THE process of applying for the regulatory approvals to commercialise Bollgard III in Australia is now well underway. In the second half of 2014, Monsanto aims to submit to the APVMA the data package for the product’s Resistance Management Plan. In the lead up to this, Monsanto and the Bt Technical Panel of Cotton Australia’s TIMS Committee are working closely together to review resistance risks using local and international research.

Prior to introducing the first commercial Bt transgenic cotton in 1995, the Australian cotton industry was well aware of the risks to production associated with insect resistance. *Helicoverpa armigera* had already developed resistance to conventional insecticides, particularly pyrethroids. The efficacy of many insecticides was short-lived, providing only a few days protection. Spray failures were common, as was the practice of using more than one active ingredient in spray mixtures to increase the likelihood of satisfactory control.

The resistance risks associated with Bt cotton today are less obvious than the situation experienced by the industry in the mid 1990s. Bt cotton has virtually eliminated yield losses from *Helicoverpa* across the industry and back-up from insecticides is rarely required to achieve this.

It is the reliability of the very high levels of control that have been achieved with Bollgard II that the RMP has aimed to protect. This aim will continue with Bollgard III.

While risks are less obvious than in the past, the underlying resistance risk for Bt cotton is potentially much greater than for conventional insecticides. Bt toxins are expressed by the cotton plants all season long, greatly increasing exposure and selection pressure when compared to individual spray events. We also know that genes for resistance to two of the three Bt toxins are common in *H. armigera* and *H. punctigera*.

Prior to the release of Bt cotton in Australia, it was recognised by both industry and the technology provider that the success of transgenic cotton cultivars in Australia would be dependent on an effective and well-supported resistance management strategy.

In order to develop a robust resistance management plan to support the release of Ingard, representatives of the Australian cotton industry and scientific community worked closely with Monsanto to provide scientific research relevant to the Australian pest species and the Australian cropping environment as well as...
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industry knowledge as to how the management of resistance risks might be best achieved in practice. Since then, the process of making changes to existing RMPs or introducing new RMPs with the Australian regulatory authorities has involved industry consultation as an important step in the process. The RMPs for Ingard, Bollgard II and Widestrike cottons have all been developed using the process being currently undertaken to develop the RMP for Bollgard III.

**TIMS Committee**

The Australian Cotton Growers Research Association formed a broadly representative, grower led group called the Transgenic and Insect Management Strategies Committee (TIMS Committee). This Committee was established to oversee the development of the industry’s resistance management strategies for insecticides and Bt cotton and later herbicide tolerant cotton traits.

The TIMS Committee, facilitated by Cotton Australia, functions as a cotton industry stewardship group, with broad representation from growers, research organisations, crop consultants and members of the pulse and grains industries.

The TIMS Committee is strongly supported by three discipline-based Technical Panels. The Panels offer the Committee advice on the scientific merit of proposed new or amended resistance management strategies. The technical panels are comprised of appointed researchers with specific expertise in resistance management. The three technical panels advising the Committee cover the areas of:

- Insecticides;
- Herbicide tolerant crops; and
- Bt insect resistant crops.

An important role of the TIMS Committee is to endorse amendments to existing RMPs for Bt transgenic cotton or any proposed RMPs for new Bt products coming into the market, such as Bollgard III. Registrants are required as part of their application to the APVMA, to demonstrate industry support for the proposed RMP. In cotton, the TIMS Committee is recognised as the group that performs this role.

The TIMS Bt technical panel provides independent, scientific advice to the TIMS Committee on these issues. Figure 2 shows the overall process that occurs between the Bt technical panel, TIMS Committee, the Technology Provider and the regulatory authorities when new or amended RMPs are proposed.

The TIMS Bt Technical Panel is currently focused on reviewing research relevant to the third generation Bt cotton resistance management plan (Bollgard III). This involves reviewing the current Bollgard II RMP and its effectiveness and incorporating new research specific to the efficacy and expression of new Bollgard III cultivars. The range of research is complex and includes:

- Efficacy and expression characteristics of the toxins contained in Bollgard III;
- Determining baseline frequencies to Vip3A, the additional toxin contained in Bollgard III;
- Effectiveness of key tactics in the current RMP such as planting windows and refuges;
- Alternatives to pupae busting and trap crops;
- Helicoverpa ecology including flight capacity, host preference and landscape influences on Helicoverpa behavior; and,
- Continued resistance monitoring in Bollgard II, including identifying resistance characteristics and potential cross resistance between different Bt toxins and conventional insecticides.

In the lead up to developing an RMP for Bollgard III, the TIMS Bt technical panel has been working closely with Monsanto to share and review research results.

As part of the review of Bt resistance research, the TIMS Committee and CRDC facilitate an annual review of Bt resistance research and extension activities as part of the REFCOM forum meetings. REFCOM brings together researchers, growers, consultants and representatives from technology providers and the industry CottonInfo team, to discuss research project progress and communication on Bt resistance.

In the lead up to the commercial release of third generation Bt technology, it is critical that the industry gets the RMP for Bollgard III right to ensure the longevity of the product. A continued increase in Cry2Ab resistance frequencies in either Helicoverpa species is a concern, since both the Cry1Ac and Cry2Ab toxins are contained in the new Bollgard III.

The role of industry consultation via the TIMS Committee in the development of new and existing RMPs is critical, not only through the research and monitoring conducted, but just as importantly from the growers on the TIMS Committee who are able to offer a practical approach to RMP development and amendment.