This photo shows susceptible vs. resistant plant lines. Plants and plots are under a severe aphid infestation.

Courtesy of Roy Scott, SDSU

Aphid-resistant varieties are on the way

Not a silver bullet – a good management tool

Checkoff-funded researchers throughout the North Central region have been testing new genetic sources of aphid resistance, and the results look promising.

"We're screening different lines from several university breeding programs," says Kelley Tilmon, South Dakota State University entomologist.

"We test them on small plots in multiple states, with varying growing conditions and varying levels of aphids, and monitor aphid population growth and yield on the different lines. That's what we call Tier 1 screening," she says. If a line looks good in Tier 1, it moves to Tier 2 testing, which involves larger plots and insecticides – basically mimicking how growers raise soybeans.

Aphid biotypes

"In general, there's definitely a big difference between lines bred for resistance and the susceptible control varieties," Tilmon says. Unfortunately, there's a catch: aphid biotypes that can break host plant resistance.

Scientists already have identified one new aphid biotype – called biotype 1 – with some ability to overcome the source of resistance known as Rag1. "We captured biotype 1 in 2006, but there weren't a lot of reports in 2007," says Glen Hartman, the University of Illinois/USDA-ARS researcher who co-discovered the Rag1 and other sources of resistance with another UI researcher, Curt Hill. "What we don't know is how predominant biotype 1 is, or how widely dispersed it is."

Resistance: antibiosis, antixenosis and tolerance

"There are three forms of resistance," says Matt O'Neal, Iowa State University entomologist. "Antixenosis is a fancy Latin term that means the insect doesn't attach itself to the plant. The aphid may not recognize the plant, or sometimes it might be that the plant has very hairy leaves."

According to Dechun Wang, plant breeder at Michigan State University, "If you give aphids a no-choice test, where they must feed on a soybean plant with antixenosis resistance or starve, they can still survive. For unknown reasons, they don't like to feed on those plants. If there's another plant available, aphids will move on."

Antibiosis is the second form of resistance. "Aphids may feed, but somehow feeding interferes with aphid reproduction," says Wang. "We don't know the mechanism causing it."

The third type of resistance is tolerance. "In this situation, the plant can have a lot of aphids feeding on it, but you won't see a yield decrease," O'Neal adds.

Courtesy of Curt Hill, U of Ill.

Courtesy of Dechun Wang, MSU

These pictures show the difference between E06902 (top photo), an aphid-resistant variety and Skylla (aphid susceptible) in a no-choice test. Each variety was individually caged, and photos were taken four weeks after inoculating 5-10 aphids on each plant. E06902 was released as an aphid-resistant germplasm in 2007.

Tilmon says, "In most of our trials, those lines with the Rag1 gene performed well. The wild card will be the aphid biotypes that can overcome the resistance and how quickly they can evolve or spread. So now we have to consider how that will affect management in various states."

According to Dechun Wang, a plant breeder at Michigan State University, "We don't know how many biotypes there are in the United States, but we know there are differences in aphids in different locations." He doubts that aphids have already managed to overcome resistance, "since we haven't had a resistant variety available commercially yet."

Many sources of resistance

Nature's ability to overcome resistance eventually, however, is one reason researchers have so many different sources in the pipeline. "The Rag1 source may be available in commercial seed in 2008, and there's a lot more material to look at," says Hartman.

"We have material transfer agreements with several companies for the Rag1 and another resistance source," Hartman adds. "We have about 50 different PIs (plant introductions) that look very different from the Rag1 and other known sources. We need to do genetic tests on them, and that will take a couple years."

Breeder Bill Schapaugh from Kansas State University also has lines in testing, including one – K1639 – that is resistant to aphids and soybean cyst nematode. "That will be a good germplasm line," Schapaugh says, "because it also has decent agronomic traits."

Michigan State's Wang has new sources of resistance in the trials as well. One source, E06902, is already being crossed with commercial germplasm by Syngenta. "Our studies show that E06902 has two two recessive genes controlling aphid resistance," says Wang. Sources of resistance with more complicated genetic background will be more difficult for aphids to find a way around.

"This was the first year we looked at Dechun's lines," says Matt O'Neal, entomologist at Iowa State University who is leading the host plant resistance project. "Central Iowa was hit hard with aphids in 2007, and his lines looked remarkable. There was one case in Wisconsin where one of his lines didn't do very well – and that may be due to aphid biotypes."

One more tool in your toolbox

O'Neal adds that, even with aphid biotypes that can overcome some sources of resistance, it's not a total loss. What this means is that resistance is going to be a good tool for soybean aphid management, but not the only tool.

"Scout and consider an insecticide if aphid populations go above the 250 threshold, even on resistant plants," O'Neal continues. "The frequency of spraying will drop, and growers will be able to use less insecticide. But you can't just plant aphid-resistant soybeans and walk away.

"You don't want only one hammer for aphids, you want a lot of hammers," he says. "That's why we're working on different resistance sources, and why we released *Binodoxys communis*. Maybe if we have several aphid-resistant soybean varieties available, we can lower the number of aphid migration events. If fewer aphids are flying in, maybe Asian lady beetles and other predators can catch up, and the resistance can hang in there."

Tweaking the 250 treatment threshold?

Now that North Central Soybean Research Program scientists have confirmed the 250 aphid treatment threshold and published their findings, they're considering some fine-tuning.

"Will we need to adjust thresholds to incorporate the new aphid-resistant varieties?" asks Matt O'Neal, Iowa State University entomologist. "What about the release of *Binodoxys communis*?

"If there's one field at R1 and one at R6 when aphids reach threshold, would they both experience the same yield loss?" he wonders. "Later in the season, the aphids' impact is reduced." O'Neal experienced this firsthand in 2007.

"We sprayed an insecticide at the 250 threshold in July. Then aphid populations reached threshold again in mid-August. So we sprayed some acreage again, and left some with one application. In terms of yield, we couldn't see a difference. We need to explore that further, but it does suggest that later-stage beans are more tolerant, and it may take more aphids to reduce yield.

"Another thing we need to look at is 15-inch and 7-inch row spacing," O'Neal adds. "That's not to say the threshold isn't valid. We're just checking on fine-tuning it."