The Influence of 1-MCP on Shelf-Life Quality of Highbush Blueberry

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Abstract. To determine if postharvest treatments of 1-methylcyclopropene (1-MCP) retard the senescence of highbush blueberries (*Vaccinium corymbosum* L.) removed from storage, 'Burlington' (early) and 'Coville' (late) fruit were harvested from four experimental sites and treated for 24 hours at 20 °C with 0 (control), 25 (low), 100 (medium), or 400 (high) nL·L⁻¹ of 1-MCP. All fruit were then stored in a controlled atmosphere of 10–15 kPa O₂ and 10 kPa CO₂ at –1 to 1 °C for 4, 8, and 12 weeks, followed by a 20 °C shelf-life of up to 20 days. During the shelf-life period immediately after harvest and those following each storage removal, percent marketable fruit (PMF) were calculated daily as: [fruit in good condition]/[total berry number] × 100. Changes in PMF were not affected by 1-MCP treatment; hence, we conclude that 1-MCP at rates up to 400 nL·L⁻¹ does not alter the shelf-life quality of the highbush blueberry cultivars tested.

Harvested highbush blueberries have a storage life of 2 or 3 weeks in 0 °C refrigerated air or up to 5 or 6 weeks in a controlled atmosphere (CA) environment (Leyte and Forney, 1999; Pritts and Hancock, 1992). A longer storage-life duration, e.g., 8–12 weeks, would permit access to later season world markets that offer a premium for North American highbush blueberries when supply is usually low. Although blueberries do not generate large quantities of ethylene, the prevention of ethylene action may retard postharvest senescence, resulting in higher quality fruit. 1-Methylcyclopropene (1-MCP) has been shown to improve the postharvest and shelf-life quality of various fruits such as apples, pears, and kiwifruit by inhibiting ethylene-related senescence (Watkins and Miller, 2003). We hypothesized that postharvest 1-MCP treatment would retard the shelf-life senescence of CA-stored highbush

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Fig. 1. Percent marketable 'Burlington' highbush blueberry fruit (Y) during a shelf-life period (X) following A) harvest, or CA storage of B) 4, C) 8, or D) 12 weeks. Regression equations for the Control (black circles, solid line) and 400 nL·L⁻¹ (open circles, broken line) treatment data: A) Harvest, Control PMF: $92.2 + 9.52(\text{Day})^1 - 2.06(\text{Day})^2 + 0.07(\text{Day})^3$, $r^2 = 0.95$; 400 nL·L⁻¹ PMF: $93.9 + 7.82(\text{Day})^1 - 1.90(\text{Day})^2 + 0.07(\text{Day})^3$, $r^2 = 0.92$; B) 4 Weeks, Control PMF: $94.5 + 6.58(\text{Day})^1 - 1.82(\text{Day})^2 + 0.07(\text{Day})^3$, $r^2 = 0.91$; 400 nL·L⁻¹ PMF: $93.3 + 7.42(\text{Day})^1 - 1.91(\text{Day})^2 + 0.07(\text{Day})^3$, $r^2 = 0.98$; C) 8 Weeks, Control PMF: $96.0 + 5.76(\text{Day})^1 - 3.16(\text{Day})^2 + 0.17(\text{Day})^3$, $r^2 = 0.90$; 400 nL·L⁻¹ PMF: $92.6 + 11.0(\text{Day})^1 - 3.70(\text{Day})^2 + 0.18(\text{Day})^3$, $r^2 = 0.96$; D) 12 Weeks, Control PMF: $96.3 - 16.7(\text{Day})^1 + 0.72(\text{Day})^2$, $r^2 = 0.82$; 400 nL·L⁻¹ PMF: $100 - 9.38(\text{Day})^1 + 0.22(\text{Day})^2$, $r^2 = 0.84$.

Fig. 2. Percent marketable 'Coville' highbush blueberry fruit (Y) during a shelf-life period (X) following A) harvest, or CA storage of B) 4, C) 8, or D) 12 weeks. Regression equations for the Control (black circles, solid line) and 400 nL·L⁻¹ PMF (open circles, broken line) treatment data: A) Harvest, Control PMF: $97.0 + 5.62(\text{Day})^1 - 1.79(\text{Day})^2 + 0.06(\text{Day})^3$, $r^2 = 0.95$; 400 nL·L⁻¹ PMF: $91.6 + 8.22(\text{Day})^1 - 1.84(\text{Day})^2 + 0.06(\text{Day})^3$, $r^2 = 0.93$; B) 4 Weeks, Control PMF: $104.7 - 10.0(\text{Day})^1$, $r^2 = 0.87$; 400 nL·L⁻¹ PMF: $107.6 - 10.0(\text{Day})^1$, $r^2 = 0.92$; C) 8 Weeks, Control PMF: $96.4 - 8.98(\text{Day})^1$, $r^2 = 0.76$; 400 nL·L⁻¹ PMF: $89.6 - 8.41(\text{Day})^1$, $r^2 = 0.70$; D) 12 Weeks, Control PMF: $81.7 - 15.7(\text{Day})^1 + 0.75(\text{Day})^2$, $r^2 = 0.59$; 400 nL·L⁻¹ PMF: $82.8 - 16.0(\text{Day})^1 + 0.77(\text{Day})^2$, $r^2 = 0.67$.

blueberries and thereby augment the quality of fruit following storage removal.

Materials and Methods

Four experimental sites were selected for 'Burlington' (early) and 'Coville' (late) highbush blueberries in the Annapolis Valley, Nova Scotia, Canada. Fruit were harvested from ≈ 15 plants per site, after which four 1-MCP treatments (EthylBloc®, BioTechnologies for Horticulture, Waltherboro, S.C.; 0.14% active ingredient)—a) 0 nL·L⁻¹ (control); b) 25 nL·L⁻¹ (low); c) 100 nL·L⁻¹ (medium); and d) 400 nL·L⁻¹ (high)—were applied for 24 h at 20 °C prior to storage by mixing the appropriate quantity of dry powder with ≈ 22 mL of H₂O-based buffer in a 0.34-m³ chamber. The fruit were then stored at 10–15 kPa O₂ and 10 kPa CO₂ at -1 to 1 °C for 4, 8, and 12 weeks, followed by a 20 °C shelf-life of up to 20 d. During each day of the shelf-life period, berries in good condition as well as shriveled, rotten, split, and deformed fruit were counted; percent marketable fruit (PMF) was then calculated as: $[\text{fruit in good condition}]/[\text{total berry number}] \times 100$. Potential treatment effects were associated with differences in the PMF curves

over the shelf-life period. A shelf-life PMF assessment was also performed immediately following harvest.

Results and Discussion

In general, 1-MCP treatments did not alter the PMF during the shelf-life periods for either cultivar; hence, only the control and the high rates (400 nL·L⁻¹) are presented (Figs. 1A–D; 2A–D). Data were fitted to 2nd- or 3rd-order polynomial regression curves if the coefficient of simple variation (r^2) improved by at least 5% over the linear or 2nd-order fit. Although the 12-week shelf-life data indicated that the high 1-MCP rate on the 'Burlington' fruit altered the rate of decline in PMF compared with the control berries (Fig. 1D), the effect was neither physiologically nor economically meaningful.

It is possible that higher 1-MCP application rates could elicit beneficial poststorage effects. The 1-MCP concentrations used in this study were a compromise between product efficacies reported at the rates of 0.8–1.0 $\mu\text{L}\cdot\text{L}^{-1}$ for apple (Fan et al., 1999) and 5–15 nL·L⁻¹ for strawberry (Ku et al., 1999). If highbush blueberries are responsive to 1-MCP, the 16-

fold difference between the low and the high application rates should have shown a consistent incremental response; none, however, was observed. In summary, 1-MCP at rates up to 400 nL·L⁻¹ did not affect the shelf-life quality of two highbush blueberry cultivars following a CA storage regime spanning 12 weeks.

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