SMART Atlantic Balsam
Christmas Tree Research Centre

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A Link Between Water Quality and Bacterial Growth in Christmas tree stands with postharvest needle abscission in balsam fir

Introduction

Balsam fir is the primary Christmas tree species in Atlantic Canada, controlling about 99% of the total natural Christmas tree market. Postharvest needle abscission remains a major challenge for the industry. It's been shown repeatedly that fresh Christmas trees consume about 0.20 $mLg^{-1}d^{-1}$, which gradually decreases to 0.05 $mLg^{-1}d^{-1}$. It's speculated that the decrease in water flux contributes to postharvest abscission, but the reason for the decrease is unknown. It's hypothesized that deteriorating water quality in Christmas tree stands due to microbial growth is linked to decreased water use promoting postharvest abscission.

Methods

Direct effect of poor water quality

A total of 20 balsam fir branches we collected from known genotypes available in a clonal orchard. Half of these branches were placed in water (control) while the other half were placed in water from stands with Christmas trees in them for 1 week (dirty). Branches were compared for water use and needle abscission.

Water quality link with abscission

A total of 100 branches were collected. Each week 10 branches were randomly selected and assessed for needle abscission, water use, relative water content, and xylem pressure potential. The water provided to these branches was analyzed for bacterial count and percent transmittance at 600 nm. Data was submitted to repeated measures analysis to identify trends over time. Data was also submitted for regression analysis to determine trends between key parameters.

Results

Direct effect of poor water quality

There were significant differences in both water use and needle abscission over time between treatments. Water use declined to a steady rate in only a few days in branches provided dirty water, while it took several weeks in control branches (Fig. 1). Similarly, needle abscission began on day 12 in branches provided with dirty water and day 18 in control branches. There was also a significant difference in the length of time required to complete abscission; branches provided dirty water completed abscission in 38 days while control branches completed abscission in 60 days (Fig. 2).

There was a strong, positive, linear relationship between the time required to decrease to a steady state of water use and the length of time required for abscission to commence (Fig. 3).

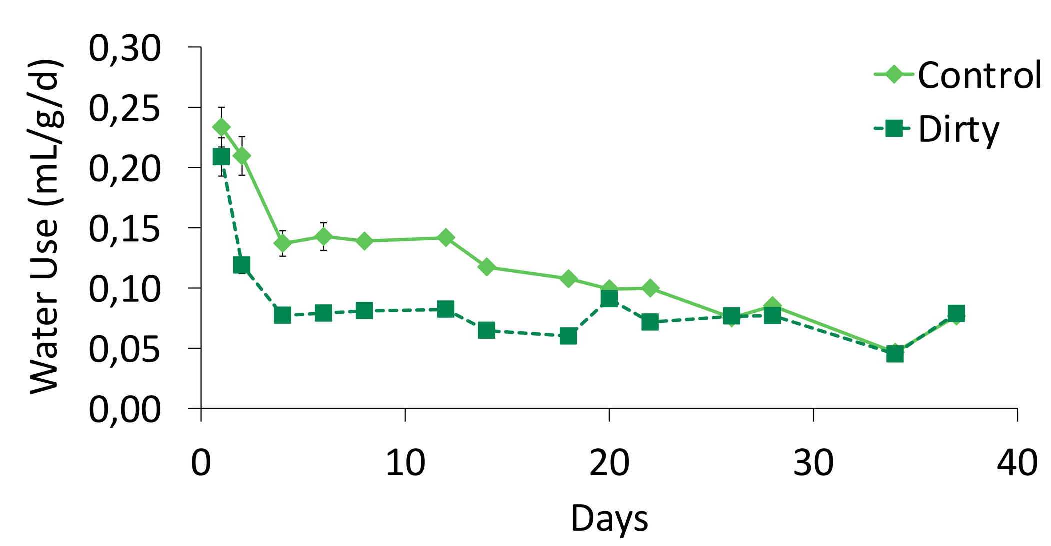

Fig. 1. Average water use for balsam fir branches placed in fresh water (control) and previously used water (dirty).

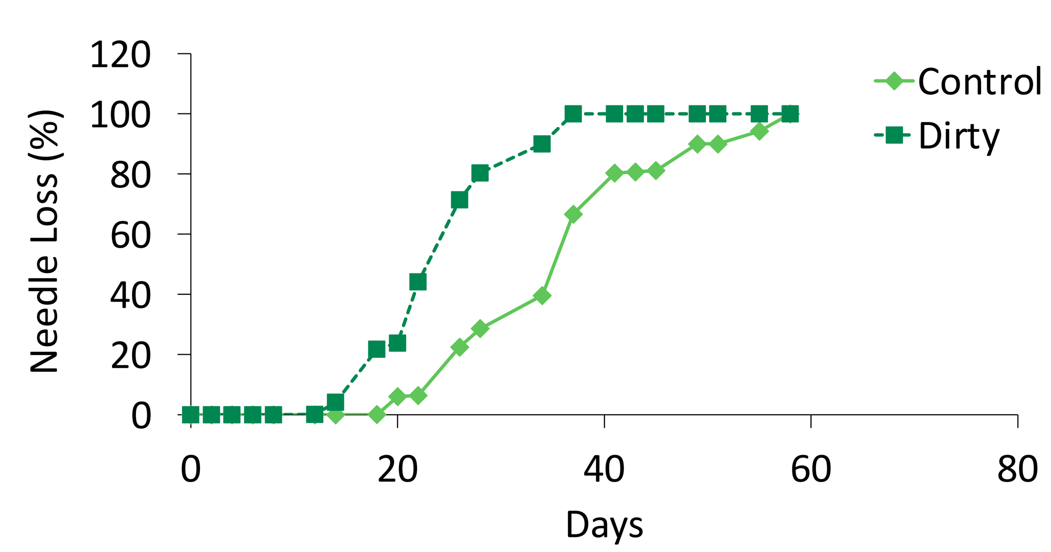

Fig. 2. Cumulative needle abscission for balsam fir branches placed in fresh water (control) and previously used water (dirty).

Results

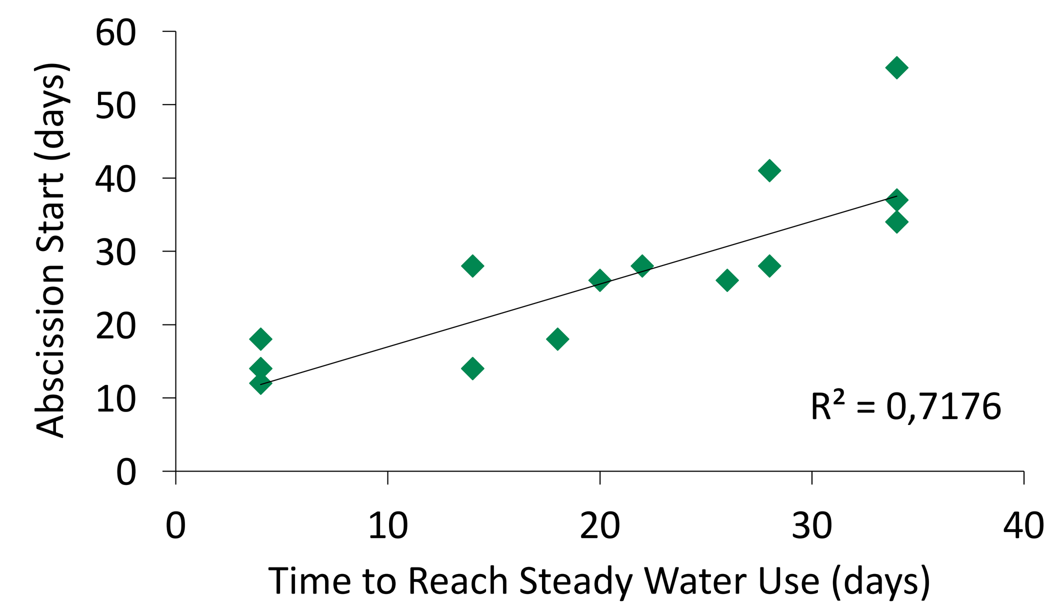

Fig. 3. Relationship between the length of time needed to reach a steady state of water use and the length of time needed to begin abscission.

Water quality link with abscission

Similar to the first experiment, postharvest needle abscission increased exponentially (Fig. 4) and water use decreased exponentially (Fig. 5). Bacterial growth increased exponentially as well, though was no longer measured after week 3 as counts had risen too high.

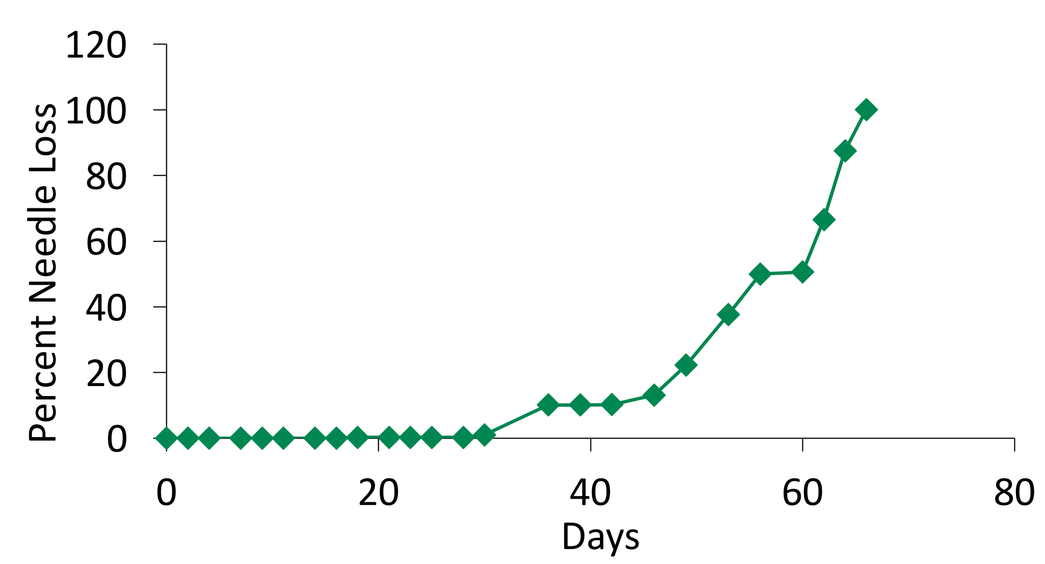

Fig. 4. Cumulative needle abscission for balsam fir branches placed in water.

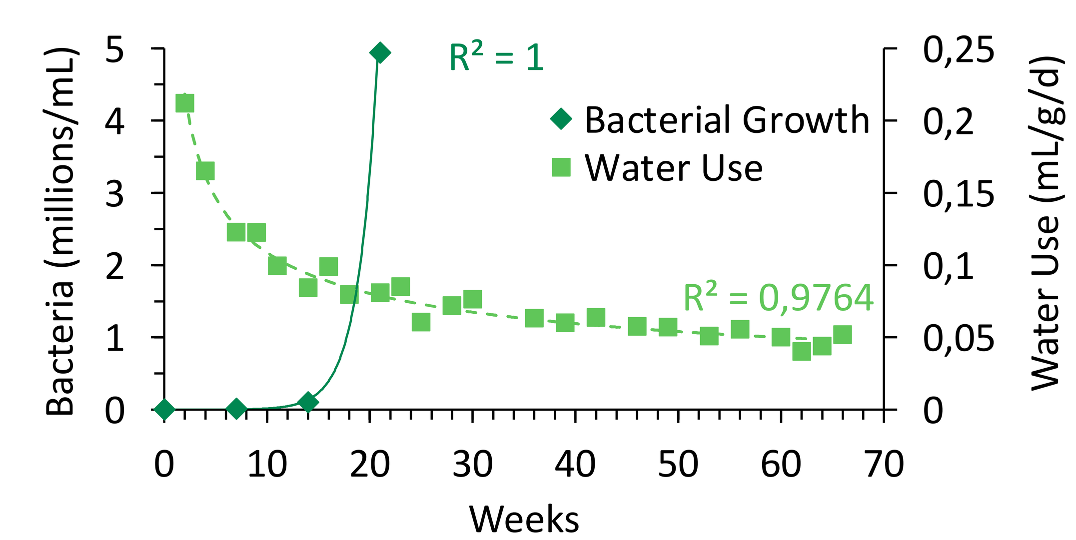

Fig. 5. Exponential decrease in daily water use and exponential increase in bacterial counts from Christmas tree stands holding balsam fir branches.

Results

There was some indication of slight drying in the branches. Over the duration of the experiment XPP decreased 3-fold and RWC decreased by 10% (Table 1). There was also discoloration of the water, which was noted by a change in transmittance of light (Table 1).

Table 1. Changes in XPP, RWC, and percent transmittance throughout the duration of the experiment with abscission.

Parameter	Initial	Final	P-value
XPP (MPa)	-0.21	-0.64	< 0.001
RWC (%)	81.7	72.3	< 0.001
Transmittance (%)	100	89.6	< 0.001

As noted in the previous experiment, there was a strong, positive, linear relationship between the length of time required for abscission to begin and the time required to hit a steady state of 0.05 mL g^{-1} d^{-1} of water (data not shown).

Conclusions

- Poor water quality directly decreased the length of time required for abscission and daily water use.
- There is a very strong relationship between the point at which water use stabilizes at a low rate and the time that abscission begins.
- Bacterial growth occurs rapidly immediately after placing the balsam fir in standing water and corresponds with decreased water use.
- There is evidence that the decreased water consumption leads to some degree of drying.
- Overall, poor water quality is detrimental to postharvest needle abscission. This may be linked to bacterial growth or other yet unidentified factors.