Conservation & Ecology

Improving the Environmental Risk Assessment of Genetically Modified Crops

Simple improvements in experimental design could greatly increase the value of safety studies.

Genetically engineered crops offer potentially huge benefits, but they also pose significant risks. Current regulatory testing requirements may not be rigorous enough. How can experimental and statistical protocols be improved to make test results more compelling, informative, and reliable?

During the 1990s a variety of corn was genetically modified to include genes from *Bacillus thuringiensis* (Bt), a bacterium that produces a highly effective caterpillar toxin generally regarded to be safe and "natural." It seemed like a brilliant idea. The plants would produce their own insecticide, improving yields and reducing the use of riskier pesticides. Farmers, consumers, everyone would come out winners—except the pesky caterpillars, of course.

Unfortunately, in some of the new varieties, Bt toxin was also being expressed in the pollen of the Bt corn. And this pollen, carried a surprising distance by wind, was coating the leaves of nearby milkweed—the favorite food of harmless, nontarget monarch butterfly caterpillars—with deadly potential.

The problem was corrected without catastrophic effect on the monarch butterfly population. Since then, new strains of Bt corn have been developed and commercially released that do not express Bt toxin in the pollen at all. The next unforseen problem with transgenic manipulation might not be so tractable, however. And the troubling question remains: If effective safety testing was done, why weren't the presence of Bt toxin in the pollen and the potential harm to nearby monarch caterpillars better understood before the Bt corn was approved?

Measuring Environmental Safety

News stories covering the risks faced by monarch butterflies helped to catalyze public concern about genetically engineered crops. People wondered what other environmental risks might have been overlooked. They wanted to know whether the studies—required for approval of the crops—had been, in fact, thorough enough.

These sorts of concerns have inspired a kind of watchdog area of environmental research, such as that being done in Santa Clara University's Environmental Studies Institute. Under the direction of Michelle Marvier, assistant professor of biology, a small but talented group of undergraduate researchers is looking at the quality of safety studies performed for transgenic crops.

For example, in one study that looked at the effects on earthworms of cotton genetically modified to express Bt toxin, only eight samples were used, four each of cotton that was not genetically modified and cotton that was. No statistical difference was found—not surprising, with so few replicates involved. The problem is, that is all the testing the government requires.

Mining the Research

The issues are compelling, even moral in nature, while the potential risks and rewards provoke intense scientific, social, ecological, and political discussion. It is a perfect environment for young researchers, such as Santa Clara senior Sabrina West. Mining the U.S. Department of Agriculture's Web site, she is systematically examining the risk assessment studies that were done on deregulated transgenic crops.

"I'm going through, looking for flaws in their logic," West says. "If you look at the actual experiments—and not all the data is necessarily available—you can sometimes tell if the researchers should have used larger sample sizes."

The other major concern about genetically modified crops—for which Marvier has West keenly hunting in published studies—is that they could unintentionally hybridize with other plants or weeds. A case in point is a new variety of golf course grass. If its herbicide tolerance is accidentally transferred into the wild population around golf courses, the weeds could become very difficult to control.

Opportunities for Students

Marvier recalls how important it was as an undergraduate to have worked in a lab. "It helped me figure out what I wanted to do in life, actually changed my mind," she says.

Her students work on a number of interesting issues in ecology and conservation. One project, for example, is examining how global priorities can be set for conservation to bring the best social and economic returns on investment.

The extent of student contributions is evidenced by their participation in numerous papers and presentations. West, for example, co-authored a note for the journal *Nature* last summer, and will be a co-author of a chapter for a forthcoming book on genetically engineered plants.

Like other science professors at Santa Clara, Marvier can not imagine doing research without student assistants. "They're a huge help," she says, "and they create a lot of positive energy in the lab."

"We are trying to get the ear of the Environmental Protection Agency and the USDA. And they are listening, they are trying to change, although no new rule has been finalized yet."

Michelle Marvier
assistant professor of biology

Sabrina West
Michelle Marvier