



EFFECT OF 1-METHYLCYCLOPROPENE (1-MCP) ON THE POSTHARVEST SENESCENCE OF 'DALLUS' ROSE DURING STORAGE AND ITS ANTIOXIDANT SYSTEM

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Abstract

Roses are sensitive to ethylene and respond to it by flower senescence. The effects of pretreatment of 1-methylcyclopropene (1-MCP) on postharvest life and its antioxidant system of cut 'Dallus' Rose flowers were investigated. 'Dallus' rose flowers at commercial stage of bud opening were exposed to 1-MCP at different concentrations (100 and 250 $\text{nl}\cdot\text{l}^{-1}$) for 4 h at 22 °C, and non-treated flower were used as the control. Afterwards, roses were dipped in a test tubes filled with distilled water and placed at 22 °C. Water uptake, color of petal, flower opening and vase life were recorded every 2 days. The petals of flower were sampled and stored at -30 °C for analysis of hydrogen peroxide (H_2O_2), glutathione and superoxide dismutase (SOD). The results showed that rose flowers pretreatment by 100 $\text{nl}\cdot\text{l}^{-1}$ of 1-MCP was higher in a and Chroma values at day 6 and prolonged vase life to almost 6 days as compared with 4 days for other concentrations. Pretreatment by 100 and 250 $\text{nl}\cdot\text{l}^{-1}$ of 1-MCP decreased flower opening in rose flowers. H_2O_2 increased during storage and pretreatment by 100 and 250 $\text{nl}\cdot\text{l}^{-1}$ of 1-MCP was higher than the non-treated flower. Rose flowers pretreatment by 100 $\text{nl}\cdot\text{l}^{-1}$ of 1-MCP increased glutathione after 4 days of storage. However, SOD was not significantly affected by different concentration of 1-MCP treatments. The results suggested that pretreatment by 100 $\text{nl}\cdot\text{l}^{-1}$ of 1-MCP could delay postharvest senescence in rose flower by regulating glutathione metabolism.

Key words: glutathione, senescence, superoxide dismutase, 1-methylcyclopropene

Introduction

Ethylene is an important factor in the postharvest life of cut flowers (Han et al., 2003) as it accelerates flower abscission and leaf yellowing (Joyce and Poole, 1993). Reid et al. (1989) found that various cut rose cultivars showed a range of responses to ethylene treatment, such as inhibition of opening, acceleration of opening, abnormal opening, petal and leaf abscission, and loss of petal gloss. 1-methylcyclopropene (1-MCP) is a competitive inhibitor of the plant senescence hormone, ethylene (Sisler and Serek, 1997). 1-MCP (1-methylcyclopropene), can effectively protect flowers against exogenous ethylene (Serek et al., 1995) and increase vase life of several flower such as Patumma (Chuticudet et al., 2011), Lotus (Suanphairoch, et al.) and White Christmas rose (Chanmanee et al., 2010). Chamani et al. (2005) have been reported that exogenous 1-MCP did not increase vase life of 'First Red' rose. However, the mechanisms of 1-MCP on cut flower are not clear. Larrigaudiere et al. (2004) suggested ethylene is involved reactive oxygen species (ROS) production. The impacts of 1-MCP on ROS production and antioxidant system are limited. The objectives of this study were investigated the effects of exogenous 1-MCP treatment on postharvest life and its antioxidant system of cut rose flowers.

Methodology

Plant materials and treatment

'Dallus' Rose flowers at commercial stage of bud opening were harvested early in the morning from Great Rose orchard Chiang Rai Province, Thailand. Pretreatment with 1-MCP was released from a commercial powdered formulation by adding distilled water, according to the manufacturer's instructions. All treatments were taken in seal plastic bucket containing distilled water and exposed to different concentrations 1-MCP (0, 100 and 250 $\text{nl}\cdot\text{l}^{-1}$) 22 °C for 4 h. Stem ends were recut under water to remove air emboli and then placed into 20 ml of distilled water at 22 °C, 80% relative humidity. The petals of flower were sampled every 2 days and stored at -30 °C until analysis.

Physical analysis

The changes of water uptake, color of petal by colorimeter (Color Quest XE Hunter Lab, USA), diameter of flower, vase life (base on acceptance score; 5 points is flesh flower, 4 points is slightly wilted, 3 points is start to bluing, 2 points is browning symptom and bluing and 1 points is abscission of petal) were recorded every 2 days.

Hydrogen peroxide concentration

Hydrogen peroxide concentrations were determined according to Velikova et al. (2000). Two grams of sample were homogenized with 1% trichloroacetic acid (TCA). The homogenate was centrifuged at 12,000 x g for 20 min at 4 °C. One milliliter of supernatant was added to 3 ml of 50 mM potassium phosphate buffer (pH 7.0) and 1 ml of 1 M KI. The mixed solution was measured at 390 nm. The concentration of hydrogen peroxide was given on a standard curve.

Glutathione concentration

Five grams of sample were homogenized in sodium phosphate buffer (pH 7.0) and centrifuged at 15,000x g for 15 min at 4 °C. The supernatant was used to perform glutathione assay using colorimetric method as described by Owens and Belcher (1965).

Superoxide dismutase assays

Two grams of sample were homogenized in 20 ml of 0.1 M phosphate buffer (pH 7.0) containing 3 mM EDTA and 1% PVPP. The homogenate was centrifuged at 15,000 x g for 15 min at 4 °C. The supernatant was used for SOD activity assay by the spectrophotometrically method as described by Oberley and Spitz (1986). Xanthine-xanthine oxidase was used to generate the superoxide radicals. Nitrobluetetrazolium (NBT) was used as an indicator of superoxide radical production. One unit of SOD was defined as the amount of enzyme that inhibited 50% of NBT. SOD activity was expressed as units of mg protein^{-1} .

Statistical analysis

Analysis of variance was performed by ANOVA procedures. Significant differences were calculated according to Duncan multiple range test. Differences at $P < 0.05$ were considered statistically significant.

Result

Effect of pretreatment by 1-MCP at 0, 100, 250 $\text{nl}\cdot\text{l}^{-1}$ on changes of L, a, b and Chroma values of rose flower are shown in Figure 1. At day 6, a and Chroma values of rose flowers was significantly higher in 100 $\text{nl}\cdot\text{l}^{-1}$ of 1-MCP than other concentrations. However, L and b values were not different among treatments.

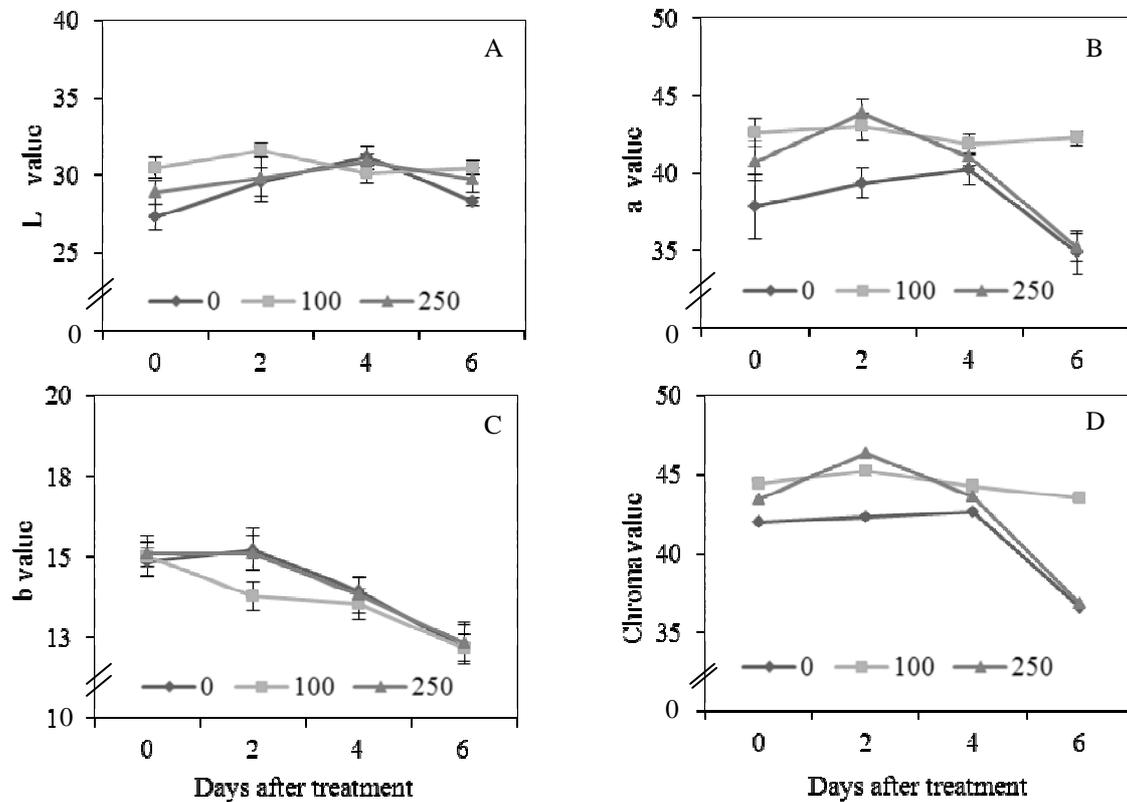


Figure 1 Effect of pretreatment by 1-MCP at 0, 100, 250 $\text{nl}\cdot\text{l}^{-1}$ on changes of (A) L value as lightness, (B) a value as redness, (C) b value as blue color and (D) Chroma value of rose flower placed at 22 °C. Bars represent SE (n = 10)

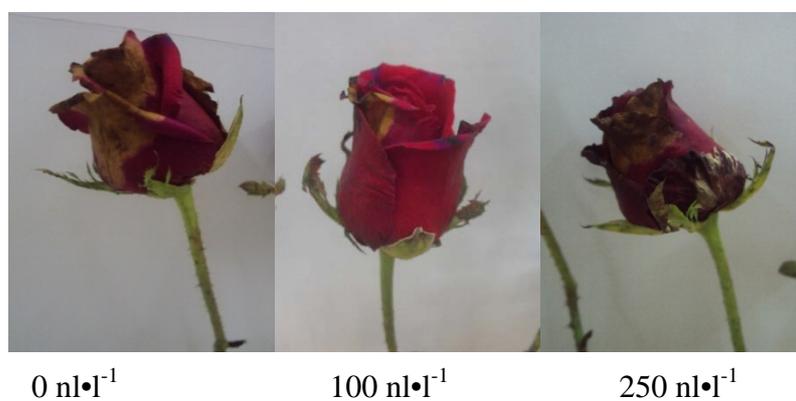


Figure 2 Characteristics of rose flower at day 6

Effect of pretreatment by 1-MCP at 0, 100, 250 $\text{nl}\cdot\text{l}^{-1}$ on changes of flower opening, water uptake and acceptance score of rose flower are shown in Figure 3. Flower opening was increased from 0 to 6 days after treatment. Flower opening was significantly higher in non-treated flower than pretreatment by 100 and 250 $\text{nl}\cdot\text{l}^{-1}$ of 1-MCP. Water uptake was rapidly increased from 0 to 6 days after treatment and there was no significantly different among treatment. Vase life of rose flower was based on the acceptance score and below 3 points can not be accepted. Rose flower pretreatment by 100 $\text{nl}\cdot\text{l}^{-1}$ of 1-MCP prolonged vase life to almost 6 days as compared for other concentrations.

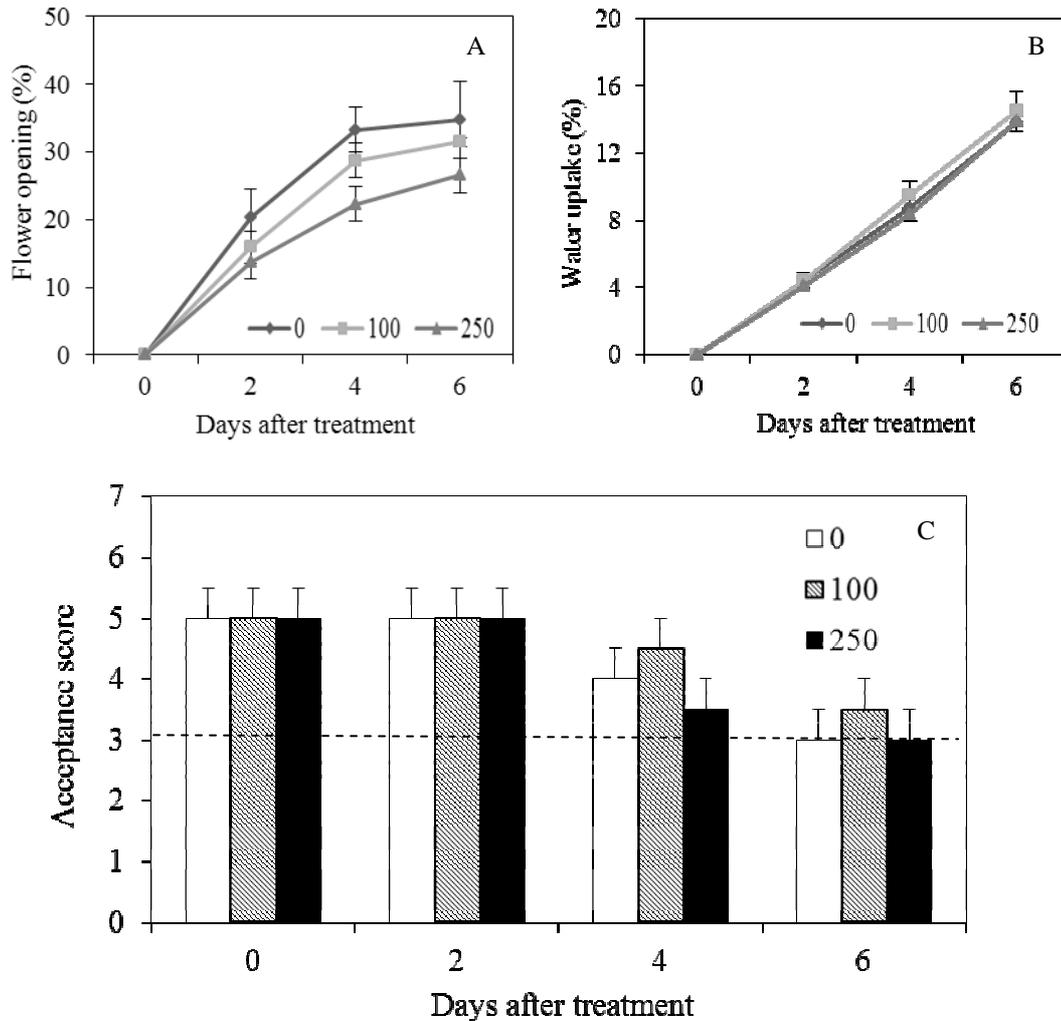


Figure 3 Effect of pretreatment by 1-MCP at 0, 100, 250 $\text{nl}\cdot\text{l}^{-1}$ on changes of (A) flower opening (B) water uptake (C) acceptance score of rose flower placed at 22 °C. Bars represent SE (n = 10)

Effect of pretreatment by 1-MCP at 0, 100, 250 $\text{nl}\cdot\text{l}^{-1}$ on changes in hydrogen peroxide, glutathione and superoxide dismutase of rose flower are shown in Figure 4. Hydrogen peroxide of rose flower increased from 0 to 6 days and then decreased. The hydrogen peroxide was higher in 100 and 250 $\text{nl}\cdot\text{l}^{-1}$ of 1-MCP than non-treated at 2 days after treatment. Glutathione was significantly higher in 100 $\text{nl}\cdot\text{l}^{-1}$ of 1-MCP than other concentrations at 6 days after treatment. However, superoxide dismutase was not significantly different among treatments.

Discussion

Serek et al. (1994) found that treatment of Rosa hybrid 'Victory Parade' with $1\mu\text{l}\cdot\text{l}^{-1}$ ethylene decreased its vase life. Chamani et al. (2005) found 'First Red' rose is climacteric cultivars as characterized by a pronounced peak in ethylene production that was evident during postharvest evolution in the vase. Pretreatment with $1\mu\text{l}\cdot\text{l}^{-1}$ 1-MCP for 2 h completely inhibited ethylene induced petal abscission in *Pelargonium peltatum* (Cameron and Reid, 2001). Our data show that, pretreatment by $100\text{ nl}\cdot\text{l}^{-1}$ of 1-MCP preserve color changes (Fig 2) and extended vase life (Fig 3) in rose flower.

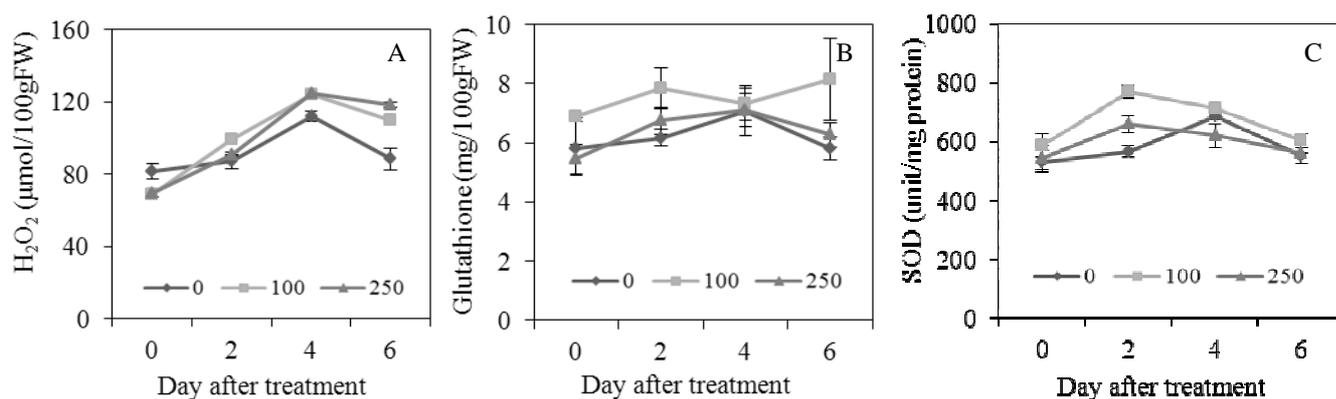


Figure 4 Effect of pretreatment by 1-MCP at 0, 100, 250 $\text{nl}\cdot\text{l}^{-1}$ on changes of (A) H_2O_2 (B) Glutathione and (C) SOD of rose flower storage at 22°C . Bars represent SE ($n = 3$)

In this result agreement with Sisler et al., (1996) demonstrated that 1-MCP completely protects senescence of carnations. Kebenei et al. (2003) reported that pretreatment of sweet pea flowers by $200\text{ nl}\cdot\text{l}^{-1}$ of 1-MCP for 6 h at 20°C protected against ethylene ($1\mu\text{l}\cdot\text{l}^{-1}$) and prolonged display life to almost 7 days as compared with the control. Pretreatment by 1-MCP $150\text{ nl}\cdot\text{l}^{-1}$ for 6 h in the absence of exogenous ethylene neither extended vase life nor improved quality of the Asiatic lilies flowers (Elgar et al., 1999). However, pretreatment of 1-MCP had no effect on the water uptake of rose flower during storage. These data are consistent with those of Chutichudet et al. (2011) found that 1-MCP fumigating had no effect on the water uptake of Patumma flowering stalk during vase life. Pretreatment by 100 and $250\text{ nl}\cdot\text{l}^{-1}$ of 1-MCP were lower the flower opening of rose flower than non-treated flower. Reid et al. (1989) reported that a very low concentration of ethylene ($0.5\mu\text{l}\cdot\text{l}^{-1}$) markedly inhibited the opening of cut rose flowers. A significant treatment effect was also observed in the glutathione (Fig 4). Pretreatment by $100\text{ nl}\cdot\text{l}^{-1}$ of 1-MCP significantly increased glutathione in rose flower. The results indicate that 1-MCP extended vase life of rose flowers, by increasing glutathione as a protection mechanism against reactive oxygen species compounds. Hassan and Mahfouz, (2012) has been reported that effects of 1-MCP was not confined exclusively to its effects on ethylene, but also included effects no antioxidant systems. Pretreatment by $100\text{ nl}\cdot\text{l}^{-1}$ of 1-MCP significantly increased hydrogen peroxide in rose flower. On the other hand, 1-MCP sprayed in soybean had lower hydrogen peroxide content compared with the untreated control (Djanaguiraman et al., 2011). In addition, factors affecting postharvest quality of cut flower are flower maturity, temperature, food supply, light, water supply, air embolism, ethylene, mechanical damage and disease. In suggestion, the effect of 1-MCP on ethylene production in 'Dallus' rose should be further studied.

Conclusion

The results suggest that pretreatment by $100 \text{ nl}\cdot\text{l}^{-1}$ of 1-MCP could delay postharvest senescence in rose flower by regulating glutathione metabolism.

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