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Efficacy of 1-MCP on controlling ethylene sensitivity and extending vase life of sensitive and less sensitive cut orchid flowers

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ABSTRACT

This study was conducted to investigate the effects of 1-MCP on the sensitivity to ethylene and postharvest quality of selected cut orchid flowers. Cut orchid flowers are considered as the ethylene sensitive but there are apparently variation in sensitivity among species, cultivars and hybrids. Low effective concentration of 1- MCP and its minimum residues have caused that 1-MCP been viewed as an important and safe candidate for replacing STS. Inflorescences of each Dendrobium 'Darren Glory' (DDG), D. 'Sonia Bom' (DSB), Mokara 'Calypso Jumbo' (MCJ) and M. 'Chiti Gold' (MCG) hybrids were purchased from a commercial farm. After harvest and transport to the Postharvest Lab they were divided into two groups and placed in two chambers. They exposed to 0 and 300 nL L^{-1} 1-MCP for 4 hours. The chambers were opened for 1 hour airing. Then inflorescences of each chamber divided to two subgroups and treated with 0 and 1 μL L^{-1} ethylene gas, balanced with nitrogen. After 24 hours the chambers were opened and the inflorescences were taken out from them. The inflorescences were kept in the laboratory with normal condition. The most weight loss and longest vaselife was recorded in DDG and MCG with 44% and 14 days respectively. Meanwhile, maximum postharvest quality improvement was obtained by 1-MCP pretreatment in very sensitive cut orchid hybrids.

Keywords: Inflorescence, Dendrobium, Mokara, postharvest quality, bud opening

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1 Introduction

Dendrobium is the second large genus in Orchidaceae family (Adams, 2011) that consists over 1000 species which have been scattered in the Himalayan range, through Southeast Asia to Japan, Australia, Tasmania and Pacific Islands. Dendrobium is the most popular orchids. Mokara is a trigeneric (*Arachnis* × *Ascocentrum* × *Vanada*), monopodial and no pseudobulbs hybrid from Dendrobium Group (Epidendrum subfamily) which was produced in Singapore in 1969. The beautiful colors of Mokara have given them high position among the other genera. Mokaras are often similar to Ascocenda hybrids, and their inflorescences can last 4-6 weeks (White, 1996). Ethylene sensitivity and its control have been considered as a major concern for long term storage of many cut flowers. The ethylene sensitivity is manifested as senescence and abscission of leaves, flowers and buds (Dole and Wilkins, 1999). Cut orchid flowers are regarded as the ethylene sensitive (Beyer, 1976; Goh et al., 1985; Porat et al., 1994) but there are apparently variation in sensitivity among species, cultivars and hybrids (Sun et al., 2009).

The affinity of 1-MCP to the ethylene binding receptor is ten times more than the substrate itself (Blankenship and Dole, 2003). Low effective concentration of 1-MCP and its minimum residues have caused that 1-MCP been viewed as an important and safe candidate for replacing STS (Watkins, 2006). Autocatalytic ethylene production is inactivated by the binding of 1-MCP to the ethylene receptors and thus, plants will be protected from both endogenous and exogenous ethylene production (Serek et al., 1994).

Uthaichay et al. (2007) noted that 100-500 nL L^{-1} 1-MCP treatment remarkably reduced inflorescences abscission of Dendrobium 'Karen' during transit. This treatment was performed before simulated air transport. In addition, they reported that 1-MCP treatment reduced both ACC synthase in open flowers and ACC oxidase activity in floral buds and thus, prevented the ethylene production by inflorescences. On the contrary, Singh and Jaroenkit (2011) reported that effect of 1-MCP treatment on physiological characteristics and vase life of cut Mokara 'Sayan Dongporn' was not significant. They suggested that it is possible that the binding of 1-MCP to the ethylene receptors in the plant tissue may be temporary or they bind to other receptors, so their effects for blocking ethylene action would not be permanent at the later storage period (Sisler and Serek, 1997). Meanwhile, some crops such as flowers and tomatoes are able to reproduce new binding sites relatively higher than other crops and this can lead to ineffectiveness of 1-MCP treatment. Therefore, availability of binding sites after 1-MCP treatment differs greatly among the plants (Blankenship and Dole, 2003).

Sun et al. (2009) found that flowers and buds dropped in all studied mini Phalaenopsis cultivars were promoted with exogenous ethylene treatment. However, there were obvious differences sensitivities among various cultivars. Cultivar Sogo 'Vivien' showed the maximum sensitivity but Sogo 'Berry' displayed the minimum water loss, bud drop and change within membrane permeability in tepal which showed the lesser sensitiveness of this cultivar. 1-MCP treatment also reduced bud dropped induced by ethylene in cultivar Sogo 'Yenlin'. Ethylene exposure stimulated the ABA content in floral buds, while 1-MCP significantly reduced the ABA level in floral buds. They suggested that increase in ABA content during bud drop is correlated to ethylene. Ichimura et al. (2002) compared the effect of 1-MCP with STS on vase life of three sensitive flowers. They observed that 1-MCP extended the vase life of cut carnations twofold and significantly improved the vase life of cut Delphinium and sweet pea. However, the effect of 1-MCP on longevity of Delphinium was much weaker than STS. Two ethylene sensitive cut orchids including Oncidium and Odontoglossum pre-treated with 300 nL L^{-1} 1-MCP exhibited distinct improvement in postharvest quality (Raffeiner et al., 2011). Study of ethylene sensitivity and 1-MCP in cut orchid hybrids are not well documented in Malaysia despite of existence of several studies on Dendrobium and Mokara cut hybrids in other countries. Research on control of ethylene sensitivity is important because cut orchid flowers are ethylene sensitive but, yet high value floriculture crops. In 2011, the wholesale value of cut orchids produced in Malaysia by growers was RM 109 million from the total RM 333.6 million sales (MAS, 2012). This is the highest wholesale value of a single flower type in the Malaysia cut flowers industry.

This experiment was conducted to determine the efficacy of 1-MCP in controlling ethylene sensitivity of selected cut orchids and thus, improving postharvest quality of the flowers.

2 Materials and Methods

2.1 Experimental site

Based on Köppen classification system, the experimental site (3°0′21.34″N, 101°42′15.06″E) is located in Tropical rainforest climate (Af) which characterized by continous high temperature (18 °C or higher) throughout the year, average rainfall of at least 60 mm in every month and no dry seasons. During the experimental period, monthly average maximum and minimum temperature and relative humidity ranged from 32.9 to 34.8 °C, 22.6 to 24.4 °C and 93.7 to 95.9%, respectively, while rainfall, evaporation and sunshine hours ranged from 4.8 to 13.4 mm d^{-1}, 3.9 to 4.4 mm d^{-1} and 6.75 to 7.89 h d^{-1}, respectively.

2.2 Plant materials

Four orchid hybrids namely Dendrobium 'Darren Glory' (DDG), D. 'Sonia Bom' (DSB), Mokara 'Calypso Jumbo' (MCJ) and M. 'Chiti Gold' (MCG) were used as the plant materials in this study. Orchids were purchased from a commercial farm. Inflorescences with 60 to 70 percent open florets were harvested between 8 to 9 a.m. and then immediately transported to the Postharvest Lab, Faculty of Agriculture, UPM, Serdang, Selangor within one hour.

2.3 Experimental design and treatments

The experiment was conducted using a Completely Randomized Design (CRD) in a factorial arrangement of treatments. The study on the determination of weight loss, vase life and bud opening was replicated five times. Treatments comprised four orchid hybrids namely, DDG, DSB, MCJ and MCG, two different concentrations of 1–methyl cyclopropene (1-MCP) such as 0 (control) and 300 nL L^{-1}, and two ethylene exposure concentrations such as 0 and 1 μL L^{-1}.

2.4 MCP and ethylene treatment

Inflorescences of DDG, DSB, MCJ and MCG were subjected to 1-MCP treatment within 1 h of harvesting. In the laboratory, inflorescences were divided into two groups and placed in two Plexiglass chambers of size 51 × 46.5 × 33.5 cm^3 each. To deliver 300 nL L^{-1} 1-MCP to one of the chambers, a small vial containing 37.92 mg Ethylbloc was taped to the chamber's internal wall. Then, 190 μL L^{-1} deionized water was added to the tube and the chambers were immediately sealed for 4 h. To homogenize the air, small fans were placed inside the chamber. The chambers were opened for 1 h airing. Then inflorescences of each chamber divided to two subgroups and after labeling the 4 chambers they were placed inside them gently. The chambers were hermetically-sealed. Then, two separate 1 μL L^{-1} ethylene gas, balanced with nitrogen, were injected into the two chambers. After 24 h the chambers were opened and stems of inflorescences. Each inflorescence's basal stem was trimmed to 12 cm from the first open floret before being put into a cylindrical polyethylene (PE) bag (thickness 10 μm) containing 60 mL distilled water. Each plastic bag was then held in a 300 mL glass bottle with cotton wool placed around each stem for the purpose of holding it upright. The inflorescences were kept in the laboratory at means temperature, relative humidity and light intensity of 25 °C, 78% and 6.57 μmol m^{-2} s^{-1}, respectively.

2.5 Weight loss

The weight of each inflorescence with the PE bag, bottle and vase solution was recorded daily for five days without replenishing the vase solution. The differences between the daily measurements were calculated as percentage loss of fresh weight per day.

2.6 Vase life

Color, appearance and number of florets and buds were recorded for all flowers. Vase life was considered ended when more than one third of florets and buds wilted.

2.7 Bud opening

Percentage of bud opening was calculated using following formula:

$$\text{Bud opening (BO) \%} = \frac{B_2 - B_1}{B_1} \times 100 \qquad (1)$$

where, B_1 = initial number of buds, and B_2 = number of buds on the day of measurement.

2.8 Statistical analysis

The data were subjected to analysis of variance (ANOVA) by using SAS software version 9.1. Treatment means were compared by Duncan's Multiple Range Test (DMRT) at p≤0.05. When there was significant interaction between the factors, regression analysis by SAS software version 9.1 were performed.

3 Results and Discussion

3.1 Weight loss

There were significant interactions between factors on the weight loss of the flowers. Weight loss of DDG hybrid was significantly higher than other hybrids (Table 1). Effect of 1-MCP on weight loss depended on hybrids (Fig. 1a). Different hybrid responded in a different way to 1-MCP where DDG loosened the highest weight compared to other hybrids with its application. However, with control, naturally DDG seemed to loose more weight compared to other hybrids. Overall 1-MCP reduced weight losses between hybrids except for DDG. Loss of flower's weight is often considered as one of the most paramount factors responsible for the quality degradation in flowers. Our findings cast more light on the different rate of weight losses in different hybrids due to variations to ethylene sensitivity.

These were consistent with the results of (Macnish et al., 2004) which reported that there was a different flower abscission rate among various genotypes and species of Chamelaucium cut flowers. So it can be seen that sensitivity of cut flowers to ethylene exhibited more premature senescence and abscission and ultimately more weight loss. Remarkable reduction with 1-MCP treatment could probably be due to blockage of ethylene receptors which reduced ethylene sensitivity. This blockage, postpones the climacteric increase of respiration and ethylene production and thus, the freshness of flowers would be maintained longer. This behavior seems to be a general effect of 1-MCP in most of the studied flowers, such as patumma (Chutichude et al., 2011) and the Siam tulip (Chutichude et al., 2010). Both studies cited a positive effect of 1-MCP treatments on fresh weight.

Moreover, the decline in weight loss of cut studied orchid hybrids after harvest by 1-MCP treated flowers may be from 1-MCP's inhibition effect on the autocatalytic production of ethylene (Sisler et al., 1996). With

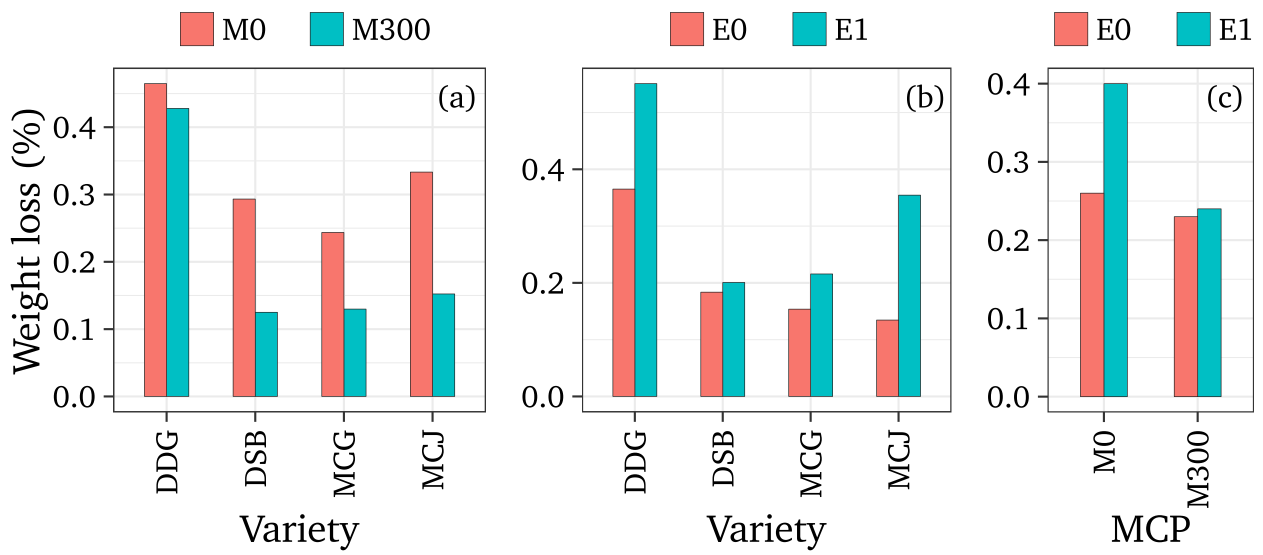

Figure 1. Effects of (a) 1-MCP (M0 = 0 and M300 = 300 nL L^{-1}) (b) ethylene (E0 = and E1 = 1 μL L^{-1}), and (c) interactions of 1-MCP and ethylene on weight loss of different orchid hybrids. DDG = Dendrobium 'Darren Glory', DSB = D. 'Sonia Bom', MCJ = Mokara 'Calypso Jumbo', and MCG = M . 'Chiti Gold'

this inhibitory effect, 1-MCP in addition to suppression of ethylene action reduces ethylene too. Ethylene plays major role in flower senescence in many plants, such as Delphinium (Ichimura et al., 2009), sweet pea (Mor et al., 1984), carnation (Wu et al., 1991) and Phalaenopsis (Porat et al., 1995). In these plants, ethylene exposure induces the flower senescence, and Fig. 1b showed the interaction between hybrids and ethylene exposure on the weight loss. Here, we can see the different responses of hybrids to ethylene exposure.

Without ethylene exposure (E0), DDG showed significantly higher weight loss compared to MCJ, MCG and DSB and between these three latter hybrids, DSB had significant higher losses. However, with exposure to ethylene, there were higher weight losses in DDG and MCJ compared to MCG and DSB. On the other hand, the means comparison within each hybrid indicated that with exposure to ethylene, only DDG and MCJ had significant higher weight loss compare to without exposed to ethylene but MCG and DSB after ethylene exposure also had almost same weight loss. These findings showed higher sensitivity of DDG and MCJ to ethylene compared to MCG and DSB. Meanwhile these results confirmed our results in last experiment to determine the sensitivity of 12 cut orchids to ethylene (Almasi, 2012; Almasi et al., 2013). DDG and MCJ were categorized in very ethylene sensitive group.

Another interaction effect between hybrids and day in distilled water is presented in Fig. 2. This graph shows that water loss during displayed depended on the hybrids where each hybrid had different trend of water loss compared to MCJ, MCG and DSB and between these three latter hybrids, DSB had significant higher losses.

However, with exposure to ethylene, there were higher weight losses in DDG and MCJ compared to MCG and DSB. On the other hand, the means comparison within each hybrid indicated that with exposure to ethylene, only DDG and MCJ had significant higher weight loss compare to without exposed to ethylene but MCG and DSB after ethylene exposure also had almost same weight loss. These findings showed higher sensitivity of DDG and MCJ to ethylene compared to MCG and DSB. Meanwhile these results confirmed our results in last experiment to determine the sensitivity of 12 cut orchids to ethylene. DDG and MCJ were categorized in very ethylene sensitive group. Fig. 1c demonstrates the interaction between 1-MCP and ethylene exposure on the weight loss. It shows that without 1-MCP pretreatment, ethylene exposure has brought about higher weight loss in the cut flowers compared to non-exposed to ethylene but with 1-MCP pretreat ment firstly there was no differences with and without exposure to ethylene and secondly, the rate of weight loss in with and without exposure to ethylene declined. Thus, it can be claimed that the efficiency of 1-MCP on controlling ethylene sensitivity of tested hybrid is acceptable.

Another interaction effects was found between hybrid, 1-MCP treatment and exogenous ethylene which has presented in Table 1. It shows that effects of 1-MCP pretreatment and exogenous ethylene on the weight loss of various hybrids are different. As, the highest loss in fresh weight observed in two sensitive hybrids; DDG and MCJ when they exposed to ethylene. Furthermore, this table shows that efficiency of 1-MCP in declining of weight loss was

Table 1. Effects of orchid hybrids, 1- methyl cyclopropane (1-MCP) concentrations, exposure to ethylene and their interactions on weight loss, vase life and bud opening

Factors	Weight Loss (%)	Vase Life (d)	Bud Opening (%)
Hybrid (H)			
DDG	0.44 a	8.20 d	27.10 b
MCG	0.25 b	14.08 a	61.11 a
MCJ	0.23 b	10.00 c	39.93 b
DSB	0.20 c	10.71 b	27.48 b
1-MCP (M)			
0 nL L^{-1}	0.33 a	7.17 b	18.74 b
300 nL L^{-1}	0.23 b	14.33 a	59.07 a
Ethylene (E)			
0 $\mu L\ L^{-1}$	0.24 b	12.60 a	42.40 a
1 $\mu L\ L^{-1}$	0.32 a	8.90 b	35.41 b
Interactions			
H × M	0.41**	2.86*	40.98**
H × E	0.27**	4.10**	59.23**
M × M	0.15*	6.54**	63.56**
H × M × E	0.31**	3.12**	54.18**

Means, within column and factor, followed by the same letter are not significantly different by Duncan's Multiple Range Test (DMRT) at P = 0.05; *, ** = significant and highly significant p≤0.05 and p≤0.01, respectively.

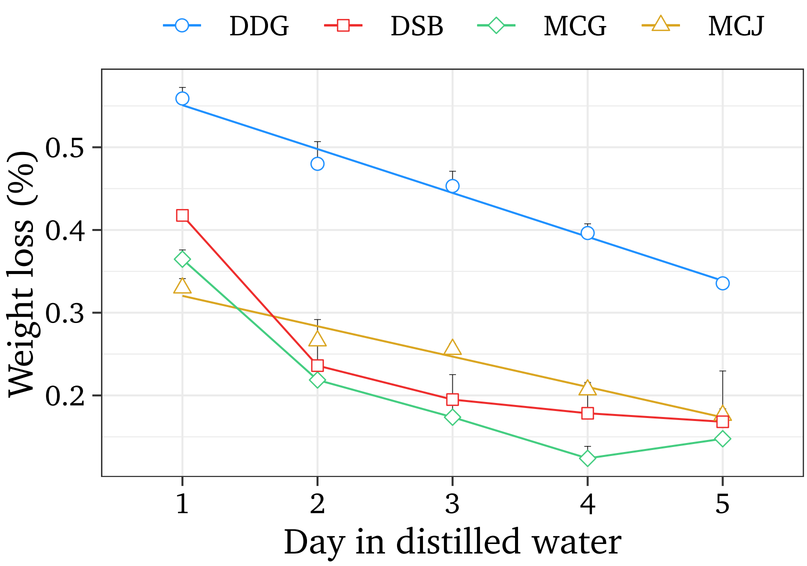

Figure 2. Weight loss pattern of orchid hybrids DDG (Dendrobium 'Darren Glory'), DSB ('Sonia Bom'), MCJ (Mokara 'Calypso Jumbo'), and MCG (M . 'Chiti Gold') in distilled water. $y_{DDG} = 0.602 - 0.054x$ ($r^2 = 0.112$); $y_{MCJ} = 0.357 - 0.037x$ ($r^2 = 0.082$); $y_{MCG} = 0.63 - 0.26x + 0.035x^2$ ($r^2 = 0.297$), $y_{DSB} = 0.515 - 0.188x + 0.063x^2$ ($r^2 = 0.272$)

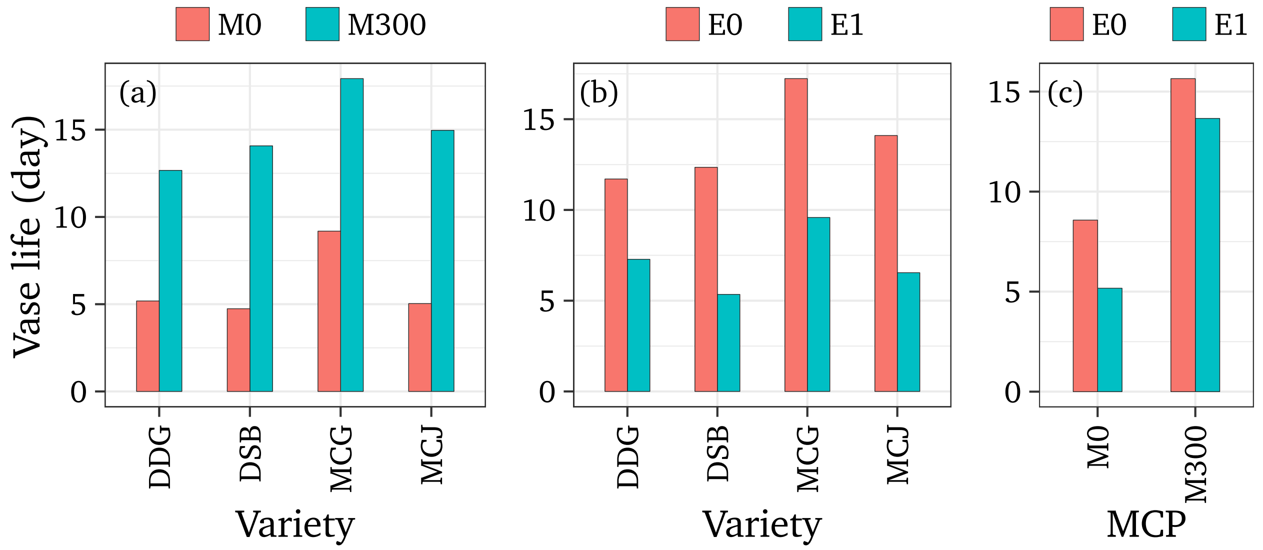

Figure 3. Effects of (a) 1-MCP (M0 = 0 and M300 = 300 nL L^{-1}) (b) ethylene (E0 = and E1 = 1 μL L^{-1}), and (c) interactions of 1-MCP and ethylene on vase life of different orchid hybrids. DDG = Dendrobium 'Darren Glory', DSB = D. 'Sonia Bom', MCJ = Mokara 'Calypso Jumbo', and MCG = M . 'Chiti Gold'

observed in DDG, MCJ and DSB even with exposure to ethylene. MCG did not showed significant reduction in weight loss. It can be claimed that less sensitive cut orchid like MCG did not improved its postharvest quality remarkably. So, efficacy of 1-MCP fumigation is be correlated to hybrids. These finding was consistent with the results of Obsuwan and Uthairatanakij (2007) on cut orchis as they reported that Mokara Jairak Gold and Vascostylis Sakura did not promoted their postharvest quality by 1-MCP treatment but Dendrobium 'Aroon White' responded well.

3.2 Vase life

There were significant interactions between all factors of the vase life of the flowers. The vase lives of hybrids were affected differently by 1-MCP treatment (Fig. 3a). Longest vase life for the control treatment was found with MCG hybrid. Similar result was observed when the flowers were exposed to 1-MCP. Other hybrids were not significantly affected by the treatment when compared between hybrids.

However, vase lives of all hybrids improved significantly with 1-MCP treatment. These results were consistent with the findings of (Valenzuela-Vázquez et al., 2007) on cut Lupinus havardii Racemes, Porat et al. (1995) on cut phlox, Huang and Paull (2009) on Oncidium cut flowers and Uthaichay et al. (2007) on Dendrobium cut orchids. They reported that from one hand, all the mentioned flowers were ethylene sensitive and the exposure to 1-MCP pretreatment effectively extended their vase lives. Vase life responses of highly sensitive and less sensitive hybrids to the 1-MCP are positive but with different magnitude. Longest vase life extension was observed in highly sensitive hybrid (MCJ) about 59% with 300 nL L^{-1} 1-MCP treatment and minimum extension was occurred in less sensitive hybrid (MCG) about 39%. So, probably the effectiveness of 1-MCP on controlling of ethylene sensitivity is better with highly sensitive hybrids.

On the other hand, our finding was in contradiction with the results of Obsuwan and Uthairatanakij (2007) who reported Mokara 'Jairak Gold' and 'Vascostylis Sakura' did not respond to 1-MCP whilst, we found both studied Mokara hybrids, MCJ in particular, displayed positive feedback after 1-MCP application. This paradox may partly be due to the existence of variation among Mokara hybrids hence, some of them respond positively to 1-MCP treatment and others not. Other possible reason may be because of the difference in concentrations applied and period of exposures. We used 300 nL L^{-1} 1-MCP for 4 hours but they used 1000 nL L^{-1} for 1.5 h.

Interaction effect of hybrid and ethylene exposure on vase life was highly significant (Table 1). Fig. 3b exhibited the interaction between hybrids and ethylene exposure on the vase life. With exposure to ethylene, vase lives of all tested hybrids decreased when compared with those flowers that were not exposed. However, between the hybrids of flowers treated with ethylene, no significant differences were observed. With the control, it seemed that naturally MCG flowers lasted longer than other hybrids which were equally long between each other. But, between treatments with ethylene, the vase lives of MCJ, MCG and DSB were significantly reduced. These re-

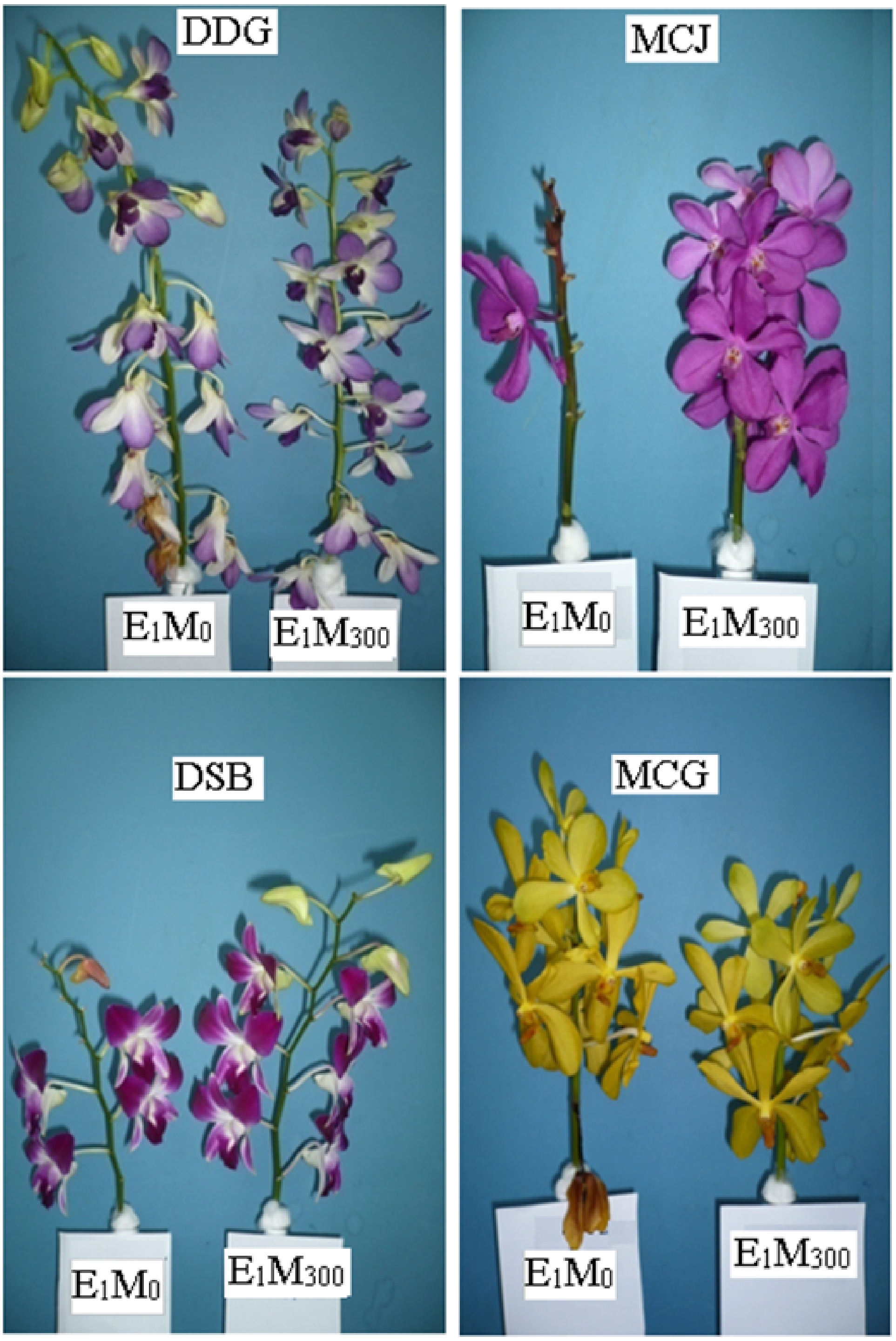

Figure 4. Effect of 4 h exposures to 300 nL L^{-1} 1-MCP and 1 μL L^{-1} ethylene on postharvest quality of two very sensitive [Dendrobium 'Darren Glory' (DDG), Mokara 'Calypso Jumbo' (MCJ)] and less sensitive [M . 'Chiti Gold' (MCJ) and D. 'Sonia Bom' (DSB)] cut orchid hybrids 11 d after harvest. E1M0 = exposure to 1 μL L^{-1} ethylene without 1-MCP pretreatment; E1M1 = Exposure to 1 μL L^{-1} ethylene with 300 nL L^{-1} 1-MCP pretreatment.

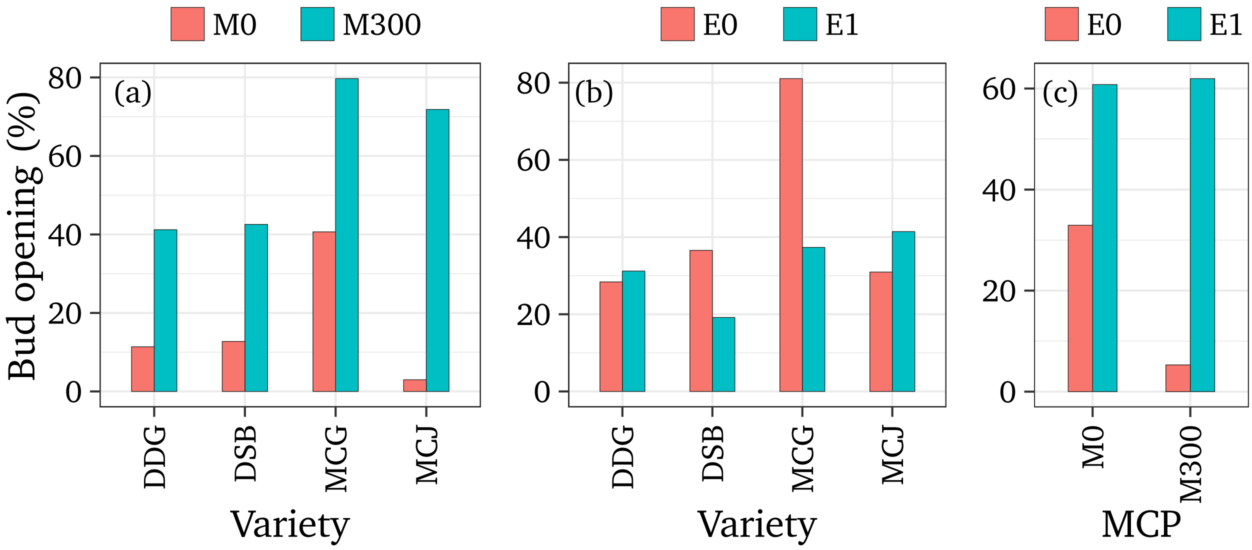

Figure 5. Effects of (a) 1-MCP (M0 = 0 and M300 = 300 nL L^{-1}) (b) ethylene (E0 = and E1 = 1 μL L^{-1}), and (c) interactions of 1-MCP and ethylene on bud opening of different orchid hybrids. DDG = Dendrobium 'Darren Glory', DSB = D. 'Sonia Bom', MCJ = Mokara 'Calypso Jumbo', and MCG = M . 'Chiti Gold'

sults were similar to other researches which reported that exogenous ethylene enhances the senescence processes in sensitive cut flowers and shortens their life span (Ahmadi et al., 2009; Chamani et al., 2005; Sun et al., 2009). The probable reason for the lacked of substantial difference in vase lives of DDG inflorescences with and without exposure to ethylene can be related to high ethylene production and sensitivity of this hybrid to ethylene. Even without exposure to the ethylene, naturally it wilted in less than 6 d.

Interaction effect of 1-MCP and ethylene exposure is presented in Fig. 3c. Interestingly, it showed that treatment with 300 nL L^{-1} 1-MCP significantly abled to extend the vase lives of all hybrids even with exposure to 1 μL L^{-1} ethylene. Even there was no significant difference between flowers exposed and not exposed to ethylene. However, without 1-MCP treatment, ethylene treated flowers showed shorter vase lives. These results concurred to the results of Huang and Paull (2009) on efficacy of 1-MCP in prolonging the vase life of both ethylene-treated and non-ethylene-treated cut Oncidium. The findings of (Çelikel et al., 2002) regarding the pre-treatment of oriental lilies (*Lilium* cvs. 'Monalisa' and 'Stargazer') with 1-MCP also prevented the negative responses of the flowers to ethylene. So, 1-MCP could probably be suggested as a suitable tool in extension of displayed lives of highly and less sensitive cut orchid hybrids (Fig. 4).

3.3 Bud opening

There were significant interactions between various factors that affected the percentages of bud opening of the cut orchid flowers. There was a significant interaction between hybrids and 1-MCP treatment on the %bud opening (Fig. 5a). With 1-MCP treated flowers, MCG gave the highest percentage of openings which were obviously different from DDG and DSB. However, MCJ was no difference from all other hybrids. Natural ability of MCG to open buds was visually high but statistically not when compared to DDG and DSB except for MCJ. 1-MCP treatment also increased bud opening a crossed all hybrids significantly. Sun et al. (2009) reported that exogenous ethylene enhanced flower bud drop in all tested Phalaenopsis cultivars. It is worth mentioning that 1-MCP decreased ethylene-induced floral bud drop in the cultivar Sogo 'Yenlin'. In cut orchid flowers, one important consequence of ethylene sensitivity is bud dropping and premature senescing. Since 1-MCP could effectively inhibit the ethylene production and hence, it is able to delay wilting of buds and improves the bud opening. Uthaichay et al. (2007) reported that the treatment of Dendrobium orchid. inflorescences with 100–500 nL L^{-1} 1-MCP to simulate air transport remarkably inhibited the abscission of buds and open florets during period of vase life.

Interaction effect of hybrids and ethylene exposure (H $\times$ E) on bud opening was highly significant. Without ethylene exposure, MCJ had the highest bud opening compared to other hybrids (Fig. 5b). Nevertheless, with 1 μL L^{-1} exogenous ethylene, bud openings for all hybrids were similar. Between the same hybrids, ethylene treatment significantly reduced bud openings in in DSB and MCG but not DDG and MCJ. This indicated that the latter two hybrids were not that sensitive to ethylene. These results were consistent with the results of many other researches and also from our previous experiment. The effect of exogenous ethylene on postharvest quality of sensitive cut flowers were enhancement of senescence and abscission of bud and open flowers (Huang and Paull, 2009; Sun et al., 2009; Wagstaff, 2005).

Despite of 1-MCP treatment, presence of ethylene increased bud openings compared to flowers not exposed to ethylene (Fig. 5c). With ethylene treatment, there was no significant different between 1-MCP treated flowers and non-treated. In term of bud opening, ethylene effect was more pronounced compared to 1-MCP. 1-MCP seemed to retard bud opening where treated flowers showed a significantly lower percentage of bud opening compared to non-treated when the flowers were not exposed to ethylene.

4 Conclusions

Maximum postharvest quality improvement was obtained by 1-MCP pretreatment in very sensitive cut orchid hybrids. Here it can be suggested that 1-MCP can be applied effectively for inhibition of bud dropping when inflorescences of sensitive cut hybrids are exposed to ethylene such as when the flowers are placed in cardboard for shipment.

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Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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