Fungal fight in the desert

By Erin K. Peabody, ARS–USDA Information Staff

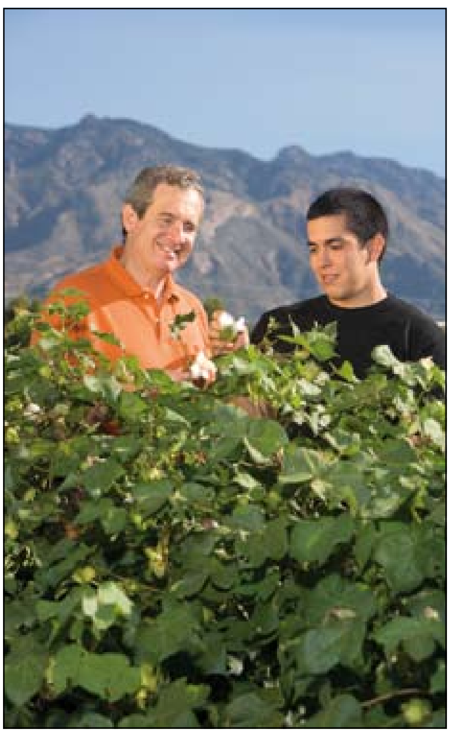
Plant pathologist Peter Cotty watches a dust cloud billow up over the baking Tucson, Arizona, desert. Oddly enough, it's got him thinking about one thing: fungi.

Despite the parched air and blazing temperatures, microscopic communities of fungi, including Aspergillus species, are thriving all around there.

"*A. flavus* fungi are found throughout the Southwest," says Peter, who is part of ARS's Food and Feed Safety Research Unit in New Orleans, La., but is based at the University of Arizona-Tucson. "They live in agricultural soils and desert soils, on crops and native plants—even in the dust and air."

The problem with some *A. flavus* fungi is that, as they invade agricultural fields, they can produce potent poisons. The carcinogenic compounds they make, a type of mycotoxin called "aflatoxin," are a major concern for US cotton growers. That's because cottonseed is an important feed source of the nation's dairy herds. Toxins in contaminated cottonseed transfer to the animals' milk.

To ensure that aflatoxin never makes its way into milk or other foods, the Food and Drug Administration has established a stringent 20-parts-per-billion limit on these mycotoxins in cottonseed and in other crops vulnerable to toxic molds—including corn, peanuts, pistachios, almonds, walnuts, and figs.



Plant pathologist Peter Cotty (left) examines cotton in an Arizona research field with University of Arizona graduate student Alejandro Ortega-Beltran. (Photo: Peggy Grebb)

A little competition among fungi could help save the cotton crop.

Because of these troubling toxins, farmers lose profits and export opportunities. And natural resources, like irrigation water and fertiliser, are inefficiently used. Every year in the Southwest, toxin-producing fungi ruin $3 to $8 million worth of cottonseed.

THEY'RE NOT ALL THE SAME

But not all *A. flavus* fungi have a bad reputation. In fact, there's much diversity among the *A. flavus* bunch. For instance, some strains, Peter says, like the S strain, can pump out incredibly high levels of aflatoxin. "It's not unusual," he says, "for an S strain isolate to produce more than one million parts per billion of aflatoxin in the lab."

In contrast, many *A. flavus* strains are essentially harmless. They lack the genetic equipment needed to churn out poisonous aflatoxins. And it's one particular nontoxic strain that Peter is banking his hopes on.

Eighteen years ago, Peter discovered a strain of *A. flavus*, called AF36, that not only lacks the ability to produce toxins, but can also outcompete and outlive fungi that do.

In 1996, after many laboratory and field studies, ARS was awarded approval from the US Environmental Protection Agency (EPA) to test the biocontrol fungus in commercial fields in Arizona. When tests under an experimental-use permit were successful, EPA awarded a Section-3 pesticide registration for the fungus, allowing treatments of unlimited acreage in Arizona and Texas. California was added to the label in 2005.

Ten years ago, only 120 acres of commercial cotton were treated with AF36. Since that time, AF36 has been sprinkled, sprayed, and dropped onto well over 100,000 experimental acres of southwestern cotton. And it's making a serious dent in the populations of toxic *A. flavus* fungi present in those fields.

"We routinely observe more than 80-per cent reduction in aflatoxin-producing fungi in cottonfields in Arizona and Texas after treatment with AF36," says Peter.

A FIELD GUIDE TO AF36

To optimise the biocontrol's chances for success, Peter is drafting cultural recommendations that he can pass on to growers interested in using AF36. So far, after multiyear field studies in both Arizona and Texas, he's found that both soil type and crop rotation type influence fungal community structure.

"High-clay soils and cotton rotations," Peter says, "favor the incidence of the S strain." He and Ramon Jaime-Garcia of the University of Arizona have linked this particular strain to some of the most severe aflatoxin outbreaks in cottonfields in southern Texas. With this information, growers now know they should target their control efforts on this especially potent strain.

ARS biological science aid Alix McCloskey and University of Arizona scientist Ramon Jaime-Garcia examine wheat kernels containing a strain of *Aspergillus flavus* that acts as a biocontrol agent against strains of *A. flavus* that produce aflatoxin. The kernels are sterile, so they won't germinate when applied in a field; instead, they will be a food source for the biocontrol agent to establish itself. (Photo: Peggy Grebb)

Peter and Jaime-Garcia have also found that corn-cotton rotations growing in southern Texas and treated with AF36 need prompt harvest. Leftover corncobs can serve as "oases" for poison-producing *A. flavus* fungi, providing them a critical food source and refuge through the winter season.

WHEN DEFECTIVE IS DESIRABLE

Peter is also addressing concerns that AF36 could evolve in the field over time, somehow gaining the ability to make toxins. To help assuage such worries, Peter needed proof that his AF36 strain is inherently nontoxic.

Now, he's got that proof. Last year, Peter and colleague Ken Ehrlich of ARS's Food and Feed Safety Research Unit in New Orleans, Louisiana, confirmed that it simply isn't in AF36's genes to produce aflatoxins. In fact, according to the scientists scrutinizing its genetic material, the fungus possesses defective genes. Without normal versions of such genes, AF36 cannot create the gene products needed for making aflatoxin.

Furthermore, Peter and Ehrlich defined the specific genetic kink that makes AF36 so different from its *A. flavus* cousins. This finding means that AF36 can be monitored easily and rapidly in the field.

A MASS-PRODUCTION LINE

As with most beneficial microbes, the AF36 fungus has little practical value until it can be mass-produced. On this front, Peter has succeeded, too. Along with the grower-run Arizona Cotton Research and Protection Council (ACRPC), Peter has helped develop a commercial-scale process for making large quantities of AF36.

In this southwestern corner of the United States, the future is bright for AF36. In the last 10 years, it's helped reduce aflatoxin levels by up to 90 percent. And Peter expects that its use will spread. "We know that pistachio growers in California and corn growers in the Southwest are also interested in tapping AF36's potential," he says. "I'm hopeful they'll get the chance."

This research is part of Food Safety, an ARS national program (#108) described on the World Wide Web at www.nps.ars.usda.gov.

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"A Fungal Fight in the Desert" was published in the August 2007 issue of Agricultural Research magazine.

Guide to cotton pest management

Queensland DPI&F Principal Entomologist, David Murray, has issued some new guidelines on the latest developments in Integrated Pest Management for sucking pests in cotton.

Speaking on the CSD Web on Wednesday video after a recent IPM research workshop, he said a major problem remains the impact of broad-spectrum chemicals on natural enemies of cotton pests.

He noted that pyrethroids, the organophosphates (like dimethoate and omethoate) and more recently increased usage of fipronil (or Regent) for green mirid control, have the potential to adversely affect natural enemy numbers.

"Take away natural enemies and you run the risk of increasing the numbers of secondary pests, particularly those like silverleaf whitefly, which is one of several pests that potentially can be a major issue for the cotton industry.

"We are also concerned that as we see more and more treatments being applied for green mirids on Bollgard II crops, we run the risk of selecting for resistance to these products."

In regard to thresholds used for mirids in the field, David said current thresholds are the result of trials conducted by Dr Moazzem Khan, Qld DPI&F entomologist.

"Moazzem's data shows that 50–60 per cent retention can be compensated for in a high yielding crop, but one of the concerns has been the use of insurance sprays in treating sub-threshold populations of green mirids, and that is something we want to avoid if possible.

"Later in the season during the boll stage (peak flowering, early bolls), that's when the mirid threshold is again critical, not from fruit loss per se, but more from feeding on those young bolls, causing them to fall off or damage developing lint within those early bolls."

David said the origin of mirids in the field plays a major role in the development of resistance.

"Clearly if we have major flights of mirids arriving from sources elsewhere, resistance is less of a concern for us, but until we know definitively that local populations are not contributing to the broader population to a large extent, we have got to be careful in the way that we manage insecticides.

Dr David Murray.

"Hence the concern about the increased use of fipronil for green mirids and the potential there for developing resistance. So I guess it is work underway and the outcome will vary from year to year."

He noted that research by Dr Mary Whitehouse from CSIRO has flagged a number of predators that are important for green mirid control with some of the spider species, particularly the Lynx spiders, towards the top of the list.

"Their potential is certainly to reduce numbers of green mirids through direct predation and some of these spiders are quite effective in tackling larger nymphs and adults. Data suggests that fruit retention can improve when you have these predators active in the crop.

"As far as parasitism is concerned, to my knowledge we have not recorded any parasitoids, so there is nothing currently suggesting that parasitoids are important for the mirid species that we have."

David also noted research by Alice Del Socorro and Peter Gregg from the University of New England and the Cotton CRC looking at pheromones (sex attractants) that attracts green mirid males, which is showing some potential.

"The other area, and really it's an area of preliminary work, is the use of plant volatiles to attract particularly female mirids, but at this stage the work is in a preliminary stage."

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