Weevil damage in spruce: solutions through genetic selection

Dead leaders caused by the white pine weevil *(Pissodes strobi)* result in slowed growth, stem deformation, and delayed free-growing status in many areas planted to spruce in southern and of central BC. Genetic resistance now offers a solution in many parts of the province.

Adult weevils overwinter in the forest floor and climb to the top of young spruce trees in the spring where they feed, mate, and oviposit in the upper section of the previous year's leader. The eggs hatch within about 2 weeks and larvae feed in the young stem, killing the top 2 or 3 years of growth. Larvae pupate under the bark and emerge as adults in the late summer to feed and return to the forest floor to overwinter.

Genetic resistance to weevil attack was first observed in Sitka spruce provenance trials established in the late '70s by the BC Forest Service. This resistance was much higher in sources from the Qualicum area of eastern Vancouver Island and from specific areas of the Fraser Valley. Some trees within these sources showed more ability to resist or avoid weevil damage than other trees. Further research into this resistance revealed a number of mechanisms, including a large number of resin cells to produce pitch that interferes with the weevils ovipositing and feeding, sclerid cells (or stone cells) that are hard bodies which make feeding difficult and reduce the nutritive value, and suppression of weevil ovarian development.

The differences in resistance between seed sources and between trees within seed sources is genetically based, providing the opportunity to select individual trees with greater weevil resistance. Work by Cheng Ying and John King from the FLNRO, René Alfaro from the Canadian Forest Service, and others, led to the testing and selection of parent trees that passed on high levels of weevil resistance to their offspring. These trees were grafted into seed orchards and are now producing seed for operational planting.

Photos

Right - Weevils mating on a spruce leader *(T. Sexton)*;

Left - Weevil damage on spruce *(W. Strong)*;

Bottom - Weevil larva in a spruce leader *(W. Strong)*.

Following the Sitka spruce experience, interior spruce testing was started by Gyula Kiss and Alvin Yanchuk from the FLNRO, with support from Alfaro, and has been carried on by Barry Jaquish and Ward Strong from the FLNRO. This work revealed the same resistance mechanisms observed in Sitka spruce, and studies were successfully implemented to test interior spruce families for resistance to weevil damage. This allowed the selection of resistant parent trees and the development of a seed orchard by Vernon Seed Orchard Company Ltd. that now produces resistant seed for the Prince George area.

Selection and breeding for genetic resistance to the weevil is done in a complex background of both host and pest patterns of genetic diversity. Complete resistance is not feasible; rather, seedlings from resistant orchards of both Sitka and interior spruce exhibit lower attack rates than seedlings grown from non-selected or wild seedlots. A weevil resistance rating (GWr) of 86 means that about 86% of the trees will avoid or repel attack in a given year. This increased resistance provides foresters with an option that can be used in combination with silvicultural techniques such as mixed species planting to increase plantation success and better secure future wood supply.

Genomics research being led by Jöerg Bohlmann and Timothy Sexton at UBC, in collaboration with the FLNRO, is now leading to accelerated identification and selection of resistant parent trees through marker-aided selection.

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