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Frontline Express

Canadian Forest Service – Great Lakes Forestry Centre

Biological control of Emerald Ash Borer

INTRODUCTION

The emerald ash borer (EAB), *Agrilus planipennis* Fairmaire, is an invasive pest thought to have arrived from Asia in the 1990s. It was first detected in Michigan and southwestern Ontario in 2002 and is rapidly spreading throughout North America, where it poses a serious threat to all native ash trees. In addition to the ecological consequences that may ensue, such as the effects on forest biodiversity, the loss of ash trees will have a significant effect on the hardwood forest industry, private woodlot owners, First Nations and municipalities. Tens of millions of ash trees have succumbed to EAB in Ontario, Quebec and a greater part of north-eastern United States, and economic losses are significant. Cities have incurred substantial costs for the treatment or removal and replacement of these high value trees. Removal costs of a single dead ash tree can be up to $1500. The amount spent for ash tree removal in the north-eastern US alone is estimated to be in the billions of dollars.

EAB is particularly difficult to control because the insect spends its destructive larval stages under the bark, and by the time damage is visible trees may have already succumbed to infestation. In Canada, control measures to date have included quarantines and restrictions on transport of ash materials, tree removal and the use of the botanical insecticide TreeAzin™ for individual, high-value trees. Currently there is no single effective control option for wide-spread use against this invasive pest. Consequently, scientists are studying many aspects of the pest with the aim of managing established populations in the longer term. Control strategies to be adopted will require a multi-tactic management program that will include effective detection and trapping. One promising possibility is a biological control approach using natural enemies, which is recognized as one of the most suitable long term pest management strategies for invasive species because it may decrease population densities and reduce the spread and duration of outbreaks.

GREAT LAKES FORESTRY CENTRE (GLFC) RESEARCH

GLFC researcher George Kyei-Poku, has been concentrating his efforts on the search for natural enemies that have colonized EAB populations since the arrival of this invasive pest in Canada. He has been investigating the possible use of native entomogenous (growing on or in an insect body) fungi and soil-borne nematodes as biological control agents because they are capable of killing EAB (Figure 1). A fungus works by first landing as a spore on the insect, where it germinates, penetrates the insect's body and then produces enzymes that eventually kill it. These native entomopathogens are already well adapted to local climatic conditions, which may be harsher than those of EAB's native habitat in Asia.

Figure 1. *Metarhizium* - infected emerald ash borer adult.

Finding the pathogens

These prospective biological control agents can be found by collecting pathogen-infected samples of the insect in its various life stages, as well as cuticle (outer skeleton of an insect), remnants and gallery frass (insect excrement) from existing outbreak sites, particularly older infestations. Exploratory surveys, which began in May 2008 within old outbreaks in the southwestern Ontario cities of Sarnia, Windsor and London, found four species of entomopathogenic fungi in the following genera: *Beauveria*, *Paecilomyces*, *Metarhizium* and *Lecanacillium*, that are all common native species present in Canadian soil, and a species of nematode belonging to the subgenus *Oscheius*. The most predominant fungal species infecting EAB at these three locations were *Beauveria* spp.

Laboratory testing: identification and testing of virulence

Once a species has been isolated and identified, including DNA characterization, further testing is carried out to determine its potential as a biological control agent. This testing involves both laboratory and microcosm (greenhouse) experiments to test efficacy of the pathogen, first on a test insect, mealworm, *Tenebrio molitor* (due to the difficulty in obtaining adequate EAB) and then on EAB. Different concentrations of the fungal isolates are tested under varying temperature and humidity conditions. Parameters measured include colony growth rate, conidial (spore) yield, conidial germination, tolerance to ultraviolet light, extracellular protease (enzyme) activity and pathogenicity (survival time and mortality) to EAB among the tested *B. bassiana* isolates. Prospective species must also be suited to large scale laboratory production to be useful as biological control agents. The most virulent strains with the greatest host specificity are chosen. A few of the *B. bassiana* strains currently being tested appear promising; their virulence matches that of the comparative control, the commercial product *B. bassiana* GHA that is registered for use against various insect pests.

Transmission and field testing

Transmission of the fungus between contaminated EAB and healthy individuals is one strategy required for effective EAB population control. Fungal spores are naturally spread in the environment, but to be effective in population control their spread needs to be enhanced.

A method currently being tested is putting the fungi in traps baited with lures that are known to be effective in attracting EAB. The fungi-contaminated EAB will fly off from the traps and mate with others, which will in turn contaminate the bodies of those mates, thereby spreading the disease. This strategy avoids blanket spraying of the selected fungi, which may affect other insects, but rather provides targetted control of EAB in the field.

Nematodes

A species of nematode is also being tested as a potential biological control agent. An indigenous nematode species was found to parasitize EAB in the outbreak sites sampled in southwestern Ontario and is believed to hold promise as a control agent. The nematode, identified as *Rhabditis (Oscheius)*, was found on dead adult and larval EAB residing underneath the bark of dead ash trees. Field trials are planned to test this nematode by injecting it under the bark of stumps of felled ash trees to test its ability to suppress EAB larvae and beetles developing in the infested stumps and roots. This field trial mimics conditions typically found on golf courses, where it is important to keep the environment pristine and appealing to customers and at the same time stopping the spread of EAB from stumps to surrounding trees. Effectiveness of the treatment will be determined by comparing the number of adult insects emerging from treated and untreated stumps, as well as the number of nematode-killed larvae found under the bark of stumps and roots. Such a treatment would be environmentally sound because these nematodes are native and also cannot travel more than a metre within the perimeter of release.

FUTURE WORK

It is important to have methods that permit the reliable identification and sensitive monitoring of biocontrol agents after release into the environment. Future work will be centered on developing molecular markers and tools for quantitatively detecting entomopathogenic fungi naturally occurring in or artificially released into EAB population by this auto-contamination approach and to investigate the persistency of the released fungi and their suppressive action on EAB. Also, a comparison will be made between the native nematodes and commercially available nematode species of the genera *Steinernematidae* and *Heterorhabditidae* for their ability to control EAB, both in the laboratory and in the field.

CONCLUSION

A variety of approaches need to be integrated for successful management of EAB populations, including area wide detection surveys, trapping, treatment of individual high value trees with TreeAzin™ and ideally a biocontrol agent. The development of such a control strategy using fungi or nematodes would be helpful in reducing existing EAB populations and slowing their spread. Further testing will be required before these products can be produced on a larger scale or be approved for use beyond research trials. It is hoped that ultimately a commercial biocontrol product approved for use in Canada against EAB will become available to provide forest managers, communities, woodlot owners and others with more control options for protecting ash trees.

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SUGGESTED READING

Lyons, D.B. 2010. Emerald ash borer. Natural Resources Canada, Canadian Forest Service, Great Lakes Forestry Centre, Sault Ste Marie, Ontario. Frontline Technical Note 110. 4 p

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