

November 2002

FarmJournal

The Magazine of American Agriculture

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November 2002

This grain-handling system started with bins built 30 years ago, and leaves room for the future. See "An Eye for Expansion" by Charlene Finck, on page 22.

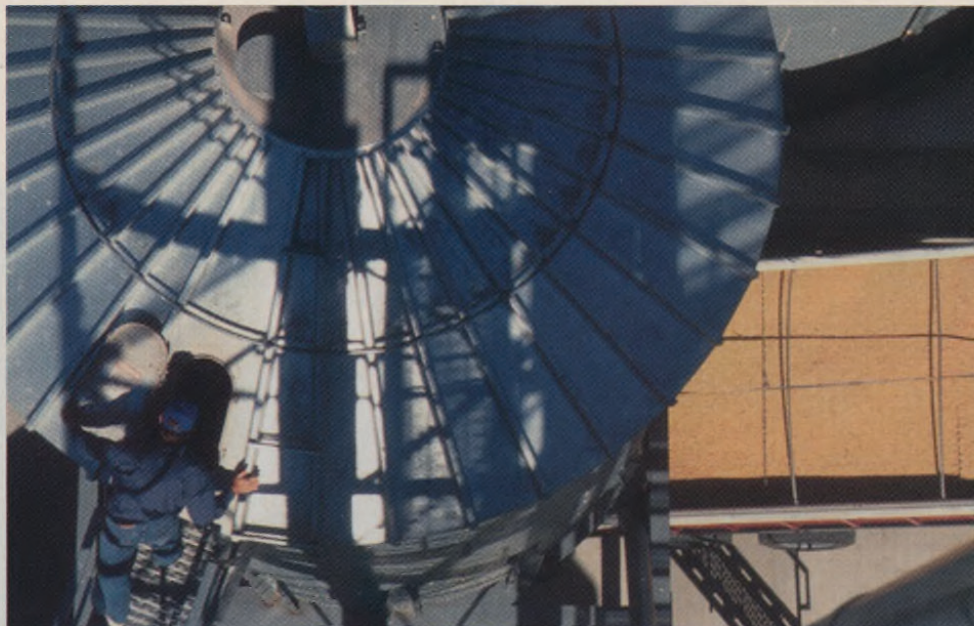


PHOTO: GREG TOMLINSON

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PHOTO: BYRON LEE

The Best Tools to Tile 8

The popularity of pull-type tile plows has the drainage industry split on which tools work best under various conditions. *By Charlene Finck*

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For the first time, denizens of the rhizosphere are getting their photographs taken. Here's a first look at the microbes that live in your soil. *By Darrell Smith*

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Farm input prices hinge on Iraq and tight supplies. Maximum-price contract programs help. *By Katie Humphreys and Jeanne Bernick*

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PHOTO: ANDREW BURCHETT

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Hide that truck hitch till it's time to tow. *By Pam Henderson*

Bt's New Bite 42

In coming years, look for *Bacillus thuringiensis* to take on more bugs, killing some twice. *By Andrew Burchett*



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PHOTO: PAM HENDERSON

On our cover

An image of *Ametoproctus ores-bios*, a fungus-eating soil mite, is captured by a scanning electron microscope. Photo: Byron Lee

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The Agricultural Research Service's Crop Sequence Calculator CD helps you plan optimal crop rotations using 100 combinations of 10 crops.

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New combines are coming soon. Also see a luxury pickup that's built tough, a compact tractor with brains and a digitally controlled sprinkler that reaches ragged field edges.

PHOTO: PAM HENDERSON



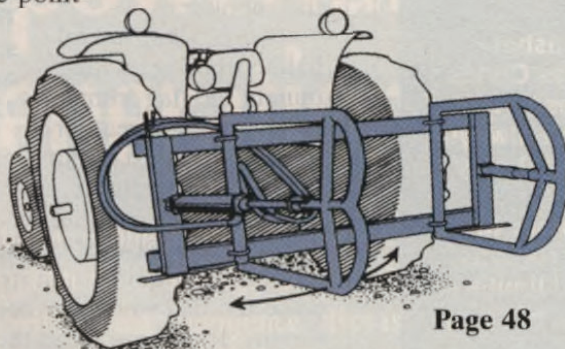
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Freestall pipes from a dairy barn, a box beam and a hydraulic cylinder are all it took to make a three-point-hitch bale mover.

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Tourism breathes new life into a vintage fruit farm. A recipe for "Curried Fruit" is a family favorite.



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A strong livestock sector is necessary for crop producers to thrive.

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Bt's New Bite

In coming years, Bt will take on more bugs, killing some bugs twice

By Andrew Burchett

If an insecticide could have a legacy, the soil bacterium *Bacillus thuringiensis* (Bt) and its bug-busting proteins would be the granddaddy of them all. By some accounts, Egyptians probably knew about Bt thousands of years ago. In 1901, it was discovered in Japan. By the mid-1900s, it was developed into commercial insecticide products for topical use—126 are currently registered in the U.S. However, Bt didn't come into its own until 1996, when transgenic corn, cotton and potatoes with Bt genes entered the market.

Expect 2003 to be another red-letter year as a flush of second-generation Bt crops arrives. The new Bt products control more insects than the first wave.

Corn growers now have the option of purchasing a new Bt trait developed by Dow AgroSciences LLC and Pioneer Hi-Bred International Inc., a DuPont company. Branded as Herculex I, the trait expresses in corn the Cry 1F protein, which is toxic to black cutworm, fall armyworm, southwestern corn borer and European corn borer. At press time, Monsanto is expecting to receive full registration of its new YieldGard Rootworm product this fall. The new product uses the Bt



PHOTOS BY THE AUTHOR

The roots tell the story at Monsanto's rootworm-infested experimental use plots near Yuma, Colo. Above, Todd DeGooyer, crop technology development manager, compares a plant protected by rootworm-resistant Bt, on the left, with a plant guarded by conventional insecticide. Monsanto chief technology officer Robb Fraley, left, demonstrates the difference above ground.

protein Cry 3Bb to protect corn against corn rootworm.

A subsequent registration of Monsanto's YieldGard Plus is expected for the stacked combination of the Cry 1Ab protein, currently used to control European corn borer, with the new corn rootworm trait, says Jennifer Ozimkiewicz, Monsanto's corn traits marketing manager. If full registration is received in time to produce seed for next year, growers can expect to see a limited offering of both the corn rootworm and the stacked trait.

Monsanto's new Bollgard II cotton

will also hit the market next year. See "Cotton's Second Generation."

While the industry is doting on new Bt arrivals, even more products are being considered. "Nature has given us a richer toolbox to fight insect pests than the best research lab could have conceived of. There is no real limit to the application of Bt technology to agricultural systems," says Monsanto's chief technology officer Robb Fraley. He says his company has a library of more than 8,000 Bt proteins, with only a handful used in today's Bt crops.

Many Bt proteins are currently be-▶

ing developed for new crop traits. Monsanto is creating a Bt soybean, which has performed well against insect pests, such as the velvetbean caterpillar—a leaf-eating pest found in southern states. Other exciting activity includes improvements and new competition in current Bt crops.

The Dow AgroSciences-Pioneer Hi-Bred collaboration expects to develop the Bt proteins Cry 34/35Ab1 in order to offer growers another choice of corn rootworm-resistant Bt hybrids. A product launch could occur in 2005, says David Borgmeier, marketing specialist for Dow AgroSciences. Nick Storer, senior research biologist for the company, says the product is unique because it uses two proteins in a single mode of action against corn rootworm.

Syngenta has a corn rootworm-resistant Bt trait targeted for 2005, says Mike Moss, Syngenta's head of biological research and development. There will also be another Bt trait for European corn borer, which can be stacked with the company's rootworm or existing corn borer traits.

Long lasting. In 2004, Dow AgroSciences plans to launch its own Bt cotton through its PhytoGen brand and license the trait to the industry. The product will use the Bt proteins Cry 1F and Cry 1Ac, which will provide cotton growers with an alternative to Monsanto's Bollgard II trait. In addition to a broad spectrum of resistance, Duane Canfield, cotton marketing specialist, says the new Bt cotton plant's insecticidal traits won't taper off later in the season.

Cotton and corn Bts can be stacked with herbicide resistance traits, too. Bt varieties in both crops can be combined with the Roundup Ready glyphosate-resistance trait. In the case of Herculex I corn, the Liberty herbicide trait that makes plants tolerant of glufosinate comes standard. However, the industry is looking at another type of trait stacking to reduce the chances of target insects developing resistance to Bt traits.

"When you talk about an ideal insect resistance management plan, stacking two novel proteins, each with high efficacy against the pest and with different modes of action, would in-

crease the long-term durability of a product," says Storer. That way if a few pests turn up with a random mutation that allows them to survive eating one Bt protein, the second one will kill them and prevent the mutants from reproducing. Currently, refuge requirements for Bt crops rely on nearby non-Bt crops providing enough Bt-susceptible survivors to overcome resistant mutants by breeding with them.

"Essentially, all invertebrate plant pests can be managed with Bt technology," says Fraley. "As scientists start to incorporate multiple Bt proteins into plants, targeting multiple pests, you can foresee the ability for insect control to be based predominantly on biological rather than chemical approaches."

Manipulating the toxicity of Cry proteins is another frontier. Donald Dean, professor of biochemistry, molecular genetics and entomology at the Ohio State University, says protein engineering can increase toxicity

of Bt proteins for target pests from a few-fold to as high as 2,000-fold in some cases. Protein engineering also can make toxicity more specific, reducing potential impacts on non-target organisms.

Other possibilities that may one day improve transgenic Bt technology include gene expression technology that enables inducible expression of insecticide proteins. A theoretical example is a plant that would produce insecticide only in tissues where insects are feeding.

Advancements with plastid transformation show promise, too. Certain crops, including corn, do not inherit plastids in their pollen. Plastid transformation would prevent the spread of Bt traits through pollen.

Researchers also are looking elsewhere to find proteins that kill crop pests. "We're looking at bacteria [other than Bt] associated with insect parasites to find insecticidal activity," says Storer. That means the Latin initials "Bt" could be joined by those of another organism for future generations of insect-resistant crops. **F**

"Essentially, all invertebrate plant pests can be managed with Bt technology"

Cotton's Second Generation

Blake Layton is impressed with the results he's finding in second-generation Bt cotton plots. An end-of-season damaged boll count conducted by the Mississippi State University Extension entomologist in unsprayed Bollgard II plots showed less than 1% boll damage, compared with more than 4% in original Bollgard and 13% in conventional cotton plots.

"Control with Bollgard II is as much better than original Bollgard, as Bollgard was better than conventional cotton," he says. "We have seen only low levels of boll damage from bollworm in unsprayed Bollgard II plots. Bollgard II also looks better than the original Bollgard against armyworms and loopers."

The extra control is thanks to the expanded spectrum of the new Bt cotton, which has the Cry 2Ab gene as well as Cry 1Ac that is in the initial version. That stacking provides

additional control for beet armyworms, fall armyworms, soybean loopers and bollworms.

It's likely that cotton growers will embrace second-generation Bt cotton as quickly as they did the original Bt, which hit the market in 1996. In Mississippi, Bollgard acreage has climbed from 37% that year to 80% in 2001, and in Louisiana, it has increased even more dramatically from 21% in 1996 to 87% last year.

Although Monsanto had not received regulatory approval for second-generation Bt cotton at press time, seed companies are set to have limited supplies available for 2003. Delta and Pine Land has two varieties for limited release in January 2003. Stoneville Pedigreed also has two varieties waiting in the wings, but expects its major launch in 2004, as does Bayer CropSciences' FiberMax.

BARBARA FAIRCHILD



Cotton bollworm