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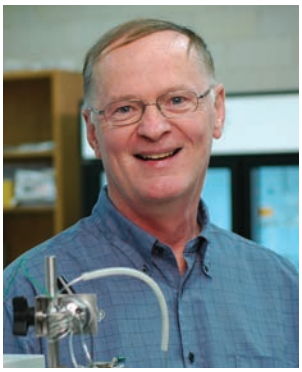
Carleton
UNIVERSITY
A PARTNERSHIP IN INNOVATION
by J.D. Irving, Limited and Carleton University
to Make Healthier Forests

Background

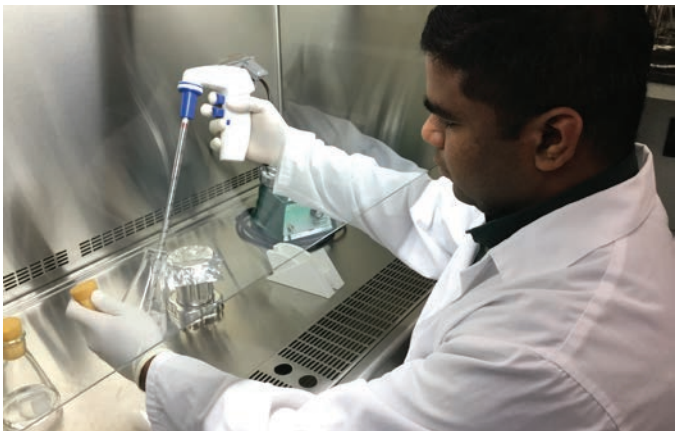
Many plants harbour fungi, known as endophytes, which live inside them without causing damage. Some endophytes have been shown to produce anti-insect or antifungal compounds that make the host plants more tolerant to insects and disease. This has led to commercial development of endophyte-enhanced turf grass with improved pest tolerance. Use of enhanced turf grass seed has been encouraged by Health Canada and the US Environmental Protection Agency in order to reduce pesticide use.

Native endophytic fungi live inside the needles of most trees in the forest. Some of these fungi produce anti-insect or disease chemical compounds.

Research initiated by Professor J.D. Miller and led by Professor John Findlay of the University of New Brunswick was supported by NSERC in the 1990's to determine what role foliage endophytes played in conifer trees. A specific objective was to see if there was any linkage with the spruce budworm, a dominant ecological driver of forest dynamics in spruce/fir forests. Spruce budworm is the most significant forest pest in Canada which affects balsam fir and all species of spruce to a varying degree. This is a native insect which causes major losses across the country in periodic epidemics (typically 20-30 years). Over 6 million hectares of forest received defoliation in the Province of Quebec in 2015. Mortality or growth loss occurs after several years of defoliation of affected species.



Professor J.D. Miller



Initiating endophytic fungi cultures in laboratory.

In the 1970's and 80's, spruce budworm infestations in Eastern Canada reached 50 million hectares, destroying hundreds of millions of cubic meters of timber.

Eastern spruce budworm is a native insect which attacks balsam fir and spruce species. Severe infestations occur periodically across most of Canada.

Research Collaboration

After sampling several thousand local native strains of endophytes from the needles of balsam fir and spruces, a small percentage of strains were found to produce anti-insect compounds. Prof. Miller continued his interest in endophytes after joining Carleton University. He began research collaboration with the J.D. Irving, Limited's tree improvement program in 1998 to explore the potential of endophyte enhancement of spruce seedlings in the nursery to improve tolerance of planted trees to spruce budworm attack. Collaboration focused on:

- Developing methods to inoculate seedlings efficiently in the nursery with selected endophyte strains
- Demonstrating persistence of the fungus in the trees over time and the presence of anti-insect compounds
- Assessing the effect of endophyte-enhancement on spruce budworm health and on the overall defoliation by spruce budworm
- Making new and larger collections of needle endophytes to study

As a result of our research, efficient methods have been developed to inoculate seedlings in the nursery and to date over 100 million seedlings have been treated. Studies of the earliest inoculated trees show that endophytes remain in the trees past 10 years of age and that the anti-insect compounds are present throughout the tree. Results from laboratory, nursery and field experiments have consistently demonstrated that trees inoculated in the nursery with selected endophytes are more tolerant to spruce budworm. These results have been published in over a dozen high quality peer-reviewed journals and five patents have been issued in Canada, the United States, Australia, and Europe. A number of species of spruce endophytes are used which produce different compounds. In controlled feeding experiments, some endophytes reduce the survival rate to adulthood (typically around 10%) and others reduce the amount of defoliation per insect (observed at up to 30% less). Testing is currently underway with trees planted in areas with active spruce budworm infestation.

Large scale production of endophytic fungi in the laboratory for seedling inoculation.

Procedures were developed to efficiently inoculate seedlings in the greenhouse.

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Conclusion

Over the past 17 years, endophyte enhancement collaborative research between J.D. Irving, Limited and Carleton University has effectively explored the ecological relationship between trees, endophytic fungi and the spruce budworm. The science has been developed to commercialization in forests of Eastern Canada. Research is now being conducted on other tree species/ insect and disease problems. The collaboration has been conducting work since 2008 on white pine blister rust which is a devastating introduced fungal disease of several pine species across North America.

Acknowledgements

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From Discovery to Commercialization & New Jobs

The $3.5 Million Maritime Innovation Limited laboratory was constructed in Sussex, NB in 2014 to commercialize new technologies including endophyte enhancement of seedlings.