Low temperature storage overcomes the negative effects of baling on postharvest needle abscission in balsam fir trees

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Introduction

Postharvest needle abscission is a serious threat to balsam fir Christmas tree industry. Baling of trees, one of the important handling processes by most producers has been shown to negatively contribute to postharvest needle abscission through mechanically-induced stress. However, exposure of trees to low temperature or cold acclimation has also been shown to delay needle abscission.

This study tested the hypothesis that low temperature can override the negative effects of the mechanical stress caused by tree baling.

Fig 1: Baling of Balsam Fir Trees

Methods

Material Preparation and setup

In all, 30 six-year old trees, 90cm in height with similar girth were harvested from New Germany, NS. Canada in December, 2016. A bale of trees in groups of 3 and non-baled trees were exposed to varying temperatures of 5, 10, 20, or 30°C for 30 days while the control trees was kept outside the laboratory at ambient temperature that ranged between 2°C to 3°C. After that, trees were transferred to 5L jars containing 3L water until a minimum of 60% needle loss was achieved.

Response Measurements

- Percent needle loss – PNL (%),
- Needle retention duration - NRD (day),
- Average weekly water use (AWU) per gram of fresh weight ($mL \cdot g^{-1} \cdot w^{-1}$),
- Ethylene and VTC evolution were measured using designed air-tight chamber for gas trapping, airtight syringe for ethylene and solid phase microextraction (SPME) kit for VTC extractions (Fig. 2A). Analysis of ethylene and VTC was accomplished using GC-FID (Fig. 2B) (Carlow et al. 2006).

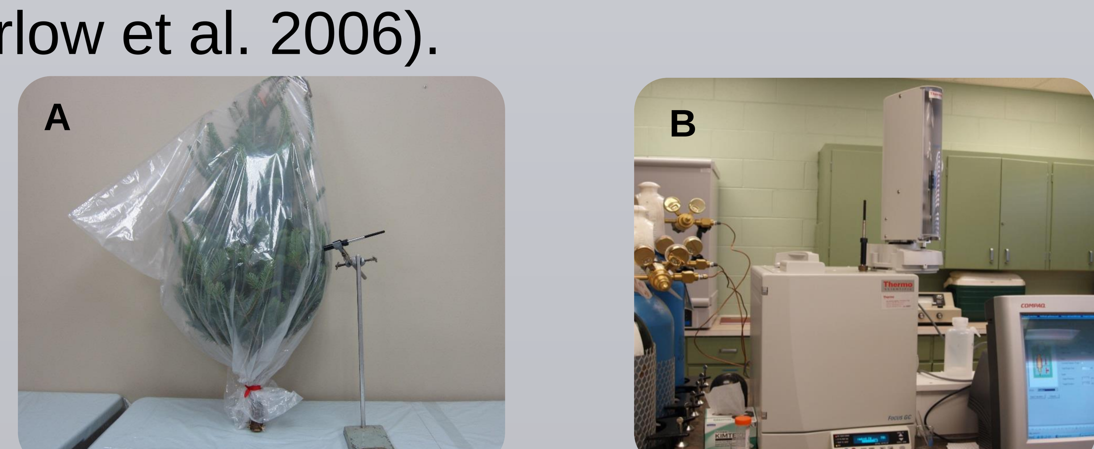

Fig. 2: (A) VTC and Ethylene sampling set up. (B) VTC and ethylene analysis using GC-FID

Results

- The needles were lost within 14 days of storage primarily through discoloration in the absolute control (non-baled trees) irrespective of the storage temperature.
- Trees stored at 20°C and 30°C lasted for a duration of 7 and 14 days at significantly higher humidity of 83% and 85%, respectively (Fig. 3).
- Our results also show that postharvest storage of trees under varying lower temperatures (3.2, 5°C and 10°C) strongly mitigate NRD through its effect on AWU, ethylene and VTC evolutions (Fig. 4).
- At lower temperature (<5ºC), tree had higher AWU, high NRD despite high ethylene and VTC evolution.

Fig. 3: PNA characteristics as influenced by storage temp (A) Before storage treatment (B) After 30 days in storage (C) 21 days after storage treatment.

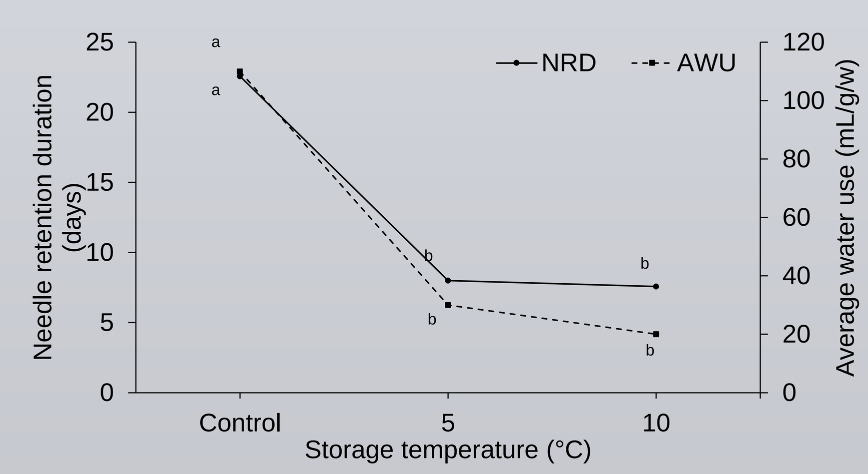

Fig. 4: Effect of storage temperature 5, 10°C and control on needle retention duration (days) and average water use (L) of balsam fir trees

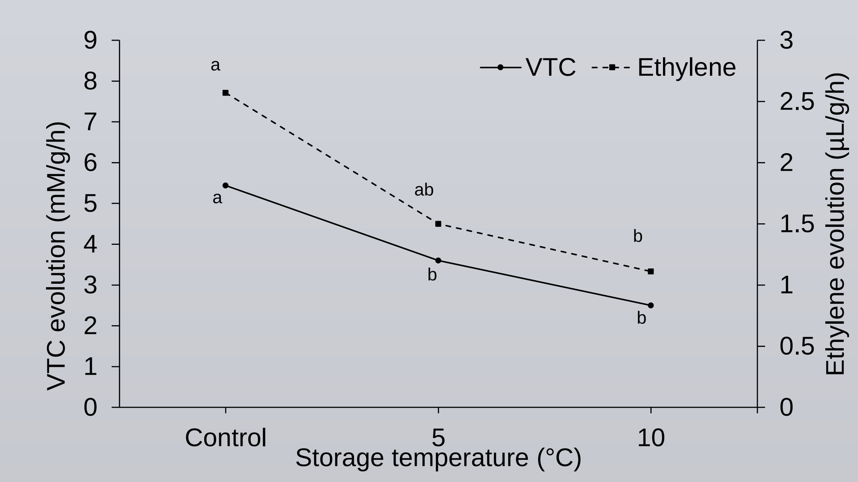

Fig. 5: Effect of storage temperature 5°C, 10°C and control on volatile terpene compounds ($mM \cdot g^{-1} \cdot h^{-1}$) and ethylene ($\mu L \cdot g^{-1} \cdot h^{-1}$) evolution.

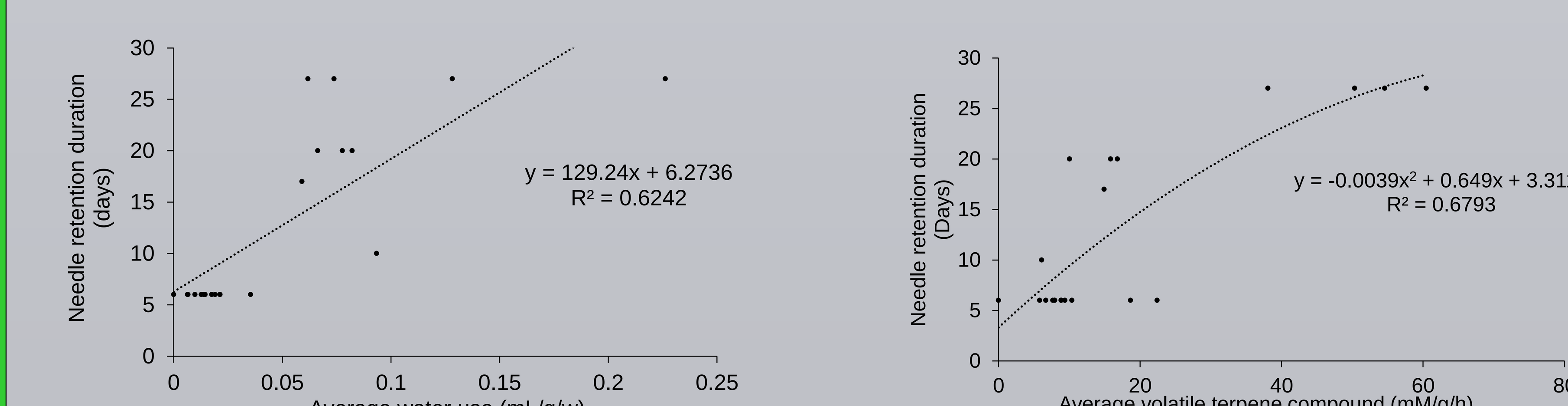

Fig 5: (A) Relationship between the average volatile terpene compound (mM/g/h), (B) average water use ($mL \cdot g^{-1} \cdot w^{-1}$) and needle retention duration (days) in balsam fir.

Conclusion

- This study suggests the ability of trees to take up water depicted by high AWU in trees under mechanically-induced stress.
- Despite an increase in ethylene and VTC, suggesting the negative effects of baling, ethylene and VTC can be overcome by low temperature storage.

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