ENHANCING BIOCONTROL AGENTS

Jim Ligon of Syngenta Biotechnology, Inc. at Research Triangle Park, NC, USA, reports on a recent NATO workshop

Biocontrol, the inhibition of a pest by another organism (the biocontrol agent), has attracted interest in recent years as a potential replacement or supplement of traditional chemical pesticides since it is generally regarded as safer for human health and the environment. In mid-June about 50 scientists from 18 countries came together at a NATO-Advanced Research Workshop to discuss important developments in this promising technology. Although there are a few successful biocontrol products on the market today, they suffer from the impression that they are less effective than chemical pesticides. A key point of discussion at the workshop was the use of genetic technologies to enhance the activity of biocontrol agents. Although the meeting venue was scenic and enticing (a secluded villa in the Tuscan hills near Florence), the workshop was intense and focused, with presentations on many different aspects of biocontrol.

Bioherbicides

A weakness of some biocontrol agents is that unlike most chemical pesticides, they are often active against a narrow range of pests. However, David Sands (Montana State University) described the development of a broad-spectrum bioherbicide based on *Sclerotinia* that infects and kills several key weed species. In order to limit its spread in the environment, they isolated a version of *Sclerotinia* requiring arginine for growth, which is added to the formulated spores to preclude the spread of the *Sclerotinia* in the environment after the death of the weed. Another version overproduces branch-chain amino acids, acting like ALS-inhibiting herbicides. The group of Alan Watson (McGill University) has focused on the fungus *Colletotrichum coccodes,* a pathogen of velvetleaf. Applied alone, *Colletotrichum* is only partially effective, but Watson and his group have discovered that co-inoculation of the fungus with a saprophytic *Pseudomonas* that grows on leaf surfaces enhances its activity. The bacterium consumes much of the available carbon on the leaf surface, forcing the fungus to shorten its saprophytic phase and invade the plant where it is better able to survive. Adding oxalate enhances the early *Colletotrichum* growth in the leaf.

Biofungicides

Several interesting findings on the development of biofungicides were presented. Gary Harmon from Cornell University described his work to enhance natural activity by fusing strains of the fungus *Trichoderma harzianum,* the active agent of RootShield. *T. harzianum* has broad activity against important plant pathogens, including *Rhizoctonia, Pythium,* and *Fusarium*, while enhancing plant root growth and nitrogen utilization by up to 25%. Don Nuss of the University of Maryland described the development of transgenic viral biocontrols that infect and reduce pathogenicity of *Cryphonectria parasitica*, the casual agent of chestnut blight.

Bioinsecticides

Several presentations focused on the key area of bioinsecticides. Tariq Butt (University of Wales, Swansea) described his work with entomophagus fungi. He described a 'Push-Pull' control strategy to attract the insect pests to a sacrificial 'trap' crop, to concentrate the pest in a smaller area for more efficient treatment with the biocontrol agent. The ability to transport bioinsecticidal nematodes was enhanced by Mike Wilson (University of Aberdeen) by engineering in proteins that allow the organism to withstand transient heat stress. Tom Grigliatti (University of British Columbia) described an interesting new TAC (transposon-armed cassette) approach for the control of insect pests. He is developing P-element transposons that easily spread through the population of a target insect pest and contain an inducible insect-lethal gene that can be activated by a harmless nontoxic chemical to kill the pest during times of severe crop predation. Ray St. Leger (University of Maryland) is using functional genomics to identify genes in the fungus *Metarhizium anisopliae* that are involved in its insecticidal activity. He is developing an EST database to discover genes that could be enhanced in the fungus to improve its activity.

Enhancement with genetic technology

The group of Jonathan Gressel (Weizmann Institute of Science) has been working with a *Fusarium* that is pathogenic on the parasitic weed broomrape. A transgenic *Fusarium* that overproduces the plant hormone indole acetic acid was more effective than the wild type. The author of this article described efforts to genetically engineer a *Pseudomonas* biofungicide to produce more active, broad-spectrum antifungal metabolites to enhance its activity.

There are concerns about the spread of transgenes or transgenic organisms in nature and their potential adverse affects on human health and the environment. Accordingly, many presentations included potential strategies to limit the spread of the transgene or transgenic organism in the environment.

There are many challenges facing the development of genetically modified, enhanced biocontrol agents. Technical

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hurdles aside, there are many problems related to regulatory approval and public acceptance. Julian Kinderlerer of the Institute of Biotechnological Law and Ethics in Sheffield, England gave a concise overview of the political, legal, and societal hurdles to the registration and marketing of genetically modified organisms. He pointed out that the Cartagena Protocol requires the assessment of environmental and health risks of GMOs but not their benefits and does not allow comparisons of new GMO-based technologies with the current practices that they are targeted to replace. This makes it impossible to conduct a valid risk-benefit analysis of GMOs to support their introduction and use. Developers of GMO products are being asked to prove that they pose zero risk to health and environment, a standard to which no other new technology has been held. Another threat to biocontrol products is the plethora of dubious, unregistered biocontrol products. Since many of these are marketed not as pesticides but as soil amendments or plant growth promoting products, they do not require stringent regulatory review. Most of these products are ineffective and give effective biocontrol products a bad reputation.

Conclusion

At the conclusion of the workshop, it was clear to all participants that biocontrol is a promising technology that has great potential to produce excellent biopesticide products. The application of genetic technology to enhance biocontrol agents will undoubtedly lead to much better products that will compete successfully with their chemical counterparts. The co-organizers of the workshop, Maurizio Vurro and Jonathan Gressel have prepared a book of the proceedings to be published this winter by the IOS Press in the Netherlands.

ICM/ PEST MANAGEMENT – BLENDING NEW WITH OLD TECHNOLOGIES

Hamish Kidd reports on a few highlights from a recent meeting organised by the SCI Crop Protection Group

On 11 September 2001, over 40 people met for a conference principally on spray application, within the context of integrated crop management (ICM).

Paul Hamey from The UK Pesticides Safety Directorate started the meeting with a broad outline of how spray application is regulated in the UK as part of an overall risk assessment approach. The different types of spray equipment, nozzle types, buffer zones and LERAPs were outlined, with special reference to potential spray drift and consequent risk to spray operators and consumers. Buffer zones were a topic returned to later in the conference by Alastair Burn of English Nature, who emphasised their value for protection of wildlife.

Miles Thomas presented some results from the UK Pesticide Usage Survey – a survey which was started in 1965 and has been carried out ever since on a 3–5 year cycle. The most recent survey of pesticide use in 1999 has shown some important trends. As the more persistent compounds have been withdrawn, there has been:

- A reduction in the range of pesticides applied
- A trend towards reduced-rate applications
- An increase in the number of applications

For example on carrots, usage of insecticides and fungicides had increased in intensity with almost 2/3 of all crops receiving more than 3 insecticide sprays, almost inevitably lambda-cyhalothrin, compared to 37% in 1986, when organophosphate use dominated, while fungicide use had changed from an exclusively mancozeb/metalaxyl use to tebuconazole, fenpropimorph and metalaxyl-M.

Ian Gillott, who advises Thames Valley vegetable and salad growers, made the point strongly that lack of support for minor-use pesticides was making life very difficult for such growers, and he feared for the future of the industry. The reduction in available pesticides was putting reliance on the few remaining compounds, with consequent risk of the development of resistance. He made a plea for manufacturers to support minor uses and for the Government to provide funding to develop new molecules. Pressure from the large supermarkets to keep reducing pesticide use, while at the same time wanting cosmetically perfect produce, was putting an intolerable burden on vegetable and salad growers.

Paul Miller pointed forward with a presentation on the use of electronics to reduce pesticide use, especially patch spraying for weed control, and adjustment of spray delivery to measured canopy characteristics. The message of precision agriculture was echoed by Graham Matthews from IPARC at Silwood Park, who also made a plea for reduced spray volumes to maximise the benefits of surfactants, and for improved nozzles, such as those which are air-assisted.

Alan Dewar from IACR Broom's Barn in Suffolk outlined the potential advantages to be gained by the use of GM herbicide-tolerant sugar beet. These could enable less herbicide to be applied, and also enable weeds to be left in the crop for longer, with consequent benefits in the control of potato cyst nematodes and volunteer potatoes, and also environmental benefits.

The SCI Crop Protection Group holds regular meetings, for further details see http//:sci.mond.org