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## Widely Used Crop Herbicide Is Losing Weed Resistance

By ANDREW POLLACK

**T**he world's most widely grown genetically engineered crops — soybeans, cotton and corn developed to be impervious to a popular herbicide — are facing a new challenge to their continued long-term use. The herbicide, known as Roundup, is beginning to lose its effectiveness in controlling weeds.

In the last few years, weeds resistant to the herbicide have emerged in Delaware, Maryland, California, western Tennessee and at the edges of the Corn Belt in Ohio and Indiana.

The problem, crop scientists say, is the very success of the genetically engineered crops, particularly the soybeans, which now account for more than three-quarters of all soybeans grown in the United States. Farmers like the genetically engineered crops, which are sold under the brand name Roundup Ready, because they can spray Roundup herbicide directly over those fields, killing the weeds while leaving the crops intact.

But the popularity of the crops has caused the use of the Roundup herbicide to skyrocket, setting up "survival of the fittest" conditions in which the rare weeds that survive the herbicide can flourish. Eventually, experts say, farmers will need to reduce their applications on the genetically engineered soybeans and other crops to preserve the long-term usefulness.

The resistant weeds could also be a problem for the [Monsanto Company](#), which developed both Roundup and the Roundup Ready crops. Roundup is Monsanto's biggest product, accounting for about 40 percent of its estimated 2002 revenue of \$4.6 billion, according to Bear, Stearns. The Roundup Ready crops, the linchpin of Monsanto's agricultural biotechnology business, had revenue of roughly \$470 million last year, Bear, Stearns said.

Referring to Roundup herbicide by its generic name, Mark J. VanGessel, an associate professor of crop science at the University of Delaware, said, "With the advent of Roundup Ready crops, all we're using is glyphosate."

"Long term," he said, "what's going to have to happen is getting away from the continuous use of Roundup Ready crops."

The resistance is currently found only in a few types of weeds, crop scientists say, and farmers can easily use other herbicides to kill those weeds.

But some scientists are concerned that the resistance could spread, rendering Roundup herbicide less useful. That would be a problem for farmers because glyphosate is by far the most popular weed-killing chemical in the world. It is considered relatively benign in environmental terms and safe enough for use in home gardens, and it helps farmers control weeds without the tilling that can contribute to soil erosion.

Weed specialists say it might be hard to find good replacements, in part because the very success of Roundup has cut profits from other herbicides, causing farm chemical companies to reduce investments in developing new ones.

"There aren't a lot of new herbicides coming down the road that will bail us out," said Christy Sprague, a weed specialist at the University of Illinois.

Monsanto executives say that the resistance is not a significant problem. "The reality is, and the facts are that, one, resistance to glyphosate is rare and, two, where it has occurred around the world it is very manageable," said Kerry Preete, vice president for United States markets. Company officials said they expected use of the crops and of glyphosate to continue increasing.

Still, at its annual meeting next month, the Weed Science Society of America is to discuss if Roundup is being overused and will perhaps recommend restraint, said Ian Heap, chairman of the society's committee on herbicide-resistant plants.

And competitors of Monsanto have seen an opportunity to push their own products as alternatives to Monsanto's. [Syngenta](#) is widely advertising its recommendations that farmers limit the use of Roundup and not grow Roundup Ready corn if they are also growing Roundup Ready soy. "If it works on one thing, it might not work on the other," one ad reads, picturing a meal with ketchup slathered on a hot dog and French fries — and also on the apple pie.

Besides soybeans, about 65 percent of the cotton and 10 percent of the corn grown in the United States contains the Roundup Ready gene, according to Monsanto. Roundup Ready canola, an oilseed crop, is widely grown in Canada. Monsanto is also developing Roundup Ready wheat, alfalfa and grass for use largely on golf courses.

The use of glyphosate, both Monsanto's Roundup and generic products, has grown two and a half times since the introduction of the first Roundup Ready crops in 1996. In the Midwest, use of the herbicide has increased even more.

The resistance issue is surfacing at a tough time for Monsanto. The company lost \$1.75 billion in the first nine months of 2002 as sales plunged more than 18 percent, to \$3.45 billion from \$4.25 billion. Its chief executive, Hendrik A. Verfaillie, was forced to resign last month.

With its stock price low, Monsanto is considered a takeover target. Charles Benbrook, an agricultural biotechnology consultant in Sandpoint, Idaho, said he had been approached by two investment banks that were exploring whether Monsanto could be bought and sold off in pieces. "The whole issue is what the Roundup and herbicide-tolerant franchise is worth," said Dr. Benbrook, who has been a critic of Monsanto. And that, he said, depends on how long Roundup herbicide remains effective against weeds.

Opponents of genetically modified crops have long warned that such crops might cross with weedy relatives, giving rise to "superweeds" resistant to herbicides or insects. But the Roundup-resistant weeds that are now causing concern were not created this way, scientists said, but rather through evolution.

The problem was first noticed by farmers in Delaware with a weed called mare's-tail, or horseweed.

Rex Mears of Seaford, Del., said he had been growing Roundup Ready soybeans for several years and all had worked well. But in 2000, he said, some mare's-tail was not killed by the herbicide. Last year, Mr. Mears said, he sprayed Roundup a number of times to try to kill the weeds. "It gets expensive," he said.

Dr. VanGessel of the University of Delaware said the weed now infested 20,000 acres in the Delaware-Maryland-eastern Virginia peninsula and in southern New Jersey. The weed, combined with a severe drought last summer, made some fields a total loss, he said.

The Roundup-resistant mare's-tail has also been found in cotton and soybean fields in western Tennessee and some neighboring states like Kentucky. As many as half a million acres are affected, said Robert M. Hayes, professor of plant sciences at the University of Tennessee.

Crop scientists are also noticing that water hemp, a weed that is abundant in the Corn Belt, is becoming harder

to kill with glyphosate. And resistant ryegrass has appeared in almond orchards in Northern California and in many wheat fields in Australia.

Resistance eventually develops in virtually all herbicides and insecticides, and many products continue to be widely used despite that. What is surprising is that Roundup has been used for nearly 30 years, and resistance has developed only recently.

"It's been an amazing herbicide," said Dr. Heap of the Weed Science Society, who also runs the International Survey of Herbicide Resistant Weeds in Corvallis, Ore. "It's been used all around the world for many years, and we haven't seen much resistance."

The fact that little resistance has emerged so far is reassuring, scientists say, because it suggests that resistance will not spread quickly to other types of weeds. Still, Roundup herbicide is now being used more frequently and in different ways from before.

Scientists say herbicides should be varied to prevent a buildup of resistance. Yet many farmers are now using only glyphosate, they say. Rotating crops usually helps deter resistance because different herbicides are used with different crops. But now some farmers are rotating Roundup Ready soybeans with Roundup Ready cotton or corn, meaning that the same herbicide is used every year. And with Roundup Ready crops, the herbicide may be used both before seeds are planted and while the crops are growing.

When farmers plant the other major type of genetically modified crop, containing an insect-resistance gene known as BT, the government requires a portion of the fields to be planted with non-BT crops in order to slow the development of insects resistant to the toxin produced by the BT gene. But the government has no rules for Roundup Ready crops.

Monsanto officials said that because weeds do not move around like insects, leaving fields free of Roundup Ready crops would not solve the resistance problem. They say the company advises farmers on how to use Roundup herbicide properly to prevent resistance from emerging. For the Roundup-resistant mare's-tail, Monsanto is advising farmers to use another herbicide along with Roundup.

Crop specialists said it might be hard to get farmers to reduce their use of Roundup herbicide and Roundup Ready crops unless the resistance became severe.

"The Monsanto scientists understand" the possibility of resistance, said Joseph Di Tomaso, a weed specialist at the University of California at Davis. "The real problem is the farmers. It's just so darn easy for them to control their weeds with Roundup."