Mj. Int. J. Sci. Tech. **2007**, *01(2)*, 184-193

Maejo International

Journal of Science and Technology

ISSN 1905-7873

Available online at www.mijst.mju.ac.th

Full Paper

Effect of ethanol on the longevity and abscission of bougainvillea flower

A. B. M. Sharif Hossain*, Amru Nasrulhaq Boyce, Haji Mohamed A. Majid, Somasundran Chandran, and Razali Zuliana

Plant Physiology and Biotechnology Laboratory, Institute of Biological Science, Faculty of Science, University of Malaya, Kuala Lumpur 50603, Malaysia

*Corresponding author, email: sharif@um.edu.my

Received: 27 July 2007 / Accepted: 26 October 2007 / Published: 31 October 2007

Abstract*:* The experiment was carried out to study the effect of different concentrations of ethanol on bougainvillea flower vase life and delayed abscission. Young and fresh flowers were harvested from 4-year-old bougainvillea trees randomly. Flower stems (petiole) were placed individually in an open solution containing different concentrations of ethanol immediately after harvesting. The solutions used for treatment were water (control), 2, 4, 8, 10, 20, 30, 40, 50 and 70% ethanol. Positive responses were found in the case of 8 and 10% ethanol after 5 days of treatment. Flower longevity was 2 days longer in 8 and 10% ethanol than in water control and other concentrations of ethanol. Petal wilting and abscission occurred 2 days later than water control. Perianth abscission was later in 8 and 10% ethanol than water control. Percent petal scar (color changing) was later in water control, 2, 4, 8 and 10 than 20, 30, 40, 50 and 70% ethanol The result showed that the flower vase life was significantly affected by ethanol concentrations and longevity was more in 8 and 10% ethanol than water control and other concentrations.

Keywords: bougainvillea flower, longevity, abscission

Introduction

Bougainvilleas are popular ornamental plants and used as official flowers in most areas with warm climates, including Australia, India, Malaysia, the Mediterranean region, Mexico, South Africa, Taiwan, and the United States in Arizona, California, Florida, Hawaii, and southern Texas. It is used to

decorate fences and arbours with explosions of colour in the house corridor, office and play ground. A bougainvillea tree can be made guarding the entry or framing a window. It is a great vine for large containers to decorate hot patios and plazas. It is also used to create beautiful flowering bonsai specimens. Its flowers are usually dropped having a short vase life. Cameron et al. [1] reported that bougainvillea bracteoles were attractive at the end of 6-day observation period and dropped 32.2% when treated with silver thiosulfate [STS, (0.5 oz/gallon)], while 100% dropped in control tree.

In normal senescing, cut carnation flowers show irreversible wilting of the petals. Previous reports [2,6] showed that ethanol (4 and 6%) increased the vase life of carnation flowers and cultivars showed variable response to ethanol treatment with regard to vase life increment. Moreover, it was reported that treatment with 4% ethanol inhibited ethylene production as well as sensitivity to ethylene. Longevity of vase life is an important factor for consumer preference and considerable research has been carried out on the causes of carnation senescence [7, 8, 9]. Senescence of cut flowers is induced by several factors, e.g. water stress [10], carbohydrate depletion [11], microorganisms [12], and ethylene effects [13]. Ethanol has been found to be effective in increasing the vase life of carnation flowers by inhibiting ethylene biosynthesis [14,15] as well as its action [15]. The effective concentration of ethanol in increasing the vase life of carnation flowers ranges from 2% to 8% [14,15]. This variation in response could be due to differences in cultivar sensitivity to ethylene [16,17] or differences in age of the flowers used [15].

Podd and Staden [18] stated that ethanol, when applied at a low concentration in holding solutions, extended the vase life of cut carnation flowers. They also mentioned that a low concentration of either ethanol or acetaldehyde apparently decreased the formation of ethylene by inhibiting the action of 1-aminocyclopropane-1-carboxylic acid (ACC) synthase. Treatment of cut carnation flowers with low concentrations of ethanol increased their vase life significantly [15, 19, 20]. Podd and Staden [20] also reported that carnation flower senescense was delayed by ethanol.

The literature has not yet been available on similar work for bougainvillea flowers. Thus, our interest has grown to develop on the vase life of these flowers. The aim of this project is then to improve on their post-harvest qualities (color development, longevity extension and delayed senescence) by applying different ethanol concentrations, the result of which may have a positive effect on the use of this ornamental plant in social and occasional functions.

Materials and Methods

Site

The experimental site was University of Malaya campus, Kuala Lumpur, Malaysia.

Plant material

Three four-year-old bougainvillea trees from nursery, University of Malaya campus were used in this experiment for collecting flower samples. Each tree was about 1.2 m high and canopy length was about 2.0 m. Each tree consisted of 6 branches. Flowers were harvested from each branch randomly. Weeding, irrigation and pesticide were applied as needed.

Flower harvesting and measurement

Flowers were harvested on January 18, 2007. They were weighed immediately after harvest and used in the following treatments.

Design of experiment and treatment setting

The experiment design was Randomized Completely Block Design (RCBD). A total of 40 flowers from 7 branches were used for 10 treatments. Mean separation was done by Duncan's multiple range test (DMRT). The treatments were set following completely blocked design. Each treatment was done in quadruplicate. The treatments were water (control), 2, 4, 8, 10, 20, 30, 40, 50 and 70% ethanol The flowers were put individually with the petiole dipping in different concentrations of ethanol (20 ml) in a vial bottle (25 ml) immediately after harvest with scissors and placed at room temperature (28 ^{0}C) (Figure 5).

Response character determination

Response characters were observed. Positive (+) indicates the freshness of flower just before wilting. Negative (-) indicates the onset of wilting of flower

Vase life, petal wilting, scar (color change) and abscission evaluation

Vase life was observed by counting day after treatment. Longevity was determined as the mean number of days after harvest until initial wilting or rolling-in of the petals [5]. Petal wilting was investigated. Percent petal wilting was calculated by dividing the wilted petal area by the total petal area and multiplying by100. Color changing (petal scar) was determined by visual observation. After wilting phase, petal abscission was evaluated by observing petal abscised position.

Fresh and dry weight measurement

Fresh weight of each flower was measured immediately after harvest. Dry weight was measured after all flowers were abscised.

Chlorophyll content measurement

Chlorophyll content was measured by Chlorophyll Meter SPAD-502, Minolta Co. Japan, and was represented by SPAD value. The petal was inserted into the meter and SPAD value was measured 5 times from different spots of a single petal, then averaged.*-

Petal drop measurement

Petals were forced to drop with blown air using a table electric fan at medium speed. The flowers were kept in front of the fan for 5 minutes. The number of petals dropped by air was observed and the percentage of dropping was calculated.

Results and Discussion

The response character to ethanol was seen to be positive (before wilting) from 12h-day 7 (D7) after treatment and afterwards negative for all treatments (Table 1). The highest positive response (D7) was found for 8 and 10% ethanol treated flowers and the lowest (D1) was found for 70% ethanol treated flowers. In case of water (control) wilting occurred on D6, while it was observed in D8 for 8 and 10% ethanol treated flowers (Figure 1). The wilting started from D1 for 70% ethanol, D2 for 40 and 50 % ethanol, D3 for 30 % ethanol, D4 for 20 % ethanol, D6 for 4, 2 % ethanol and water (control), D8 for 8 and 10 % ethanol treated flowers (Figure 1). In the case of water (control), 100% wilting occurred in D8, while it was found in D10 for 8 and 10% ethanol treated flowers. Percent petal abscission was earlier for water control, 2, 4 than 8 and 9% ethanol (Figure 2). The petal abscission duration was D2-12 in different concentrations of ethanol.

Table 1. Response character of bougainvillea flower at different concentrations of ethanol

Treatments	Response Character											
	12h	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11
Water	+	+	+	+	+	+	-(W)	-(W)	-(W)	-(A)	-(A)	-(A)
2% ethanol	+	+	+	+	+	+	-(W)	-(W)	-(W)	-(A)	-(A)	-(A)
4% ethanol	+	+	+	+	+	+	-(W)	-(W)	-(W)	-(A)	-(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)	-(A)
50% ethanol	+	+	-(W)	-(W)	-(A)	-(A)	-(A)	-(A)	-(A)	-(A)	-(A)	-(A)
70% ethanol	+	-(W)	-(W)	-(A)	-(A)	-(A)	-(A)	-(A)	-(A)	-(A)	-(A)	-(A)

+ : positive, -: negative, W: wilting, A: abscission, D: day

The abscission order was 70< 50 < 40 < 30 < 20 <water control<8 and 10% ethanol. A similar trend was found for percent perianth abscission (Figure 3). However, the perianth abscission was 1 day later than petal abscission. The 100% perianth abscission was found for 8 and 10% ethanol on D13 while for water control, 2, 4 and 20% ethanol treated flowers, it was found on D11. Percent petal scar was earlier in water, 2, 4 20, 30, 40, 50 and 70 than 8 and 10% ethanol respectively (Figure 4). A similar increasing (day) trend was found in case of all ethanol treated flowers. Petal scar started in D4 for water control and peaked (100%) on D12, whereas it started in D6 and peaked (100%) in D12 for 8 and 10% ethanol treated flowers.

The vase life was 2 days longer for 8 and 10% ethanol than water, 2 and 4% ethanol treated flowers (Table 2). The vase life was gradually decreasing as 7, 5, 3, 2, 1 and <1 day following the order of 8 and 10> water control, 2 and 4> 20 >30 >40 and 50 >70% ethanol. Fresh weight (before wilting) was measured and there was no significant difference among all treatments (Table2). Dry weight was measured after abscission. It was significantly reduced for all treatments but much more so for 30, 40, 50 and 70% ethanol treated flowers. Fresh to dry weight ratio was lower for 2, 4, 8 and 10% ethanol

treated flowers than water, 20, 30, 40, 50 and 70% ethanol treated flowers (Table 2). Petal was shed 33% for 8 and 10% ethanol, 66% for water, 2, 4, 20 and 30% ethanol and 100% for 40, 50 and 70% ethanol treated flowers.

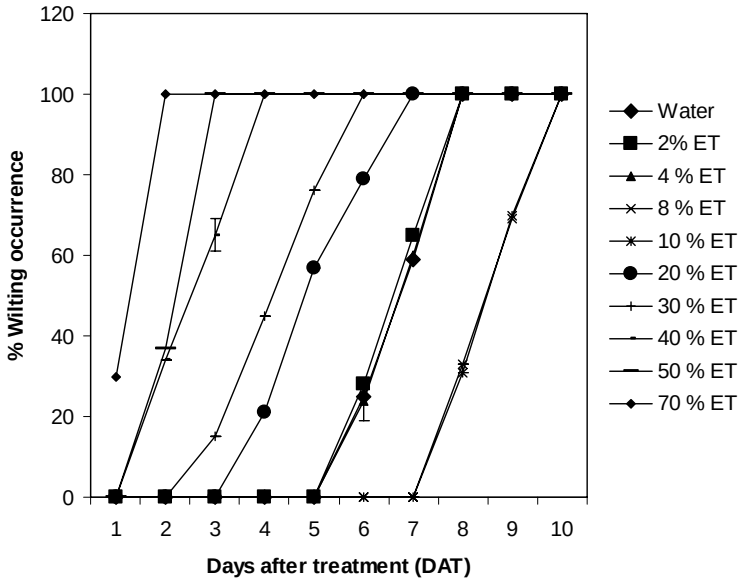

Figure1. Wilting occurrence followed at different concentrations of ethanol. Bars represent SE (n=4).

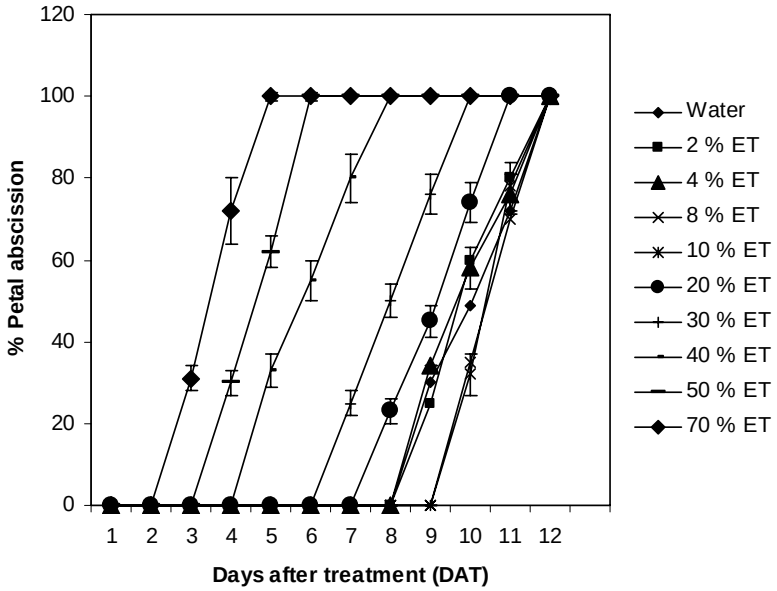

Figure 2. Petal abscission followed at different concentrations of ethanol. Bars represent SE (n=4).

Table 2. Fresh and dry weight of bougainvillea flowers at different concentrations of ethanol.

Treatments	Fresh weight (Initial) g	Dry weight After abscsion (Final) g	Ratio (FW/DW)	Vase life (Day)	Petal shedding (%)	Chlorophyll content (SPAD value) Initial	Final
Water	0.66±0.10a	0.36±0.05b	1.83±0.20a	5.1±0.31c	66±5.7b	3.8±0.5a	0.4±0.02b
2 % ethanol	0.72±0.11a	0.45±0.06c	1.61±0.11a	5.3±0.35c	66± 5.7b	3.7±0.4a	0.4±0.02b
4 % ethanol	0.56±0.09a	0.31±0.05b	1.80±0.13a	5.2±0.34c	66±5.7b	3.6±0.4a	0.3±0.01a
8 % ethanol	0.65±0.08a	0.37±0.06c	1.73±0.12a	7.2±0.45d	33±3.3a	3.8±0.3a	0.6±0.03b
10% ethanol	0.61±0.12a	0.40±0.05c	1.51±0.15a	7.3±0.38d	33±3.3a	3.8±0.3a	0.7±0.03b
20% ethanol	0.52±0.07a	0.32±0.04b	1.65±0.16a	3.0±0.27b	66± 00b	3.6±0.4a	0.3 ±0.01a
30% ethanol	0.70±0.11a	0.30±0.04b	2.33±0.23b	2.0±0.25b	66± 00b	3.7±0.5a	0.2±0.01a
40% ethanol	0.68±0.10a	0.19±0.03a	3.56±0.28c	1.1±0.12a	100±00c	3.5±0.4a	0.2±0.01a
50% ethanol	0.53±0.08a	0.12±0.03a	4.20±0.37c	1.0±0.05a	100±00c	3.8±0.5a	0.1±0. 005a
70% ethanol	0.62±0.09a	0.09±0.02a	7.12±0.51d	<1.0±0.05a	100±00c	3.8±0.5a	0.1±0.005a

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

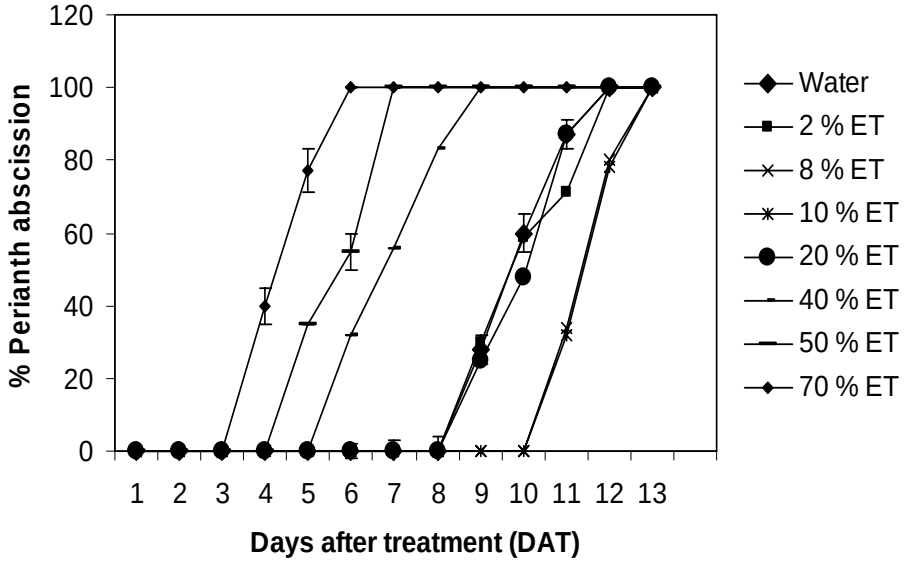

Figure 3. Perianth abscission monitored at different concentrations of ethanol. Bars represent SE (n=4).

Initially chlorophyll content (SPAD value) was higher for water, 8, 10, 50, 70 than 2, 4 20, 30 and 40% ethanol treated flowers. Finally, however, it was higher for 8 and 10% ethanol than all other treatments. Figure 5 shows the different flower structures and colour changing after various treatments at different stages.

The results showed that ethanol was effective as an ethylene inhibiting component in bougainvillea flower. It was found that the more effective concentrations of ethanol were 8 and 10%. The results seemed to indicate that sensitivity to ethylene developed several days after flower opening such that ethanol had only a limited capacity to delay vase life as well as petal abscission. It was reported that ethylene was the major coordinator for senescence in many flowers [2]. Podd and Staden [16] stated that ethanol, when applied as low concentration holding solutions, could extend the vase life of cut carnation flowers. They also mentioned that a low concentration of ethanol apparently decreased the formation of ethylene by inhibiting the action of ACC synthase. The vase life of carnation flowers has been increased using ethanol by inhibiting ethylene biosynthesis [14, 15] as well as its action [15].

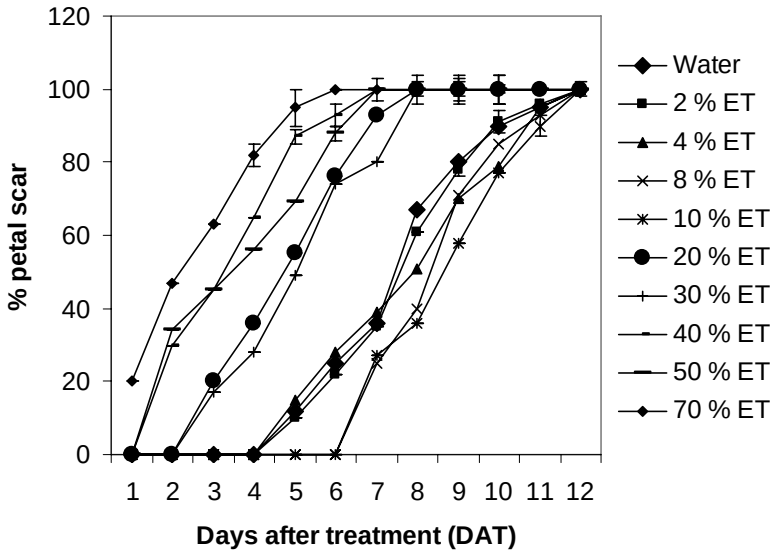

Figure 4. Petal scar monitored at different concentrations of ethanol. Bars represent SE (n=4).

Similar results have been reported by other researchers. The concentration of ethanol effective in increasing the vase life of carnation flowers ranges from 2% [14] to 8% [15] for the different cultivars. This variation in response could be due to differences in cultivar sensitivity to ethylene [16, 17]. Treatment of cut carnation flowers with low concentrations of ethanol increased their vase life significantly [15, 19, 20].

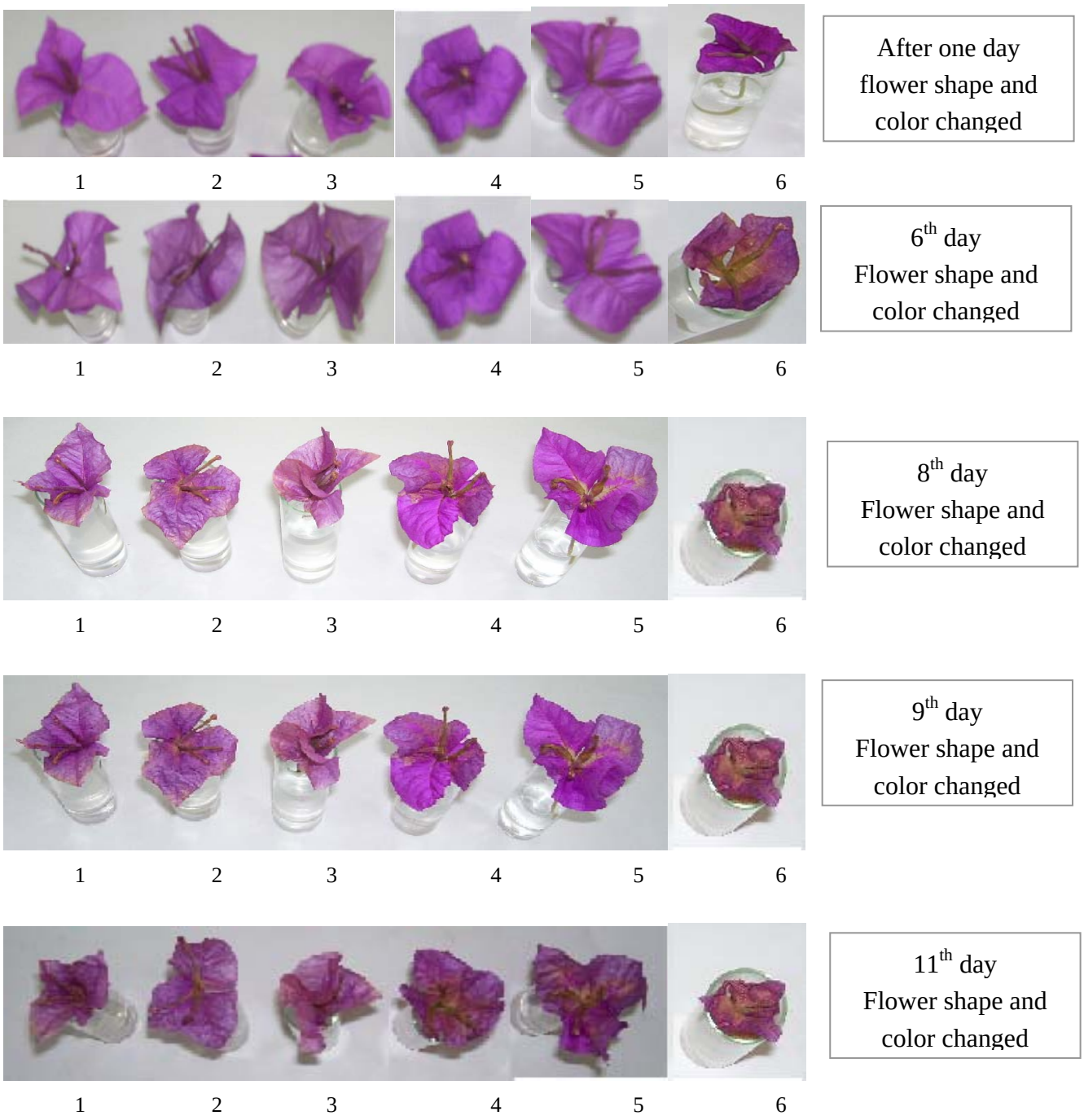

Figure 5. Petal and perianth wilting and abscission (shape and colour) after treatment;
1: water control, 2: 2%ethanol, 3: 4% ethanol, 4: 8% ethanol, 5: 10% ethanol, 6: 70% ethanol

Conclusion

It is possible to extend the vase life of bougainvillea flowers using 8% and 10% ethanol by causing delayed senescence. A low concentration of ethanol presumably decreased the formation of ethylene by inhibiting the action of ACC synthase. While low concentrations of ethanol (2-8%) had been found to be effective in extending the vase life of cut carnation flowers, the results of the present experiment also showed similar effects in bougainvillea flowers.

Acknowledgements

The authors are grateful to Musammath Maimuna Akter for assistance in sample preparation and computing data in this research.

References

1. C. A. Cameron, M. S. Reid, and G. W. Hickman, "Using STS to prevent flower shattering in potted flowering plants—progress report. Flower and nursery report for commercial grower", Cooperative Extension, University of California, **1981**, p.6.
2. R. Nichols, "The response of carnation (*Dianthus caryophyllus*) to ethylene", *J. Hort. Sci.* **1968**, *43*, 335–349.
3. E. L. Cook and J. V. Staden, "Senescence of cut carnation flowers: ovary development and CO_2 fixation", *Plant Growth Regul.,* **1983**, *1*, 221–232.
4. E. L. Cook and J. V. Staden, "The ovary as a sink in the senescence of cut carnation flowers", *Acta Hort.,* **1986**, *181*, 345–352.
5. A. H. Halevy and A. M. Kofranek, "Silver treatment of carnation flowers for reducing ethylene damage and extending longevity", *J. Amer. Soc. Hort. Sci.*, **1977,** *102*, 76-77.
6. U. K. Pun, R. N. Rowe, J. S. Rowarth, M. F. Barnes, C. Dawson, and J. A. Oheyes, "Influence of ethanol on climacteric senescence in five cultivars of carnation", *New Zealand J. Crop Hort. Sci.*, **1999**, *27*, 69-77.
7. M. S. Reid, J. L. Paul, M. B. Farhoomand, A. M. Kofranek, and G. L. Staby, "Pulse treatments with the silver thiosulphate complex extend the vase life of cut carnations", *J. Amer. Soc. Hort. Sci.*, **1980**, *105*, 25-27.
8. M. S. Reid, A. M. Kofranek, and S. T. Besemer, "Postharvest handling of carnations", *Acta Hort.,* **1983**, *141*, 235-238.
9. A. Menguc and E. Usta, "Research on the effects of silver thiosulphate plus sucrose pretreatment on the cold storage period and post storage vase life of cut flowers of carnation cv. Astor havested at different maturities", *Acta Hort.,* **1994**, *368*, 802- 807.
10. C. K. Sankat and S. Mujaffar, "Water balance in cut anthurium flowers in storage and its effect on quality", *Acta Hort.,* **1994**, *368*, 723-732.
11. S. Ketsa, "Vase life characteristics of inflorescences of dendrobium 'Pompadour'", *J. Hort. Sci.*, **1989**, *64*, 611-615.
12. Y. De Witte and W. G. Van Doom, "The mode of action of bacteria in the vascular occlusion of cut rose flowers", *Acta Hort.*, **1991**, *298*, 165-167.
13. M. J. Wu, W. G. Van Doom, and M. S. Reid, "Variation in the senescence of carnation *(Dianthus caryophyllus L.)* cultivars. II. Comparison of sensitivity to exogenous ethylene and of ethylene binding", *Scientia Hort.*, **1991**, *48*, 109-116.
14. R. D. Heins and N. Blakely, "Influence of ethanol on ethylene biosynthesis and flower senescence of cut carnation", *Scientia Hort.*, **1980**, *13*, 361-369.
15. M. J. Wu, Z. Lorenzo, M. E. Saltveit, and M. S. Reid, "Alcohols and carnation senescence", *Hort. Sci.*, **1992,** *27*, 136-138.

16. M. Serrano, F. Romojaro, J. L Casas, and M. Acosta, "Ethylene and polyamine metabolism in climacteric and non-climacteric carnation flowers", *Hort. Sci.*, **1991**, *26*, 894-896.
17. S. Mayak and T. Triosh, "Unusual ethylene-related behaviour in senescing flowers of the carnation Sandrosa", *Physiol. Plantarum*, **1993**, *88* ,420-426.
18. L. A. Podd and J. V. Staden, "The role of ethanol and acetaldehyde in flower senescence and fruit ripening", *J. Plant Growth Regul.*, **2004,** *26*, 183-189.
19. R. D. Heins, "Inhibition of ethylene synthesis and senescence in carnation by ethanol", *J. Amer. Soc. Hort. Sci.*, **1980,** *105*, 141–144.
20. L. A. Podd and J. V. Staden, "The role of ethanol and acetaldehyde in flower senescence and fruit ripening - a review", *Plant Growth Regul.*, **1998,** *26*, 183–189.