

Testing for heliothis resistance

By Don Turner, Cottonworld

Arguments for and against genetically modified organisms are so extreme and so widely published it is difficult to tell fact from fiction.

Consider this statement issued by Greenpeace in Shanghai on June 3 and reported by Reuters, that "transgenic Chinese cotton, developed by US bio-tech giant Monsanto, is bad for the environment because it encourages continued use of pesticides, and that Bt cotton, genetically engineered to be more resistant to pests, is building up resistance toward cotton bollworm after just five years of commercial cultivation."

Aside from the fact Bt cotton plants cannot become resistant to cotton bollworm — since plants do not eat bollworm, as the article implies — Monsanto says it has fresh Australian evidence that *Helicoverpa* spp. is not developing resistance to Bt (*Bacillus thuringiensis*).

Monsanto scientific director Eric Sachs describes the Greenpeace report as misleading and flawed. "There is no evidence of resistance to Bt crops," he says, adding that testing cited by Greenpeace was done in a laboratory and "bears no reality in the field."

In Australia, a team led by Monsanto entomologist Stewart Addison has replicated resistance testing protocols and compared results.

Resistance testing has been conducted in Australia since Bt cotton was introduced in 1996, first by Dr Neil Forrester, and then by Ho Dang of NSW Agriculture. Neil Forrester found no heliothis resistance to Bt. In their report, entitled "Research in Resistance Management", Ho Dang and Robin Gunning say there is evidence of a shift in susceptibility to Bt.

Specifically, they point to a shift in susceptibility to *Bacillus thuringiensis* delta-endotoxin CryIAc in Australian *Helicoverpa armigera*. Their paper reports the results of Bt resistance monitoring to date and evidence of "possible esterase mediated mechanism of resistance in *H. armigera*". (This paper is archived at: http://www.cips.msu.edu/whalonlab/rpmnews/vol.11_no.2/rpm_research.htm).

Stewart Addison's team at Boggabri conducts Monsanto's own testing, but it also works with researchers in various studies.

This article attempts to explain the differences between methods used by researchers to test for resistance, based on Stewart's observations of their methods. It is not an attempt to prove or disprove resistance to Bt.



Monsanto's Stewart Addison

Monsanto follows three sets of testing protocols — one of its own, as well as those of Neil Forrester and Ho Dang. Much of the confusion over resistance lies in the difference between these protocols.

Neil looked at developmental bio-assays, where larvae of a particular size were exposed to a diet of a particular concentration of Bt. This level of concentration was determined in baseline studies of 32 heliothis populations, to see which concentration of Bt would control 99 per cent of the population. Neil chose as his diagnostic dose a concentration of Bt which prevented development in either first instar or third instar larvae.

Ho Dang used third instar larvae on a diet with much higher concentrations of Bt.

“Ho was looking at mortality, not development. So he was exposing grubs to a diet with Bt in it and looking at what percentage survived at the end of a 10-day period. There is quite a difference in the kind of results you get from those protocols,” says Stewart.

“With Neil’s protocol, we have seen no development in the populations we have checked — from first instar to third instar — or from his other protocol, from third to fourth instar with two different diagnostic doses.”

Monsanto says it tested 5000 bio-assays this year and 6000 last year, from 10 populations ranging from Emerald in the north to Warren in the south. “We made the test more sensitive this year, by halving the diagnostic dose.”

By halving the diagnostic dose you would expect to see a higher proportion to develop. Monsanto found that 0.2 per cent of grubs tested did develop through to third instar, and that 0.5 per cent developed through to second instar.

“This shows us that Neil’s diagnostic dose was effective, and that if you submit those larvae to lower doses you do get some development — it confirms for us there has been no change since 1996–97.”

When Monsanto used Ho’s protocol the result matched Ho’s own finding — that the rate of survival on his diagnostic dose has increased.

Monsanto weighed these larvae when they came on to the diet and when they came off it. “We found that although you may get 15 per cent of larvae surviving at that dose, those survivors weighed 16 per cent less at the end of the trial than when they went on to the diet.”

So grubs are surviving but not developing, and grubs feeding on lower doses of Bt are still being controlled.

“The fact we are getting a higher proportion surviving on Ho’s protocol may be telling us that some grubs are becoming more aware of Bt and not feeding,” he says. “If they are not feeding, they are not developing, and not producing eggs

so they will not have an effect in the field.”

Time will tell whether resistance develops. Hopefully, we have shed light on the testing process for growers, who find Bt cotton holds different challenges for managers compared with conventional varieties. And despite protestations from the anti-GMO lobby, there are some checks and balances on the technology.

Another piece of good news on *Heliothis* control: Micro-satellite analyses of *heliothis* genetics and migration by a University of Queensland team also reveal low levels of migration between regions. This should help to combat build-up of resistance to chemicals. Interestingly, the UQ team concludes that “responsibility for increased resistance to chemical controls is likely to be the result of local management practices”. This could have implications for the Insecticide Resistance Management Strategy, since some valleys want to localise strategies.

The full article on *Heliothis* genetics and migration is archived as Central Queensland Cotton Tales 34, by David Kelly of the QDPI at: http://www.cotton.pi.csiro.au/Publicat/Tales/01_02/index.htm

For video of resistance testing and an interview with Stewart Addison, look for Cottonworld Video, issue 14 winter 2002, out now.