NEW APHID TOOLS REQUIRE A SHARP EYE, CLEAR THINKING AND REASONABLE EXPECTATIONS

By Steve Werblow

The good news for the annual soybean aphid battle is that growers will be able to see, and maybe even try, a powerful new management tool – soybeans with bred-in resistance to soybean aphid. The better news is that the resistance genes seem to not only discourage aphids from feeding and reproducing on the crop, but also may confer some tolerance to feeding damage.

That's a huge relief when it comes to battling a pest that can suck away as much as 40 percent of a soybean crop's yield in a bad season.

But here comes the reality check. Growers may still see aphids on the resistant crop – in fact, perhaps even a lot of aphids, enough to require treatment.

That may come as a surprise for many growers. David Wright, director of research for the North Central Soybean Research Program, did an informal, back-of-a-napkin phone survey of leading growers and consultants to see what producers expected of the new, resistant varieties. "All of them assumed that 'resistant plants' meant 'no aphids, period,'" he says.

That made Wright – and entomologists across the Midwest – nervous.

"It's important for producers to understand what aphid-resistant soybeans can and can't do for them," says Kelley Tilmon, soybean research and extension entomologist at South Dakota State University. "They can be a good part of your management strategy, but they aren't a silver bullet.

"In our NCSRP-funded multi-state trials, in heavy years we have seen 2,000 aphids per plant or more on resistant lines – which was pretty good compared to the 10,000-plus aphids we saw on non-resistant lines," Tilmon cautions. "But 2,000 aphids per plant is still enough to cause yield loss. The good news is that in low to moderate aphid years, resistant varieties may maintain aphids below the injury level when non-resistant varieties exceed it. So you won't always need the insecticide backup – you just need to remain vigilant to know whether you do or not."

Natural Resistance

The trait being bred into this year's releases and pre-commercial trials is called the Rag1 gene, an acronym for "resistance: *Aphis glycines*." (*Aphis glycines* is the scientific name for the soybean aphid.) It was identified in a pair of Southern soybean varieties, tested in the field against native and captive aphid populations, and bred into shorter-season beans. Unlike the gene that produces *Bacillus thuringiensis* protein in genetically modified Bt corn hybrids, the Rag1 gene is not an insecticide inserted into the crop's DNA – it's a defense native to soybeans, the product of millions of years of soybeans and aphids evolving side-by-side in Asia. As a result, Rag1 varieties survive aphid infestations, and have been shown to limit yield loss to as little as 5 percent in infestations where susceptible varieties lost as much as 40 percent to aphids. But they're not immune.

No New Thresholds Yet

David Ragsdale, entomology interim department chair at the University of Minnesota, points out that a greater understanding of how fast aphids can multiply on resistant soybeans and how much feeding those plants can tolerate may help entomologists set new aphid treatment thresholds for the resistant varieties in the years to come.

"The actual economic injury level is 674 aphids per plant," he says. "When you hit 250 aphids per plant, that's kind of a trigger point that says, 'within the next seven days, the aphid population is expected to reach 674 per plant.' But with the resistant varieties, it may take two weeks or longer, or it may never reach that 674."

For this season, though, researchers are playing it conservative.

"For now, we recommend that producers stick to the standard 250-per-plant threshold, but with the caveat that if you are on the fence about it, in a borderline situation, you have more wiggle room to hold off with resistant beans because the aphids don't have the potential to get away from you as quickly," says Tilmon.

A slow-growing population on resistant plants may allow beneficial insect populations to build up and tackle the problem themselves, notes field crops entomologist Christine DiFonzo at Michigan State University.

"Rag1, maybe by having a little pressure on it, may keep natural predators in the field," DiFonzo points out. "You may have some aphids, but hopefully natural enemies will come and clean them up."

That slower population growth may also delay the buildup of large populations until after the R5 stage of growth, when seeds near the top of the main stem are at least one-eighth of an inch long, says entomologist Matt O'Neal at Iowa State University. At that point in the crop's development, aphid feeding is less damaging to yield.

"As you get past R5, the impact isn't that great," O'Neal notes. "It's a little more art than science as you get past R5. Our data suggest that we will raise the threshold for when insecticides should be applied to Rag1 soybeans, but for now we do not have enough data to say what the new threshold will be. Overall, from three years of testing, soybeans with the Rag1 gene had fewer aphids than susceptible lines, no matter when we planted them. But the long story short on this is the Rag1 gene will not be aphid-free."

Resistant Aphids

Adding to the challenge of fighting aphids with host plant resistance, some populations of soybean aphids are already proving to exploit unknown chinks in the genetic armor. A population nicknamed the "Ohio biotype," as well as another biotype discovered last year in Indiana, have already demonstrated in test sites and laboratory trials that it is unfazed by the Rag1 gene.

A greenhouse trial pitting two aphid biotypes against several soybean varieties illustrates the point. O'Neal says just 15 aphids from Illinois survived on the Dowling variety – one of the sources of the Rag1 gene – while 639 aphids from the Ohio biotype infested Dowling. Ragsdale adds that a third biotype has been identified that thrives on soybean plants that express another Rag gene, the next generation of host plant resistance.

Despite the presence of the biotypes that can overcome today's resistance genes, all is not lost – resistant varieties are still effective on most soybean aphids. But growers can't let down their guard.

"If you're going to plant an aphid-resistant soybean line, this does not mean you can give up scouting," warns Ragsdale. "An aphid biotype that overwhelms the current Rag1 genes could end up causing a significant yield loss."

If aphid populations are growing rapidly on an aphid-resistant variety, a foliar insecticide application may be warranted. At that point, consider whether conditions are hot and dry enough to risk flaring spider mites – if so, it might be worthwhile choosing an insecticide that is less likely to spark a spider mite outbreak, he says.

Exciting New Tool

Tilmon points out that although host plant resistance is not a stand-alone remedy for soybean aphid problems, it helps create a three-legged stool for aphid management – resistant varieties, biological control and insecticide backup.

Many growers will find the new varieties an exciting tool, adds O'Neal. When growers ask whether they should plant resistant varieties, he reminds them not to forget the hard-learned lessons of the past 10 years.

"If you believe it is necessary to keep your plants aphid-free, then no," he says. "If you use thresholds, then yes."

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SIDEBAR

The Race for Resistant Varieties

Almost as soon as soybean aphid emerged as a pest in U.S. soybeans a decade ago, researchers began searching for genes to combat them. Combing through commercial varieties, Asian lines, ancestors of modern soybeans and other collected germplasm, geneticists identified gene sequences that discourage aphid feeding, slow population growth and tolerate more aphid activity.

The first of the gene sequences – dubbed Rag1 – was found in a pair of Southern soybean varieties, Dowling (a maturity group VIII) and Jackson (group VII). While entomologists tested the gene for efficacy, breeders scrambled to cross it into shorter-season commercial varieties so it could be deployed in areas hardest hit by soybean aphids.

This year, the first of the Rag1 varieties are commercially available or in the final stages of pre-commercial testing. Rag2 varieties, featuring another resistance gene sequence from PI 200538, a Japanese soybean variety, are in the works. Breeders at Michigan State University have licensed a pair of resistant genes to seed companies for further development, and lines from Iowa State University and the University of Wisconsin are looking very promising, according to David Ragsdale of the University of Minnesota.

Ragsdale points out that incorporating several resistance genes into commercial soybean lines over the next several years will give the crop broader, more durable resistance to the huge and genetically diverse populations of soybean aphids that plague growers.

At Michigan State University, field crops entomologist Chris DiFonzo points out that the race for resistance has started off with an impressive sprint.

"When you look at the fact that this aphid was found in 2000 and it's 2010 and we have viable resistance coming out, it's pretty remarkable," she says.

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SIDEBAR

Waiting for the Big Test

Host plant resistance to soybean aphid using the Rag1 gene, which discourages aphids and improves tolerance to feeding, shows promise to be a very helpful tool in blunting the attack of the Midwest's most virulent soybean pest. But last year, preparing for the first commercial Rag1 resistant varieties, researchers faced a different kind of challenge.

The weather was perfect for withstanding aphid damage no matter which variety was in the field, says David Ragsdale at the University of Minnesota.

"Peak aphid densities were probably approaching 2,000 aphids per plant and it didn't matter," he recalls. "They'd already set pods, already had seeds mature."

Following a huge population buildup, heavy dews set the stage for a fungal infection that wiped out the aphids. In short, it was a great year for soybean plants to survive an aphid onslaught, and a tough year to see how well host plant resistance works.

As a result, entomologists like Ragsdale are cautioning growers who plant the resistant varieties to scout their soybeans carefully and stick to standard treatment thresholds this year.

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