



How Have GE Crops Effected Herbicide Use? A Complex Question with an Evolving Answer

Our most recent Biotech in Focus bulletin discussed crops genetically engineered to produce insecticidal Bt proteins. Bt crops have been very popular with corn and cotton farmers because they have demonstrated consistent improvements in yield coupled with diminished use of insecticides. The other trait that has been widely incorporated into genetically modified (GM) crops is herbicide tolerance. Here we'll look at how adoption of an herbicide tolerant (HT) crop has effected herbicide use. We'll focus on GM soybeans, which were among the first commercial GM crops in the United States.

In 1996, U.S. farmers started growing Round-Up Ready soybeans that tolerate the herbicide glyphosate. Within five years, HT soybeans accounted for more than 50% of the nation's soybean acreage. Today, more than 9 of 10 U.S. soybean acres are planted with crops that tolerate a herbicide, primarily glyphosate.



Before HT soybeans, farmers frequently fought weeds by incorporating herbicides into the soil before the soybeans were planted or before any weeds emerged from the soil. Once weeds were established and growing aboveground, additional herbicides were often applied directly to the weeds, sometimes several times during the growing season. This process consumed time, energy, and money.

HT soybeans made life much easier for farmers, who could spray their fields after planting without harming the crops. Because it didn't require incorporation into the soil, glyphosate was compatible with farming methods that minimize plowing to conserve topsoil. Ten years after their introduction, more than 80% of HT soybeans were grown using no-till and low-till soil conservation practices, compared with less than 40% of conventional soybeans.

Glyphosate is also less toxic than the herbicides it replaced. Less persistent in soil and water than many herbicides, glyphosate was also poorly absorbed by rats in feeding studies. Glyphosate does not accumulate in human or animal tissues, and has very low acute toxicity.



This week's Biotech in Focus came from a paper written by Amber Au, a University of Hawaii at Manoa student who recently enrolled in TPSS 416



(Introduction to Social, Ethical, and Political Issues Associated with Biotechnology). Designed for non-majors, this class is offered by the Department of Tropical Plant and Soil Sciences in UH Manoa's College of Tropical Agriculture and Human Resources.



Ania Wieczorek, PhD

Professor
Department of Tropical Plant and Soil Sciences
College of Tropical Agriculture and Human Resources
University of Hawai'i at Manoa
Honolulu, HI 96822
ania@hawaii.edu

Thank you to Carol Oshiro for web design, Jessica Radovich for graphics and Kathleen Vickers for text editing.

Repeated Exposure Leads To Resistance



Unlike Bt crops that make their own insecticides, HT crops didn't lead to significant declines in pesticide application. HT soybeans had little effect on the rate of herbicide use, but dramatically changed which herbicides were used, with farmers abandoning a variety of herbicides more toxic than glyphosate for a single, less toxic product. However, this meant that farmers began to depend on a single product for weed management, always a concern with regard to resistance build-up.

Now, the widespread adoption of RoundUp Ready soybeans has put this simple and popular weed control technology at risk. Spraying fields repeatedly with just one herbicide has selected for weeds with naturally occurring mutations that allow them to resist glyphosate. Neither the herbicide nor the bacterial gene added to HT soybeans caused these weed mutations. However, repeated exposure to herbicides kills susceptible weeds, making it easier for the resistant weeds within the population to reproduce and pass on their resistant genes.

Resistant Species

As of 2014, at least 15 U.S. weed species had evolved resistance to glyphosate. There are about 32 weeds world-wide that resist glyphosate and similarly acting herbicides, including two in France, where HT crops are not grown. World-wide there are about 150 weeds that resist some kind of herbicide. For example 73 weed species show resistance to the second most popular herbicide, atrazine that has been used since the 1960s, and 32 weeds are resistant to synthetic plant growth regulator, 2,4-D, first marketed in 1945, both long before GE crops were on the market.



Farmer Response



In response, farmers are turning once again to some of the herbicides that became less popular as HT soybeans became widely adopted. Soybeans are being genetically engineered to tolerate some of these herbicides. A soybean that tolerates both glyphosate and dicamba, for example, is currently undergoing regulatory review.

Lesson Learned

A clear lesson that can be drawn from the first twenty years of HT soybeans is that reliance on a single tool to combat a pest can speed up the evolutionary processes by artificially selecting for resistance traits, that eventually make that tool less useful.

