

January, August & Final Reports

REPORTS

Part 1 - Summary Project Details

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CRDC Project Number: **CSE98C**

January Report: Due 29-Jan-02
August Report: Due 02-Aug-02
Final Report: Due within 3 months of project completion

Project Title: 4th Pacific Rim Conference on the Biotechnology of *Bacillus thuringiensis* and Its Environmental Impact

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The 4th Pacific Rim Conference on the Biotechnology of *Bacillus thuringiensis* and Its Environmental Impact was held in the Manning Clark Centre, Australian National University, from 11th to 15th November 2001. The conference attracted 111 registrants from 17 countries, 49 of whom were from Australia. In the seven symposia of the program, 26 invited speakers reviewed major issues for the use of Bt technology (public perceptions, safety, regulatory issues, environmental impact of Bt crops, mode of action of Bt toxins, resistance, and novel Bt toxins). There were also 19 contributed papers and 18 posters presented. The conference was supported by sponsorship from 11 corporations and government agencies.

The conference opened with the keynote address by Dr Roger Frutos (CIRAD, France) in which he outlined the issues that must be faced in realising the potential offered by *Bacillus thuringiensis*. This address was followed by a symposium entitled Public Perceptions which explored the current attitudes to Bt usage in several countries. Ms Paula Fitzgerald (Agrifood Awareness Australia) reported that farmers and their advisors felt the need for more information on GM crops. She discussed various gene technology communication programs, including hands-on workshops for farmers, being used to provide reliable information to farming communities. Ms Fitzgerald noted that, although GM food was not a major issue for Australian consumers, there is increasing concern with medical biotechnology. Professor Supat Attathom (Kasetsart University, Thailand) noted that Thais are, in general, more concerned about chemical residues than GM foods. Although Thai growers are enthusiastic about Bt cotton as a means of reducing chemical insecticide usage, the Thai Government is insisting on six years of field testing before commercial release. He attributed this lengthy evaluation period to the strong anti-GMO lobby in Thailand. Dr Marty Pearce (Capital Health Region, Canada) found that community attitudes strongly affected self-reporting of illnesses and need to be considered in designing human health surveillance programmes for biotechnology applications. In brief, the survey team found those opposed to the Bt spray program were more likely to report illnesses than those who supported or were neutral, irrespective of whether they had been in the spray zone or not. The final paper in this symposium was presented by Dr Mark Lonsdale (CSIRO Entomology, Australia) who described the objectives and methods of the CSIRO Ecological Risk Assessment Group, which is developing a risk assessment framework for GMOs. The Group will test this framework against several case studies of GMOs that have been or are proposed for release in the next decade.

The conference focus then shifted to the science underpinning the use of Bt for pest control. Dr Mike Adang (University of Georgia, USA) discussed the current state of knowledge of the binding that is a critical factor in Bt specificity. Dr Raynald Laprade (Université de Montreal, Canada) reported the current state of knowledge of pore formation, which follows binding and lead directly to cell death. It was clear from these presentations that, although much has been learned, the information is only available for the Cry1A toxins and that there is still much to be learned about even this small group. Dr David Heckel (University of Melbourne, Australia) discussed his genetic analysis of resistance, which showed that resistance to Cry1A in *Heliothis virescens* is associated with a defective cadherin gene. His preliminary analysis of Cry1A-resistant *H. armigera* indicates that the cadherin gene is not involved in resistance in this Australian pest. Professor Brian Federici (University of California-Riverside, USA) reviewed the data on synergism between Bt toxins that has shown interactions between Cry proteins and between Cry and Cyt proteins, particularly in relation to overcoming resistance. He also reported that Zwittermixin A, a non-protein product of some Bt strains, produces a 3-13 fold synergy with Cry proteins.

There was a large emphasis on resistance management in the conference, with a symposium and nearly half of the contributed papers being devoted to the subject. Dr Rick Roush, University of Adelaide, Australia, reviewed the options for managing resistance to Bt. He identified the problem of refuge sizes that are commercially acceptable are usually too small to be effective and believes that pyramiding can address this problem. He reported that experiments with chimeric plants indicate that tissue specific expression probably does not help in resistance management. He also noted that unless a fitness cost is associated with heterozygotes it has little effect on resistance. Dr Yves Carrière (University of Arizona, USA) defined incomplete resistance as occurring when the fitness of homozygous resistant individuals is lower on transgenics than on non-transgenic plants. He reported that a change in the extent of incomplete resistance or in the inheritance of fitness costs can induce a rapid decline in resistance, even when the frequency of the resistance allele is high. Dr Neil Forrester, (Deltapine International, Australia) presented a detailed analysis of resistance monitoring methods, stressing the difficulties imposed by the large natural intraspecific variation in susceptibility in Bt and the significance of population vigour in interpreting bioassay data.

Several options for obtaining new Bt toxins were presented in the Novel Toxins symposium. Dr Alejandra Bravo (Instituto de Biotecnología/Unam., Mexico) described the strategies that her group used for surveying Mexican soils and insects for Bt and for characterising and testing the strains isolated. Professor Donald Dean (University of Ohio, USA) reported improving the toxicity of Cry1Ab for gypsy moth by modifying domain to improve its binding affinity and reducing the toxicity of Cry1Aa to a beneficial insect (silkworm) without reducing its toxicity to the target pest (gypsy moth). He reported changes in Cry2A, Cry3A and Cry4B that enhanced their toxicities for their target pests. Dr Takashi Yamamoto (Maxygen Inc., USA) described his method of improving the toxicity of Cry proteins by DNA shuffling. Non-Bt insecticidal proteins were discussed by Dr Travis Glare (AgResearch, New Zealand). Homologues to the insecticidal proteins originally reported from *Xenorhabdus* and *Photorhabdus*, the bacterial symbionts of entomopathogenic nematodes, have now been found in *Serratia entomophila*, a pathogen of New Zealand grass grub, and in *Yersinia pestis* and *Salmonella*, which are mammalian-toxic bacteria.

The environmental impact of Bt crops was evaluated in four papers. Dr Gary Fitt (Australian Cotton CRC, Australia) described studies on the impact of Bt-cotton on non-target invertebrates. This study involved scoring 450 species for three years of research prior to release and four following. There was little difference in biodiversity between blocks of unsprayed Bt and unsprayed conventional cotton, but less insects in sprayed conventional cotton. The introduction of Bt cotton has resulted in an average drop of 50% in chemical sprays. The weediness potential of GM crops was reviewed by Dr Rowena Eastick (CSIRO Plant Industry, Australia). She reported that there is some risk for canola and sunflower but minimal risk for potato, maize in the USA and cotton in the Australia. She noted that although cotton has no weedy relatives in Australia, it does persist in northern Australia. She described her large-scale experiment to evaluate the weediness potential of Bt cotton in northern Australia. Dr Tanja Schuler (IACR-Rothamsted, UK) conducted population-scale with parasitoids and target pests on transgenic oilseed rape. Although *Cotesia* that were forced to develop in Bt-treated diamondback moth died with their hosts, Dr Schuler concluded that behavioural factors will probably limit this effect in the field. She did note that *Cotesia* were attracted to those plants damaged by Bt-resistant host and so could delay the development of resistant populations. Neither peach aphid nor its parasitoid *Diaretiella*

rapae were affected by the Bt plants and the aphids were controlled equally on Bt and conventional rape. Dr Mark Sears (University of Guelph, Canada) presented a detailed analysis of the monarch butterfly/Bt- maize situation. He found that, with the exception of the highly expressing BT176 event plants, Bt-maize had no impact on field populations of the monarch butterfly (the BT176 event has not been re-registered).

On behalf of the Agricultural Biotechnology Stewardship Technical Committee, Dr Lori Artim (Syngenta, USA) reported the results of feeding trials with Bt crops. No detectable levels of Bt protein or DNA were found in poultry or ruminants fed Bt-maize, including BT176 event lines. Mycotoxins levels in the Bt grain were lower than in conventional and may account for the better growth results for some Bt grain than for conventional grain. The overall mammalian safety of Bt was assessed by Dr Maureen O'Callaghan (AgResearch, New Zealand). Although further investigation of increased antibody levels following exposure to Bt sprays may be warranted, epidemiological studies around aerial applications of Bt sprays in New Zealand (1996) and Canada (1999) found no increase in illness. Dr O'Callaghan concluded that the long experience with large scale Bt sprays and the rarity of reports of mammalian infections indicates that the risk from Bt is very low.

The conference concluded with a symposium on regulatory issues. Dr Anatole Krattiger (SWIFFT, USA) reviewed international regulatory trends for GM crops, observing that these trends are strongly influenced by perceptions of fairness, fears of corporate domination, and public acceptance. He commented that the great efforts to make regulatory approaches largely science-based have done little to appease consumers. He concluded that the benefits of the technology must be made more apparent to consumers if public acceptance of GM crops is to increase. Dr Nancy Millis (University of Melbourne, Australia) discussed Australia's Gene Technology Act and the way in which the Office of the Gene Technology regulator will administer the Act. An analysis of the findings of the NZ Royal Commission into Genetic Engineering was presented by Dr Travis Glare (AgResearch, New Zealand). The Royal Commission Report recognised the potential advantages of GM technology and advised that New Zealand should keep its options open. The report stressed the need to minimise and manage risk associated with field release. The final paper was the description by Dr Richard Stanwick (Capital Health Region, Canada) of the regulatory processes involved in obtaining approval for an aerial spray of part of the city of Victoria (B.C., Canada) by Bt for eradication of gypsy moth. He described the difficulties of presenting health data to a "quasi-judicial" review board and the dangers of being a "public face" during the running of an emotive issue.

The Standing Committee for the Pacific Rim Conferences on the Biotechnology of *Bacillus thuringiensis* and Its Environmental Impact chose Hanoi, Vietnam as the venue for the next conference, to be held in 2003. Professor Donald Dean resigned as Chairperson of the Standing Committee and Dr Ray Akhurst was elected to replace him in that position.

A Proceedings is being prepared for publication. Most of the manuscripts are in hand and a publisher has been chosen. Anticipated date of publication is July 2002.