Response of Potted Rose Varieties to Short-Term Ethylene Exposure

Ria T. Leonard[1], Terril A. Nell[1] and Lars Høyer[2]
[1]Department of Environmental Horticulture, University of Florida, Gainesville, Florida USA
[2]Infocus, Algade 34, 1, DK 5750 Ringe, Denmark

Keywords: longevity, postharvest, senescence, *Rosa hybrida* L.

Abstract

Postharvest longevity and sensitivity to short-term ethylene exposure of several miniature potted Parade® rose varieties were investigated. Plants were treated with a continuous flow of 1µl l^{-1} ethylene for 24 h at 20°C when plants were at marketable stage (3-5 open flowers).

The reaction to the injurious effects of exogenous ethylene can occur after a short exposure time of 24 h with considerable variation found in the response among varieties. The varieties response to ethylene differed in the time it took for visible symptoms to appear, the amount of damage observed and the plant part affected (buds verses flowers). For most varieties, it took several days before the effects of ethylene were evident. The varieties 'Charming', 'Fiesta' and 'Lady' did not respond significantly to ethylene. These varieties, which have long lasting qualities under ethylene free conditions, withstood this amount of ethylene without visible symptoms. The other varieties had an increase in bud and/or flower damage when exposed to ethylene. The magnitude of ethylene effects and the plant part affected was found to be variety dependent. Short lasting varieties were consistently found to be sensitive to ethylene, while most, but not all, long lasting varieties were tolerant.

INTRODUCTION

Differences in variety performance of many potted flowering plants such as lilies (Nell et al., 1995), kalanchoes (Serek and Reid, 2000), poinsettias (Miller and Heins, 1986) and roses (Muller et al., 1998) range from delayed senescence to increased tolerances to ethylene exposure. Exposure of potted roses to exogenous ethylene, which often occurs during transport, storage and/or retail displays, can cause leaf yellowing, flower, bud and leaf abscission, and premature flower senescence (Serek, 1993; Serek et al., 1994). The response to exogenous ethylene was found to be different among several potted roses varieties. Muller et al. (1998) found that all of the varieties tested were sensitive after being exposed to ethylene for 6 days, but there were major differences in their response. Relatively low concentrations of ethylene caused rapid loss in display life of some varieties while higher concentrations were needed for similar responses in other varieties.

The concentration of ethylene, temperature during exposure and the duration of the exposure will dictate how plants will response to the detrimental effects of ethylene. The floral industry strives to provide faster transport times for flowers to make it through the transport channels to the consumer in an ethylene free environment, however, there are situations where unfavorable conditions still persist. With the continued goal of faster transport times, the actual time of ethylene exposure may be reduced. Our study has evaluated 12 varieties of potted roses to determine differences in postharvest longevity and to test their sensitivity to short-term (24 h) ethylene exposure. Identifying varieties that have long-lasting characteristics and are tolerant to short-term ethylene exposure would be beneficial to increase quality, allow better tolerance to unfavorable transport/retail conditions and to enable breeders to incorporate these varieties into their breeding programs.

MATERIAL AND METHODS

The Parade® rose varieties originate from Poulsen Roser, ApS, Fredensborg,

Denmark. The varieties were grown in 10 cm pots and were commercially produced in the USA. At marketable stage (3-5 open flowers), plants were sent to the University of Florida lab and arrived within 24 h after packing. The varieties tested included 'Bianca', 'Claudia', 'Charming', 'Cherry', 'Fiesta', 'Julie', 'Lady', 'Mistral', 'Monica', 'New Heidi', 'Nicoline' and 'Sterling'. Upon arrival, plants were removed from the boxes, unsleeved and maintained at 21°C overnight. The next day, plants were treated with 1 µl l^{-1} ethylene for 24 h to test for differences in variety response to ethylene. The temperature during ethylene exposure was maintained at 20°C and the lights were on for 12 h/day at a light level of 10 µmol $m^{-2}s^{-1}$ from cool-white fluorescent lights. Ethylene treatment was provided by placing plants in sealed glass chambers using a continuous flow of 1 µl l^{-1} ethylene or air (control) at a flow rate of 6 l/minute. The ethylene concentration in the chambers was checked daily using a Hewlett Packard flame ionization gas chromatograph model 5890 Series II.

After the 24 h ethylene treatment, plants were placed in postharvest rooms maintained at 21°C and 10 µmol $m^{-2}s^{-1}$ (12 h/day) for evaluation. Relative humidity was maintained at 50±5%. The total number of flowers and buds and the number of damaged flowers and buds were counted every 2-3 days and the percentage of damaged flowers/buds was calculated. A flower or bud was considered damaged when they wilted, turned yellow or dropped.

A complete randomized block design was used with a total of six replicates per treatment with one plant per replicate. Differences between the means at each time point for each variety were determined using Tukey's honestly significant difference multiple comparison test ($P \leq 0.05$).

RESULTS

The effect of ethylene exposure on bud and flower damage for each variety is presented in Figure 1. Varieties differed in their response to ethylene in terms of their reaction time, the plant part affected (buds verses flowers) and sensitivity. The varieties 'Charming', 'Fiesta', and 'Lady' did not respond significantly to ethylene. These varieties, which have long lasting qualities in an ethylene free environment, withstood this amount of ethylene with no adverse effects. Conversely, 'New Heidi', which also has excellent postharvest longevity, had a significant increase in damaged buds when exposed to ethylene.

The other varieties had an increase in either bud and/or flower damage when exposed to ethylene (Table 1). The varieties susceptible to bud damage but not flower damage include 'Cherry', 'Mistral', and 'Nicoline'. Varieties susceptible to flower damage only include 'Bianca' and 'Julie'. The varieties 'Claudia', 'Monica' and 'Sterling' were susceptible to both flower and bud damage. For most varieties, it took nearly 2 weeks before the effects of ethylene were evident. For 'Julie', 'Nicoline' and 'Sterling', however, reaction to the adverse effects of ethylene occurred sooner. Interestingly, these same varieties declined quite rapidly in postharvest conditions when not exposed to exogenous ethylene.

The performance of the varieties when not exposed to ethylene based on the total percentage of damaged flowers and buds at day 14 show a wide range of responses from virtually no damage observed on 'Charming' to 100% damage on the variety 'Nicoline' (Fig. 2). Varieties with greater than 50% total damaged flowers and buds at day 14 all showed significant and most times faster responses to the injurious effects of ethylene.

DISCUSSION

The results demonstrate that potted rose varieties can be sensitive to short-term ethylene exposure or quite tolerant. Differences in ethylene response of potted rose varieties have also been found after long-term exposure (Muller et al., 1998). The variation found in ethylene sensitivity can partially be attributed to differences in postharvest longevity, especially on short lasting varieties. Varieties with shorter lasting qualities were all found to be sensitive to ethylene, while most, but not all, long lasting

varieties were tolerant. ‘Charming’ and ‘New Heidi’ have excellent longevity, yet ‘New Heidi’ was sensitive to short-term ethylene exposure while ‘Charming’ was not. Other researchers have also concluded that the variation in postharvest life can partly be due to differences in sensitivity to exogenous ethylene and additionally, partly due to differences in endogenous ethylene production (Muller et al., 1998). Although it was beyond the scope of this study, other studies have investigated the role of endogenous ethylene production and could not find a consistent relationship to potted rose longevity, as both the short-lived variety ‘Bronze’ and the long-lived variety ‘Vanilla’ had high ethylene production, while the long lasting variety ‘Charming’ had very low ethylene production (Muller et al., 1998). Further work showed that there were no differences in ethylene binding site activity between long and short-lived varieties (Muller et al., 2000), while differences in ethylene receptor levels showed a strong relationship (Muller et al., 2001).

The results indicate miniature potted rose varieties differ in their postharvest life and that their reaction to the injurious effects of exogenous ethylene can occur after a short exposure time of 24 h with considerable variation in the response among varieties. This sensitivity to exogenous ethylene plays a major role in their quality and lasting characteristics and can be a major problem during transport/retail conditions. Continually testing new varieties for their postharvest performance and their sensitivity to ethylene provides important information for breeding programs. These characteristics may be able to be incorporated into particular breeding lines with the goal of producing varieties that may be more resistant or tolerant to the injurious effects of ethylene to improve quality and extend longevity.

ACKNOWLEDGMENTS

Florida Agricultural Experiment Station Journal Series No. R-09710. This research was supported by Poulsen Roser, ApS, Fredensborg, Denmark and partly by the American Floral Endowment, Glen Carbon, Illinois, USA. Much appreciation is extended to Nurserymen’s Exchange, Half Moon Bay, California, USA for donation of the plant material.

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Table

Table 1. Comparison of Parade® rose variety response to 1 µl l^{-1} ethylene for 24 h.

	Plant part affected by ethylene	
Variety	Buds	Flowers
Bianca	No	Yes
Charming	No	No
Cherry	Slight	No
Claudia	Yes	Yes
Fiesta	No	No
Julie	No	Yes
Lady	No	No
Mistral	Slight	No
Monica	Slight	Yes
New Heidi	Yes	No
Nicoline	Yes	No
Sterling	Yes	Yes

Figures

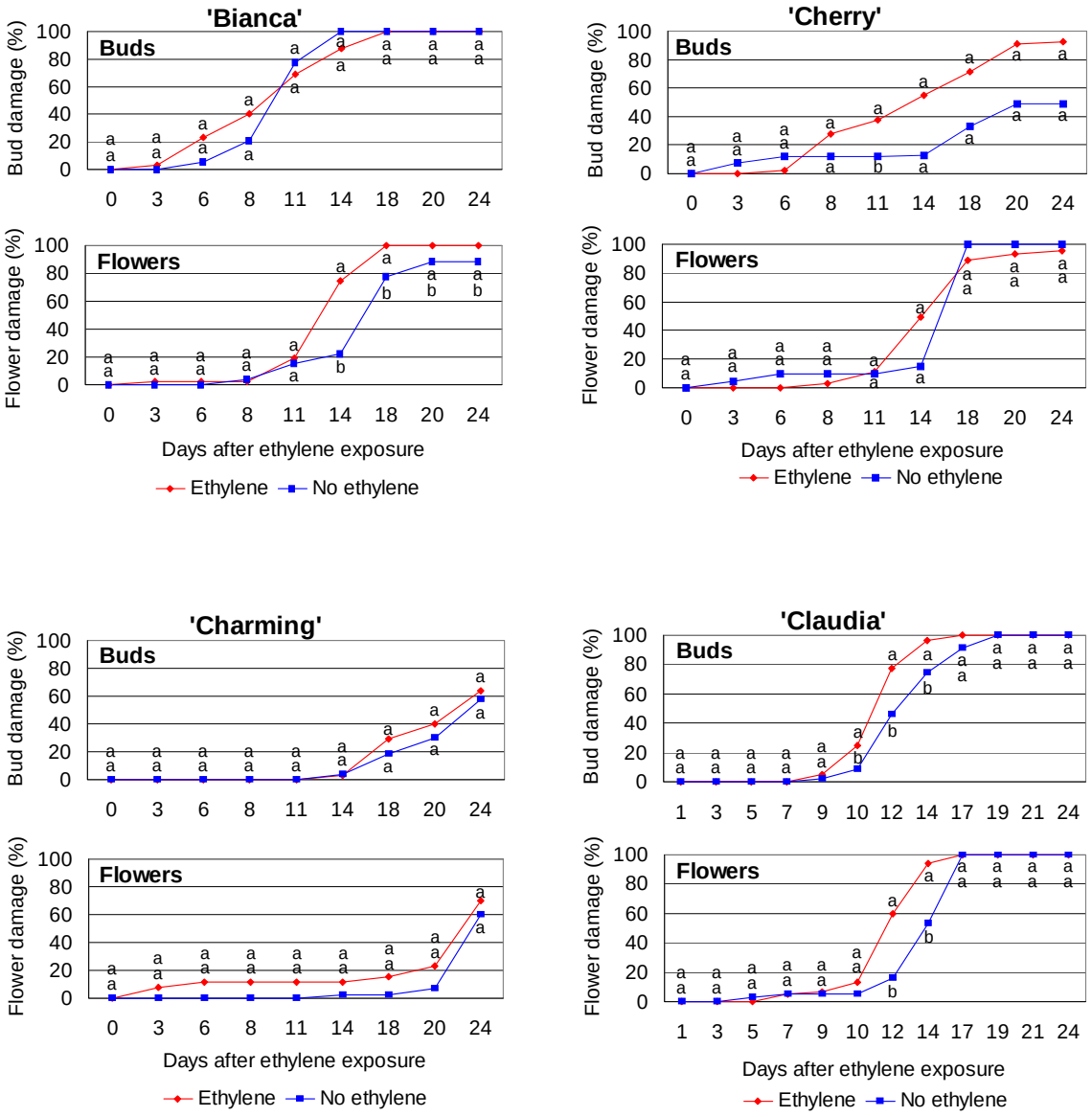

Fig. 1. The effect of 1 µl l^{-1} ethylene for 24 h on bud and flower damage of potted roses over time in postharvest conditions.

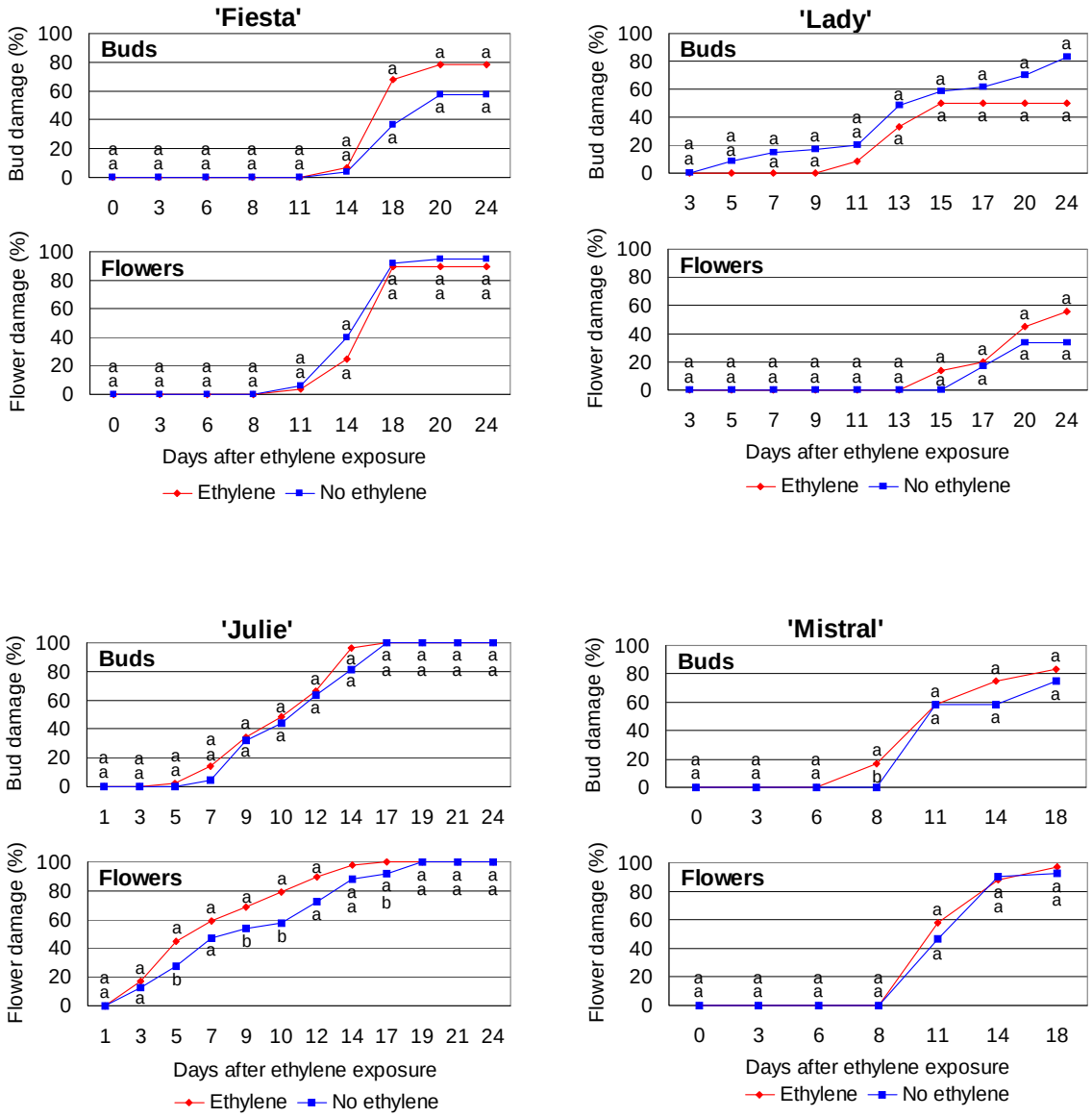

Fig. 1. (continued).

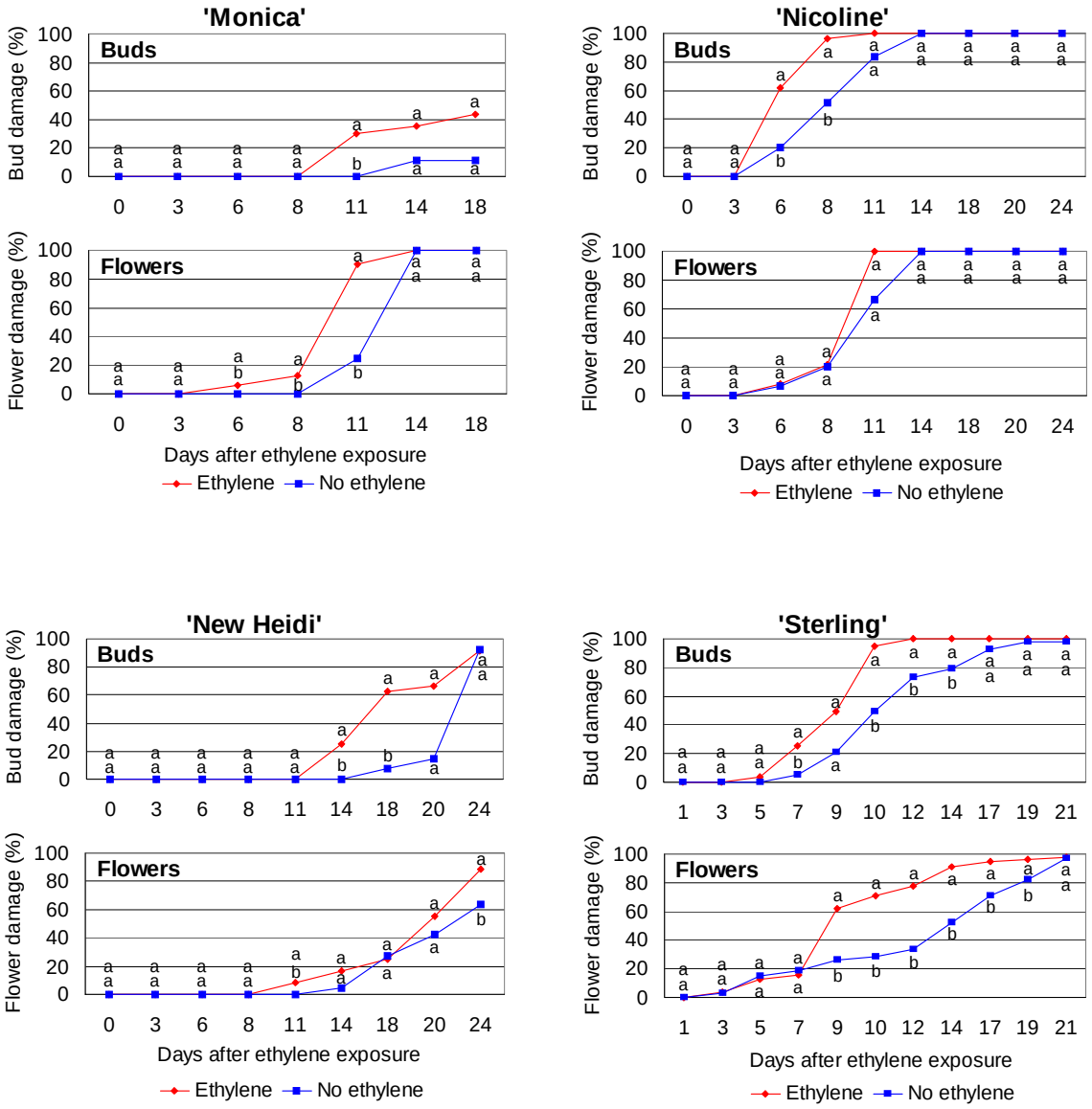

Fig. 1. (continued).

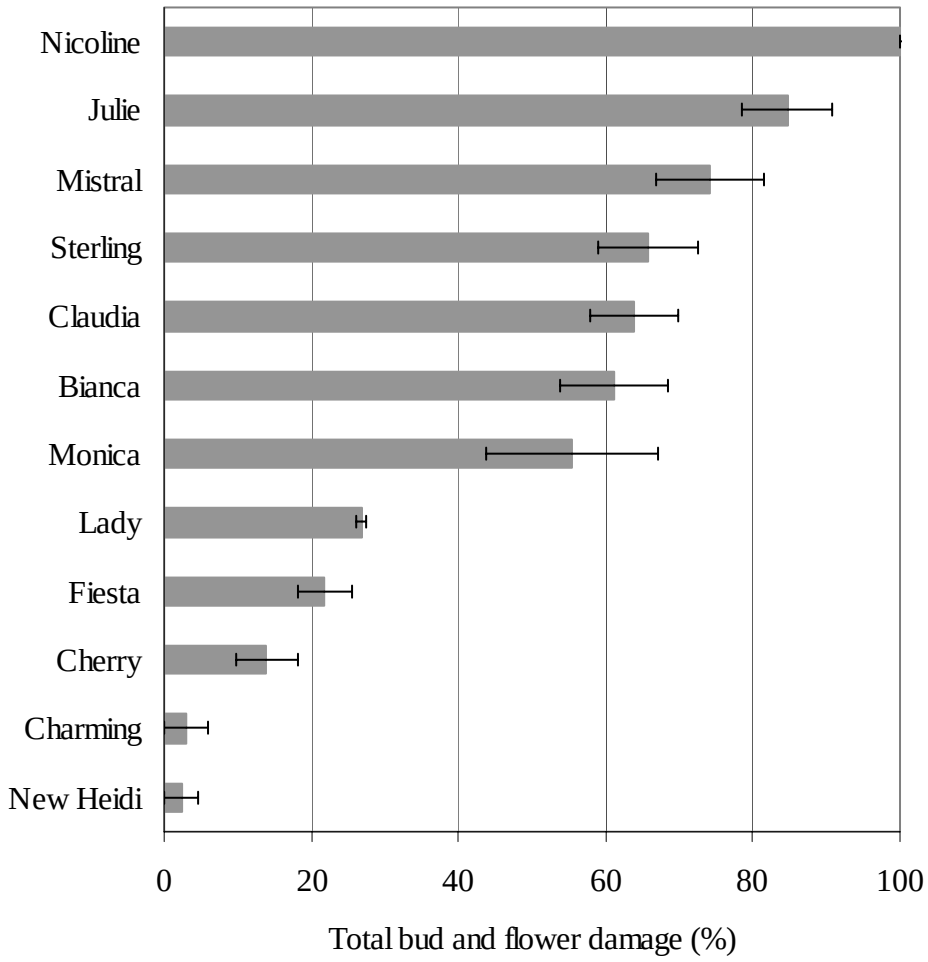

Fig. 2. Differences in longevity of potted rose varieties expressed as the percent of damage buds and flowers after 14 days in postharvest conditions when not exposed to exogenous ethylene.