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The Responses of *Oncidium* Cut Flowers to Ethylene and 1-MCP [1]

Chao-Chia Huang[2,4] and Robert E. Paull[3]

Abstract

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The ethylene production by *Oncidium* 'Gower Ramsey' buds and florets and response to 1-methylcyclopropene (1-MCP) were investigated. Small flower buds produced little ethylene (0.12 nL g^{-1} hr^{-1}) and the production declined to being undetectable as the bud grew and became a floret. Ethylene production increased again as the floret began to senesce. A peak of ethylene production occurred (1.5 nL g^{-1} hr^{-1}) at the half senescent floret stage. The rises in ethylene production occurred after the start of floret senescence. Floret buds were more sensitive to exogenous ethylene than the floret, as it took 5 versus 7 days for senescence symptoms to appear at 0.03 nL mL^{-1} exogenous ethylene. The ethylene inhibitor, 1-MCP was effective in prolonging the vase life of both ethylene-treated and non-ethylene-treated cut sprays. When 1-MCP was applied again after 7 days to the same sprays, senescence symptom development was further delayed. Concentration of 1-MCP as low as 235 nL m^{-3} which was one fourth of the concentration recommended for commercial use extended vase life. Bud opening also increased following 1-MCP treatment in ethylene-treated sprays. No difference in response to 1-MCP treatment was found when the treatment was varied from 2 to 12 h and from 10℃ to 28℃. A treatment with 1-MCP was a useful tool to extend vase life of *Oncidium* cut flower sprays.

Key words: *Oncidium* cut flower, Ethylene, 1-MCP, Temperature, Concentration.

Introduction

The bicolored *Oncidium* hybrid 'Gower Ramsey' is popular both as a cut flower spray and as a potted plant. However, researches on the postharvest physiology of *Oncidium* cut flower sprays were rather limited. Goh *et al.* (1985) reported that the sensitivity of *Oncidium* cut flower to ethylene was low. Huang (1998) observed that removal of the pollenia cap of 'Gower Ramsey' *Oncidium* floret resulted in ethylene production and a reduction in vase life. The vase life was also shortened when treated with 1 nL mL^{-1} ethylene. Small *Oncidium* flower buds produce little ethylene, and the production increases as the floret begins to wilt and senesce. A peak of ethylene production is reported to occur during senescence (Song 1997). However, the relationship between ethylene production and exposure to exogenous ethylene, and *Oncidium* bud development and floret senescence is unclear.

The ethylene inhibitor, 1-Methylcyclopropene (1-MCP) has been widely used to inhibit detrimental effects of ethylene on flower senescence (Serek *et al*. 1995; Blankenship & Dole 2003). Here, we report that 1-MCP is effective on prolonging the vase life of *Oncidium* cut flower. The conditions of 1-MCP treatment such as concentration, treatment temperature, and treatment time were determined.

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2. Associate Researcher, Crop Science Division, TARI, Wufeng, Taichung, Taiwan, ROC.
3. Professor and Head, Department of Tropical Plant and Soil Sciences, College of Tropical, Agriculture and Human Resources, University of Hawaii at Manoa.
4. Corresponding author, e-mail: cchuang@tari.gov.tw; Fax: (04)23317121.

Materials and Methods

Plant Material

'Gower Ramsey' *Oncidium* sprays were obtained on the day of harvest direct from growers. The flower buds and florets were cut from the inflorescence and sorted into 10 different developmental stages. Buds were sorted into 5 stages of development from very small to large buds: Stage 1: buds had a diameter between 3.5 to 4.5 mm, Stage 2: 4.5 to 5.5 mm, Stage 3: 7.5 to 9.5 mm, Stage 4: 9.5 to 11.0 mm, and Stage 5: 12.5 to 15.5 mm. Floret developmental stages were ranked from 6 to 10 for florets that were partially open to the full open stage. Floret senescence was ranked from 10: full open with no senescence symptoms, 8: start of senescence, 4: half senesced, 2: senesced, and, 0: complete senescence and abscised.

Ethylene Production

The ethylene production rates of buds or florets at various stages were measured. Five buds or florets of the same stage were sealed in a small flask (20 mL for buds, 50 mL for florets). The flash head-space ethylene concentration was analyzed after 4 h by a gas chromatograph. Five replications were taken for each measurement. In measuring the daily ethylene production rates of buds at stage 5 or open florets, the buds or florets were removed from the spray and kept in distilled water. Ethylene production was determined every day by sealing each bud or floret in a small vial and analyzed as previously described.

Ethylene Treatment

Individual spray stems were held in a small test tube (12 mL) with distilled water. Sprays were treated with 0, 0.01, 0.03, 0.05, and 0.1 nL mL^{-1} ethylene for 1, 3, 5, 7 d at 20℃, then held at 20℃. The vase life of buds was considered as terminated when the buds became yellow, brown or abscised. The vase life of florets was considered as terminated when the florets had senesced with a score of 5 or lower. Another group of sprays was continuously treated with ethylene.

1-methylcyclopropene Treatment

Cut florets and sprays were sealed in a 1 m^3 container at 20℃. Before sealing 1-MCP (EthylBloc, Floralife, Inc., Walterboro, South Carolina) was added at a concentration of 0, 235, 470, and 940 nL m^{-3}. The sprays were fumigated with 1-MCP for 4 h. On the second day after 1-MCP fumigation, the sprays were treated with 0.5 nL mL^{-1} ethylene for 48 h, then held at 23℃ to 28℃. The vase life of flower sprays was considered as terminated when half of the buds or florets had wilted.

Another group of cut sprays was treated with 940 nL m^{-3} 1-MCP at 10℃, 20℃, and 28℃ for 2, 6, 8, and 12 h. These sprays were then treated with 0.5 nL mL^{-1} exogenous ethylene for 24 h after the 1-MCP treatment. In another experiment, 10 sprays were untreated, 10 sprays received 940 nL m^{-3} 1-MCP for 6 h on day 0, and, the final 10 sprays were treated twice with 1-MCP the first time on day 1 and retreated again on day 7.

Results

Ethylene Production

Small *Oncidium* flower buds at stage 1 produced relatively high amounts of ethylene compared to larger buds (Fig. 1A). No ethylene was detected when the bud developed larger to stage 3 or higher. Fully opened florets did not produce any ethylene, but began to produce ethylene when the floret began to wilt with a peak occurred at the half senescence stage (Fig. 1B).

Buds removed from the spray at stage 5 developed into fully opened florets in 4 to 5 d (Fig. 2A), then began to senesce and wilt slowly. The bud did not produce ethylene until 9 d after removal (Fig. 2C). The ethylene

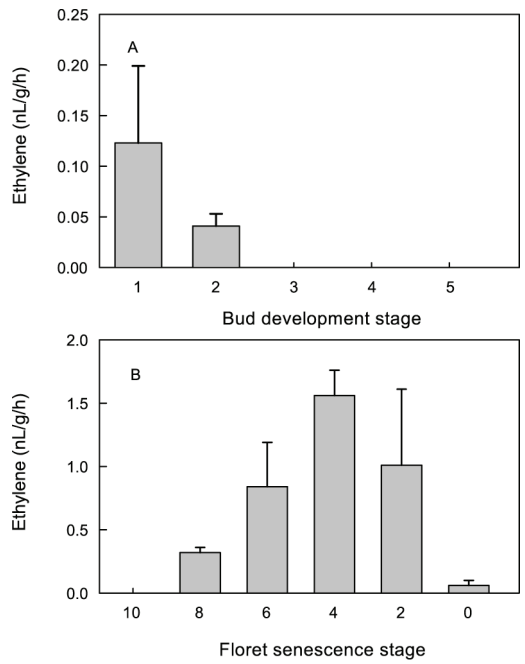

Fig. 1. Ethylene production by individual 'Gower Ramsey' *Oncidium* flower bud at different stages of development (A) and during floret senescence (B). Bud development stages were from 1 to 5, with very small buds being 4.0 mm in diameter to large buds at 14.0 mm in diameter: Floret senescence score of 8 represented a floret that had started to wilt while a score of 4 represented half senescence, and, a score of 2 represented full senescence. Each data point was the mean ± SE, n = 5.

production reached a peak about 1 d later. Fully opened florets began to wilt 4 to 6 d after removal from the spray (Fig. 2B), and ethylene production started to increase 3 d later (Fig. 2D). The ethylene production reached a peak on the 10th day after floret removal while the floret was about half senescence. No ethylene production was detected from fully opened florets for 7 d after the floret was removed from the flower spray (Fig. 2D).

The Effect of Ethylene Treatment

The vase life of flower buds was not affected by a 0.01 nL mL^{-1} exogenous ethylene treatment (Fig. 3A to 3E) but was shortened following exposure to 0.05 nL mL^{-1} and 0.1 nL mL^{-1} ethylene for 3 d (Fig. 3B) and 0.03 nL mL^{-1} for 5 d (Fig. 3C). The vase life of florets was also not affected by exposure to 0.01 nL mL^{-1} ethylene (Fig. 3F to 3J) but was shortened by 0.1 nL mL^{-1} for 3 d (Fig. 3G), 0.05 nL mL^{-1} for 5 d (Fig. 3H) and 0.03 nL mL^{-1} ethylene treatment for 7 d (Fig. 3I).

1-MCP Treatment

The 1-MCP treated flower sprays had a vase life of about 8 d while the untreated control was 3 d (Table 1). The effect of 1-MCP on vase life, at 235 nL m^{-3}, one fourth of the commercial recommended concentration, was similar to that of full concentration 940 nL m^{-3}. The vase lives of floret as well as buds were all prolonged with 1-MCP treatment. Bud opening was 57% in 1-MCP treatment while it was 5% in the control.

Florets began to abscise from the stem 5 d after harvest (Fig. 4). Sprays treated with 1-MCP showed an initial loss of 10% of the florets, then the rate of abscission slowed for 3 d before increasing again. Sprays that were treated with 1-MCP on days 0 and 7, had 5 additional days of delayed floret abscission. The rate of floret drop for 1-MCP treated sprays was similar to that of the untreated control sprays, only with a slight delay. Sprays treated on day 0 and again on day 7 had about 12 d usable vase life with less than 10% floret drop while the untreated control sprays had lost about 60% of their florets (Fig. 4).

The vase life of sprays treated with 1-MCP at 10℃, 20℃, or 28℃ for 2 h, 6 h, or 12 h were similar (Table 2). All 1-MCP treated flowers had up to 12 d vase life while the vase life of the untreated flowers was 5 d.

Discussion

Ethylene produced by small flower buds had been suggested as a growth inhibitor and slowed the bud growth in morning glory (Raab & Koning 1987). Small

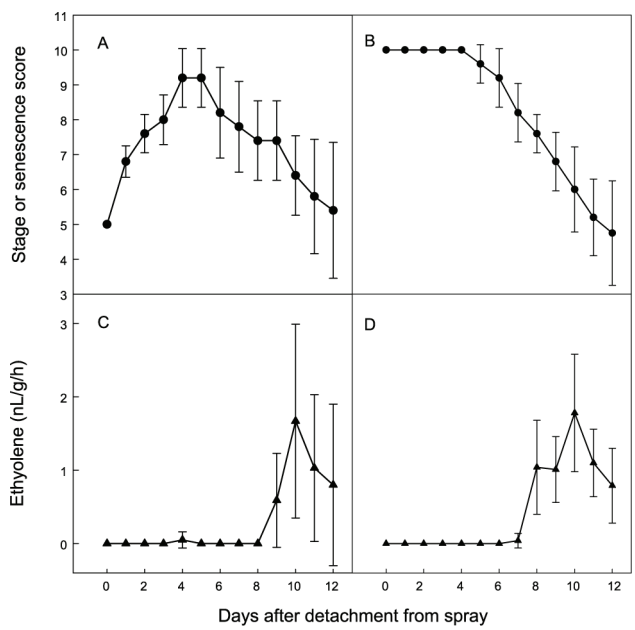

Fig. 2. Relationship between stage of bud development (A) and floret senescence (B) of 'Gower Ramsey' *Oncidium* and bud (C) and floret (D) ethylene production. Buds were cut at Stage 5 and florets cut at Stage 10 then kept in water at 20℃. Floret buds were ranked from 5 to 10 as to stage of opened floret development, and florets from 1 to 10 as to degree of senescence; from no senescence to fully senesced. Each data point was the mean ± SE, n = 5.

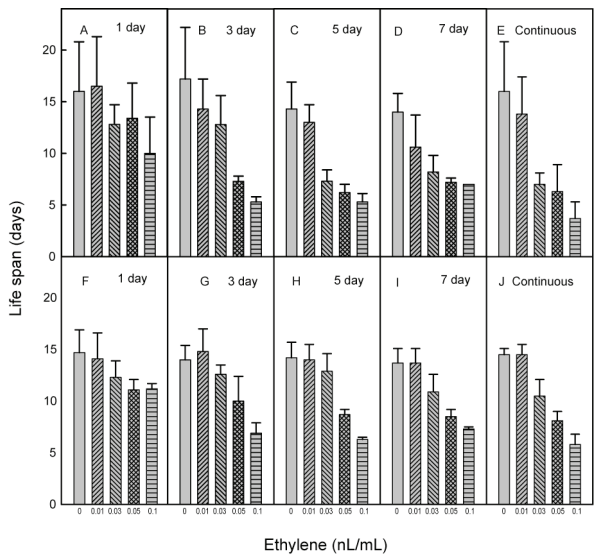

Fig. 3. The effect of exogenous ethylene treatment at different concentrations from 0 to 0.1 nL mL^{-1} and durations from 1 day to continuous presence on the vase life of 'Gower Ramsey' *Oncidium* flower buds (A to E) and florets (F to J). Each data point was the mean ± SE, n = 10.

Table 1. Effect of 1-MCP at various concentrations on the vase life of 'Gower Ramsey' *Oncidium* cut flower. The cut flower sprays were treated with 0.5 nL mL^{-1} ethylene for 48 hours after 1-MCP treatment

1-MCP concentration (nL m^{-3})	Spray vase Life (day) [z]	Floret life (day)	Bud life (day)	Bud opening (%)
0	3.0 ± 0.0	2.9 ± 0.2	1.0 ± 0.0	5.0 ± 7.8
235	8.0 ± 1.1	7.3 ± 0.8	12.0 ± 1.3	57.3 ± 10.0
470	8.4 ± 0.9	7.8 ± 0.4	13.6 ± 2.5	56.6 ± 9.7
940	8.5 ± 0.8	8.1 ± 0.8	14.0 ± 2.2	59.8 ± 14.7

[z] Each data was the mean ± SE, n = 10.

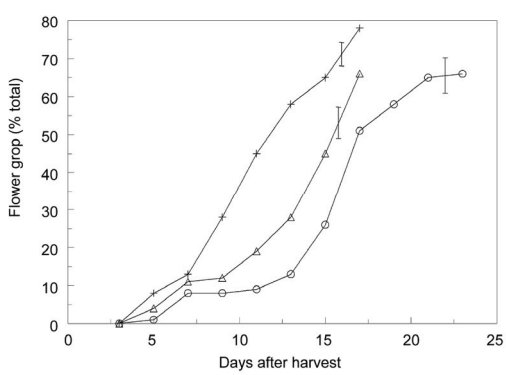

Fig. 4. The effect of treating sprays with 1-MCP immediately after harvest (△—△) and again 7 days after harvest (○—○) on floret drop compared to the control (+—+). Each data point was the mean, the error bar ± SE, n = 5.

Oncidium flower buds (4 to 5 mm in diameter) produced a small amount ethylene (Fig. 1A) and the production declined as the buds grew bigger. The ethylene production was not detectable as the bud grew from 8 to 14 mm (diameter), therefore it is likely that ethylene has little role in the bud growth. A similar ethylene production pattern has been reported for *Phalaenopsis* flower buds (Lin 1988).

Florets produced relatively high amounts of ethylene as they began to wilt and senesce (Fig. 1B & 2). Ethylene production reached a peak then declined as the floret wilted. Similar phenomena have been observed in *Cattelyia*, *Dendrobium*, and *Phalaenopsis* flowers (Goh *et al*. 1985; Huang *et al*. 1997; Nair & Fong 1987). In *Cattelyia* and *Phalaenopsis* flower, ethylene production increased before the start of flower senescence (Goh *et al.* 1985; Huang *et al*. 1997). Ethylene was proposed in these reports to be

Table 2. Effect of temperature and time of 1-MCP treatment on the vase life of 'Gower Ramsey' *Oncidium* cut flower. The cut sprays were treated with 0.5 nL mL^{-1} ethylene for 24 h after the 1-MCP treatment. The vase life of control was 5.2 ± 1.0 days

	Time (h) [z]			
Temperature (℃)	2	4	8	12
10	10.8 ± 1.8	10.3 ± 1.2	9.5 ± 1	9.8 ± 1.0
20	10.5 ± 1.3	10.3 ± 1.3	10.5 ± 1.3	9.7 ± 0.9
28	11.0 ± 1.5	11.6 ± 1.4	10.3 ± 0.7	10.8 ± 1.0

[z] Each data was the mean ± SE, n = 10.

an inducer of flower senescence. However, the rise in ethylene production by *Oncidium* florets always occurred later than the start of floret senescence and therefore as a byproduct that accompanied floret senescence. Since exogenous ethylene at very low concentrations accelerated senescence of *Oncidium* flower bud and floret and 1-MCP effectively prolonged the vase life of ethylene treated flowers, it was apparent that ethylene does play an important role in *Oncidium* flower senescence.

Oncidium flower bud and floret were very sensitive to ethylene. The vase life of the buds and florets was significantly shortened by exposure to 0.03 nL mL^{-1} ethylene (Fig. 3). The bud was more sensitive than the floret as it took 5 d for the ethylene treatment to result in any detrimental effect on the bud compared to 7 d for the floret.

A repeat treatment of sprays with 1-MCP after 7 d further delayed floret senescence and abscission (Fig. 4). This delay is similar to that experienced with fruits and flowers (Sangwanangkul *et al*. 2008). It has suggested that the initiation of senescence is due to production of new ethylene receptors that are not blocked by ethylene (Blankenship & Dole 2003).

Treatment with 1-MCP was very effective in delaying ethylene induced senescence (Table 1 & 2). The concentration of 1-MCP at one fourth that recommended for commercial use extended the vase life of *Oncidium* sprays. The duration of 1-MCP treatment could be as short as 2 h and up to 18 h. The 1-MCP treatment was successful when applied between 10℃ and 28℃ (Table 2). These data indicated that 1-MCP had the commercial potential for treatment of *Oncidium* cut flower sprays as it enhanced bud opening and delayed floret senescence.

Acknowledgments

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Literature cited

Blankenship, S. M. and J. M. Dole. 2003. 1-methylcyclopropene: a review. Postharvest Biol. Technol. 28: 1–25.

Goh, C. J., A. H. Halevy, R. Engal, and A. M. Kofrank. 1985. Ethylene evolution and sensitivity in cut orchid flowers. Sci. Hortic. 26:57–67.

Huang, C. C., M. H. Pan, and T. T. Wang. 1997. Senescence, ethylene production and electrolyte leakage of different parts of chilled *Phalaenopsis* flower. J. Agric. Res. China 46:167–180.

Huang, C. C. 1998. Ethylene production of *Oncidium* flower and the change of flower quality affected by ethylene treatment and pollinia cap removal. J. Agric. Res. China 47:125–134.

Lin Y. S. 1988. Postharvest Physiology and Senescence of *Phalaenopsis* Cut Flower. Master thesis. Department of Horticulture. Natl. Taiwan Univ. 170 pp.

Nair, H. and T. H. Fong. 1987. Ethylene production of orchid flowers and 1-amino cyclopropan-1-carboxylic acid levels in detached *Dendrobium* 'Pompadour'. Sci. Hortic. 32:145–151.

Raab, M. M. and R. E. Koning. 1987. Changes in responsiveness to ethylene and gibberellins during corolla expansion of *Ipomoea nil*. J. Plant Growth Regul. 6: 121–131.

Sangwanangkul, P., P. Saradhuldhat, and R. E. Paull. 2008. Survey of tropical cut flower and foliage responses to irradiation. Postharvest Biol. Technol. 48:264–271.

Serek, M., E. C. Sisler, and M. S. Reid. 1995. Effect of 1-1-MCP on the vase life and ethylene responses of flowers. Plant Growth Regul. 16:93–97.

Song, C. J. 1997. Studies on Handling Quality of Pollenia De-capped of Cut *Oncidium*. Master thesis. Department of Horticulture. Natl. Chung-Hsing Univ. 117 pp.

文心蘭切花、花苞與花朵對乙烯之反應[1]

黃肇家[2,4] Robert E. Paull[3]

摘 要

黃肇家、Robert E. Paull。2009。文心蘭切花、花苞與花朵對乙烯之反應。台灣農業研究 58:1–6。

本研究探討"南西"文心蘭 (*Oncidium* 'Gower Ramsey') 切花之花苞與花朵之乙烯生成，以及對乙烯與乙烯抑制劑甲基環丙烯 (1-methylcyclopropene, 1-MCP) 之反應。文心蘭小花苞產生少量的乙烯 (約爲 0.12 nL g^{-1} h^{-1})，隨著花苞長大到開張爲花朵，乙烯之生成量漸漸降低，到測不出來的程度。花朵開始老化時，乙烯生成量又增加，在花半衰老時，乙烯生成達到高峰 (約爲 1.5 nL g^{-1} h^{-1})。花朵於開始顯現老化症狀之後，乙烯之生成才開始增加。花苞比花朵對乙烯更爲敏感，在外加乙烯 0.03 nL mL^{-1} 環境下，花苞 5 d 會產生老化症狀，而花朵要 7 d 才產生老化症狀。1-MCP 可以有效的延長外加乙烯處理或未經外加乙烯處理之文心蘭切花之瓶插壽命，如果 1-MCP 在處理後 7 d 再處理 1 次，可以進一步延緩切花之老化。1-MCP 使用劑量降爲 0.125 g m^{-3}，亦即商業推薦量的 1/4 量，仍然可以有效的延長切花壽命。1-MCP 也可以有效的恢復經乙烯處理之花苞之開張能力。1-MCP 處理時間由 2 h 增至 12 h，處理溫度由 10℃至 28℃，結果都一樣有效，顯示 1-MCP 處理是延長文心蘭切花壽命有效的方法。

關鍵詞：文心蘭切花、乙烯、甲基環丙烯、溫度、劑量。

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2. 本所作物組副研究員。台灣 台中縣 霧峰鄉。
3. 美國夏威夷大學熱帶植物暨土壤科學系教授兼系主任。美國 夏威夷州 火魯魯 (檀香山)。
4. 通訊作者，電子郵件：cchuang@tari.gov.tw；傳真機：(04)23317121。