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Chemically Speaking

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RNAi Insecticides Coming

With corn rootworm building resistance to genetically modified corn that makes its own pesticide, seed companies are working on new crops that target the insects' genes. A decade ago, researchers developed corn genetically modified to produce a protein that kills the bugs, allowing farmers to back off chemical pesticides. However, the effectiveness of Bt corn is beginning to decrease, leading farmers across the Midwest to revert to older management schemes. Seed companies are preparing a new solution: RNA-interference, sometimes called gene silencing. Researchers using the technology introduce a strand of RNA that essentially stops an organism ingesting the molecule from expressing a certain gene.

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Genes are expressed through RNA that is transcribed from DNA. By introducing a piece of interfering RNA, a gene can be suppressed. RNA-interference, or RNAi, is a natural way plants and animals fight off viruses, but scientists use it as a genetic on/off switch to study and manipulate plants. Tom Clemente, a researcher in plant biotechnology at the University of Nebraska Lincoln, says RNAi was discovered in plants when researchers were trying to make flowers darker. "They were trying to make a darker, purple flower and they were getting white flowers," Clemente said. "They were trying to make more of this protein and they were making zero of the protein."

As RNAi is being studied to treat human diseases from cancer to high cholesterol, RNAi crops are already in the field. "The classic example is for virus resistance," Clemente said. "In the state of Hawaii, the entire papaya population is papaya ringspot virus (resistant) and it is a form of RNAi that provides that resistance."

Corn could be the first row crop to attack an invading insect with RNA. Monsanto hopes to commercialize rootworm resistant corn with RNAi by the end of the decade. When a rootworm eats the corn roots, it would ingest interfering RNA that would silence a gene the rootworm can't live without. "It blocks expression of that particular gene – no other gene – and impedes the life cycle of that rootworm," Clemente said.

The question goes to the Environmental Protection Agency (EPA). At a meeting in early 2014, scientists from around the world will advise the EPA on how to assess the potential risks of RNAi crops. For his part, Tom Clemente doesn't believe the technology warrants extra scrutiny. "You can dial it in to be very specific for a gene in a particular organism," Clemente said. "Now, we can never say with a straight face that would mitigate any collateral damage in any other organism. But you can mitigate that probability to a very, very small number." Clemente says, when paired with Bt in corn, RNAi would give farmers a more durable weapon against rootworms. (*KCUR.org*, 12/30/13).

Increased No-Till/Decreased Carbon Dioxide

Dr. John Baker, who was a finalist for the World Food Prize in 2013, says that while most local bodies have robust policies to address air and water quality, they overlook soil quality. Farmers who have good quality soil have less runoff after heavy rain events, he says. "The better the quality of the soil, the better the infiltration and water holding capacity at depth and therefore the lower the risk of fertilizer leaching off the land and contaminating water. That is why any environmental policy should include the impact of soil quality coupled with its ongoing destruction by conventional tillage."

He warns that conventional tillage such as ploughing progressively destroys soil organic matter by oxidation and therefore should be discouraged. Plowing releases carbon into the atmosphere and depletes the micro-organisms which enrich the soil. Eventually it will lead to crop failure, soil erosion and in extreme cases, famine. The vast majority (95 percent) of carbon dioxide is released from soil during plowing with the other five percent coming from tractor exhausts while the reseeding can contribute over a ton of carbon dioxide per acre. When examined from a global level, 15-20 percent of the carbon dioxide in the world's atmosphere comes from plowing.

Dr. Baker has been researching low-disturbance no-tillage for 40 years and invented and manufactured a low-disturbance no-tillage drill that penetrates through crop residue on top of the ground and sows seed and fertilizer directly into unploughed ground. No-tillage causes minimal disturbance to the soil, traps the humidity, preserves micro-organisms and soil life, largely prevents carbon from escaping into the atmosphere and significantly improves crop yields. However, poor no-tillage and minimum tillage achieve few of these things. (*Farming Online News*, 1/15/14).

Cotton Weed Control Currently Unsustainable

For nearly a decade, southern cotton growers have been battling to save crops from glyphosate-resistant Palmer amaranth. Though in many ways they are finally gaining the upper hand, an expert with the Weed Science Society of America says progress has come at a great cost. "The current model simply isn't sustainable," says Stanley Culpepper, a professor in crop and soil science at the University of Georgia and member of WSSA. "Growers have gone to war, and they are making progress from a weed management perspective, but not from an economic or environmental perspective. We need to figure out a way to get the same result far more cost effectively and in a way that better protects our natural resources."

Palmer amaranth became a problem in cotton after growers began to rely solely on glyphosate for weed control. After repeated and exclusive exposure to the chemical, resistant weeds began to appear. It was clear that growers would need to make significant changes in their weed control practices or lose their crops. Current integrated weed management programs complement glyphosate with a variety of other weed control tools and techniques that have become commonplace in cotton. They also are using two approaches that may seem decidedly "old school."

More than 90 percent of cotton growers in Georgia are now hand-weeding a significant portion of their cotton crop, Culpepper says. They also are tilling more to keep Palmer amaranth at bay. Though the multifaceted approach is working, there are definite downsides. Additional herbicides, labor and fuel have tripled the cost of weed control in cotton and that means profit margins are declining. In addition, increased tillage raises concerns about soil erosion from water and wind.

Scientists and growers are collaborating on new options. One of the latest involves the use of heavily planted winter rye as a cover crop for cotton. Once the rye is established, it is rolled down to create a thick, horizontal bed of mulch that can reduce Palmer amaranth infestations by as much as 70 to 90 percent. The impact of glyphosate resistance on cotton represents a cautionary tale for anyone relying on a single herbicide mode of action for weed control, scientists say. If the resistance "tipping point" is reached in a crop, it can be very costly to turn back the tide. (*Delta Farm Press*, 1/13/14).

Studies Confirm Non-target Safety of Bt Proteins

A large body of literature has shown that genetically-modified plants that produce proteins from the bacterium *Bacillus thuringiensis* (Bt) to protect themselves from insect pests have little to no

effect on a wide range of nontarget insects. However, concerns about Bt crops still exist. Two new studies using more exacting methods show that Bt crops have no negative effects on two beneficial insect predators or on a beneficial, entomopathogenic nematode.

In an article in the February 2014 issue of *Environmental Entomology*, called "Using Resistant Prey Demonstrates that Bt Plants Producing Cry1Ac, Cry2Ab, and Cry1F Have No Negative Effects on *Geocoris punctipes* and *Orius insidiosus*," researchers took caterpillars that were known to be resistant to Bt proteins and fed them Bt maize and Bt cotton. They then fed the caterpillars to two common, beneficial, predatory insects - insidious flower bug (*Orius insidiosus*), and big-eyed bug (*Geocoris punctipes*) - for two generations and compared them to another group of predators that consumed caterpillars fed on non-Bt plants.

The researchers found that the survival, development, adult mass, fecundity, and fertility of the insect predators in both groups were similar, regardless of whether they consumed caterpillars that fed on Bt plants or non-Bt plants. "This research demonstrates that the current Bt proteins used in corn and cotton crops globally do not harm *Geocoris punctipes* or *Orius insidious*, two important insect predators that help suppress pest populations on corn, cotton, and many other crops," said Dr. Anthony Shelton, a professor of entomology at Cornell University and one of the co-authors. "By using caterpillars resistant to the Bt proteins in this study, we were able to remove any 'host quality effects' that might have led to spurious misinterpretation of the results. This work demonstrated that the caterpillars consumed the Bt proteins, and the predators consumed the Bt proteins when they fed on the caterpillars, but they did not suffer any harm even over multiple generations."

In a similar article appearing in the February 2014 issue of the *Journal of Economic Entomology* called "Tri-Trophic Studies Using Cry1Ac-Resistant *Plutella xylostella* Demonstrate No Adverse Effects of Cry1Ac on the Entomopathogenic Nematode, *Heterorhabditis bacteriophora*," Shelton and his colleagues used similar methods and found that an important nematode predator was not harmed when it ingested another Bt protein. For this study, resistant caterpillars were fed Bt broccoli and then exposed to *Heterorhabditis bacteriophora*, a beneficial nematode that preys on insects. The researchers found that the virulence, reproductive potential, and time of emergence of the nematodes that consumed Bt-fed caterpillars were not significantly affected, compared to nematodes that did not ingest the Bt protein. "This is the first report we are aware of in which a nematode predator has been tested in such detail against a Bt protein," Dr. Shelton said. "Together, these two studies add to the scientific literature demonstrating that Bt plants can control targeted insect pests while not harming important natural enemies that help suppress pest species and maintain biodiversity in agricultural systems. (*SeedQuest*, 2/3/14).

Pesticide Registrations and Actions

Food Related Actions

- The Florida Department of Agriculture and Consumer Services (FDACS) has issued the special local needs (SLN) registration (FL-140003) to Gowan Company for the reduction in the post-emergence weed

control PHI on cucumber in Florida for the herbicide halosulfuron (Sandea®) from 30 days to 21 days. (FDACS PREC Agenda, 3/6/14).

- Based on a request by Nichino America, Inc., tolerances have been granted for residues of the insecticide tolfenpyrad (Apta®/Torac®). Tolerances of interest to the region include citrus, pecan, persimmon, and stone fruit. (*Federal Register*, 1/9/14).

- Based on a request by DuPont Crop Protection, tolerances have been granted for residues of the insecticide cyantraniliprole (Exirel®/Verimark®). Tolerances of interest to the region include brassica head and stem (subgroup 5A), brassica leafy vegetables (subgroup 5B), blueberry, citrus, fruit, pecan, bulb/green onion, peach, cucurbit vegetable (group 9), fruiting vegetable (group 8-10), leafy vegetables except brassica (group 4), and tuberous and corm vegetable (subgroup 1C). (*Federal Register*, 2/5/14).

- Based on a request by Monsanto, tolerances have been granted for residues of the herbicide acetochlor. Tolerances of interest to the region include peanuts, peanut hay, and peanut meal. (*Federal Register*, 1/22/14).

- Based on requests by IR-4 and DuPont Crop Protection, tolerances have been granted for residues of the insecticide chlorantraniliprole (Coragen®). Tolerances of interest to the region include peanuts, peanut hay, green onion, papaya, passionfruit, stone fruit except cherry, chickasaw plum, and damson plum, and spice subgroup 19B. (*Federal Register*, 2/7/14).

Non-food Actions

- On February 20, the FDACS registered the insecticide novaluron (Mosquiron 0.12P®) for control of mosquito larvae. The EPA registration number for the Tumaini Controlled Release Technologies Inc. product is 66222-231-89382. (FDACS PREC Agenda, 3/6/14).

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Other Actions

- In mid-January, the U.S. Supreme Court denied to hear the case, *Organic Seed Growers and Trade Association et al v. Monsanto*. Farmers had sought court protection under the Declaratory Judgment Act that should they be found with incident patented technology on their crop, they could not be sued for patent infringement. The suit was filed in 2011 in Federal District Court in Manhattan. In a complicated ruling issued in June 2013 by the U.S. Court of Appeals for the Federal Circuit in Washington, D.C., the court ordered

Monsanto not to sue American farmers whose fields were contaminated with trace amounts of patented material, which the Court defined as 1 percent. (*USAgNet.com*, 1/14/14).

- Two leading U.S. grain groups have asked Syngenta to suspend the commercial use in the United States of two genetically modified (GM) strains of corn not currently approved in China. The request follows rejection of multiple cargoes of U.S. corn, some 600,000 tons, by Chinese authorities since November because they contained Syngenta's Agrisure Viptera GM trait, known as MIR 162, which has been awaiting Beijing's acceptance for more than two years. The National Grain and Feed Association (NGFA) and North American Export Grain Association (NAEGA) wrote to Syngenta, asking the company to hold back its Viptera and Duracade corn varieties until China and other U.S. export markets have granted regulatory approval. "NAEGA and NGFA are gravely concerned about the serious economic harm to exporters, grain handlers and, ultimately, agricultural producers ... that has resulted from Syngenta's current approach to stewardship of Viptera," the groups said. The intended product launch of Duracade this year "risks repeating and extending the damage. Immediate action is required by Syngenta to halt such damage," NAEGA and NGFA said in their letter, which was released in late January. The groups also urged U.S. farmers to "evaluate these issues" when preparing to plant their 2014 corn crops. It remains unclear why Beijing began rejecting MIR 162 corn this season when the variety has been part of the U.S. corn supply since 2011 after U.S. government approval. At the same time the cargoes were rejected, Chinese forecasters sharply raised estimates for the country's corn crop, harvested late in 2013. (*AgriMarketing.com*, 1/24/14).

Pesticide Potpourri

- At the end of 2013, Chinese scientists said they had unraveled the genetic code of the plague locust, laying bare "hundreds" of genes that can be targeted by insecticides. The genetic code of *Locusta migratoria* is remarkably large at 6.5 gigabytes and is the largest animal genome sequenced so far, as reported in the journal *Nature Communications*. Large clusters of the insect's genes are associated with long-distance flight, eating plants and metabolizing food, they said. But there are also many repeated, mobile sections of DNA, called transposable elements, that were never weeded out by evolution and remain in the genome, the scientists said. In one of the biggest documented events, billions of locusts swarmed across 11.2 million square miles of land in 60 countries in 1988, even crossing the Atlantic from Africa to the Caribbean. The genome code is a draft, but once it has been polished, could serve a blueprint for scientists seeking new ways of attacking the voracious insect. It should reveal "hundreds of potential insecticide target genes," according to the probe, headed by Le Kang of the Institute of Zoology at the Chinese Academy of Sciences in Beijing. Previous work into locusts has found a biochemical mechanism

that prompts the creatures to swarm. Locusts are usually solitary, but are stimulated into gathering and searching for food en masse by jostling, which triggers serotonin, a pleasure chemical in the brain. Once in swarm mode, locusts change color from green to bright yellow, gaining large muscles that equip them for prolonged flight. (*GlobalPost.com*, 1/1/14).

- Amid concerns over climate change and environmental impacts of farming, "greener" agricultural technologies are drawing the attention of regulators, producers, and consumers. Not all will be equally successful, but the nascent biopesticide market will more than double to $4.5 billion in 2023, or about 7% of the total pesticide market, according to Lux Research. That group expects outside pressures will provide new growth opportunities in biopesticide use, such as the case of the EU's ban on nicotinoid pesticides. Among other findings is that biopesticides offer new partnership opportunities. Incumbent pesticide developers should prepare to team up with biopesticide makers to offer a broader suite of products. Vestaron (synthetic spider poison produced by the plant) is an excellent example of a multi-pronged approach. (*Digital Journal.com*, 1/30/14).

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