Genetic Resistance a Key To Controlling Aflatoxin

Ask Ron Henning how important the aflatoxin problem is to the peanut industry and you get this response: "On a scale of 1 to 10, it's an 11."

Henning, a scientific consultant to the National Peanut Council, calls aflatoxin the Achilles heel of the peanut marketing system. Produced by certain strains of *Aspergillus* fungi, this toxin can—under drought conditions—contaminate peanuts in storage or in the field.

Aflatoxin is carcinogenic. Peanuts with more than 20 parts per billion cannot be sold for human consumption but must be processed into lower-value products. That, of course, means losses for peanut growers and shelling companies that buy peanuts—meaning a potential loss of jobs and income for rural areas.

Peanut losses from aflatoxin are hard to pin down. They vary from year to year based on weather and other factors, according to Henning and peanut council president Kim Cutchins. In drought years, aflatoxin is usually worse, because the peanuts are weakened and more susceptible to attack from the fungi.

Also, the *Aspergillus* fungi take over to a greater extent in the soil, outcompeting other fungi and producing more toxin.

According to USDA estimates, U.S. growers in 1995 produced about 3.5 billion pounds of peanuts, which not only were sold fresh but wound up in everything from candy bars to peanut butter. Peanuts have become a staple food item in many households, providing a valuable source of protein and other nutrients.

So it's no surprise, Cutchins and Henning say, that aflatoxin remains the industry's number-one food safety priority.

"We're working with all the resources we have to reduce aflatoxin at every level," says Henning, noting that the industry has a goal to eliminate aflatoxin from peanuts by the turn of the century.

A key to reaching that goal, he says, is finding peanuts that have genetic resistance to the fungi that produce the toxin. Two U.S. Department of Agriculture scientists at Tifton, Georgia, have discovered peanut germplasm that resists both aflatoxin-producing fungi and insects that can damage peanut pods.

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Robert E. Lynch, an entomologist with the Agricultural Research Service at Tifton, has been studying the connection between aflatoxin contamination and insect damage since the late 1980's, when he traveled to Burkina Faso, in western Africa, to study peanut damage caused by termites.

These notorious wood feeders are also fond of the cellulose fibers in peanut pods—the outside shells that many a baseball fan has cracked. When termites feed on the pod, they often weaken or pierce it—creating an entrance for aflatoxin-producing fungi, Lynch says.

It turns out that the lesser cornstalk borer also feeds on peanuts in Georgia and other peanut-producing areas of the United States, damaging peanuts in much the same way that termites do.

Lynch and cooperators in Africa have found that two accessions, NCAC 343 from North Carolina and RMP 12 from Africa, were highly resistant to termites when grown under drought conditions in Africa. "Only about 5 percent of those resistant peanuts suffered pod damage, compared to 40 percent damage for susceptible peanuts," he says.

Now Lynch and cooperators are testing those varieties at Tifton and other locations to see if they have the same genetic ability to ward off the cornstalk borer. He says that appears to be the case in preliminary laboratory and field studies.

Meanwhile, Corley C. Holbrook, Jr., an agency plant geneticist also based at Tifton, has analyzed data for the 7,000 accessions in the peanut germplasm collection to develop what is called a core collection—a more manageable group of 831 accessions representing the genetic diversity of the entire collection.

By screening the core collection, Holbrook says he's found peanut germplasm that, in field studies, had 70 percent less aflatoxin than Florunner, a common variety planted in Georgia and other areas.

"We have about 60 accessions that show promise," Holbrook says. "The goal is to identify the best 10 to 20 that can be used to breed resistant varieties."

Holbrook says it is important to find peanut germplasm that resists drought, aflatoxin-producing fungi, and feeding insects. Such germplasm would go a long way toward minimizing the problem, he says, if it could be bred with Florunner and other varieties that produce high yields and top-quality peanuts.

Florunner, released by the University of Florida in the early 1970's, still accounts for about 50 percent of peanut acreage but is not aflatoxin resistant. "Right now, we don't have any aflatoxin-resistant peanut varieties," Holbrook says.

At the National Peanut Laboratory in Dawson, Georgia, researchers are taking a slightly different approach. They are working with private companies to develop ways to mass-produce *Aspergillus* strains that do not produce aflatoxin.

The Dawson scientists found that spreading the harmless fungi in the soil crowds out the aflatoxin-producing strains—serving as a biological control against contamination. ARS and outside cooperators plan field tests to develop ways to mass-produce and deliver the harmless fungi as a commercial product peanut growers can use.

And ARS researchers at New Orleans, Louisiana, are looking at how the fungi form aflatoxin—with an eye toward finding ways to block the fungi's toxin production.

Henning says all these approaches will ultimately be needed to effectively control aflatoxin in peanuts. "I don't think there's a silver bullet," he says. "We have to approach this from a lot of different angles."**—**By **Sean Adams,** ARS.

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Microbes Clean Up Wastewater

A microbial cleanser of water pollution does its best work when surrounded by neither too many nor too few of its own kind—and when it has developed a taste for junk food.

This phenomenon, seen in an ARS laboratory, is stimulating new thinking about finding and harnessing nature's talent for detoxifying industrial wastewater—an approach called bioremediation.

Baqar R. Zaidi, associate professor of marine microbiology at the University of Puerto Rico, found the bacterium *Pseudomonas putida* surviving—but not flourishing—on nitrophenol wastes at a petrochemical plant in Guayanilla, Puerto Rico. The plant had been closed because of concern for the island's coastal waters environment.

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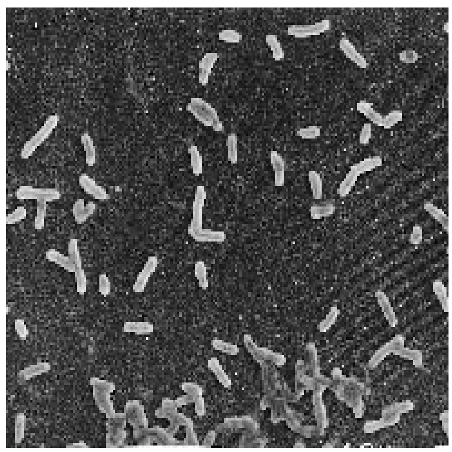

A strain of *Pseudomonas putida* bacterium thrives on a diet of nitrophenol—a chemical byproduct of some manufacturing processes. Magnification about 3,000X.

Nitrophenols are generated by industries involved with dyes, explosives, leather, paper, and wood. In high concentrations, they can be toxic to plants, fish, and other life forms.

An industry/University of Puerto Rico consortium granted Zaidi support for further research. And ARS chemists Richard V. Greene and Syed H. Imam at the National Center for Agricultural Utilization Research (NCAUR) in Peoria, Illinois, shared their laboratory facilities and expertise on biodegradation.

Included in the research was a strain of *Corynebacterium* bacteria that Zaidi, while a postdoctoral researcher at Cornell University, had isolated from Cayuga Lake near Ithaca, New York.

By culturing each strain in a series of otherwise sterile liquid diets with increasingly large amounts of nitrophenols, Zaidi developed strains of each that could survive only if they had their needed dose of the toxic soup. But in a nonsterile environment more like the real world, only the *P. putida*—added in amounts not too large nor too small—reduced nitrophenol concentrations to levels regarded as nonpolluting.

"Until we did this research, we had thought that bioremediation on highly concentrated pollutants would also work at lower levels," says Imam.

That assumption could cause some good microbes to be overlooked.

And the finding may encourage more on-site bioremediation—before wastewater is released into the environment. The scientists envision sequential steps, with different microbes taking turns digesting toxic organic molecules.

The research was begun through NCAUR's Outreach Programs, in which ARS scientists are encouraged to develop collaboration with scientists at 1890 Land-Grant Institutions.—By **Ben Hardin,** ARS.

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