ScienceWatch - Genetically Engineered Crops: Yes? No? Maybe!

The scientific debate on the safety of genetically modified (GM) crops is perhaps as polarizing as the disagreement over the origin of birds, which I discussed in the last issue of *Rivertown Naturalist*. Recently the GM crop dispute has centered on the use of genetically modified plants that make toxins to kill insects. The toxin genes come from a bacterial insect pathogen, *Bacillus thuringiensis* (Bt), a soil bacterium whose spores contain a crystalline (Cry) protein. In the insect gut the protein breaks down to release a toxin, known as a delta-endotoxin. This toxin binds to and creates pores in the insect intestinal lining, resulting in ion imbalance, paralysis of the digestive system, and after a few days, death. Different versions of the Cry genes, also known as "Bt genes", have been identified. The toxins they make are effective against different orders of insects, or affect the insect gut in slightly different ways. One toxin acts against butterflies and moths (Lepidopterans), while another kills beetles (Coleopterans), still another is lethal to flies and mosquitoes (Dipterans).

Proponents of Bt crops argue that they are pest-specific and they reduce the use of chemical pesticides that kill harmful and beneficial insects alike as well as polluting the environment. Genetically engineered cotton, corn and soybeans required 8.2 million fewer pounds of pesticide in 1998 alone. Moreover, cotton farmers increased their yields by 85 million pounds. Proponents say this means more preservation of natural habitats because less land is used for agriculture. Opponents argue that once a Bt plant is released into the environment the ecological consequences cannot be adequately predicted and could result in unforeseen risks. They fear that Bt plants could affect non-target species and that the target pest(s) could become resistant due to widespread toxin production. They point to recent laboratory studies suggesting that adverse effects may occur when monarch butterfly (*Danaus plexippus*) caterpillars ingest Bt-corn pollen on milkweed (*Asclepias curassavica*) and to EPA guidelines recommending that up to 40% of each crop be set aside as an unmodified “refuge” to prevent pest populations from becoming completely resistant.

A review of the existing scientific literature, published in the December 15th issue of the journal *Science* concludes that key experiments to determine environmental risks or benefits are lacking. The authors, L.L. Wolfenbarger and P.R. Phifer, contend that the complexity of ecological systems makes it difficult to design experiments that properly assess the risks and benefits of genetically engineered plants. For example, they say the studies showing that milkweed coated with Bt corn pollen can kill monarch caterpillars (see *ScienceWatch* September 1999) are impossible to apply to natural populations because no one knows the extent to which monarch larvae actually encounter the toxin in the field, a necessary component for assessing the direct risk to non-target species.

Bt crops may also affect non-target species indirectly through bioaccumulation, which could occur when predators consume prey that has ingested the toxin. The disastrous effect of DDT on predatory birds is a classic example of the bioaccumulation of a toxic chemical that can remain in the environment unchanged for many years. In contrast, Bt spores have been sprayed on leaf surfaces for decades to protect crops from insect pests, and the toxins they contain have been shown to rapidly lose potency, leaving little opportunity for bioaccumulation. Similarly, conclude the authors, most studies conducted with Bt crops indicate no negative effects on predatory insects eating prey that have ingested plant tissue containing toxin. However, when green lacewings (*Chrysoperla carnea*) were fed cotton leafworms (*Spodoptera littoralis*) that had ingested Bt corn, increased mortality occurred. Bioassays reveal that Bt toxin released into the soil from Bt corn and Bt cotton rapidly decline. However, the toxins may persist much longer in certain soil types with high clay content. Thus, potential risks to non-target species exist, but no one knows how these compare to the better-known risks of continued widespread use of chemical pesticides.

Extensive use of Bt crops that continuously produce toxin could lead to increased resistance among target species. The diamondback moth (*Plutella xylostella*) is already resistant to Bt toxin, and at least ten other moth species, two species of beetles and four species of flies have developed resistance under laboratory conditions. Resistance in the field can be managed by using high toxin doses and maintaining refuges of susceptible individuals to mate with resistant ones. How long this will work before new toxins are needed remains to be seen.

Wolfbarger and Phifer contend that neither the pro- nor the anti-biotechnology forces have enough hard scientific evidence to provide a compelling argument for their positions. A prudent course for the immediate future is to proceed slowly and introduce few, if any, new GM crops while we wait for scientists to develop evaluations that will allow decision-makers to balance potential environmental benefits against the extent and risks of ecological change brought on by GM crops.

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To learn more about GM (also called transgenic) crops, including how they are made, who regulates them, possible risks and future crops, visit www.colostate.edu/programs/lifesciences/TransgenicCrops.