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Identification of the Optimal Attack Density of Mountain Pine Beetle in Hybrid and Jack Pine in its Expanded Range in Alberta

Project Importance

The mass attack dynamics of mountain pine beetle (MPB) have not been described in jack pine or lodgepole × jack pine hybrids in the beetle's expanded range. During mass attack, there are two threshold densities: mass attack threshold density and optimal attack density (Figure 1). Below the mass attack threshold density, beetles are expelled and killed by the tree with constitutive and induced physical and chemical defenses. Above the mass attack threshold density, beetles overwhelm tree defenses and colonize the tree. Beetle success increases until it reaches the optimal attack density (Figure 1) when enough resources exist for the developing offspring. Above the optimal attack density, beetle success decreases as developing offspring become crowded and compete for finite resources (Figure 2).

This project aims to describe the mass attack dynamics of MPB in hybrid and jack pines in Alberta as well as the impact of tree defenses against the beetle in these dynamics. Quantification of the mass attack dynamics of MPB in Alberta is integral to understanding long-term population dynamics in its expanded range. The transition from the endemic to epidemic population phase is characterized by sufficient beetle density on the landscape to successfully initiate mass attack. An accurate mass attack threshold density of MPB in Alberta will inform the endemic-epidemic dynamics in the expanded range of the beetle.

MPB Management Implications

An estimate of the attack density required to overcome tree defenses and allow beetle colonization will be immediately applicable to forest managers in Alberta. These data will refine the approach used to determine "successful" attacks during green attack surveys. Currently, trees with more than 40 visible attacks on the bole are controlled in fall-and-burn surveys, but this number could be modified as a result of this research. Determining the mass attack and optimal attack densities for MPB in jack pine and hybrids provide information on the endemic-epidemic transition of MPB in the expanded range.

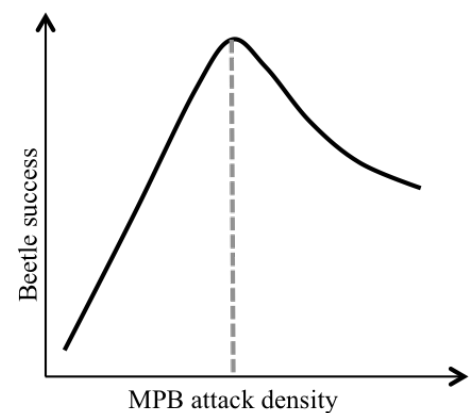


Figure 1: Mountain pine beetle attack dynamics. Dashed grey line indicates optimal attack density. Adapted from Raffa and Berryman (Figure 6; 1983).



Objectives

1. Quantify the number of MPB required to breach the endemic-epidemic threshold in jack pine and lodgepole × jack pine hybrid hosts in Alberta.
2. Determine the impact of attack density on overwintering success of MPB in novel hybrid and jack pine hosts in Alberta.
3. Measure defensive capacity of experimental trees through assessment of long-term terpenoid retention in pine phloem tissue from differentially attacked hybrid and jack pine hosts in Alberta.

Outputs

- Data that will inform management strategies in determination of successfully attacked trees.
- Data that will inform population spread and growth models for MPB.
- Data on long term tree defenses in trees attacked at different densities.

Outcomes

- An understanding of the relationship between MPB attack density and attack success with offspring production in hybrid and jack pines in Alberta.
- An understanding of long-term tree chemical defense profiles in trees attacked at different densities in the expanded range.

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Figure 2: High density attacks result in competition between developing larva under the bark. Photo by Colleen Fortier, used with permission.