Frontline EXPRESS
Canadian Forest Service, Great Lakes Forestry Centre

Bulletin No. 7

GROWTH LOSS RESULTING FROM INFECTION BY ARMILLARIA ROOT DISEASE

INTRODUCTION:

Armillaria ostoyae, the causal agent of Armillaria root disease, is a serious concern in second-growth stands because it infects all tree species. The inoculum of this fungus is widespread in Canada and worldwide, is increased by cutting (especially partial cuts), and non-lethally infected trees remain alive without symptoms, but their growth is reduced. When trees are cut, the fungus spreads and colonizes the stump, increasing the fungal food base and later infecting the surrounding trees. Infected trees die or suffer growth loss due to non-lethal infections that cover the root system. Further growth reduction losses are poorly quantified in managed stands where inoculum has increased in the remaining stumps. This situation is further aggravated by silviculture techniques that increase tree growth causing a reduction in the time to inoculum contact by tree roots. Worse, these cryptic losses accumulated since time of infection are hidden within existing and new inventory techniques, reducing site productivity, and threatening long-term sustainability. Losses occur because a portion of fixed carbon is used for defence instead of growth; alternatively, the root lesions may interfere with the vascular transport system. Volume loss can be detected by a reduction in height and radial increment in the stem. The objectives of this study are: 1) to develop an accurate and precise method of measuring volume loss due to non-lethal root infections; 2) develop a method of assessing infection date of tree roots; 3) determine the relationship between the number and type of roots infected and volume loss of juvenile and mid-rotation Douglas fir; 4) determine how growth affects disease epidemiology; 5) provide a mathematical model that estimates losses due to non-lethally infected roots on a single tree basis.

LOCATION/SITE:

Study plots are located in the Interior Cedar Hemlock (ICH) Biogeoclimatic Zone near Kaslo, British Columbia.

RESULTS:

The effects of root disease on annual ring width can be seen in Figure 1. The infected tree was growing at about the same rate as the healthy tree before infection. The roots immediately below the area of reduction on the infected disk become infected first, then fungus spread to other roots. Infection class and time period affects cross-sectional area at DBH. In periods before infection, dead trees sampled had grown more quickly (about 25%) than the others. Infection started at about age 5 and peaked at about age 14, and loss accumulated in the final time period. Loss in area was positively correlated with both increasing time and increasing infection. Dead trees sampled had greater height growth before infection and greater loss occurred with increasing time and infection. Even within dead trees, death occurred sooner when the trees were growing more rapidly in the first 10 years. Initial volume was the most important main effect in modelling volume loss, while infection period, not significant as a main effect, interacted with initial volume. This interaction, indicated that trees growing more rapidly, initially, showed more volume loss with increasing time since infection than smaller trees (about 40% over 4-8 years). The proportion of infected roots was marginally significant as a main effect. No other interactions were significant.

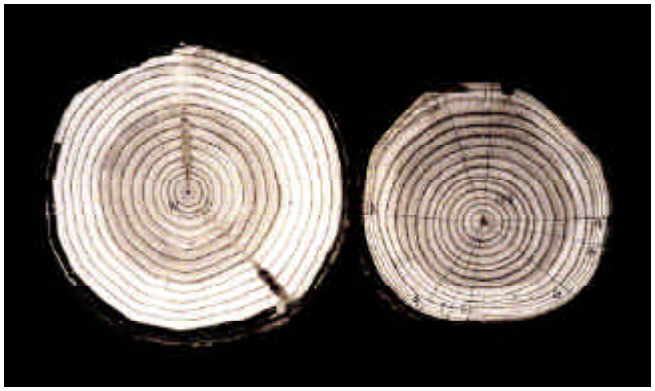

Fig. 1 Discs at 1.3 m for uninfected (left) and infected Douglas-fir.

CONCLUSIONS:

Research is ongoing with more results and conclusions to come in future publications. So far, analysis of growth reduction indicates that time since infection is more

Natural Resources Canada | Ressources naturelles Canada
Canadian Forest Service | Service canadien des forêts
Canada
Ministry of Forests

important than the amount of infection a root system has sustained. Soon after a main lateral root becomes infected, loss can be detected in the stem. This effect lasts at least 8 years. Larger trees lose more volume than smaller trees probably because they are putting on more increment. Volume reduction could occur because of loss of vascular tissue, loss of energy to defence, or replacement of new tissues such as callus and new roots. Heavily infected trees do not show a period of appreciable volume loss because they become girdled and die quickly. Why increased growth and mortality seemed to be related is not clear. Faster growing trees may die more quickly because they touch

Armillaria root disease fruiting bodies

the stump inoculum sooner when the fungus is at a higher inoculum potential, or they allocate less energy to defence. These results indicate that Armillaria root disease in the interior affects larger more vigorous juvenile trees more selectively in many ways.

MANAGEMENT INTERPRETATIONS:

Many silvicultural techniques are aimed at increasing the growth of the trees in the first 20 years; consequently, trees become infected sooner when all tree species are susceptible. Techniques such as brushing and weeding, planting, burning, and juvenile spacing, and more recently breeding all shorten the time to contact with stump inoculum. Futher, harvesting increases the volume of inoculum on site because the fungus can colonize the stumps and spread to the surrounding crop trees. Stands in which trees become progressively non-lethally infected are expected to reach given volumes later than those without effects of disease. Given the wide distribution of this fungus in Canada and worldwide, and the potential to amplify the inoculum by forest activities, the long-term threat to forest productivity is considerable. Non-mortality losses in growth due to Armillaria root disease go undetected and are confounded with forest inventory.

SOURCES OF RELEVANT INFORMATION:

Cruickshank, M.G. 1999. Volume loss of Douglas-fir infected by *Armillaria ostoyae*. In: C.Hollstedt, K. Sutherland, and T. Innes editors. From science to management and back Dec. 1-2 Kamloops, BC. A science forum for Southern Interior Ecosystems. Southern Interior Forest Extension and Research Partnership. 146 pp.

Cruickshank, M.; Morrison, D. 1997. Fungal root disease starts at the stump. Canadian Silviculture Magazine 5:26-29.

Bloomberg, W. J.; Morrison, D.J. 1989. Relationship of growth reduction in Douglas-fir to infection by Armillaria root disease in southeastern British Columbia. Phytopathology. 79:482-487.

CONTACT:

Mike Cruickshank, Research Scientist,
Canadian Forest Service-PFC,
mcruicks@nrcan.gc.ca

Duncan Morrison, Research Scientist,
Canadian Forest Service-PFC,
dmorriso@nrcan.gc.ca

Kevin Pellow, Research Scientist,
Canadian Forest Service-PFC,
kpellow@nrcan.gc.ca

Barry Jaquish, Research Scientist,
BC Ministry of Forests,
barry.jaquish@gems7.gov.bc.ca

ISSN 1496-7847

For more information on Frontline Express Contact:
Canadian Forest Service - Great Lakes Forestry Centre
1219 Queen Street East
Sault Ste. Marie, Ontario P6A 2E5
(705) 759-5740
http://www.glfc.cfs.nrcan.gc.ca