

Bollgard II® resistance update

New evidence confirms that genes allowing *Helicoverpa* to survive Cry1Ac are rare in Australian populations.

However the industry is concerned about the high and potentially increasing frequency of Cry2Ab resistance genes in populations of *Helicoverpa armigera* and *H. punctigera*.

REFCOM recently brought together researchers, growers, consultants, and representatives from Monsanto and the Cotton CRC's extension team to discuss research progress & communication on Bt resistance. As a precautionary measure, the industry and CSIRO are working with Monsanto to develop protocols to help decide what Cry2Ab resistance frequency would trigger a revision of the current RMP, when that proposed RMP change may occur, and what the change may be. The frequency data for the entire season will be considered at another REFCOM meeting to be held in May/June. The following results are until the end of February 2008/09.

The Cry2Ab gene in Australian populations of *Helicoverpa* is recessive. This means that larvae must carry two copies of the gene to survive the toxin. The F₂ and F₁ methods used to test for resistance can detect recessive genes. So far we have not found any individuals that have two copies of the Cry2Ab gene. The main aim of the monitoring program is to detect increases in the frequencies of individuals that carry one copy of the gene so that we can modify the RMP before individuals with two copies of the gene become common.

F₂ screens for Cry2Ab to end of February

- **F₂ screens** test the grandchildren from two field-collected moths that are mated and take 10 weeks to complete.
- *H. punctigera*: 6 out of 348 genes tested conferred resistance to Cry2Ab. This frequency (0.017) is 4 times higher than the frequency at the end of the 2007/08 season (0.004).
- *H. armigera*: 3 out of 380 genes tested conferred resistance to Cry2Ab. This frequency (0.008) is similar to the frequency at the end of the 2007/08 season (0.005).

Species	Year	Cry2Ab F ₂ screen		
		Tested	Positive	Frequency
<i>Helicoverpa punctigera</i>	2002/03 - 2006/07	2272	3	0.001
	2007/08	1142	5	0.004
	2008/09	348	6	0.017
	Total	3762	14	0.004
<i>Helicoverpa armigera</i>	2002/03 - 2006/07	2206	12	0.005
	2007/08	772	4	0.005
	2008/09	380	3	0.008
	Total	3358	19	0.006

F₁ screens for Cry2Ab to end of February

- **F₁ screens** test offspring from a field moth mated with a Cry2Ab resistant lab moth. As the method is shorter than F₂ screens it is possible to test more individuals.
- We expected F₁ screens to give the same frequencies as the F₂ screens but the values are consistently higher. We do not understand the reason for this difference but the higher F₁ value is most likely to reflect the real situation in field populations.
- *H. punctigera*: 21 out of 338 genes tested conferred resistance to Cry2Ab. This frequency (0.062) is 6 times higher than the frequency at the end of the 2007/08 season (0.010).
- *H. armigera*: 28 out of the 1078 genes tested conferred resistance to Cry2Ab. This frequency (0.026) is similar to the frequency at the end of the 2007/08 season (0.032).

Species	Year	Cry2Ab F ₁ screen		
		Tested	Positive	Frequency
<i>Helicoverpa punctigera</i>	2007/08	196	2	0.010
	2008/09	338	21	0.062
	Total	534	23	0.043
<i>Helicoverpa armigera</i>	2007/08	278	9	0.032
	2008/09	1078	28	0.026
	Total	1356	37	0.027

What should growers do?

It is essential that end of season Bt resistance management measures are followed – maintain refuge attractiveness, ensure pupae busting is timely and control cotton volunteers in fallow fields.

The RMP for 2009/10

Changes proposed for the 2009/10 season RMP include clarification & tightening of some practices. For NSW & SQ these proposed changes include:

- A clearer definition of situation around sprayed crops & planting near refuges.
- The refuge planting dates have been better defined relative to the first date of planting Bollgard II. This ensures that Bollgard II planted early in the window has a specific refuge rather than being assigned the same refuge as Bollgard II planted later in the window.
- Date change for pupae busting
- Failed crop section reworded to leave it up to grower to decide how best to remove crop.

The RMP is subject to approval by APVMA &, as the Registrant, Monsanto submits it to the regulator. More details will be available once the review is finalised.

Glossary:

- **Cry1Ac** is the Bt toxin produced in Ingard® & is also in Bollgard II®. The production of Cry1Ac within plants is presumed to decline late in the season.
- **Cry2Ab** is the second toxin in Bollgard II®. The production of Cry2Ab is thought to remain reasonably consistent throughout the season.
- **REFCOM**- industry forum on resistance research led by Cotton Australia's TIMS Committee & CRDC