Agriculture and Agri-Food Canada / Agriculture et Agroalimentaire Canada

Crop Protection Biotechnology at the Pacific Agri-Food Research Centre in Summerland

Like people, plants can get sick. They are susceptible to a variety of pathogens: viruses, fungi and bacteria. These can be transmitted by “vectors” such as insects, nematodes, pollen, by physical means such as wind and rain, and through cultivation practices such as pruning, grafting, and the use of irrigation systems.

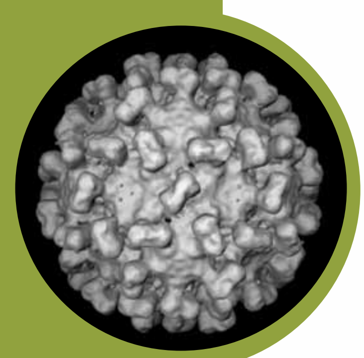
By better understanding plant-microbe interactions such as how viruses replicate in host plants, how insect and fungal vectors transmit viruses, and what role viral proteins play in affecting their host plants, researchers can target specific pathogen and host factors in the disease process. Targeting such factors allows them to design new methods to control diseases, leading to reduced use of pesticides.

Plants can also be severely damaged by insects, causing significant economic loss. Insects are also affected by similar pathogens including viruses, fungi, and bacteria. These pathogens can be used in beneficial ways to protect crops in environmentally sustainable methods by controlling insects using their natural diseases.

As early as 1921, plant pathologists at Agriculture and Agri-Food Canada’s (AAFC) Pacific Agri-Food Research Centre (PARC) in Summerland kept a careful watch on our crops. Today, researchers from the Crop Protection Biotechnology program are working on several fronts to find new ways to protect crops from pathogens and insects. Benefits include enhanced environmental and human health, increased crop value and greater economic returns for producers.

Researchers at PARC-Summerland are experts in genomics and proteomics, the large-scale analysis of the structure and functions of all genes and proteins in an organism. They conduct studies on why pathogens are found in certain ranges, how they interact with their plant and insect hosts, how they spread, and how plants and insects defend themselves against them.

Plant Viral Pathogens



Understanding the protein structure of a virus paves the way for researchers to develop alternative methods of fighting diseases. By identifying the molecular mechanisms of viral replication inside host cells and learning how they spread within and among plants, researchers can pull the plug on essential virus functions.

Assessing loss of fruit quality is an important aspect of viral disease management. Anti-viral compounds, many of them natural products, offer an attractive alternative for crop protection. For example, growing tissue cultures resistant to a virus and grafting them onto infected plants can provide a cure.

Canada

The Canadian Plant Virus Collection

While generally regarded as pathogens, viruses can also be considered as sources of important genetic material. Furthermore, when dealing with viral outbreaks it is necessary to have such a national resource to supply reference material. The plant virus collection at PARC-Summerland is one of the largest in the world. Freeze-dried cultures comprise over 350 isolated strains representing 160 different viruses. In addition to the preserved cultures, there are 'live' cultures maintained in living plants.

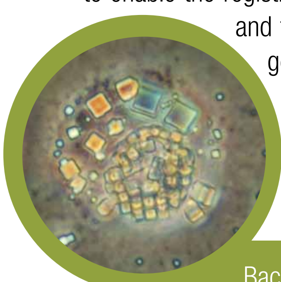
Diagnostics

Knowing which viruses, bacteria and fungi are implicated is the first step toward a better understanding disease and disease development. This insight allows researchers to develop newer diagnostic methods and strategies for disease control, including disease management through the use of natural products. Using molecular detection systems, both pathogenic and beneficial microbes can be monitored and identified in a bid to understand the relationship between microbial ecology and agriculture practices.

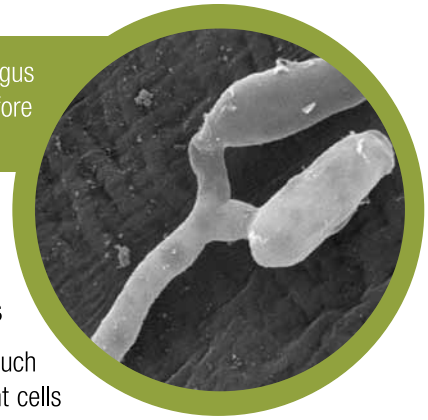
Detecting pathogens early and understanding their genetic diversity, population dynamics and spread helps lead to sound advice on disease management. Recently, Summerland researchers played a key role in developing a very sensitive, rapid and specific diagnostic test for Plum Pox Virus (PPV) which is being used throughout North America.

Insect Viral Pathogens

Baculoviruses can be used to control crop insect pests and can be applied to crops in the field or the greenhouse. Moreover, they do not damage the environment and are highly specific for crop-damaging insects. By studying the infection strategies employed by baculoviruses, researchers can find better ways to use these biological insecticides for enhanced insect control. In addition, in collaboration with other AAFC research centres the groundwork is being laid to enable the registration of baculoviruses for greenhouse and field applications. Baculovirus-derived genetic elements have also been developed into commercial systems that allow researchers to express foreign proteins in insect tissue culture cells for research or commercial purposes.



Baculovirus infection in caterpillar cells



picture: Smut fungus on barley leaf before infection

Fungal Pathogens

When pathogens such as fungi enter plant cells during infection, many produce chemicals and proteins which interact with the plant's own proteins to cause disease or trigger defence. A pathogen's crucial "disease factor", its "Achilles heel" can be targeted to develop ways to enhance a plant's disease resistance through biotechnology and breeding.

To this end, the complete genetic content of several cereal-infecting fungal pathogens is being dissected at the molecular level to understand their disease capability. The wheat leaf rust fungus, *Puccinia triticina*, causes one of the major diseases of wheat in Canada and world-wide. Its relatives, barley and corn smut fungi, serve as model systems that help predict disease determinants in these classes of pathogens.

Much of the Crop Protection Biotechnology program is intertwined with other programs at AAFC Research Centres across Canada to take advantage of the department's network of resources and expertise. In addition, many scientists are adjunct professors at the University of British Columbia and jointly supervise graduate student research.

Other collaborators include the BC Wine Grape Council, the University of British Columbia, the University of Alberta, Trent University, ON, the Broad Institute, Cambridge, MA, and the University of California at Berkeley.

Collaborations with the Genome Sciences Centre in Vancouver, USDA labs in St. Paul, MN, and Manhattan, KS in the USA, and the Max Planck Institute in Marburg, Germany, have resulted in major genome projects.

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