Biological Control of Greenhouse Diseases

by Mario Lanthier

They eat the food released by plant roots. That is how beneficial microbes survive in the soil, said Melanie Jones. In the process, they stimulate many features that are useful to the host plant.

Dr. Jones is a professor of biology and associate dean at the University of British Columbia – Okanagan. "The region around the root, called the rhizosphere, is rich in nutrients" she added. As much as 40% of the photosynthates manufactured by the plant are leaked through the roots. "This food supports a large and active microbial population capable of exerting beneficial, neutral or detrimental effects on plant growth."

Dr. Jones was speaking at the workshop "Biological Control of Greenhouse Diseases" held in Kelowna, B.C., on April 19.

The 1-day event, to hear from researchers on the latest developments on the topic, was attended by 42 persons, most being growers of vegetables, ornamental flowers and forest seedlings. Participants came from all over the Okanagan but also from the Kootenays and the Lower Mainland, no small feat considering the unexpected snow storm that blanketed the province that morning.

Support funding was received from COABC (Organic Sector Development Program) and Agriculture and Agri-Food Canada (Pesticide Risk Reduction Strategies Initiative).

On April 19, the whole province woke up to an unexpected snowstorm which blanketed all plants, including this Forsythia in bloom. In the Okanagan, many orchardists lost a major portion of their crop, including apricots and cherries.

Common greenhouse diseases

Powdery mildew, gray mould, damping-off and root rot are common diseases of greenhouse crops around the world. "Lean to recognize the early signs and symptoms and have a plan to help your crop escape infection" said Ron Howard, from Alberta Agriculture & Rural Development in Brooks, Alberta.

Dr. Howard is a recognized plant pathology research scientist and co-editor of the must-have text book "Diseases and Pests of Vegetable Crops in Canada" (available from the Canadian Phytopathological Society at the website http://www.esc-sec.org/disease.htm).

Ron Howard

Gray mould is caused by the fungi *Botrytis cinerea*. It can infect a wide range of host plants. It is favoured by cool temperatures and high humidity, usually starting on damaged or dying plant parts then moving to healthy tissue. Management is achieved by controlling ambient humidity and removing dead plant parts.

Powdery mildew is caused by various fungi. It is commonly seen on many ornamental flowers and cucumbers. This pathogen is favoured by high humidity and warm temperatures. Management is achieved by using known resistant cultivars and providing good air circulation.

Root and stem rot are caused by different pathogens. Pythium is very common in greenhouse production of vegetables and flowers. It is favoured by

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water logging, poor soil quality and stressed plants. Management is achieved by strict irrigation management, balanced fertilisation and using biologically-active soils.

Ron Howard

Biocontrol of leaf diseases

"Using biologicals will require a lot of thought and understanding, because different products are effective on different diseases" said Janice Elmhirst, speaking of commercial biofungicides recently registered in Canada. She has worked in plant pathology for over 20 years and is currently the owner of Elmhirst Diagnostics and Research, based in Abbotsford.

Dr. Elmhirst tested various products against powdery mildew of roses. The best results were obtained with Rhapsody ASO (based on a strain of *Bacillus subtilis*, also sold as Serenade) and PreStop (based on a strain of *Gliocladium catenulatum*). Results were significantly better than untreated and similar or significantly better than Nova, a standard synthetic fungicide. For grey mould on geranium, both PreStop and Rhapsody controlled the disease as well or better than the synthetic fungicide Captan. The work was done in collaboration with Dr. Zamir Punja from Simon Fraser University and funded by Agriculture and Agri-Food Canada.

The trial results were submitted for extension of the product labels. Dr. Elmhirst also discussed uses of the product Actinovate (based on a strain of *Streptomyces lydicus*) and Mycostop (based on a strain of *Streptomyces griseoviridis*).

Biocontrol of root diseases

"The commercial biological fungicide PreStop has the most potential to reduce root rot and damping off caused by *Pythium* on greenhouse cucumbers" said Zamir Punja when presenting his research data. "But the product must be applied as a preventative treatment". Dr. Punja is a professor at Simon Fraser University.

In one set of experiments, cucumber seeds were placed in rockwool blocks, followed by a specific biocontrol treatment then inoculated after 48 hours with *Fusarium* or after 10 days with *Pythium*. Compost from greenhouse plant waste material significantly reduced plant mortality due to *Fusarium* and results were similar to Benlate, a standard synthetic fungicide. Two other composts (windrow composted dairy solids and vermicomposted dairy solids) also reduced plant mortality, but not significantly. The results highlight the variability between composts, a factor which must be considered before making widespread recommendations to growers. Commercial biological fungicides were also tested in a series of trials over 2 years. Under high disease pressure in a growth chamber, the product PreStop (*Gliocladium*) significantly reduced *Pythium* (58% mortality vs 92% mortality in control) and *Fusarium*. Under low to moderate disease pressure in commercial greenhouse conditions, all products tested were effective (PreStop, RootShield and Mycostop).

Dr. Punja noted that seasonal differences in growing conditions affected the severity of the disease and the efficacy of the biological control agents.

Dr. Punja making his presentation to the room of greenhouse growers

Biocontrol in Cuba

In the early 1990s, the collapse of the Soviet Bloc virtually ended food, oil and fertiliser imports into Cuba. "The country had to learn how to feed the population with limited petroleum inputs" said Deborah Henderson, a director of the Institute for Sustainable Horticulture at Kwantlen University College, in Langley. Dr. Henderson also owns a crop management company in the Fraser Valley.

To achieve food security, Cuba converted from conventional agriculture to a semi-organic system dependent on local resources and low external inputs. To help biocontrol of crop diseases, over 200 facilities were built across the country for artisanal production of biocontrol agents, and 30 brewing factories were converted for industrial production of high-quality products based on *Bacillus*, *Beauveria, Metarhizium* and *Trichoderma*. The end result has been a drastic reduction in the use of pesticides by the country's farmers.

Dr. Henderson is heading an effort to build a small production facility for native biocontrol products for use in British Columbia.

The Cuban "organoponico", or urban garden, is now an important source of fresh produce in the cities and provide paid employment to over 350,000 persons country-wide. These gardens, built on empty city lots, are managed along agroecological principles.

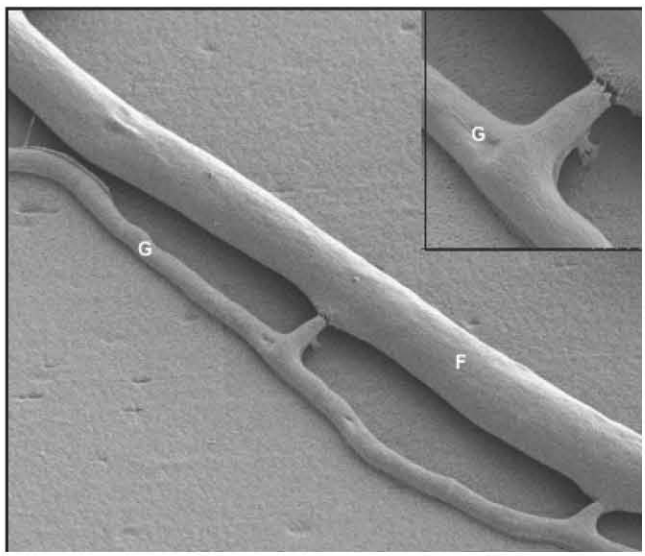
Deborah Henderson

Mechanisms of disease suppression

Workshop participants were served a special treat: Zamir Punja, the editor-in-chief of the Canadian Journal of Plant Pathology, a highly respected scientific publication. Dr. Punja is also co-author of numerous papers on biocontrol of plants diseases, including for greenhouse cucumber production.

Disease suppression has been considerably studied with composts. Different mechanisms are at play. Most commonly, beneficial micro-organisms colonize the roots of the host plant to feed on root exudates, in the process outcompeting root pathogens. This mechanism is known as "general suppression". Less commonly, specific beneficial micro-organisms secrete enzymes or abiotic inhibitory factors which are directly antagonistic to root pathogens. Researchers study these "super-hero microbes" and select strains which can be formulated into commercial products.

A view under the microscope illustrates biocontrol of plant pathogens. A strand of the beneficial microbe *Gliocladium* (labelled "G") has punctured the cell wall of the root pathogen *Fusarium* (labelled "F"), in order to feed on the cell contents. The commercial product PreStop, made from *Gliocladium*, has just received OMRI approval.



Syama Chatterton and Zamir Punja

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Root bacteria

"Greenhouse systems show considerable promise for the use of beneficial rhizobacteria" said Louise Nelson. "They offer consistent environmental conditions and a high incidence of fungal diseases".

Plant growth promoting rhizobacteria are soil bacteria that colonize plant roots and enhance plant growth. They offer an environmentally sustainable approach to increase crop production and health. One example is the use of rhizobial inoculants for legumes to enhance nitrogen fixation, a practice that is over 100 years old.

Dr. Nelson is an Associate Dean of research and strategic planning at the University of British Columbia – Okanagan. She examines disease-suppressive soils to identify naturally-occurring bacteria that promote plant growth and suppress disease pathogens. She has worked so far with field crops but is now examining the efficacy against pathogens of tomatoes.

"We can expect more commercial products to become available" she concluded. "The success of these products will depend on our ability to manage the rhizosphere and enhance survival and competiveness of the beneficial micro-organisms. We are still in our infancy in understanding how these biologicals work".

Mycorrhizal fungi

"About 95% of plant species naturally form mycorrhizal associations" said Melanie Jones. She explained that specialised fungi attach to plant roots in a mutually beneficial symbiosis. The plant transfers photosynthate materials to the fungus. In exchange, the fungus helps with nutrient uptake, prevention of water stress, reduced uptake of toxic metals and resistance to pathogens.

Dr. Jones, from the University of British Columbia – Okanagan in Kelowna, is researching the diversity and influence of ectomycorrhizae on nutrient uptake in B.C. forests. "The mycorrhizal fungi extend hyphae into the soil far away from the roots" she said. "I have measured 300 cm of hyphae per centimetre of plant root".

Continuing on the same topic, Carolyn Scagel commented that in agriculture, the most benefits are seen when plants are inoculated in earlier crop stages. "Less inoculum is needed and the fungus grows as the roots grow".

Dr. Scagel is a research root physiologist at the U.S. Department of Agriculture in Corvallis, Oregon. Her trials have documented many benefits from using mycorrhizal fungi in greenhouse production:
- In seed propagation, it confers higher tolerance to damping off and abiotic stresses.
- With unrooted cuttings, it improves rooting because of more rapid root induction and higher root numbers.
- With bulb and corm propagation, it results in a higher number of corm and higher number of flowers per plant.

"But mycorrhizae will not solve all problems" she cautions. "The benefits are most obvious under stress conditions, when placed side-by-side with untreated plants. Application and effectiveness varies with the production system, the plant species and the inoculum source".

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British Columbia Organic Grower

Journal for the Certified Organic Associations of BC

Fall 2008
Volume 11, Issue 4

British Columbia Certified Organic

Official mark of the BC Certified Organic Program

COABC, 202-3002 32 Ave. Vernon BC V1T 2L7
Canadian Publications Mail Agreement #40047167