5. Flower shape and color after treatment. A: Control, B: 2%ethanol, C: 4% ethanol, D: 8% ethanol, E: 10% ethanol, F: 70% ethanol

Treatment of cut carnation flowers with low concentrations of ethanol increased their vase life significantly (Heins, 1980; Podd and Staden, 1998; Wu *et al.,* 1992). In normally senescing cut carnation flowers, irreversible wilting of the petals and a concurrent swelling and "greening" of the ovaries is well documented (Cook and Staden, 1983, 1986; Nichols, 1968). Concentrations of ethanol (2-8%) has been found effective in extending vase life of cut carnation flowers by several wrokers and in this experiment our result highlighted the similar effect on bougainvillea.

Our results show that it was possible to extend vase life of bougainvillea using 4, 8 and 10% ethanol by causing senescence delay. Lower concentrations of ethanol decreased the formation of ethylene by inhibiting the action of ACC synthase as a result over all flowers (wilting, abscission, scar and color changes) were affected.

Acknowledgements

The authors are grateful to Musammath Maimuna Akter for assistance in the present investigation.

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