Biotechnology

The Latest Buzz on Pest Control

What is Biotechnology?

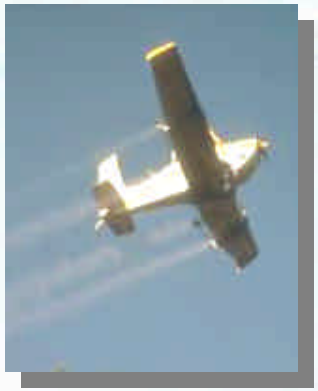
Biotechnology is the use of genetic information and biological techniques to create new products and services, like better medicines or hardier crops. Organisms like plants, fungi and bacteria are used in this process.

Canada is currently exploring biotechnology as a way to develop innovative new tools for forest pest management.

Managing Forest Pests

While most people think of forest fires and human activity as the most damaging to Canadian forests, deadly insects and disease are working behind the scenes with hugely destructive results.

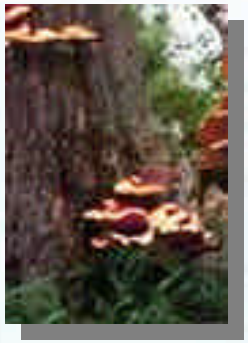
That's why Canadian scientists are relying on biotechnology to create powerful new weapons in the fight against persistent pests and pathogens.



Areas of Study

The use of biotechnology in forest pest management touches on three main areas:

- Control agents – products created to stop specific insects and pests from destroying trees
- Detection and diagnosis of pathogens – identifying agents that cause disease (especially living microorganisms like bacteria and fungus) and learning how they work

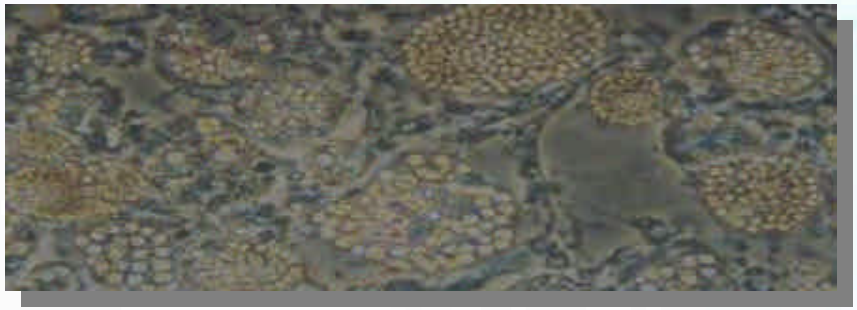


- Transgenic trees – creating genetically modified trees that are resistant to a specific pest or pathogen

Control Agents

Most of the current research on control agents falls into two main categories:

- Genetic improvement of baculovirus-based insecticides
- Biotechnology-assisted development of biorational insecticides



Baculovirus-based Insecticides

Insects, like humans, can be infected with viruses that cause disease.

Baculoviruses are found in nature and some strains of baculovirus only infect certain kinds of insects. When the insect eats the baculovirus it becomes sick and eventually dies.

Baculoviruses are a widely favoured weapon in the war against forest pests. An insect-specific virus is sprayed in areas where the pest is most likely to invade. As the pest makes its way through the area, it consumes the sprayed foliage and dies.

Room for Improvement

Although baculoviruses are a good tool for pest management, scientists are using biotechnology to make them even better. Using genetic engineering, they are working toward viruses that are more potent, kill a greater range of pests and work faster.

Advantage of Baculoviruses

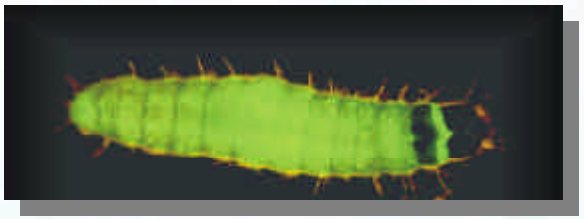
- Only kill the insects they are targeting
- Don't hurt the environment or human health like chemical sprays
- Can be produced relatively easily
- Protein matrix protects from virus break down with UV exposure

Disadvantage of Baculoviruses

- The virus may take a long time to kill the insect, which keeps eating a lot of foliage until it dies
- Some viruses are not that potent, so they either take a long time to kill or don't quite do the job
- Because it only kills a few specific pests, it is often not worth it to make it commercially available

Building a Better Virus

The Canadian Forest Service (CFS) is conducting baculovirus research in two areas.



i) Genetic modification of the virus

A team of scientists at the CFS Great Lakes Forestry Centre have been studying genes in the spruce budworm that cause it to molt. Why? Because interfering with the molting process can kill it. Research has shown that too much CHR3 (one of the molt-related genes) will do the trick, so they are adding this gene to baculoviruses to help kill this destructive pest.

Building a Better Virus

ii) Identifying genes for virus improvement

Researchers at the CFS Laurentian Forestry Centre are paying close attention to a parasitic wasp that stings the spruce budworm and injects it with its eggs, along with a nasty virus that disrupts the budworm's metamorphosis and leads to its death. The goal of this study is to identify the viral genes that alter the spruce budworm's development and use them to improve the effectiveness of baculoviruses used in pest management.

Biorational Insecticides

Biorational insecticides are control products with active ingredients that target and interfere with biochemical functions in insects, like how they grow or reproduce.

Because they are highly specific to certain insects and biochemical functions, they pose a very low risk to humans, wildlife and the environment.

Targeting Hormones

CFS scientists are currently looking at the function of juvenile hormone (JH) at the molecular level to find ways of interfering with its production and/or activity in insects. Some insects need JH for proper development during molting and metamorphosis, and – in adulthood – to promote sexual maturation.

When JH malfunctions during molting and metamorphosis, the insect dies. In adults, JH interference inhibits reproduction.

Tracking Down Pathogens

The second use of biotechnology in forest pest control involves developing methods for the detection and diagnosis of tree pathogens.

Pathogens are agents that cause disease – especially living microorganisms like fungi, bacteria and viruses. Tree pathogens cause widespread damage in Canada's forests, accounting for losses of over 45 million m^3 of wood annually through retarded tree growth, deterioration of wood and death.

Biotechnology to the Rescue

There are many uses for biotechnology in the fight against tree pathogens, including:

- deciphering disease resistance at the molecular level;
- understanding pathogen population genetics;
- developing new methods of disease control; and
- creating disease-resistant trees.

Speeding up Detection

When disease is on your doorstep and time is of the essence, conventional methods of tree pathogen diagnosis just don't cut it. At the CFS Laurentian Forestry Centre, scientists have developed a DNA diagnostic kit for the early detection of scleroderris canker that is highly accurate and takes just hours to complete.

With sudden oak death now found in B.C. and current diagnosis taking up to two weeks, scientists have developed a similar kit for this deadly and rapidly spreading disease. The new kit not only tells whether or not the pathogen is present, but also identifies its potential to reproduce.

Transgenic Trees

Trees can be genetically modified for improved traits like pest and disease resistance. These trees can then be specifically deployed to to reduce use of pesticides and minimize yield lost due to insects and diseases.

Current research is focusing on molecular characterization of genes for resistance to pathogens and insects.

Strengthening the Spruce

Bacillus thuringiensis (Bt) is a naturally occurring bacterium that can kill the spruce budworm. CFS scientists at the Laurentian Forestry Centre have successfully inserted the toxin gene of Bt into the DNA of white spruce with great success. Trials studying these genetically modified trees, which started in 2000, show that they produce the Bt toxin and are effectively able to reduce spruce budworm-related defoliation.

Making poplar more popular

As the global need for wood increases, intensively-managed plantations of fast-growing species like poplar have become a reality world wide for short-rotation cultures. However, poplar is often found susceptible to fungal pests (such as melampsora leaf rust and septoria leaf spot). In order to genetically improve fungal resistance in poplar, genes encoding anti-microbial compounds are currently being tested. Data from greenhouse trials using transgenic poplars have clearly shown increased resistance toward microbial pathogens.

Fast Facts

- In 1994, the spruce budworm did more damage to Canadian forests than forest fires. It took just one year for these pests to seriously defoliate over 6.31 million ha.

- The rate at which disease and insects destroy trees in Canadian forests has surpassed 50% of our annual forest harvest.

Contact Information

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