Literature Review on: 1-MCP Ethylene Inhibitor/ Needle Abscission

Sam Dykeman
CTCNS Fieldwork Summer Student

What is 1-MCP?

1-Methylcyclopropene (1-MCP) is a ethylene inhibitor. Meaning, it inhibits certain plants from producing ethylene hormone (Thompson & Bishop, 2016). 1-MCP is commonly used in the fruit and fresh cut flower industry to delay ripening in order to increase shelf life. 1-MCP accomplishes this by competitively binding to ethylene receptors in the plant cells which helps preserve membrane integrity (Siddiqui, 2017). It can be found on the market being sold as Ethylbloc™ and SmartFresh™ (Watkins, 2003).

Implications on the Christmas Tree Industry

In relation to Christmas tree production, 1-MCP is used as an anti-abscission chemical treatment. Meaning, a treatment to help Christmas trees retain their nettles post-harvest.
Research has concluded that ethylene is positively correlated to needle loss in balsam fir post-harvest (MacDonald et al., 2010). When tree branches are exposed to exogenous ethylene the rate of needle abscission increases in excess of the natural rate of needle loss by 63%. Though experimentation the same study showed needle loss duration (days needed to shed all needles) decreased by 147% in branches exposed to exogenous ethylene and 1-MCP. That is in compared to branches exposed to exogenous ethylene but not 1-MCP. Also, when the control (untreated branches) were exposed to 1-MCP needle loss decreased by 73% (MacDonald et al., 2010). Currently, Gary Chastagner is conducting research on the effectiveness of a preharvest application of 1-MCP (California Christmas Tree association, 2019). In talking with Murray Crouse, he said he heard the research was indicating that pre-harvest application wasn't working as well as post-harvest applications. Unfortunately, I was unable to retrieve the findings of the study.

1-MCP Tree Application

The application process is as followed for Ethylbloc™, the product used in both studies that researched the relationship between 1-MCP and needle retention in balsam fir (MacDonald et al., 2010; Wang, 2017). In order to create a large induction chamber the trees need to be placed in

an airtight room. Ethylbloc™ is applied as a vapor by mixing a maximum of 0.5g/m^3 in a bucket of water containing 3.8L. The number of application buckets required to fill rooms of different volumes can be found on the label (Pesticide Label for Ethylbloc™ (https://pr-rp.hc-sc.gc.ca/1_1/view_label?p_ukid=195346920)

Once mixed the room is sealed for a minimum of 4 hours if the temperature is between 10 and 24 Celsius, or a minimum of 8 hours if the temperature is between 2 and 10 degrees Celsius. Though it is common practice carry out the treatment for 24 hours. The space must be vented for a minimum of 30 min before re-entering.

In contrast, MacDonald et al. noted the best nettle retention using a concentration of 0.125g/m^3, 10g of 1-MCP in 0.5L of distilled water within a 80L container for 24 hours (2010). Unfortunately, I was unable to find research concerning the use of 1-MCP on balsam-preharvest. Though, given the low temperature in November and December it is unlikely that a pre-harvest application would work given the temperature requirements of Ethylbloc™ (see label reference).

A research study out of South Carolina has shown that liquified 1-MCP can also be used to retain needles post-harvest(https://www.searates.com/services/distances-time/). Though, in comparison to gasified 1-MCP there is less research on the use of liquified 1-MCP for Christmas trees. In the study Harvesta was used.

The label for Harvesta can be found here:
https://www.bartlett.ca/Bartlett/nmb/MSDSLabel.nsf/0/D33628D15E237C71852582FA004596B1/$file/Harvista+1.3+lable+english.pdf

Benefits

Decreasing the needle abscission rate by as much as 73% would be beneficial, specifically in regards to reaching export markets (See Figure 1.) (MacDonald et al., 2010). Specifically, those further away such as Panama and the United Arab Emirates. For instance, accounting only for time spent at sea, form Halifax it takes a minimum of 20 days for a ship to reach the UAE. (https://www.searates.com/services/distances-time/). Thus, if NS producers had the ability to use 1-MCP it would allow them to export to previously unreachable markets while maintaining product quality.

Insights from Murray Crouse

In talking to Murray, he expressed that the greatest benefit of making use of 1-MCP would be increasing Nova-Scotia growers' ability to reach far away lucrative market.

In conversations with Scotia Gold, who currently use 1-MCP for apples, he learned that 1-MCP is very forceful in its ability to block ethylene receptors. Meaning, we can expect a successful treatment even if the trees are bailed and stacked tightly together. The North Carolina department of agriculture researched this and found that loosely baled trees treated with 1-MCP gas did have a higher needle retention rate than trees palletized when treated. Unfortunately, the publication did not provide clear data or explain the concentrations and length of the 1-MCP gas treatment. (https://www.ams.usda.gov/sites/default/files/media/NC15Final%20Report.pdf)

Perhaps most notable was Murrey's idea to treat Christmas trees in the shipping containers on the farm. This would eliminate the need to construct additional facilities and transport trees to a central location for treatment. Saving both time and money. Additionally, because trees are shipped in climate-controlled trailers the reefers can stabilise the temperature in the sea containers to obtain optimal climatic conditions for 1-MCP application. In fact, a publication from Ohio State University stated that the most economical manner to treat plants with 1-MCP was in in containers during transport. (https://u.osu.edu/greenhouse/2014/05/14/protecting-plants-from-ethylene-damage-using-1-mcp/)

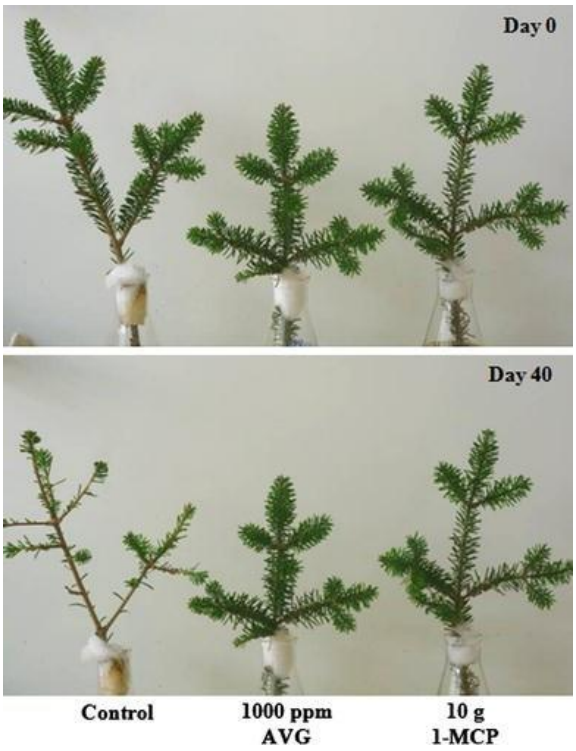

Figure 1. needle retention experiment 1-MCP (MacDonald et al., 2010).

References

California Christmas Tree association. (2019). *The Bulletin*. California Christmas Tree Association. https://cachristmas.com/wp-content/uploads/2019/07/Summer2019.pdf

MacDonald, M. T., Lada, R. R., Martynenko, A. I., Dorais, M., Pepin, S., & Desjardins, Y. (2010). Ethylene triggers needle abscission in root-detached balsam fir. *Trees - Structure and Function*, *24*(5), 879–886. https://doi.org/10.1007/s00468-010-0457-2

Siddiqui, M. W. (2017). Preharvest Modulation of Postharvest Fruit and Vegetable Quality. *Preharvest Modulation of Postharvest Fruit and Vegetable Quality*, 1–516.

Thompson, A. K., & Bishop, D. (2016). Controlled Atmosphere Technology. *Reference Module in Food Science*. https://doi.org/10.1016/b978-0-08-100596-5.21136-0

Wang, J. (2017). THE RELATIONSHIP BETWEEN PECTINASE AND CELLULASE AND POST- HARVEST NEEDLE ABSCISSION IN BALSAM FIR (Abies balsamea (L.)). *Dalhousie University Halifax, Nova Scotia December*, *December*.

Watkins, C. B. (2003). POSTHARVEST PHYSIOLOGY | Transport. *Encyclopedia of Applied Plant Sciences*, 835–845. https://doi.org/10.1016/b0-12-227050-9/00080-6