COMPATIBILITY OF INSECT-RESISTANT TRANSGENIC PLANTS WITH BIOLOGICAL CONTROL

Jörg ROMEIS[1] and Anthony M. SHELTON[2]

[1] Agroscope FAL Reckenholz
Swiss Federal Research Station for Agroecology and Agriculture
Reckenholzstr. 191
8046 Zurich, Switzerland
joerg.romeis@fal.admin.ch

[2]Department of Entomology
Cornell University, NYSAES
630 W. North St.
Geneva, NY 14456, U.S.A.
ams5@cornell.edu

SESSION 7 INTRODUCTION

Insect resistant transgenic crops that express genes derived from the soil bacterium *Bacillus thuringiensis* (*Bt*) are grown on a steadily increasing area worldwide since their first introduction in 1996. In 2004, *Bt*-transgenic plants were grown on 22.4 million ha worldwide (James 2004).

Bt (Cry) toxins are known to have a very specific mode of action and plants commercialized today target either lepidoteran pests, including stem borers in maize and the budworm-bollworm complex in cotton, or coleopteran pests including the Colorado Potato beetle, *Leptinotarsa decemlineata*, and corn rootworms, *Diabrotica* spp. (James 2004 ; Shelton *et al.* 2002;). *Bt*-crops should not be viewed as silver bullets to solve all insect pest problems but should be regarded as just another tool to help manage certain pest populations in an economically viable and environmentally safe manner.

While in some areas of the world, especially in Europe, the debate is focusing on the potential environmental risks that could come with the large scale deployment of *Bt*-transgenic crops, other countries are investing time and efforts to evaluate how these crops can be implemented in integrated pest management (IPM) programs for sustainable pest control. One factor of particular interest in this respect is the impact of *Bt*-transgenic crops on non-target organisms that fulfil important ecological and economic functions within the agricultural system. This includes pollinators and biological control agents such parasitoids and predators that are of importance for natural pest regulation. Since *Bt*-transgenic plants express proteins with insecticidal properties, their effects on non-target arthropods should be assessed within an ecological risk assessment prior to commercialization of the crop (Conner *et al.* 2003; Dutton *et al.* 2003). Research to date on commercialized *Bt* crops indicates that the expressed Cry toxins do not have any direct effect on species belonging to orders other than the target insects (Lepidoptera or Coleoptera) (O'Callaghan *et al.* 2005). This is not surprising given the long history of safe and very targeted use of microbial *Bt* products (Glare and O'Callaghan 2000).

Thus, *Bt*-transgenic crops have the potential to be a viable alternative to conventional insecticides. In cotton fields, broad-spectrum insecticides are generally applied for the control of lepidopteran pests, i.e. the bollworm-budworm complex. Around the globe, deployment of *Bt* cotton has consistently resulted in a 60-80% decrease in insecticide applications in this crop (Fitt *et al.* 2004). Similarly, *Bt* sweet-corn has been found to be a suitable alternative for control of lepidopteran pests (Musser and Shelton 2003). In other crops such as maize, the introduction of the *Bt* gene to control the European corn borer, *Ostrinia nubilalis*, has not lead to substantial insecticide decreases simply due to the fact that this pest is generally not controlled by foliar insecticides so many growers simply did not treat and were resigned to the losses (Phipps and Park 2002).

The published information available to date reveals no detrimental impact of *Bt*-transgenic crops on the abundance or efficiency of biological control agents. In cases where *Bt* crops replaced the use of conventional insecticides (e.g., cotton or sweet-corn), substantial positive effects on the biocontrol fauna have been reported, resulting in increased control of potential secondary pests such as aphids (Reed *et al.* 2001; Wu and Guo 2003). Thus *Bt*-transgenic crops should be regarded as a biocontrol friendly technology that can help promote the conservation of biological control agents for key pests in cropping systems that are currently dominated by insecticide use. Furthermore the replacement of broad-spectrum insecticides by *Bt* crops opens up an opportunity for biocontrol of secondary pests, such as plant and stink bugs in cotton, that were controlled by the insecticides applied against the lepidopteran pest complex (Green *et al*. 2001; Wu *et al*. 2002).

The following session will provide information on the non-target risk assessment conducted by biotech companies as part of the regulatory process (Graham Head). This will be followed by examples from *Bt*-maize (Rick Hellmich) in the U.S. and *Bt* cotton in the U.S. (Steven Naranjo), China (Kongming Wu) and Australia (Gary Fitt) on how *Bt* crops can be implemented in IPM systems.

REFERENCES

Conner, A. J., Glare, T. R., and Nap, J. P. 2003. The release of genetically modified crops into the environment - Part II. Overview of ecological risk assessment. *Plant Journal* **33**, 19-46.

Dutton, A., Romeis, J., and Bigler, F. 2003. Assessing the risks of insect resistant transgenic plants on entomophagous arthropods: *Bt*-maize expressing Cry1Ab as a case study. *Biocontrol* **48**, 611-636.

Fitt, G. P., Wakelyn, P. J., Stewart, J., James, C., Roupakias, D., Hake, K., Zafar, Y., Pages, J., and Giband, M. 2004. "Global Status and Impacts of Biotech Cotton." Report of the second expert panel on biotechnology of cotton. International Cotton Advisory Committee.

Glare, T. R., and O´Callaghan, M. 2000. "*Bacillus thuringiensis*: Biology, Ecology and Safety". John Wiley and Sons Ltd, Chichester, U.K.

Green, J. K., Turnipseed, S. G., Sullivan, M. J., and May, O. L. 2001. Treatment thresholds for stink bugs (Hemiptera: Pentatomidae) in cotton. *Journal of Economic Entomology* **94**, 403-409.

James, C. 2004. "Preview: Global Status of Commercialized Biotech/GM Crops: 2004", ISAA Brief No. 32, International Service for the Acquisition of Agri-Biotech Applications, Ithaca, NY, U.S.A.

Musser, F. R., and Shelton, A. M. 2003. *Bt* sweet corn and selective insecticides: Impacts on pests and predators. *Journal of Economic Entomology* **96**, 71-80.

O'Callaghan, M., Glare T. R., Burgess, E. P. J., and Malone, L. A. 2005. Effects of plants genetically modified for insect resistance on nontarget organisms. *Annual Review of Entomology* **50**, 271-292.

Phipps, R. H., and Park, J. R. 2002. Environmental benefits of genetically modified crops: Global and European perspectives on their ability to reduce pesticide use. *Journal of Animal and Feed Sciences* **11**, 1-18.

Reed, G. L., Jensen, A. S., Riebe, J., Head, G., and Duan, J. J. 2001. Transgenic *Bt* potato and conventional insecticides for Colorado potato beetle management: comparative efficacy and non-target impacts. *Entomologia Experimentalis et Applicata* **100**, 89-100.

Shelton, A. M., Zhao, J. Z., and Roush, R. T. 2002. Economic, ecological, food safety, and social consequences of the deployment of *Bt* transgenic plants. *Annual Review of Entomology* **47**, 845-881.

Wu, K. M., and Guo, Y. Y. 2003. Influences of *Bacillus thuringiensis* Berliner cotton planting on population dynamics of the cotton aphid, *Aphis gossypii* Glover, in northern China. *Environmental Entomology* **32**, 312-318.

Wu, K., Li, W., Feng, H., and Guo, Y. 2002. Seasonal abundance of the mirids, *Lygus lucorum* and *Adelphocoris* spp. (Hemiptera: Miridae) on *Bt* cotton in northern China. *Crop Protection* **21**, 997-1002.