Biocontrol Files

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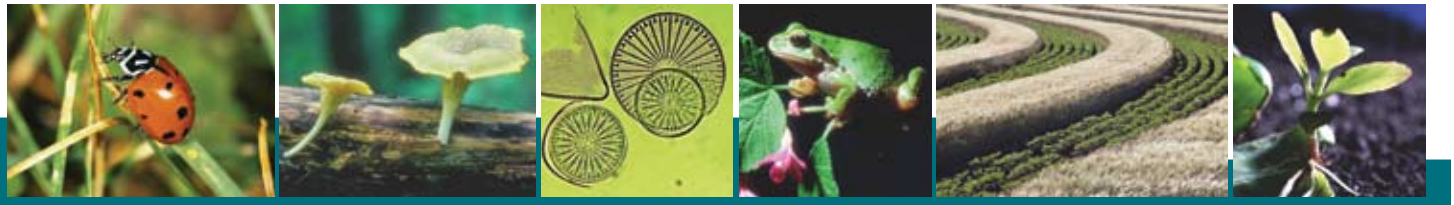
Canada's Bulletin on Ecological Pest Management

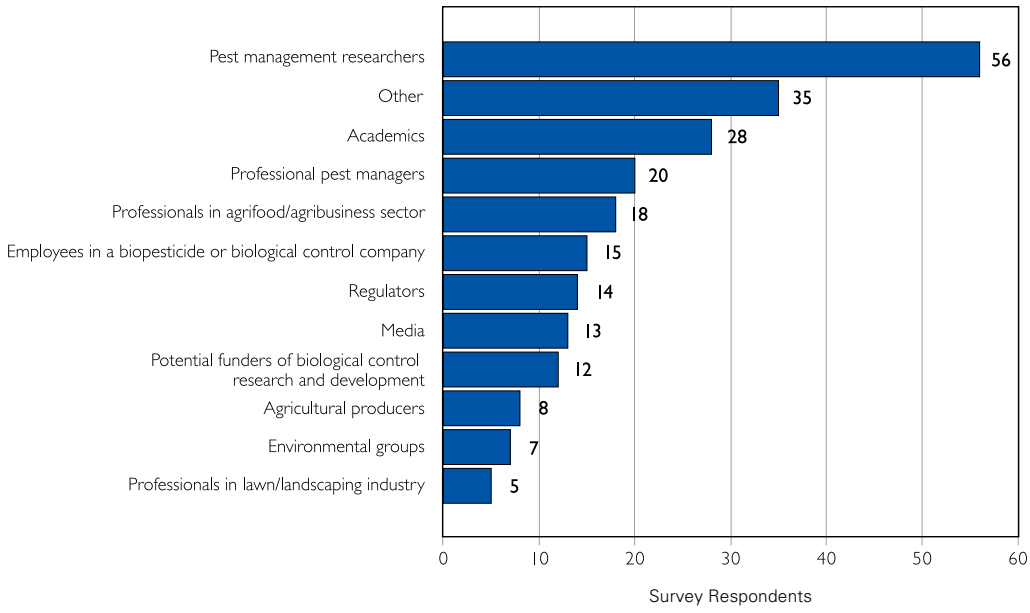


Barriers to wider adoption of biocontrol and strategies to address them – final results of a Biocontrol Files reader survey

Between January 25th and February 17th, 2006, an on-line survey of Biocontrol Files readers was conducted by Ethos Strategy Group. The survey focused on readers' opinions of the relative importance of a set of 11 potential "barriers to greater use of biopesticides and biological control strategies" and on "what strategies should be employed in the next year to promote wider adoption of biological pest management".

The 176 respondents were also asked to identify their affiliation. As illustrated in Figure 1, the majority of respondents fell into four camps: pest management researchers, academics, professional pest managers and professionals in the agrifood or agribusiness sector. These four groups accounted for 53% of all affiliation responses (on average, 1.3 affiliation responses were given per respondent).

Figure 1: Respondent Identification



With regard to barriers, as illustrated in Figure 2 (page 2), the six greatest barriers were judged to be, in order of importance:

- real or perceived lack of efficacy
- lack of education or experience (in using biological pest management strategies)
- quality concerns (inconsistency of results)
- lack of awareness (about biological pest management strategies)
- real or perceived higher cost
- lack of availability.

The average "scores" for these six factors were clustered fairly closely, with concerns about efficacy rated significantly higher than other barriers.

(continued on page 2)

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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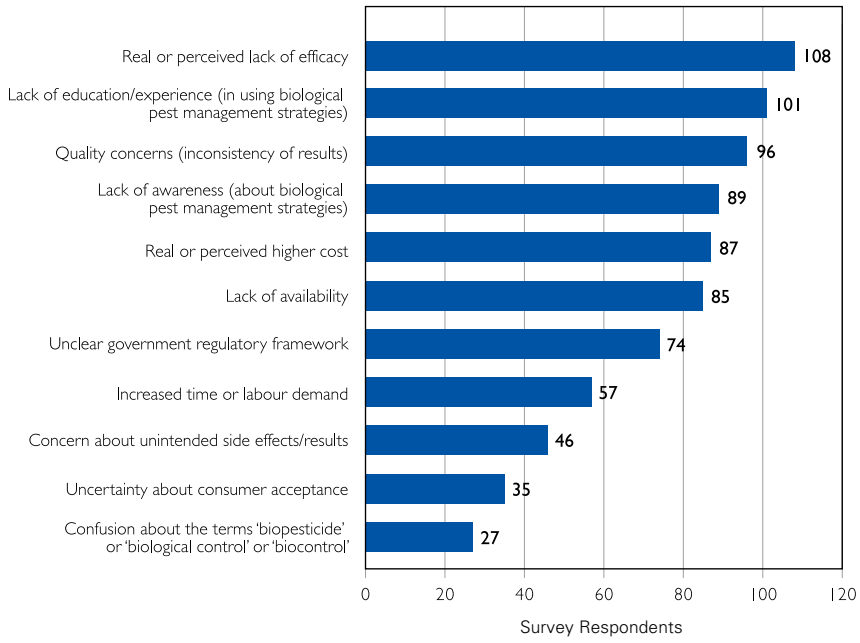
Barriers and Strategies (page 1 continued)

Figure 2: Barriers



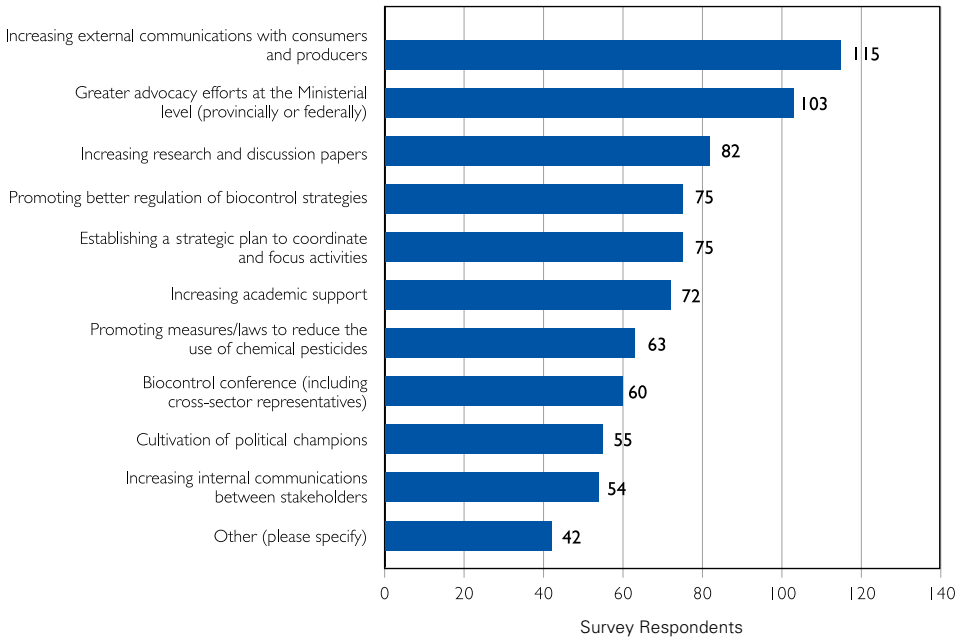
There were significant differences between the affiliation groups in their rating of the relative importance of barriers (see Table 1). With regard to a given barrier, groups to the left side of average considered the barrier less important than did the average respondent, while groups on the right considered it more important than did the average respondent.

Table 1

Barrier	Group affiliation
Cost	Employees in biopesticide/biocontrol companies –> Average –> Pest management researchers –> Regulators
Efficacy	Agricultural producers –> Pest management researchers –> Average –> Employees in biopesticide/biocontrol companies
Availability	Regulators –> Average –> Agrifood/agribusiness professionals –> Employees in biopesticide/biocontrol companies
Regulatory system	Regulators –> Agrifood/agribusiness professionals –> Average –> Employees in biopesticide/biocontrol companies

Respondents were also asked to choose which of a list of 10 strategies "should be employed in the next year to promote wider adoption of biological pest management". The results are shown in Figure 3 (see page 3).

Figure 3: Strategies



There were also significant differences between affiliation groups in terms of their response to this question (see Table 2). Groups on the left side of average were less favourable than was the average respondent towards a particular strategy, while groups on the right side of average were more favourable than average towards the strategy.

Table 2

Strategy	Group affiliation
Convene conference	Regulators –> Average –> Academics *and* Professional pest managers
Strategic plan	Regulators –> Average –> Professional pest managers *and* agrifood/agribusiness professionals
Communication with external stakeholders	Employees of biopesticide/biocontrol companies –> Average –> Media –> Academics
Communication with internal stakeholders	Media –> Academics –> Average –> Professional pest managers
Better regulatory system	Agrifood/agribusiness professionals –> Average –> Academics
More research/ discussion papers	Media –> Employees in biopesticide/biocontrol companies –> Average –> Pest management researchers –> Agrifood/agribusiness professionals

Future issues of Biocontrol Files will investigate these issues in more depth and attempt to introduce opinions from across the "affiliation spectrum", beginning in our next issue (July 2006) which will address the question of efficacy. ■

European retailers driving adoption of biocontrol?

Retailers such as Marks & Spencer publish the results of their in-house pesticide residue monitoring programs.

In the UK, where debates about pesticide residues in foods are considered more newsworthy than in North America, several retail chains have chosen to publicize lists of pest control products that their suppliers are not permitted to use. Retailers such as Marks and Spencer, the Co-op, and Sainsbury's also publish the results of their in-house pesticide residue monitoring programs. The companies have stated policies supporting alternative pest management strategies. But, although such policies may well had beneficial impacts, it's difficult to say whether they have led to greater uptake of biological pest management practices.

According to Stephanie Williamson of Pesticide Action Network-UK, there are examples of European companies and grower associations making use of pheromones, beneficials, and biopesticides where available and relatively affordable, but uptake is very dependent on cropping system. Like North America, adoption is considerable in greenhouses, but low in field crops. Noteworthy is the fact that there are far fewer biopesticides registered in Europe compared to the U.S., or even Canada. According to Williamson, current price squeezes driven by fierce retail competition are real barriers to adoption of more sustainable farming systems. Few farmers can invest the time and cash required to change their farming practice without economic incentives such as higher premiums or considerable, long-term technical and marketing support.

The Co-op, a large UK retailer as well as the largest farm manager in Britain, operates a farming division called *Farmcare* with its tenant farmers in Britain and its worldwide suppliers. Growers are provided with commodity-specific advisory sheets which list available practices. Such sheets are available for a half dozen crops grown in Britain, and another half dozen grown in tropical climates. Co-op's approach to pest management is: prevention first, backed up by cultural and biological control measures, with the most benign available chemical pesticides as the final backstop.

The Dutch supermarket chain *Laurus* recently embarked on a collaborative project with University of Wageningen researchers to implement integrated pest management/integrated crop management (IPM/ICM) protocols developed at the university.

The Real IPM Company operates a training programme which enables African export growers to mass rear their own natural enemies.

Working with Dutch NGO Natuur & Milieu, Laurus will be piloting these protocols in 10 crops over the 2006 growing season. The company is under considerable pressure to improve its economic performance and it is in this context that it has taken the decision to embark on a health and environmental quality approach to attract customers.

Sainsbury's, a large UK retailer, has developed Integrated Crop Management programmes that use disease-resistant varieties and natural controls such as ladybugs to kill pests. In 1999, Sainsbury was instrumental in the European Retailer Produce Working Group's (EUREP) launch of the EUREPGap (Good Agricultural Practices) standard which is adhered to by all Sainsbury's overseas growers of fresh and frozen produce. With the exception of the Co-op, all the main UK supermarkets are members of EUREPGap. Yet EUREPGap provides no apparent support or incentives to use biological pest management. In fact, according to Williamson, current versions of the EUREPGap standards are weaker than their predecessors in terms of their support for IPM and biological pest management.

One arena in which biocontrol has been increasing is developing country export horticulture to Europe, stimulated by stricter EU residue requirements. In Kenya, the *Real IPM Company* is helping Flamingo Holdings, one of the country's leading vegetable and fruit exporters, to employ beneficials in ornamental and horticulture production. The parasitic wasp, *Diglyphus isaea*, has been very successful in controlling leafminer larvae, a serious horticultural pest. Unbeknown to growers, *Diglyphus* was already present in the field, though chemical sprays were killing it. A system was set up to harvest the parasitoid from crop debris and to apply the parasitoids to young crops for management of leafminers. As the numbers harvested from crop debris began to diminish, systems were set up to mass rear *Diglyphus*. Within a year, no chemical sprays were needed. Even the introduction rates of *Diglyphus* diminished. However, many farms in Kenya are not aware of these achievements, and leafminers continue to be intercepted on Kenyan produce exported to the EU.

The Real IPM Company also operates a training programme to enable African export growers to mass rear their own natural enemies. In addition to *Phytoseiulus* and *Diglyphus*, mass rearing of *Encarsia* (for whiteflies), *Aphidius* (for aphids), *Trichogramma* (for caterpillars), *Orius* (for thrips) and other beneficial insects is now operational in Kenya. The EU-funded Pesticide Initiative Programme (PIP), set up to enable exporters in developing countries to comply with stricter European maximum residue levels, has been instrumental in supporting horticulture companies to obtain training and consultancy services in IPM. ■

Biological solutions work for organic grower

Nestled in B.C.'s dry southern interior in the Similkameen Valley, Wayne Still's orchard produces four and a half acres of organic apples and a half acre of organic cherries. The semi-arid climate and mild but freezing winters mean that pest pressure is less than in other Canadian apple-growing regions.

The best news for growers is that the codling moth, historically the major regional pest of apples, has been virtually eradicated in the area. On Still's farm, other pests – notably leaf rollers and aphids – are kept in check by natural enemies. The one spray Still applies is dormant oil for San Jose scale, though he hopes to reduce his applications to every other year.

Wayne Still helped bring the Sterile Insect Release (SIR) program to the southern interior in the early 1980s. At that time, the research program which had proven the effectiveness of the technique had been completed, but no further action was being taken. Still helped bring stakeholders together to kick-start an area-wide program. He remains on the board of the program as a representative of organic producers.

In Still's view, the SIR program has been remarkably successful by any measure. "The fact that the codling moth has been, for all intents and purposes, eradicated from the Similkameen Valley and the lower part of the Okanagan Valley is nothing short of miraculous." However, he believes that the strength of the program lies not so much in the sterile male technique, but in the fact that the program is *area-wide*, with all growers participating in pest population reduction techniques.

Regional growers, and in particular organic growers, use a variety of methods to reduce the codling moth population. Two important ones are mating disruption, a high tech solution, and tree banding, decidedly low-tech.

Organic orchards in the region had traditionally managed codling moths by picking damaged fruit and drowning the larvae, a laborious process which still resulted in a lot of damage and loss. Then, one day in the late 1980s, a grower noticed codling moth larvae tucked into the corrugations of cardboard boxes left under a tree. He shared the news with other growers, one of whom decided to cut the boxes into four-inch strips and wrap them around the lower part of the tree trunk to trap the larvae. The practice spread. Damage plummeted from 40-50% – under the former regime – to about 5%. Banding is effective for two reasons: it's a post-emergent application, meaning that caterpillars are removed before they breed, and it's quite efficient, removing about 75% of the population.

In 1990, when Gary Judd from Agriculture and Agri-Food Canada's Summerland Research Centre began working with Still and other growers, pheromone-based mating disruption was added to their biological toolbox. Twist tie-like dispensers affixed to trees throughout the orchard emit a blanketing cloud of female sex pheromone, confusing the male moths and preventing them from finding mates.

When asked whether he considers the biological aspect of the pest control on his orchard successful, Still unhesitatingly answers in the affirmative. Yet Still has strong feelings about the SIR program: "The current problem is that it's underfunded. There's a lack of understanding of the potential of this program for the long-term survival of the apple growing business in the Okanagan." In Still's view, the area-wide program has created a huge laboratory with unique opportunities for research on biological pest management. "With UBC in Kelowna and AAFC's Pacific Agri-Food Research Centre in Summerland, we have the opportunity for a Centre of Excellence. This would provide secure funding, enhance the profile of the area and bring in graduate students, who could develop practices for habitat enhancement, population augmentation, and put in place firm practices that farmers who are currently not using biological controls could adopt." In Still's view, the potentials are great for research *and* practical applications. "But the key is to establish mature, ongoing funding." ■

Wayne Still in orchard

Versatile bacterium adds biological flair

BlightBan® C9-1, which contains the bacterium *Pantoea agglomerans* strain C9-1, not only produces an antibiotic that inhibits *Erwinia amylovora*, the pathogen which causes fire blight, but also outcompetes the pathogen for nutrients and colonization space. The product is presently in Joint Review with the U.S. Environmental Protection Agency (EPA) and Canada's Pest Management Regulatory Agency (PMRA). The manufacturer, Nufarm Agriculture Inc. (Canada) and Nufarm Americas, Inc. (U.S.), expects a registration decision sometime in the spring of 2006, but probably too late for use in the 2006 growing season.

Efficacy trials conducted in the U.S. have shown moderate to good levels of control. The product is effective in reducing incidence of blossom blight, especially when followed by streptomycin, and, in some trials, performs better than another bacterial antagonist, *Pseudomonas fluorescens* (BlightBan® A506). One advantage of this bioagent is that it grows at and beyond the upper temperature range for growth of the fire blight pathogen. However, like other bioagents found to date and unlike antibiotic products, *P. agglomerans* C9-1 is only effective if present in the flower *before* the arrival of the pathogen.

(continued on page 6)

Versatile bacterium (page 5 continued)

Continuing research is underlining the importance of timing for application of biocontrol agents such as *P. agglomerans*. There is a relatively short window in which conditions in apple and pear flowers are conducive to the growth of *E. amylovora*. If the pathogen cannot reach the stigmas during this period via rain splash, insect transmission or other means, growth (and hence damage) may be limited. However, biocontrol bacteria are also subject to this short window and need to be applied at the appropriate time in order to colonize young flowers.

Much of the work on biocontrol of fire blight – including research on *P. agglomerans* and other biocontrol agents such as *Bacillus subtilis* and *P. fluorescens* strain A 506 – has taken place in Europe where the use of antibiotics for agricultural uses is strictly controlled. Some countries have already banned the use of antibiotics for food crops, driven in some cases by the discovery of antibiotic residues in honey, and it is probable that agricultural use of antibiotics will disappear in Europe in the near future.

There may be methods to improve the effectiveness of BlightBan C9-1. Treatment of apple stigmas with trinexapac-ethyl, a growth regulator, greatly increases the population levels of *P. agglomerans* on apple stigmas. Research has also shown that honeybees and other pollinators can distribute biocontrol agents such as *P. agglomerans* to apple and pear flowers.

One of the limitations of bioagents may be that they don't survive long enough in the orchard environment to provide ongoing control. Studies in New Zealand found that *P. agglomerans* C9-1 and two other strains of the bacterium survived for several days but that the colonized leaf area decreased rapidly after 48 hours. ■

Fire-fighting bacteria: Part II

Fire blight infects terminal leaves on an unpruned and uncovered apple tree. ***(Photo by Keith Weller)***

Like *Pantoea agglomerans* (see page 5), the microbial pesticide BlightBan A506, which contains the bacterium *Pseudomonas fluorescens* strain A506, must reach the stigma surface ahead of the fire blight pathogen in order to provide good protection. Following application, the bacterium spreads throughout the tree and outcompetes the pathogen for colonization of the blossom surface. But, since flowers of many apple and pear varieties may emerge over a period of several weeks, the bacterium must be applied three or more times. Like other microbial antagonists of the fire blight pathogen, it has been recommended that BlightBan A506 be used in combination with an antibiotic such as streptomycin.

In the U.S., products containing *P. fluorescens* have been registered since 1992, and the current registrant of BlightBan A506 is Nufarm Americas, Inc., the same company which manufactures BlightBan C9-1. The Organic Material Review Institute (OMRI) has also approved the product for organic agriculture in the U.S. A submission to register the product in Canada is currently in development.

The trick in providing good disease protection with agents such as *P. fluorescens* or *P. agglomerans* is to ensure a continuous high level of colonization of flowers. Though BlightBan A506 is certainly useful in its current formulation and following label directions, a number of studies have tested methods to boost flower coverage and thus effectiveness.

A study in California found that BlightBan A506 significantly reduced fire blight symptoms when sprayed at 20, 50 and 100% bloom, as well as at early and late petal fall. Effectiveness was more than tripled, however, when low concentrations of an organo-silicon surfactant (Break-Thru®) were applied in combination with the bacterium, presumably because the surfactant increased the amount of flower surface directly inoculated with the bacterium. Throughout main bloom and into delayed bloom, bacterium populations on most flowers of trees inoculated only at first bloom with BlightBan A506 and Break-Thru were as high or higher than that of trees receiving weekly applications of the same amount of A506 alone. The study concluded that a single application of strain A506 at very early bloom should reduce the costs of disease control and facilitate adoption by growers. However, some other studies have found less positive results with both BlightBan A506 and Break-Thru.

A study in New Zealand investigated the possibility that a biopolymer gel formulation might increase colonization levels. The researchers noted that the concentrations found effective in experimental trials were often much greater than those specified on label directions and that it would be prohibitively expensive for growers to approximate these experimental rates with commercial products. By employing a gel formulation, much higher concentrations of the active ingredient were possible and much higher levels of colonization of flower surfaces.

Building on earlier lab studies which indicated that *P. fluorescens* A506 decreases fire blight incidence on media amended with iron, a field study conducted in Oregon found that treating apple or pear trees with a chelated iron product increased the ability of BlightBan A506 to reduce fire blight incidence, though not quite to the level (53% as compared to 76%) recorded for a control product containing streptomycin. As with BlightBan C9-1, further research is attempting to close that performance gap. ■

Biocontrol News Digest

NOVEMBER 15, 2005 (SciDev.net) – Climate change could upset the balance between insect pests and the "natural enemies" that control their numbers. This might make pest outbreaks more frequent and severe, warns a study published in the Proceedings of the National Academy of Sciences.

The study looked at how climate affects parasitoids – insects such as wasps and flies that lay their eggs on or inside caterpillars, allowing the hatched larvae to feed on the host. The research team assessed the impact of parasitoids on more than 5,000 caterpillar species collected in forests from central Brazil to southern Canada. They found that caterpillars had significantly fewer parasitoids in years when rainfall was most variable.

This could be because the parasitoids use cues such as changes in local climate to determine the best time for laying their eggs. If so, unpredictable rains might disrupt the parasitoids' ability to "track" their caterpillar hosts.

However, as pointed out by Frank van Veen of Imperial College, United Kingdom, parasitoids are not the only things that can control caterpillar numbers. "Other things, such as predators, diseases and fungal pathogens might be affected differently by climate change," he said.

DECEMBER 6, 2005, SAN ANTONIO (TEXAS A&M AG NEWS) – Heads will roll as the result of an upcoming phorid fly release in Bexar County, Texas. Fortunately, those heads will be attached to the bodies of thousands of red imported fire ants.

Phorid flies parasitize fire ants by depositing eggs which hatch into larvae that pupate inside the fire ant's head capsule, said Molly Keck, entomologist for Extension in Bexar County. Adult flies use chemical cues to locate fire ants and "dive-bomb" them, laying a torpedo-shaped egg in the ant's thorax. The maggot hatching from the egg then migrates to the ant's head.

"As the fly pupates, it releases enzymes which cause the head to fall off," says Keck. "The maggot continues to pupate in the decapitated head capsule, finally emerging as an adult fly."

Keck notes that the phorid fly species to be released is *Pseudacteon tricuspis*. "It is host-specific to red imported fire ants and has never been known to attack another organism."

Phorid fly activity and fire ant density will be evaluated during spring and fall, and the impact of the program will be monitored for several years.

DECEMBER 7-13, 2005 CALIFORNIA (METROACTIVE NEWS) – Michael Honig, president of Honig Winery in Napa, California, is in love. The object of his affection is a team of golden retriever puppies that are learning to "sniff out" the dreaded vine mealybug.

Because female mealybugs can't fly, they protect themselves by hiding beneath the bark on vines. Consequently, grape growers sometimes don't even know mealybugs are present until the entire vineyard is infested. That's where the pups come in. Instead of *looking* for mealybugs, they home in on the scent of the females' pheromones.

As the golden retrievers leave their puppyhood behind them, they'll learn to stand at attention before an infested vine and bark an alert. "Then," says Honig, "we'll pull the vine out," thus eliminating the need to spray the entire vineyard.

JANUARY 11, 2006 BEIJING (SciDev.net) – Chinese scientists have developed a way to protect crops using wasps that deliver lethal viruses to insect pests. According to lead researcher Peng Huiyin, the approach is 25-40 per cent cheaper than chemical pesticides, is more environmentally friendly and can control more than 20 insect pests, mainly caterpillars.

While both viruses and parasitic wasps have been used to kill pests, the Chinese scientists are the first to combine the tactics, says co-researcher Zhang Lin. The researchers took parasitized insect eggs and soaked them in a solution containing a virus lethal to the pest, but harmless to the wasp. When the wasps' offspring hatched, the virus became attached to their bodies. The idea was to exploit the fact that females often crawl over hundreds of pest eggs before selecting one to lay their egg in. "This way the virus can be spread to hundreds of pest eggs," said Zhang.

After hatching, any pest larvae that have not been parasitized feed on the remains of their eggs and ingest the lethal virus. Zhang says that during 15 years of research, the team has identified more than 20 viruses that kill different pests but not the wasp. Field trials of the methods have been conducted on more than 13,000 hectares of farmland in China. "It is very likely to be commercialized within one or two years," said Zhang. ■

Resources:

Books

In *Insect Antifeedants*, said to be the first comprehensive volume on the topic, author and authority O. Koul has usefully prefaced the 2005 work with chapters on concepts and mechanisms, bioassays, and related topics. What is likely one of the most extensive monographs – listing detailed chemistry and bioefficacy of nearly 900 compounds known to deter insect feeding – comprises the bulk of a new and informative reference.
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Web: http://www.crcpress.com.

The journal *Biological Control* has devoted its December 2005 issue (vol. 35, issue 3) to the special topic, "Science and Decision Making in Biological Control of Weeds: Benefits and Risks of Biological Control." Issue editors R.I. Carruthers and C.M. D'Antonio have included 20 papers on a variety of pertinent topics ranging from biology through economics to legal implications, prepared by an international group of scientists and authorities.
R.I. Carruthers: RIC@pw.usda.gov

Conferences

The North American Forest Insect Work Conference: Metamorphosis – forces of change in forests.
May 22-26, 2006, Asheville, NC, USA.
http://kelab.tamu.edu/nafiwc06/

Plant Pathology at the Biological Crossroads – Joint Meeting of the American Phytopathological Society, Canadian Phytopathological Society, Mycological Society of America. July 29 – August 2, Quebec City, Quebec.
http://meeting.apsnet.org/

Progressive U.S. companies push biocontrol

"Mmm-mmm good," says the old Campbell's Soup commercial. And, since the late 1980s, *Campbell's Soup Company* has been putting its money into making what goes in your mouth safer, by operating an Integrated Pest Management (IPM) program for many of its vegetable growers in Mexico and the U.S. The goal is to minimize or eliminate pesticide residues in finished products and to protect workers and the environment.

Campbell's growers are using a variety of techniques: pheromone-based products to disrupt tomato pinworm reproduction, release of parasitic wasps to control the tomato fruitworm, and *Bacillus thuringiensis* (Bt) to control armyworms. According to Hasan Bolkan, Director of Vegetable R & D, most of the strategies were developed or adapted to meet the company's needs at Campbell's R & D Center in Mexico and are used primarily for processing tomatoes.

Over the first several years of the program in the early 1990, use of synthetic insecticides and fungicides by Mexican growers dropped dramatically. While volumes have risen in the past five years, says Bolkan, most probably due to higher insect pressure in nearby fields not growing for Campbell's, they remain more than 60% lower (insecticides) and 50% lower (fungicides) than pre-program levels.

Campbell's Mexican efforts have had an additional impact. In a given year, between 1,000-3,000 hectares are enrolled in the Mexican program. Most of the *Trichogramma* wasps raised by Campbell's to control fruitworms are sold to other growers in the area and a number of competing commercial insectaries have popped up in the region.

Gerber Products Company, the famous baby food maker, has a long-established policy that none of its products may contain measurable residues of pesticides. In pursuit of that aim, the company funds a variety of programs and research projects with its contract growers.

In the fruit-growing area near Grand Rapids, Michigan, Gerber is collaborating with researchers from Michigan State University and the Pacific Biocontrol Corporation on an area-wide management program for codling moth. According to Todd DeKryger, Gerber's Manager of Global Agricultural Research, the program relies on mating disruption, granulosis virus and the judicious use of reduced-risk insecticides or conventional insecticides. A long-term goal is to catalyze wider adoption in Michigan of programs which reduce organophosphate use.

The area-wide program has grown from an initial acreage of 800 in 2004 to approximately 2000 contiguous acres in 2005. Early results show very low pest densities in orchards which are using mating disruption for the second consecutive year, as well as 87% less fruit damage in orchards using mating disruption as compared to nearby conventionally managed orchards outside the program. Fruit injury is significantly lower in program orchards treated with the virus compared to program orchards using mating disruption but not the virus.

It is expected that 2006 will see expansion of the use of mating disruption tools and increased use of granulosis virus. It's also hoped that the program will help foster similar area-wide programs for control of obliquebanded leafroller and Oriental fruit moth. ■