Stress Physiology of Postharvest Balsam Fir Trees as Influenced by Shaking and Baling

Ernest A. Korankye, Rajasekaran R. Lada, Samuel K. Asiedu and Claude D. Caldwell

Christmas Tree Research Centre, Faculty of Agriculture, Dalhousie University, 90 Research Drive. Perennia Park, Bible Hill, NS, Canada

Introduction

As part of the postharvest handling processes of balsam fir trees, farmers shake and bale trees to remove dead needles, branches and also make them easier to transport. Since shaking and baling of trees tend to break needles, branches and cause bruises on tree trunks, they have been postulated to evoke mechanical stress causing various physiological dysfunction, promoting needle loss, negatively affecting postharvest quality of the trees.

It was therefore hypothesized that shaking and baling of balsam fir trees will increase whole tree temperature, negatively affecting membrane integrity, inducing ethylene and VTCs emissions, thus, promoting postharvest needle abscission.

Fig 1: Shaking and Baling of Balsam Fir Trees

Methods

Material Preparation and setup

In all, 50 six-year old trees, 90cm in height with similar girth were harvested from New Germany, NS. Canada in August, 2015. Twenty five trees were immediately subjected to shaking treatments for 0, 15, 30 or 60 seconds. Remaining 25 trees were baled at 0, 1, 2, 3, or 4 trees per bale. The experiment followed a completely randomized design with 5 replicates for each treatment.

Response Measurements

- Tree core temperature was monitored using Thermal Infrared Imaging Technology (Fig. 2A).
- Membrane injury of trees were studied by estimating membrane injury index (MII) (Shalata and Neumann, 2001).
- 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. Analysis of ethylene and VTC was accomplished using GC-FID (Figs. 2B and C) (Carlow et al. 2006).

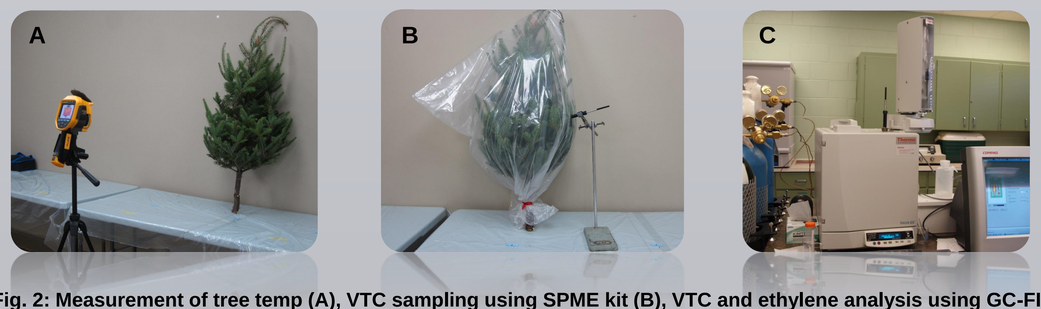

Fig. 2: Measurement of tree temp (A), VTC sampling using SPME kit (B), VTC and ethylene analysis using GC-FID

Results

- Shaking and baling of trees increased tree temperature by 0.56°C and 0.84°C respectively, compared to the control (Fig. 3).
- Baled trees exhibited 35.1% higher MII (high membrane integrity) compared to shaken trees, with MII ranging between 14.54 and 28.08% (Fig. 4).
- 5-fold increase in ethylene evolution (4.66 $\mu L \cdot g^{-1} \cdot h^{-1}$) was observed in baled trees compared to the control (0.99 $\mu L \cdot g^{-1} \cdot h^{-1}$)
- A significant increase (68.1%) in VTC when trees were baled compared to control was observed (Fig. 6).

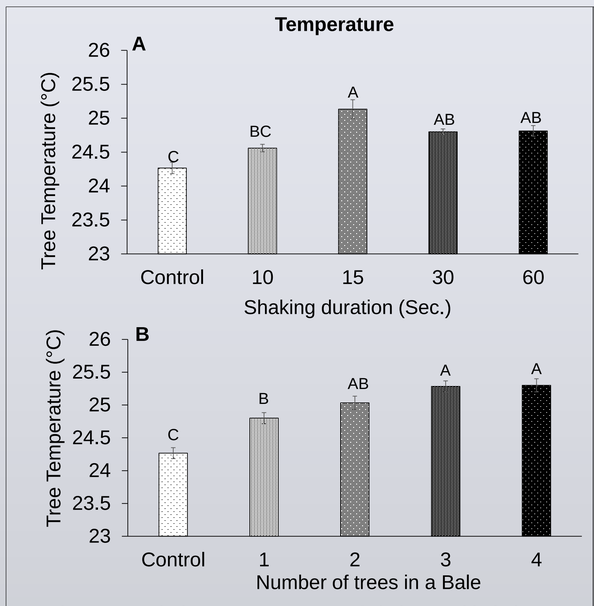

Fig. 3 A,B: Whole tree temperature of shaken and baled trees

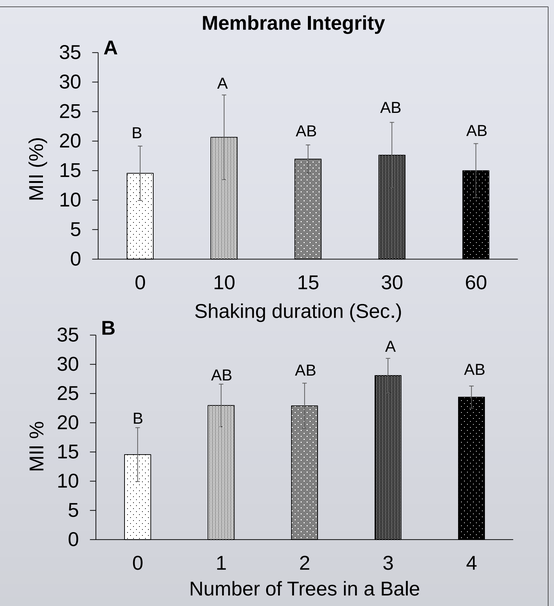

Fig. 4 A,B: Mechanical injury Index of shaken and baled trees

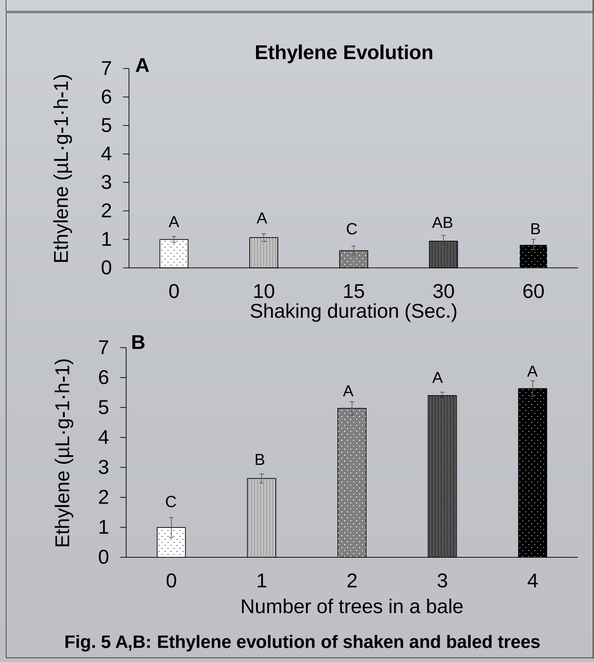

Fig. 5 A,B: Ethylene evolution of shaken and baled trees

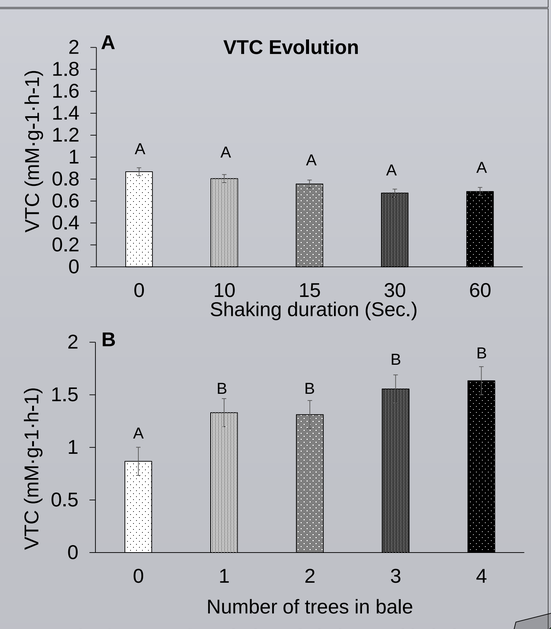

Fig. 6 A,B: VTC evolution of shaken and baled trees

Conclusion

- Prolonged shaking of trees lowered tree temperature, membrane injury, ethylene and in the case of VTC showed a continuous decline with increasing shaking period.
- Baling however, increased all stress indicators, increased temperature by 1.03°C, membrane injury by 2 folds, ethylene by 5 folds and VTC by 2 folds suggesting that postharvest handling processes can induce needle loss possibly through evoking ethylene and VTCs affecting membrane stability. These factors can be used as stress indicators.

Acknowledgements

NSERC CRSNG · SMART Atlantic Balsam Christmas Tree Research Centre · NOVA SCOTIA · DALHOUSIE UNIVERSITY FACULTY OF AGRICULTURE