Biocontrol Files

Canada's Bulletin on Ecological Pest Management

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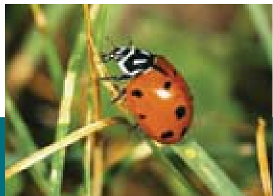

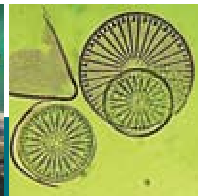

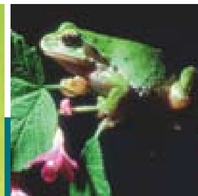

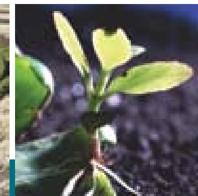

Update on new Canadian organic legislation

On December 22nd, 2006, the Minister of Agriculture and Agri-Food announced that the *Organic Product Regulations* had been published, bringing a long journey to an end for the many organizations and individuals who worked so hard to give Canada an organic standard. Canada is now one of more than 40 countries with national organic regulations.

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The Regulations introduce the new Canada Organic logo, which is allowed only on food products that have been certified as meeting the Canadian organic standard and contain at least 95% organic ingredients. The Regulations will be phased in over two years. After the phase-in period, all organic products in inter-provincial and international trade are required to be certified under the new standard. The rules do not apply to organic food produced and sold within the same province.

The new Regulations are built on existing standards and a national consultation process which took place between 2003 and 2005, and respond in part to the need to ensure international confidence in Canada's organic sector. The Standard is ratified and published by the Standards Council of Canada (SCC), and copies of the National Standard for Organic Agriculture are available on the Canadian General Standards Board website at www.pwgsc.gc.ca/cgsb.

The Standard defines accepted principles for organic agriculture as well as minimum criteria that products must meet to be defined as organic. For example, if food products contain between 70 and 95 percent organic ingredients, an organic claim may be made, providing that the percentage of organic ingredient(s) is shown on the principal display panel, e.g., "contains x% organic ingredients."

To demonstrate compliance with the national standard, producers or processors may ask an independent certifying body to inspect their farm, processing operation or product. Certifying bodies are accredited by the SCC, and provincial authorities may also provide accreditation of certifying bodies within their jurisdiction. Certification is voluntary in all provinces except Quebec. The province of Quebec has an organic regulation which *requires* certification by a certifying body accredited by the Conseil des appellations agroalimentaires du Québec (CAAQ). Certification bodies are responsible for monitoring the growers they certify, and for taking action to remove organic claims if the Standard is not being met.

Congratulations to all who brought the new Regulations and organic Standard into being! ■

OMRI and Canada

The *Organic Materials Review Institute* (OMRI), based in Eugene, Oregon, is a non-profit organization which provides the organic sector with independent reviews of products for use in certified organic production, handling, and processing. OMRI compares products against the U.S. National Organic Standards, and acceptable products are recorded on the *OMRI Products List*.

OMRI also produces another list – the *OMRI Generic Materials List*. This consists of materials that are either allowed or prohibited by the U.S. National Organic Program's *National List*.

OMRI's Board of Directors, which represents a wide variety of stakeholders in the organic sector, makes policy determinations relating to material standards, while seeking advice on scientific and technical issues from the OMRI Advisory Council, an independent body designed to provide a balanced representation of expertise on the scientific, technical, and industry aspects of standard setting.

Products listed on the *OMRI Products List* are permitted to display the OMRI Listed® seal on labels and in advertising and promotions, assuring customers of their suitability for use in certified organic production.

While the OMRI lists provide guidance on the acceptability of materials and products for production and processing, growers and processors must consult their certifying agency for a final determination of the acceptability of a product. OMRI does not provide any guarantee or warranty, express or implied, for products included on the *OMRI Products List*.

Participation in the *OMRI Products List* is voluntary. As such, the List is not a comprehensive record of products suitable for use in organic production, handling or processing, nor can a product's absence from the List be taken as a sign of its failure to comply with the U.S. National Organic Program Rule.

OMRI in Canada

As to how OMRI is used in Canada, the situation is less straightforward. For example, the Certified Organic Associations of British Columbia (COABC) posts the following guidelines on its website (http://www.certifiedorganic.bc.ca/standards/bnpl.php) for determining whether organic growers or processors can use a particular product:

First, the generic material - e.g., calcium chloride or a microbial product - must appear on the *COABC Materials List* as an allowed or regulated material. There may well be important restrictions on the use and the source of the material. Secondly, the particular brand which contains the allowed generic materials must be on the *COABC Brand Name List*. Practically speaking, this means that the 'non-active' ingredients or formulants contained in the product must all be allowed or regulated materials. For example, though *Bacillus thuringiensis* is a microbial product and microbial products are listed on the *COABC Materials List*, just one manufactured Bt product - Dipel - contains only materials that are acceptable to organic growers. Thirdly, if a manufacturing process is involved, is must also be acceptable for organics. For example, calcium chloride products that use sulphuric acid in the manufacturing process are not allowed, but those that use steam distillation are.

OMRI is useful to the Canadian organic sector in that it offers guidance to certifying agencies such as COABC for determining whether pest management products meet the criteria described in the second and third points in the process described above - and thereby whether they can be used by organic producers.

However, simply because a product is on the OMRI list and accepted by a Canadian certifier - in other words, that the brand name and manufacturing process have been deemed acceptable for organic growers - does not mean that it can be used in organic production or processing. The product must also be registered by the Pest Management Regulatory Agency (PMRA) as a legal pest control product (pesticide) in Canada. Products registered by the PMRA may only be used for the specific pest-crop combinations listed on the label. This means that, though Dipel may be on the *COABC Brand Name List* and registered by the PMRA, growers may apply the product to a wide variety of tree fruit and vegetable crops, but not to non-labelled crops such as grapes.

It should be noted that the situation is similar in the U.S., where organic growers can use a pest management product only if the materials and the product are allowable under the National Organic Program, and the product is registered by the U.S. Environmental Protection Agency (EPA). ■

Biocontrol Files: Canada's Bulletin on Ecological Pest Management is a quarterly publication which reports on tools and developments in ecological pest management. The co-publishers World Wildlife Fund Canada, the Biocontrol Network and Agriculture and Agri-Food Canada welcome additional partners and sponsors committed to advancing knowledge and adoption of ecological pest management.

Submissions and letters to the editor are welcomed. Guidelines for submission are available on request from biocontrol-network@umontreal.ca.

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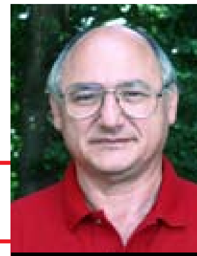
Interview with George Lazarovits



George Lazarovits

Using organic amendments to suppress pathogens: An interview with George Lazarovits, Agriculture and Agri-Food Canada

Biocontrol Files: How did your experimentation with using organic amendments to suppress disease begin?

George Lazarovits: Back in the late 80s, it was decided that Agriculture and Agri-food Canada's London research institute would focus on alternatives to chemical pesticides for use as crop protectants. I sent away for samples of microorganisms that had been already identified as biological control agents by colleagues at various locations. We went out to a potato field and started applying these things to the soil, but quickly found out that the number one problem was how to add a large enough quantity of biological agents to have a measurable impact. We thought there must be some kind of organic material which was available in large quantities, that was cheap and clean, and could be used as a delivery platform. One of my grad students, Mary Ann Hawke, went to a gardening store and came back with boxes of various materials, including meat and bone meal, kelp meal, blood meal, etc. We mixed these materials with or without the biological agents into soil that had been collected from a potato field with high levels of soilborne plant pathogens. We observed 100% disease control in all treatments that had the carrier. The presence of the biological agent was not a requirement – the carrier worked by itself. About one gram per 100 grams of soil was enough to control almost all the disease-causing agents we were looking at. Then one day we took the same 1% and it didn't control disease one bit – nothing. We redid the test with identical results - no control. It turned out that the potato soils we had collected were all gone. By switching to soil collected from another location, we lost all activity.

The report that you often see in the literature is that organic soil amendments are inconsistent ... but it's not true. What changes is the soil you add them to. A number of students, particularly Mario Tenuta, discovered why. Materials like soy meal, meat and bone meal, and poultry manure have a high nitrogen content – about 12% by weight. When they're broken down in soil, they release ammonium, which causes the pH to shift upward. As the pH approaches 9, ammonium becomes converted to ammonia, and the ammonia is the toxic ingredient.

BF: Just to clarify here – ammonia is toxic to the disease pathogens you were concerned with. What about other soil microorganisms?

GL: Well, it seems that most organisms that are biologically active - the organisms that are degrading the meat and bone meal – can detoxify these molecules. But the organisms which are not metabolically active are killed. Now the other product that is extremely active in this whole process is nitrous acid. Ammonia in soils is converted to nitrite and then nitrate. Ammonia has four hydrogen molecules. When you strip away those four hydrogen molecules, the pH of the soil shifts from alkaline to very acid. And when this pH drop occurs, nitrite becomes nitrous acid. Nitrous acid is a common meat preservative and is 500 times more biologically active than ammonia. But it's only active in low pH soils. The other important aspect of this process is that, when you add these organic materials to soil, you are feeding energy to the microorganisms. Hence, bacterial and fungal numbers can increase by 100- to 1000-fold. So you're not sterilizing the soil, you're enriching its microorganism populations.

BF: I know you have also done some work with swine and other animal manures…

GL: Now that is a completely different mode of action. My research associate Ken Conn did much of this work. We took the manure and added it to two different soils. In one soil we had incredible disease control, and in the other no control at all. Manure is very much like fermented grape juice – it's just a different fermentation, a different source of carbohydrate. When a lagoon full of nutrients becomes anaerobic it forms volatile fatty acids. Much of the volatile fatty acid content may have been already formed in animal intestines. Most swine manures that we tested had a vinegar content of about 1-4 %. There's actually about $1000 worth of vinegar in 5000 gallons of manure, and vinegar is a registered organic herbicide.

BF: So the manure is actually killing weed seeds as well?

GL: Absolutely. When you put acetic acid in an acid soil, it remains acid. But if you put the acid in a basic soil, it turns into a salt. When you put the manure in a basic soil, it's neutralized; it's no longer active. When you put it in an acidic soil, you have biological activity. The 50% equilibrium for vinegar between the salt and the acid is about 4.8.

BF: So the manures would be effective in soils with a pH less than 4.8?

GL: If you put vinegar in a soil with a pH of 4.8, half of the molecules will be active and the other half are not. If you add it at 4.2, then 80% of the molecules are active and 20% are not. At a pH of 5.5, only 10% of the molecules are active. So there's a very narrow window

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of activity. That's one of the big problems with all these organic amendments as far as their chemical mode of action is concerned. The windows tend to be very narrow and they're away from neutral pH.

BF: What about someone whose soil is more of a neutral pH?

GL: This would not be for them. It's too expensive to lower the pH of soils – it's very difficult to do.

BF: Are these materials usable in organic production?

GL: In Canada, manure and other organic amendments are allowed only if they originate from an organic farm. We have a composter for liquid manure here and we can raise the temperature of manure to 65 degrees in one to two days, and we have kept the composter at between at 60 - 65 degrees for almost two months. After 24 hours in the composter, we are sure that all potential animal, human, and plant pathogens are killed. Only the thermophylic organisms remain. Organic rules however, require several months of composting.

BF: Are there commercial products that make use of the ability of these materials to suppress pathogens?

GL: Yes, indeed. There are several. We have been involved in developing a commercial fertilizer on the market that is sold under the trade name Renew. It's a poultry feather and meat and bone meal-based material and it is registered organic. There are numerous organic products listed on the OMRI website in the U.S. that are all organic, such as fish emulsion. Now, none of them can make the claim that they suppress disease, because then you would have to register them as a pesticide.

BF: Would you say that there are knowledgeable organic or conventional producers who are using them as fungicides?

GL: Without a doubt. There are growers spraying fish emulsion on various crops, including strawberries, apple and citrus trees. They claim that they're seeing control of insects, foliar fungal pathogens, and even the devastating disease known as citrus canker. We know that fish emulsion has some very potent fatty acids in it. But they're applying it as a foliar fertilizer.

BF: What pathogens have you had success controlling with these materials in Canada?

GL: One my other research partners, Pervaiz Abbasi, has shown that fish emulsion can control diseases caused by Pythium, Rhizoctonia and Verticillium, and can even control nematode pests. Again, high nitrogen materials and those containing volatile fatty acids are invariably soil-specific, so some soils you get really great control and others none at all. With the high nitrogen materials, one can predict efficacy by taking a few soil samples, doing a few simple tests – you just need to know the organic matter content and the buffering capacity. This allows you to predict where this will work and where it won't. And of course we can also test the manures to see if they have the right active ingredients or not.

BF: You mentioned that one of the barriers to using these kinds of amendments in organic production is that organics require all materials to be organically produced. Is that the essential barrier to having something that organic producers are going to use, or are there other potential problems?

GL: As far as I can see, there really should not be any barriers. In most places, for instance in the recycling of meat and bone meal, the process is extremely rigidly controlled – high temperature, high heat, they have to grind the product into 100 micron sizes, etc etc. Organic growers have decided that only organic feathers make organic feather meal. But it's all broken back down to its elements anyway. When you put feathers back into the soil, they don't stay feathers, they turn into a fungal and bacteria biomass within one to two days. So I don't know what the concern is for the organic producer - why the feathers have to be from an organic chicken producer. In the U.S., this is not the case.

There's a huge amount of recyclable, clean, organic material that is currently waste but that I would consider an underutilized energy source. For example, we've been doing some work with recycled materials from the alcohol industry, where they grind up a lot of corn and turn the sugars into alcohol, but have a lot of non-consumed nutrients left in the soup after the alcohol is distilled off. But it will require some kind of fundamental mind shift in the organic community as to why a product coming out of an alcohol plant that's an edible, soluble product that is totally clean cannot be used as an organic fertilizer. Because the corn is not organically grown? Once it's converted to its end product, does it really matter?

I want to emphasize that in addition to the chemical changes we discovered, there are also numerous biological changes that occur in these soils also. Some of these are likely as important as the chemical activities we observe in changing the ecology of the root zone to allow for a healthier root system, if not more so. However, we do not yet have the tools to study what is occurring to the microorganism communities. We hope that the next phase of the work will focus on this aspect. ■

Interview with Greg Boland

Greg Boland

Hypovirulence as a biocontrol strategy with Sclerotinia species: An interview with Greg Boland, University of Guelph

Biocontrol Files: Can you briefly describe the phenomenon of hypovirulence in disease pathogens?

Greg Boland: Although there are other causes of hypovirulence, it most often occurs when a fungal plant pathogen is infected with a virus. Because the pathogen is then diseased, it has a reduced ability to infect plants.

BF: How can hypovirulence be useful in biological control?

GB: Well, the case study that everyone points to is chestnut blight in Europe. In this case, hypovirulent isolates emerged naturally from the pathogen population. These naturally occurring isolates spread so successfully through central Europe that they reduced the virulence of the entire pathogen population, and allowed for the successful regeneration of European chestnut through a large area.

BF: And this was without human intervention?

GB: Eventually there was some human intervention. When people started finding these isolates, they began to spread them around to speed up the process. Now hypovirulence works more effectively with some pathogens than others. The ability of two different isolates of a fungus to fuse their hyphal threads - a process called anastomosis - is controlled genetically. Anastomosis is critical to the spread of the viral infection because fungal viruses are incapable of external infection and only spread through internal cell-to-cell transmission. With *Sclerotinia sclerotiorum*, there are numerous incompatibility barriers in the populations. So, although we have found hypovirulence in this species, it doesn't spread very well. *S. minor*, on the other hand, has a relatively small number of these incompatibility groups. We have found hypovirulence in *S. minor*, and we've shown that it can give us quite good disease suppression. But *S. minor* is really only a problem on lettuce in Canada, which is a relatively small crop, so we haven't concentrated on it as much. One of the reasons we moved on to *S. homoeocarpa* is that this pathogen causes dollar spot disease, which is a big problem in turfgrass. *And* there are very few incompatibility barriers in this fungus. The hypovirulent isolates are naturally present, they're spreading, and we've shown that they can control the turf disease caused by the pathogen.

BF: So what's the state of the art on hypovirulence research?

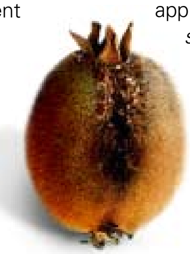
GB: The state of the science on hypovirulence is quite advanced. Researchers have been trying to identify specific sequences on the fungal virus, find out what genes are being encoded, and what portions of those genes are having the desired effect. However, the state of biocontrol practice using hypovirulence is relatively undeveloped. Currently, there are no registered commercial products in the world. The most prevalent use has been as a naturally-occurring biocontrol on chestnut blight. In the long run two strategies may result from this work. One is the more traditional approach to biocontrol in which hypovirulent isolates of a pathogen are grown and released or applied as a regular treatment to manage disease. The other strategy involves identification of a DNA- or RNA-mediated disease control technology, for instance via a viral gene that is largely or completely responsible for controlling hypovirulence in the fungal pathogen. Improved understanding of how these viruses effect the fungus may identify genetic or biochemical targets within the pathogen that are keys to controlling their virulence.

BF: So what do you think biological control using hypovirulence might look like in the future?

GB: In the early stages of studying hypovirulence, we developed a granular formulation that could be applied at fairly low rates over diseased areas. A barley or wheat-based formulation is colonized by the hypovirulent isolate, and when it receives moisture from evening dew or rain, it begins to germinate. When it encounters the normal pathogen or even diseased plant tissue, the cells of the hypovirulent treatment fuse with the cells of the virulent pathogen and the virulent isolate becomes infected by the virus. This reduces the ability of the virulent pathogen to grow and cause disease.

BF: On a field level, how long would it take to change the virulence of the population?

GB: This can happen quite quickly. The best time to apply most biocontrols for *S. minor* and *S. sclerotiorum* is when the pathogen is actively growing on host tissues. After crop harvest, you apply the biocontrol agent to the diseased tissues remaining on the surface of the soil, and then incorporate the treated diseased tissues into the soil. Typically, perhaps 75% of the virulent isolates



Scarring from *Sclerotinia sclerotiorum*

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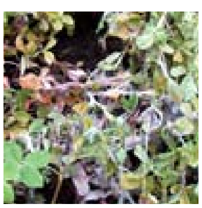
Interview with Greg Boland (continued)

would be removed from the system in the first year of such a treatment, with subsequent applications increasing this effect.

In a forestry setting, I think an inoculative biocontrol strategy would be most effective, where hypovirulent isolates are identified and released, with natural spread and transmission continuing the spread of the agent. Forest management practitioners may also promote this process. However, these fungal viruses, like other microorganisms used in pest control products, would require approval by regulatory agencies for use in these applications. To use hypovirulent isolates in an inundative biocontrol strategy in an agricultural or turf setting, we would need a company interested in developing and registering a commercial biofungicide. There appears to be sufficient economic motivation for the development of such products. Diseases caused by *Sclerotinia* species are an international economic concern, and several products have already been developed for biocontrol of these pathogens in Europe and the United States. However, if such environmentally friendly products are to become more available in Canada, the investment environment may have to be supported through the use of public infrastructure, such as changes to taxation policies or the use of public funds, to support their development and registration within Canada. ■

Research on biocontrol of sclerotinia disease

Sclerotinia head rot in sunflower



Sclerotinia symptoms in alfalfa

Though it appears that *Coniothyrium minitans* is the only widely-used commercial biological control agent against sclerotinia diseases in vegetables, oilseed and grain crops, there has been a significant amount of recent research on biocontrol of sclerotinia, much of it conducted outside North America.

- In India, researchers found that *Trichoderma harzianum* significantly reduced sclerotinia stalk rot symptoms in cauliflower and tomato, presumably from induction of plant defence mechanisms. Other promising results were found with *T. harzianum* on sunflower head rot. Further research in India found a significant reduction of sclerotinia-caused white rot in French bean after application of *T. harzianum* in combination with farmyard manure.
- Research in Argentina showed that *Fusarium oxysporum* (S6) may be a good fungal biocontrol agent for *S. sclerotiorum*, and that cyclosporine A is the metabolite involved in its antagonistic activity in vitro. Other research found that a mixture of six *Trichoderma* spp delivered by honeybees resulted in a significant reduction of sunflower head rot.
- In Iran, isolates of fluorescent pseudomonads obtained from the rhizosphere of sunflower plants were found to be effective in inhibiting sclerotial growth and increasing sunflower yield.
- In China, researchers found that two kinds of plant growth-promoting rhizobacteria increased rapeseed yield and decreased incidence of stem rot in rapeseed. Also, a *Bacillus subtilis* isolate obtained from the rapeseed rhizosphere reduced incidence of rapeseed stem rot by 92% in greenhouse and field plot seedlings. The possibility of commercial-level scale up is currently being considered.
- In the U.S., a study found that amendments of broccoli residue reduced populations of *Sclerotinia minor* on lettuce, and concluded that this practice was both economically feasible and environmentally safe for both large- and small-scale as well as conventional and organic production.
- In Canada, researchers found that six antifungal organic volatile compounds produced by bacteria isolated from canola and soybean plants inhibited sclerotia and ascospore germination, as well as mycelial growth of *Sclerotinia sclerotiorum* in vitro and in soil tests. Other researchers found that *Pseudomonas chlororaphis* (PA23) and *Bacillus amyloliquefaciens* (BS6) induced resistance via the production of defence-related gene products and protected canola from stem rot fungus under field conditions. Another study indicated that two *Pseudomonas* spp. - PA-23 and DF-41 - were effective against *S. sclerotiorum* in canola. A final study suggests that the antagonist *Ulocladium atrum* is an effective biocontrol agent of *S. sclerotiorum*, with efficacy similar to that of *Coniothyrium minitans*. ■

Biocontrol News Digest

SEPTEMBER 19, 2006, ARS NEWS SERVICE, WASHINGTON, DC: Friendly fungus could help sugarbeet fields go 'green' – How sweet it is! Scientists with the Agricultural Research Service in Sidney, Montana, may have found a natural alternative to the copious pesticides that sugar beet growers must spray on fields to fend off their biggest enemy: the sugar beet root maggot.

Stefan Jaronski, an insect pathologist at the ARS Northern Plains Agricultural Research Laboratory, has discovered that a strain of the biocontrol fungus *Metarhizium anisopliae* is not only effective at killing the maggot, but is also a vigorous colonizer that can adapt quickly to its new environment.

The maggot is certainly worthy of a unique control strategy. This subterranean pest gnaws on young sugar beet roots, inflicting deep wounds that leave the plants vulnerable to disease. Right now, unfortunately, the only tools available to growers battling it are chemical sprays, such as terbufos, phorate and chlorpyrifos. Without them, farmers in some beet-growing regions - like the Red River Valley of North Dakota - would lose up to 40 percent of their beet crop.

Jaronski, who's been studying biocontrol microbes for more than 25 years, puts a lot of stock in *Metarhizium*. He considers them the fatal 'athlete's foot' of insects, since the fungus first penetrates a vulnerable insect's cuticle, or 'skin,' using just a few spores. After that, it grows steadily inside the insect until finally overwhelming the host's entire body. Jaronski's next step is to develop an optimal delivery system for the fungus.

SEPTEMBER 25, 2006, HEBREW UNIVERSITY OF JERUSALEM: Mosquitoes' sweet tooth could be answer to eliminating malaria – Mosquitoes' thirst for sugar could prove to be the answer to eliminating malaria and other mosquito-transmitted diseases, says Hebrew University researcher Prof. Yosef Schlein in a study published in American Science magazine and the International Journal for Parasitology.

While it is generally well known that female mosquitoes need a meal of blood before laying their eggs, less has been written about their appetite for sweet snacks between meals. It is this diet of 'sweets' - derived from flower nectars and nectaries on plant leaves and stems - that provide mosquitoes with their persistent energy.

Schlein decided to exploit the mosquitoes' thirst for sweets by spraying acacia trees in an oasis in the southern desert region of Israel with a sugar solution that had been spiked with the oral insecticide Spinosad. Schlein assumed that, in the absence of other sugar sources, nectar-searching mosquitoes would be attracted to these plants.

The sucrose solution eliminated almost the entire mosquito population. The few mosquitoes that were trapped after spraying were thought to be newly emerging adults, and cumulative population growth was prevented by the continuous effect of the insecticide. Thus, the oasis was completely depleted of its mosquito population.

Spraying such an oral insecticide on planted mosquito-attracting trees or bushes in suitable habitats - such as the desert and savannah regions of sub-Saharan Africa - could provide a relatively easy and cheap way to supplement the limited arsenal against mosquitoes, and the fight against malaria.

JANUARY 8, 2007, OWEN SOUND SUN TIMES: Wal-Mart to shake up organic world – When the world's largest retailer starts selling organic food, as Wal-Mart has said it soon will do, it won't give much of a boost to Ontario's organic growers. "They'll go and get what they want wherever it's cheapest," according to Ontario organic grain grower, processor and certified seed grower Herro Wehrmann.

Wehrmann said Wal-Mart will have a tough time getting organic milk in Ontario since there is not enough in the province as it is and it can't be imported. But Wehrmann sees the federal Conservative Party's attempt to dismantle the Canadian Wheat Board as an "ominous sign" and predicted the Dairy Farmers of Ontario may keep fluid milk from being imported, but will have a hard time keeping out processed dairy products such as yogurt and cottage cheese.

Wehrmann said Wal-Mart will be able to get all the organic meat it needs from the United States and South America. Ontario producers won't be able to compete price-wise or meet the demand. And Wal-Mart will get its organic vegetables from American and South American growers. Wehrmann advised local organic growers to expand into local farm markets and community shared agriculture ventures like good food boxes.

The biggest impact may be on organic grain growers. Although the demand for grain from processors making items such as organic cookies and bread may be high, local shortfalls won't mean higher prices, as Wal-Mart will just go elsewhere if Ontario growers can't meet production. "There is organic grain available in Europe, the U.S. and South America, so don't hold your breath for better prices."

One positive development for Canadian organic producers is the national organic standards brought in last December. This may affect imports of organic products, as other countries may not meet Canadian standards. However, "Brazil may just beef up their standards to meet ours," said Wehrmann. ■

Resources:

Books

Trophic and Guild Interactions in Biological Control, edited by Jacques Brodeur and Guy Boivin. This volume explores modern concepts of trophic and guild interactions among natural enemies in natural and agricultural ecosystems - a field that has become a hot topic in ecology and biological control over the past decade. Internationally recognized scientists have combined their expertise and passion to examine how species interactions between biological control agents, such as competition, predation, parasitism, disease infection, mutualism, and omnivory affect arthropod population dynamics and the outcome of biological control. The common approach is the use of ecological theory to better interpret the prevalence, nature and outcome of trophic and guild interactions and, from a more applied perspective, to gain a comprehensive understanding of how and when to use biological control. Springer, 233 Spring Street, New York, NY 10013. Phone: 212-460-1500 or 800-SPRINGER. Fax: 212-460-1575 Email: service-ny@springer.com

Ed. Note: The above book was sponsored by the Biocontrol Network, and both editors are Network members.

The International Organization of Biological Control (IOBC) has published Version 3 of the *IOBC Internet Book of Biological Control* on-line at http://www.unipa.it/iobc/downlaod/InternetBook3March2006.pdf The publication, edited by J.C. van Lenteren, aims "to present the history, the current state of affairs and the future of biological control in order to show that this control method is sound, safe and sustainable." This resource includes 14 chapters and an appendix, as well as useful background information on an interest that was first formalized in 1948 and has now become IOBC-Global. A lengthy list of relevant papers and publications on the topic provides a valuable reference. van Lenteren, Lab. of Entomology, Wageningen Univ., PO Box 8031, 6700 EH, Wageningen, The Netherlands. E-mail: Joop.vanLenteren@wur.nl.

Report

Arguing that Ontario is missing out on a major market opportunity, World Wildlife Fund (WWF) Canada is urging the province to jump into organic with both feet, and has come up with a plan designed to ramp up both organic production and processing infrastructure.

WWF's report, entitled *Ontario Goes Organic: How to Access Canada's Growing Billion Dollar Market for Organic Food*, is available at http://www.organicagcentre.ca/Docs/OntarioOrgStrategy/OSS_full%20report_june26-06.pdf This report argues that there is a strong economic case for getting behind organics. Detailed calculations suggest that agriculture in Ontario currently costs the public a minimum of $145 million in environmental damage and human health impacts annually. The report maintains that increased adoption of organic agriculture can eliminate many of these costs, including reducing greenhouse gas emissions, improving water quality and helping enhance biodiversity. *Ontario Goes Organic* provides a 2-phase, 32-point plan to help Ontario farmers supply more than half of the organic food consumed in Ontario within 15 years. Borrowing elements that have been successful elsewhere and are adaptable to conditions in Ontario, the plan envisions coordinating the expansion of supply and demand to build infrastructure, and is designed to ensure that organic price premiums fall modestly so that farm income is maintained while consumer access increases.