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In Brief

from the Canadian Forest Service – Laurentian Forestry Centre

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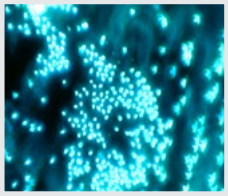


Genome-enhanced detection and identification of fungal pathogens

Exotic and invasive fungal pathogens, including rusts, cause significant damage in forestry. Given their small size, their few discriminating morphological criteria, and their confusing signs and symptoms, the visual detection of these pathogens could only be performed by trained specialists until quite recently. Today, DNA fingerprinting is making the detection of forest fungal pathogens more accessible, no matter how complex the sample or how advanced the disease.

Researchers from Laval University, the University of British Columbia and the Canadian Forest Service used the genomic approach to identify DNA regions that are unique to the targeted rust fungi species. This approach has enabled the development of rapid, sensitive, and specific tests on several fungi species responsible for white pine blister rust and poplar leaf rust, among others.

To this end, rust species were collected from artificially inoculated samples as well as from various naturally infected samples, including vector insects and various parts of blackcurrant, white pine, poplar, and larch. Real-time tests revealed a 100% detection accuracy for each of the rusts under study, even when using only one marker.

This research confirms the viability of the genomic approach in developing robust detection tools, which could contribute to ensuring the biosurveillance of pathogenic fungi in order to limit their impact on our forests

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https://cfs.nrcan.gc.ca/publications?id=39515&lang=en_CA

The striped ambrosia beetle, a profiteer of hemlock looper outbreaks

Researchers from Laval University and the Canadian Forest Service studied the responses of bark and wood boring beetles in stressed balsam fir stands or those that were recently killed during a hemlock looper outbreak in Quebec. The purpose of the study was to examine beetle assemblages at all levels of defoliation and to assess the relative effects of defoliation, tree mortality, and stand structure on beetles.

In unaffected stands by the outbreak, no beetles were noticeably present, given that few insects colonize healthy trees. However, in severely defoliated stands with tree mortality, the results show a rapid colonization of insects, mostly striped ambrosia beetles (86% of captures), two years after the onset of the outbreak. The level of defoliation, the basal area of conifers, the basal area of dead balsam fir, and the extent of recently logged areas around the sample plots all had a positive correlation with this beetle abundance. The latter probably contributes to the mortality of balsam fir trees that have become heavily defoliated by the hemlock looper. By spreading the fungi on which it feeds and creating entry points for other organisms, it also promotes decomposition.

Photo: NRCan

The striped ambrosia beetle is causing major economic losses in Western Canada. Its presence should therefore be taken into account when planning salvage cuts after an outbreak of hemlock looper in eastern Canada.

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How the roots of black spruce seedlings allow them to adapt to the restrictive conditions of reforestation sites

To test the influence of root characteristics on the short-term response of reforestation seedlings to water-, nutrient-, or oxygen-limiting conditions, researchers from the Université du Québec en Abitibi-Témiscamingue and the Canadian Forest Service compared several types of seedlings under various conditions. They evaluated the growth and physiology of four-year-old bareroot and containerized black spruce seedlings with two planting depths using different combinations of irrigation and fertilization. In a separate experiment, they also compared the cellular morphology of adventitious and initial roots of containerized plants under three irrigation regimes.

On the one hand, bareroot seedlings had the greatest relative growth rate in height compared to containerized seedlings, probably due to their bigger initial size. On the other hand, containerized seedlings responded better to fertilization, as evidenced by their higher relative growth rate in diameter compared to bareroot seedlings. Containerized seedlings were less affected by water limitation, possibly due to the fact that the root plug acts provides additional water reserve capacity. Nutrient limitation had a greater impact on seedling growth than water restriction.

For deeply planted containerized seedlings, the presence of pre-established adventitious roots was beneficial for height growth and physiological performance compared to containerized seedlings with early roots only. Adventitious roots showed greater cellular plasticity, especially under flooding conditions.

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This publication is part of a series that presents popularized summaries of scientific articles written in whole or in part by Laurentian Forestry Centre researchers.

Canada

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Conifer regeneration: finding silvicultural alternatives

Some partial cutting treatments, such as shelterwoods harvesting, are used in hardwood and mixedwood to promote forest regeneration and maintain forest composition and productivity. However, their effectiveness in promoting conifer establishment has yet to be demonstrated in boreal forests, especially those dominated by black spruce where regeneration processes differ.

Researchers from the Swedish University of Agricultural Sciences, the Université du Québec à Chicoutimi and the Canadian Forest Service sought to assess the regeneration of conifers 10 years after the onset of silvicultural treatments varying in harvesting intensities, and to identify the critical factors driving the regeneration process in boreal forests. Black spruce stands in the eastern Canadian boreal forest were submitted to various shelterwoods as well as to a seed-tree method. Local scarification was also used in order to promote regeneration.

Ten years after initial treatment, these methods produced a density of conifer regeneration sufficient to maintain forest productivity. However, they did not promote seedling growth. Black spruce was the predominant species in terms of regeneration density, with proportions 3 to 5 times higher than that for balsam fir, thereby increasing the proportion of black spruce compared to natural conditions. Black spruce seedlings grown from seed were abundant in harvesting trails, while layers dominated the residual strips.

Results confirm that shelterwood and seed-tree harvesting, combined with scarification, enable adequate regeneration in black spruce stands, and that these treatments are viable silvicultural alternatives to clear-cutting to promote sustainable forest management objectives.

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How do initial spacing and thinning interact to influence red pine production?

Management of plantation density through initial spacing and thinning has been extensively studied. However, there has been little empirical data compiled from experimental designs over the last several decades to help understand the effects of the interaction between these two treatments on tree growth and volume production.

Researchers from the Canadian Forest Service investigated the long-term effects of various spacing and thinning treatments in a 60-year-old red pine trial experiment located in Ontario. This experiment initially included six initial spacings ranging from 1.2 to 3.0 m. The commercial thinning regime was initiated when the stands reached 30 years of age and was subsequently applied every 10 years. It targeted a residual basal area of 38 m^2/ha after each intervention. Unthinned plots were used as reference points.

Based on the data, although the trees' quadratic mean diameter increased with initial spacing, the volume yield in unthinned plots peaked in 2.1 and 2.4 m spacings, whereas in thinned plots, the cumulative effect of volume interventions was greater at spacings of less than 2.1 m.

The results show that a 2.1 m spacing would be optimal. The small density of 3.0 m spacings allows for better stand quality. However, when combined with the thinning effect, it limits the potential yield of the site. In unthinned plots, narrower spacings result in more mortality and therefore less volume yield. In fact, thinning may increase the volume yield by eliminating from the calculation dead trees harvested.

This work enabled the on-site confirmation of the positive influence of commercial thinning on the size of red pine and its correlation to initial spacing density.

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Resilience of fir stands to spruce planting

With the growing use of planting to meet the demand for wood, some sites will inevitably undergo consecutive cycles of planting. As a result, the cumulative effects of planting could damage the resilience of fir forests and the maintenance of the biodiversity and ecosystem services they provide.

Researchers from the ministère des Forêts, de la Faune et des Parcs du Québec, the Université Laval, and the Canadian Forest Service wanted to assess whether planting spruce alters the resilience of fir stands. To make this assessment, they studied forest successions in 897 spruce plantations over a 40-year period.


Photo: RNCan

The main conclusion is that the planting of spruce as practised in Quebec does not influence the resilience of natural fir forests. Researchers found that this resilience is largely due to the efficient regeneration processes of balsam fir and the birch species that often grow alongside it.

Maintaining natural regeneration sustains resilience and ensures the gradual recovery of biodiversity and ecosystem services from anthropogenic disturbances. Regeneration processes should allow a resilient forest to follow the successional trajectories of natural forests to recover the composition, structure, and functions it had prior to disturbance. Therefore, planting a tree species that is not consistent with the natural succession in a resilient forest may jeopardize silvicultural investments.

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