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Canadian Forest Service – Great Lakes Forestry Centre

Annosus root rot in pine plantations and the potential risk to jack pine

INTRODUCTION

Tree diseases and their effects on forest management are of increasing concern, as wood supplies continue to become tighter and dependence on second-growth forests and plantations increases. It is estimated that in Ontario, forest decay results in annual volume losses of over 20 million m^3 and root rots represent 11 million m^3 of that total. As part of its role in the protection of Canada's forests, Natural Resources Canada, Canadian Forest Service develops tools to minimize losses to the timber supply caused by disease, including pathogens that cause root and stem rot. This work includes research into the epidemiology and pathology of diseases and development of methods to control them. In particular, biological control methods that are both economically feasible and ecologically acceptable need to be devised for root rots and stem decays.

GREAT LAKES FORESTRY CENTRE (GLFC) RESEARCH

Recently retired GLFC scientist Mike Dumas and Laurentian Forestry Centre scientist Gaston Laflamme, collaborated on research related to decay control and investigated the potential risk of *Heterobasidion irregulare* nom. nov. (formerly known as *Fomes annosus* (Fr.) Bref.), an aggressive pathogen of red pine in eastern Canada, to cause damage to jack pine.

History and identification

H. irregulare is a basidiomycete (a class of fungus that forms specialized spores called basidiospores to reproduce) that causes root and butt decay and creates pockets of mortality primarily in red pine plantations, but mortality of white pine and balsam fir has also been observed. It was first detected in 1956 in St. Williams, Ontario in a red pine plantation and was thought to have been introduced through the importation of infected seedlings from Europe in the early 1900s. By 1968 the pathogen had spread to the Simcoe, Lindsay, and Lake Erie districts. It was also found in the La Rose Forest in eastern Ontario, and in Québec in 1993. New infection centres have since become established in several other regions.

A plantation affected by *H. irregulare* will have a small epicentre of dead trees surrounded by an expanding diameter of symptomatic living trees showing smaller, paler needles. This centre continues to enlarge as more trees succumb to the disease. Initially the infected wood has the appearance of a typical white rot, but as the decay progresses the decaying wood will have black specks. This decay can be confused with that of *Armillaria* but will lack the black zone lines and be somewhat drier in nature.

Figure 1. New fruiting body of *H. irregulare*

Figure 2. Old fruiting body of *H. irregulare*

Initially the spores develop as small white pustules, usually found on infected roots. As they mature, they become bracket-like in shape and are mostly found under the duff layer. The upper layer of actively growing fungus is reddish brown with a distinct white colour underside (figure 1). The fungus frequently incorporates dead needles as it expands. Older fruiting bodies have a much darker upper layer with a light brown underside (figure 2). Not all fruiting bodies are fertile.

Spread

Basidiospores are formed from late summer to early fall and are released throughout the year. Infections are spread primarily when basidiospores land on freshly cut stumps after a stand is thinned. Secondary methods of infection occur when basidiospores are washed through the soil and the fungus then spreads to adjacent healthy trees through root grafts.

Humidity and temperature increase spore production, but there is uncertainty as to the timing of maximum spore release, so control measures should be utilized every time stands are thinned. Spores may be deposited very close to the fruiting bodies or they can be carried by wind currents over long distances. Spores have been trapped 300 km from a known source and in areas with snow cover. However, extreme climatic conditions such as prolonged dry periods, high summer temperatures and freezing of the fruiting bodies may reduce spore success. Soil properties such as high pH, low organic matter, and high sand levels increase the severity and spread of the disease. A lack of antagonistic microbes may also be a contributing factor.

Control

Treating freshly cut stumps with a protectant such as urea or borax was found to be a feasible method to control this disease and borax was used extensively in Ontario. However, due to environmental concerns, it has not been available for the past 15 years and there is interest in the potential of biological control agents, in particular *Phlebiopsis gigantea* (Fr. :Fr.) Jülich. This saprophytic wood decay fungus is widely distributed throughout coniferous forests and is capable of competing with *H. irregulare* for resources. *P. gigantea* can be grown very easily on culture medium and produces oidia (a type of spore) that are used as inocula for stump treatment. It is approved as a commercial product to control *Heterobasidion* in Europe (sold as Rotstop®).

In Canada, work is currently being done to register *P. gigantea* as a control measure since trials using logs have demonstrated its effectiveness. Dumas found that the germination and growth of oidia were enhanced when formulated in an ammonium lignosulfonate solution, which was beneficial for the rapid establishment of the control agent under field conditions. Furthermore, he has determined that the oidia inocula can be stored in dry Kaolin® over a saturated solution of lithium chloride and that after 8 years there appears to be no appreciable loss in germination rate.

H. irregulare has many hosts, including jack pine, but to date infection centers have only been found in red pine plantations. To determine the potential risk of it becoming established in the jack pine stands of Eastern Canada, Dumas and Laflamme conducted inoculation trials in southern Ontario using isolates originating from the same area. In late September 2010, freshly cut stumps of jack and red pine of variable diameters were inoculated within five minutes of felling. An additional five red pine trees were cut and left untreated to act as natural spore traps for the pathogen. Stumps were collected eight weeks later and tests were used to confirm that the isolated strains were the same as those inoculated. The results indicate that jack pine is very susceptible to *H. irregulare* over a wide range of diameters, with infection rates ranging from 94 to 100%.

There is a very high possibility that this pathogen could spread into regenerating jack pine stands that are undergoing pre-commercial and commercial thinning. Current spore trapping trials have not found spores in jack pine areas of northeastern Ontario, but given their close proximity to infected areas the probability for invasion is high. There is concern about the possibility of infection in the Eastern Townships of Québec, where the current most northern extent of the disease is within 50 km of natural jack pine stands.

CONCLUSION

The accurate identification of annosus root rot and an understanding of its method of spread will help in early detection and control of this harmful disease. In addition, testing the effectiveness of *P. gigantea* as a natural control agent under field conditions and developing methods for its long term storage will contribute to its registration in Canada. By assessing the risk of infection in jack pine, the potential of serious damage to this important commercial timber species may be prevented.

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POLICY PERSPECTIVE

Natural Resources Canada has a mandate to conduct research relating to the protection of the forest resources of Canada under the *Forestry Act*. Also, under the *Department of Natural Resources Act,* one of the general duties of the federal Minister of Natural Resources is to assist in the development and promotion of Canadian scientific and technological capabilities. It is through these Acts that the research and development of the use of *P. gigantea* is supported.

Before *P. gigantea* can be registered as a commercial product, it will be first subjected to the careful scrutiny of Health Canada's Pest Management Regulatory Agency. This review is done to ensure that the product poses minimal risk to human health and the environment. The governing legislation that covers the registration details is the *Pest Control Products Act*.

RECOMMENDED READING

The hidden enemy – root rot technology transfer. For practical use in the field: a forester's guide to identification and reduction of major root rots in Ontario. 1988. Whitney, R.D. Canadian Forestry Service, Ontario Region, Sault Ste. Marie, Ontario, Ontario Ministry of Natural Resources, Sault Ste. Marie, Ontario. 35 p.

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