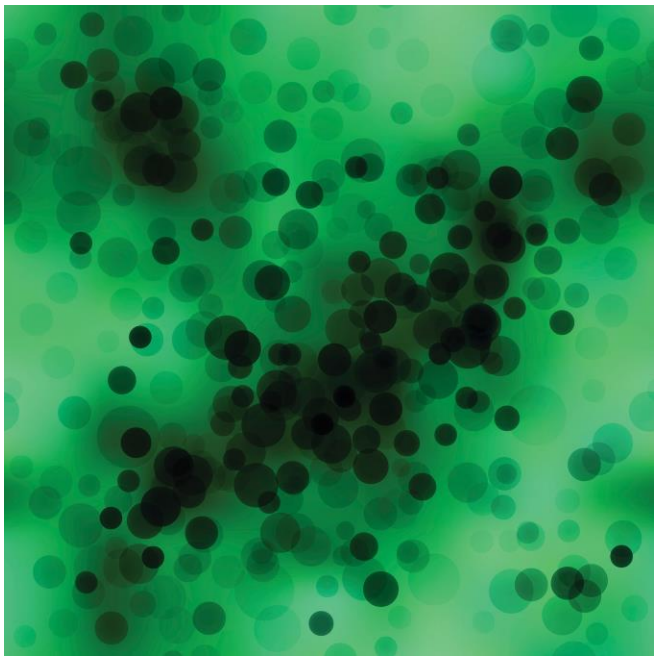
Good Riddance Chemicals: Microbes Are Farming's Hot New Pesticides

Source: wired.com

Published: March 21, 2016



Getty Images

Sarah Zhang

Organics are in. Chemicals are out. With today's food politics, the chemical fertilizers and pesticides that fantastically increased agricultural yields in the 20th century are looking...not so hot. So instead of synthesizing new chemicals, ag companies are trying out a new strategy: They're looking to nature for inspiration.

Where in nature? Just about anywhere—in plant extracts, in soil microbes, in spider venom. It might sound retrograde, but these so-called biologicals are a bit more advanced than throwing compost in your soil. Whether pesticides or growth stimulants, carefully-designed, naturally-derived products are the current agricultural darlings, attracting both startups and heavyweights like Monsanto, Bayer, and DuPont by the billions of dollars. "They're approaching critical mass," says Sara Olson[1], an analyst at the market research firm Lux Research. "This is a new frontier for crop protection and crop management."

The flood of money into biologicals is new, but the idea itself is not. Organic farmers have long used bacteria called* Bacillus thuringiensis *as a pesticide, and the gene for its insect-killing toxin is genetically engineered into most corn and cotton grown in the US. The industry would

love to find other agriculturally useful biochemicals—and the genes that generate them in certain bugs. The hard part is finding the one or two or even ten useful microbes out of billions that live in a handful of soil.

How do you solve that problem? If you're Monsanto, you throw a ton of money at it. In a partnership with Novozymes, Monsanto is testing 2,000 bacteria isolated from soil around the world. The company is looking for bacteria that can keep insects, weeds, and fungi at bay, along with bugs that might boost the growth of the plant. Robb Fraley, Monsanto's chief technology officer, compared the strategy to what's going on in medicine. "The human microbiome has been a breakthrough for human medicine," he says. "I think the crop microbiome will become a breakthrough for crop production." Monsanto's big competitors like Bayer and DuPont are sifting through microbial strains, too.

Smaller companies like BioConsortia, NewLeaf Symbiotics, and Indigo Agriculture have also proliferated in the race to find biostimulants, which like fertilizers boost plant growth but are not synthetic. That could include extracts from seaweed or peptides from other plants. There's a reason small companies see an opening: Biostimulants are lightly, if at all, regulated by a patchwork of state laws instead of the federal Environmental Protection Agency. "Everybody and their brother are jumping into biostimulants," says Pam Marrone, founder and CEO of Marrone Bio Innovations.

Marrone takes another tack with microbes. Her company specializes in biopesticides, which do fall under EPA regulation. But because naturally derived pesticides are ostensibly safer, the EPA usually requires fewer tests of them. A chemical pesticide might take 3 years to get environmental approval; a biopesticide, half that time. Biopesticides are also certified for organic farmers, who make up the bulk of Marrone's customers. And non-organic farmers may soon need more of them, too: The EPA is currently reassessing a popular class of chemical insecticides called neonicotinoids for their impact on bee health, and it's already proposed restrictingtheir use during bee season.

Marrone has four biopesticides on the market for use against insects, nematodes, fungi, and crops. All of them come from intensive screening of 18,000 bacteria back when the company first started. The company is now working on a microbial herbicide to round out its suite of crop protection products. (However sound its science, though, the company is facing some business distractions: Accounting irregularities led to theindictment of a former executivefor securities fraud earlier this year.)

Despite all the enthusiasm about biologicals, screening thousands of microbes is basically an expensive fishing expedition. "The challenge is the gap in basic knowledge," says Olson. Ag companies have spent decades synthesizing chemicals, and they know how those chemicals work. With microbial strains, they're fishing for something that works, but they rarely know why. And you can't get to more targeted discovery without understanding biological mechanisms.

Even next-generation DNA sequencing, commonly used for studying microbes living on humans, doesn't help here. "When we try to analyze a really complex matrix like soil, basically

the system breaks down," said Judson Ward, principal scientist at the berry supplier Driscoll's, at a panel on biological solutions at the World Agri-Tech Investment Summit in San Francisco last week. Next-generation sequencing works by chopping up all DNA in a sample and aligning the snippets against known bacterial genomes. But with soil bacteria, scientists just don't have that many known genomes to work with.

A lot of unknown soil bacteria are out there, but ag companies are betting that at least some of them might be gold.

[1]UPDATE 1:30 PM ET 3/21/16: This story has been updated with the correct spelling of Sara Olson's name.