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Workers inspect a banana harvest at a farm in Australia.

GENETICS

CRISPR could save bananas from fungus

Researchers are using the gene-editing tool to boost the fruit's defences against a deadly pathogen.

BY AMY MAXMEN

The race to engineer the next-generation banana is on. The Colombian government confirmed in August that a banana-killing fungus has invaded the Americas — the source of much of the world's banana supply. The invasion has given new urgency to efforts to create fruit that can resist the scourge.

Scientists are using a mix of approaches to save the banana. A team in Australia has inserted a gene from wild bananas into the top commercial variety — known as the Cavendish — and is currently testing the modified fruit in field trials. Researchers are also using the precise gene-editing tool CRISPR to boost the Cavendish's resilience against a deadly strain of the *Fusarium* fungus, called tropical race 4 (TR4).

Breeding TR4 resistance into the Cavendish using conventional methods isn't possible because the variety is sterile and propagated by cloning. So the only way to save the Cavendish might be to tweak its genome, says Randy Ploetz, a plant pathologist at the University of Florida in Homestead.

James Dale, a biotechnologist at Queensland University of Technology in Brisbane, Australia, started getting enquiries about his genetically modified (GM) bananas in July, when rumours first surfaced that TR4 had reached Colombia. "Then Colombia declared a national emergency," Dale says, "and now the amount of interest is through the roof."

This isn't the first time that a commercial banana variety has faced extinction. In the first half of the twentieth century, another strain of the *Fusarium* fungus, called TR1, nearly wiped out the top banana at the time, the Gros Michel. But farmers had a backup in the Cavendish, which was resistant to TR1, tough enough to withstand transport and had a broadly acceptable texture and taste. By the 1960s, big banana growers such as Chiquita, now based in Fort Lauderdale, Florida, were switching to the Cavendish.

There's no easy alternative this time, says Rodomiro Ortiz, a plant geneticist at the Swedish University of Agricultural Sciences, Alnarp.

And the fungus is a tough opponent. It can't be killed with fungicides, and it can linger in soil for up to 30 years. That has helped TR4 spread around the world, probably by hitching rides on contaminated equipment or in soil. The strain began destroying banana crops in the 1990s in Asia before invading Australia, the Middle East, Africa and now the Americas. Researchers say that the Cavendish could become nearly extinct in the next several decades unless they can modify it to resist TR4.

Dale's team has focused on altering Cavendish plants by inserting a gene from the wild banana *Musa acuminate malaccensis* that confers resistance to TR4 (J. Dale *et al. Nature Commun.* **8**, 1496; 2017). Fifteen months ago, the researchers planted transgenic Cavendish on half a hectare of land infested with TR4 in northern Australia. The transgenic bananas are doing well, Dale says, whereas about one-third of the regular bananas that he planted for comparison are infected with the fungus.

He plans to apply to Australian regulators for approval to market a transgenic Cavendish after the study ends in 2021. But it's impossible to predict whether officials will give the go-ahead, or how long approval might take.

GOING BANANAS WITH CRISPR

In an attempt to make biotech bananas more palatable to regulators, Dale is also editing the Cavendish's genome with CRISPR to boost its resilience to TR4, instead of inserting foreign genes. Specifically, he's trying to turn on a dormant gene in the Cavendish that confers resistance to TR4. But "it'll be a couple of years before these get into the field for trials", Dale says.

Other researchers are using CRISPR to bolster the Cavendish's defences in different ways. Leena Tripathi, a molecular biologist at the International Institute of Tropical Agriculture in Nairobi, Kenya, is using the gene-editing tool to suppress Cavendish genes that seem to render the plant vulnerable to TR4. So far, she has edited Cavendish tissue in the lab, but still needs to grow them into plants that can survive TR4.

And Tropic Biosciences, a biotech start-up in Norwich, UK, is trying to use CRISPR to essentially boost the banana's immune system. All plants produce small RNA strands that control the activity of some of their own genes. And recent studies suggest that some of these RNA strands can sometimes suppress genes in pathogens, crippling the invaders (C. Y. Huang *et al. Cell Host Microbe* **26**, 173–182; 2019). The company is attempting to edit RNA strands in the Cavendish so that they silence genes in TR4.

But it's unclear how regulators will greet gene-edited bananas. In 2016, the United States decided not to regulate a CRISPR-edited mushroom, suggesting it might treat edited bananas similarly. And several countries including Colombia, Japan and Israel have released official statements indicating that they might also be lenient on CRISPR-edited crops. The European Union, however, plans to evaluate gene-edited crops as strictly as it does other GM foods.

Ortiz supports scientists' engineering efforts, but cautions against focusing solely on a biotech solution to the banana scourge. There are more than 1,000 types of bananas, he says. They don't ship as well as the Cavendish, or taste the same, but Ortiz says that commercial growers could try creating a market for other varieties.

"We should tap into the diversity available," he says, "and have a marketing campaign that says you can enjoy the banana in other ways." ■