

First documented case of pest resistance to biotech cotton

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A bollworm, *Helicoverpa zea*, munches down on a cotton flower bud. This pest insect eats all parts of the cotton plant. In some places, bollworm have as many as six generations in one growing season. Credit: US Department of Agriculture

A pest insect known as bollworm is the first to evolve resistance in the field to plants modified to produce an insecticide called Bt, according to a new research report. Bt-resistant populations of bollworm, *Helicoverpa zea*, were found in more than a dozen crop fields in Mississippi and Arkansas between 2003 and 2006.

"What we're seeing is evolution in action," said lead researcher Bruce Tabashnik. "This is the first documented case of field-evolved resistance to a Bt crop."

Bt crops are so named because they have been genetically altered to produce Bt toxins, which kill some insects. The toxins are produced in nature by the widespread bacterium *Bacillus thuringiensis*,

hence the abbreviation Bt.

The bollworm resistance to Bt cotton was discovered when a team of University of Arizona entomologists analyzed published data from monitoring studies of six major caterpillar pests of Bt crops in Australia, China, Spain and the U.S. The data documenting bollworm resistance were first collected seven years after Bt cotton was introduced in 1996.

"Resistance is a decrease in pest susceptibility that can be measured over human experience," said Tabashnik, professor and head of UA's entomology department and an expert in insect resistance to insecticides. "When you use an insecticide to control a pest, some populations eventually evolves resistance."

The researchers write in their report that Bt cotton and Bt corn have been grown on more than 162 million hectares (400 million acres) worldwide since 1996, "generating one of the largest selections for insect resistance ever known."

Even so, the researchers found that most caterpillar pests of cotton and corn remained susceptible to Bt crops.

"The resistance occurred in one particular pest in one part of the U.S.," Tabashnik said. "The other major pests attacking Bt crops have not evolved resistance. And even most bollworm populations have not evolved resistance."

The field outcomes refute some experts' worst-case scenarios that predicted pests would become resistant to Bt crops in as few as three years, he said.

"The only other case of field-evolved resistance to Bt toxins involves resistance to Bt sprays," Tabashnik said. He added that such sprays have been used for decades, but now represent a small

proportion of the Bt used against crop pests.

The bollworm is a major cotton pest in the southeastern U.S. and Texas, but not in Arizona. The major caterpillar pest of cotton in Arizona is a different species known as pink bollworm, *Pectinophora gossypiella*, which has remained susceptible to the Bt toxin in biotech cotton.

Tabashnik and his colleagues' article, "Insect resistance to Bt crops: evidence versus theory," will be published in the February issue of *Nature Biotechnology*. His co-authors are Aaron J. Gassmann, a former UA postdoctoral fellow now an assistant professor at Iowa State University; David W. Crowder, a UA doctoral student; and Yves Carrière, a UA professor of entomology. Tabashnik and Carrière are members of UA's BIO5 Institute.

"Our research shows that in Arizona, Bt cotton reduces use of broad-spectrum insecticides and increases yield," said Carrière. Such insecticides kill both pest insects and beneficial insects.

To delay resistance, non-Bt crops are planted near Bt crops to provide "refuges" for susceptible pests. Because resistant insects are rare, the only mates they are likely to encounter would be susceptible insects from the refuges. The hybrid offspring of such a mating generally would be susceptible to the toxin. In most pests, offspring are resistant to Bt toxins only if both parents are resistant.

In bollworm, however, hybrid offspring produced by matings between susceptible and resistant moths are resistant. Such a dominant inheritance of resistance was predicted to make resistance evolve faster.

The UA researchers found that bollworm resistance evolved fastest in the states with the lowest abundance of refuges.

The field outcomes documented by the global monitoring data fit the predictions of the theory underlying the refuge strategy, Tabashnik said.

Although first-generation biotech cotton contained only one Bt toxin called Cry1Ac, a new variety contains both Cry1Ac and a second Bt toxin,

Cry2Ab. The combination overcomes pests that are resistant to just one toxin.

The next steps, Tabashnik said, include conducting research to understand inheritance of resistance to Cry2Ab and developing designer toxins to kill pests resistant to Cry1Ac.

Source: University of Arizona

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