The Super Crop

Soybeans That Have Diverse Resistance, Produce A Better Oil Are In The Pipeline

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The soybean of the future will be flood tolerant, drought tolerant, disease resistant and high yielding all in one package. That's the prediction of Dr. Grover Shannon, professor of Agronomy, plant breeder, with the Division of Plant Sciences, University of Missouri-Delta Center.

"We're taking genes from different lines and putting them into new soybean varieties," he said. Shannon pointed to the plots. "Each one of those rows is different genetically, and they obviously have different genes. We've crossed a flood susceptible with a flood tolerant and each row is a different prodigy from that cross. There are about 200 of them. Some progeny got the flood tolerant genes from a plant introduction (PI)."

Some lines from the cross had more tolerance to flooding, and some of them didn't. So Shannon and his colleagues are studying the inheritance.

"We're trying to look at the genetics of this. So we are studying some of the ones that didn't tolerate flooding and some that are very tolerant. This field was flooded for five days and the water was well up on the sides of the plants," he said, pointing to the tolerant rows.

The plants were about a foot tall and beginning to bloom when the flood was introduced. Some of the beans totally died, others showed good flood tolerance.

"You look around the Bootheel and you'll see farmers putting land to grade and they're doing it because they need to irrigate; they want to take the risk out of farming through irrigation. But if they irrigate and get a big rain they'll have flooding trouble," Shannon explained.

Last year flooding later in the season wasn't a problem, but many years it is very problematic.

"Were out in a cross of flood tolerant lines and we're comparing it to the flood sensitive, and we're studying the genetics, locating or mapping the genes on the chromosome." He pointed to two different rows. "This one obviously is susceptible, it's nearly dead. This one is very tolerant. This is what we want."

Varieties today have some tolerance, but still the plants become injured. "We want something where there's no injury."

While a cross was made between a flood tolerant and a flood sensitive line, Shannon said crosses are also being made between two flood tolerant plants.

"Here is an example of this. All these plant rows here show no injury. We crossed two lines that are very tolerant and you can see the growth. It's going to happen. We're going to have flood tolerant varieties," he promised. "I don't know if we'll get something that will live in water, but we're making progress."

He pointed to the pod load on plants that were flooded for five days. With five full days of water and 100 degree weather, the field stayed wet for a long time. Yet the soybeans withstood the stress.

"I feel confident, even more now than I did several years ago when I started this research, that we're going to make good gains, so a farmer doesn't have to worry about his crop. He should irrigate it right, but if it gets a big rain, it'll take the water," he said.

Shannon's research is funded by the United Soybean Board, and he is working with other researchers on this project. He collaborates with Dr. Henry Nguyen, Director of the National Center of Soybean Bio-Technology at Columbia, who does a lot of genetic work. He also works with Dr. Ann Dorrance at Ohio State University who is looking at how phytophthora root rot and flooding go hand in hand, how important phytophthora resistance is in flooding. He also works with Dr. Pengyin Chen, a soybean geneticist and plant breeder at the University of Arkansas.

"Dr. Chen also has some populations for flooding tolerance that look very good," Shannon said. "Some of the more tolerant varieties on the market today can limit yield losses to only 40 percent in extreme cases. However, some of the best lines from flood tolerant crosses may not show any loss or maybe only 10 percent in a severe flooding instance."

Shannon is looking for continuity in his work. It's not good enough if one year the plants show tolerance and the next year they don't.

"We've got to have something that is continuous, looks good for at least three years, then we know we've got something. It's a long term project. We have to use a lot of unadapted material to find the genes and those unadapted things have some poor traits. We have to get rid of all those poor traits first, and then move the good genes into the varieties that yield well in the presence or absence of flooding.

"We've been working on this since 2002 and we started from scratch. We've learned a lot these last 10 years. We've learned what to do, what to expect. We've also found some genes related to flooding with some other projects that we've had. So this has been great."

However, flooding is only one aspect of the study, similar research is under way on very sandy soils to find tolerance to drought.

"We've got irrigated and non-irrigated to find lines that have less yield loss under drought," he said. "Ultimately the goal is to have something with tolerance to flooding and drought in the same package, making that one super crop that's tolerant to stress."

In addition, the plan is to add cyst nematode resistance, root knot disease resistance, high yield potential to the genetics too. In the end, yield is key, it's the number one trait.

"We're hoping to put the whole package together, where we have resistance to diseases, drought, flooding and produce high yields in one variety," he said. "If the farmer wants the herbicide tolerant trait, we'll add that too.

"The idea about flood tolerant soybeans came from the fact that our U.S. soybean germplasm originated in China, Korea and Japan where a lot of rice is grown," he added. There, beans are planted in areas along the rice paddies or up on the levees and the thought is that possibly through a natural process flood tolerance could develop through natural selection.

Soybeans have been grown there under paddy conditions and in very dry areas with low rainfall. Plant introductions have been brought into the United States from China and Korea that have been selected in areas of low rainfall.

"Our genetic base here for all these varieties is very narrow, but there are yield genes in some of these plant introductions," he continued. "Since our genetic base is so narrow, the potential to improve in varieties we have is excellent. There's even more chance for advancement with some of these PIs. They have hidden genes, not yet known, and we're finding out the diversity for yield. We have some yield plots and some lines that trace back to plant introductions that show really high yield potential. Instead of making a gain of 2 percent or 3 percent in a yield gene, we're looking for the gene that's going to give us 10 percent. That's the way we look at these plant introductions."

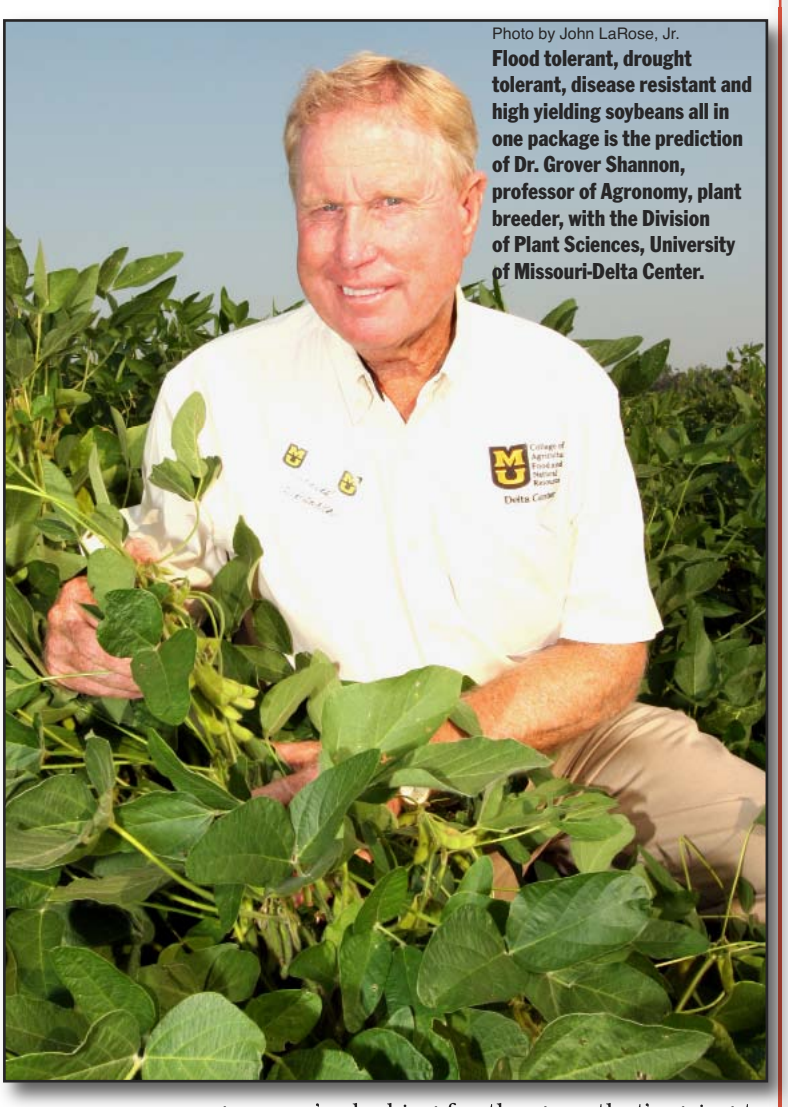

Photo by John LaRose, Jr.
Flood tolerant, drought tolerant, disease resistant and high yielding soybeans all in one package is the prediction of Dr. Grover Shannon, professor of Agronomy, plant breeder, with the Division of Plant Sciences, University of Missouri-Delta Center.

The center of origin of soybeans is the Orient, primarily China, Korea and Japan. Soybean plant introductions are genetically diverse soybean lines collected along roadsides and from various fields and gardens of these countries and they make up the USDA soybean germplasm collection. There are about 19,000 soybean plant introductions in the United States collection and each plant introduction is genetically different. They are a "gold mine" for different genes for important traits such as disease and nematode resistance; drought, flooding and salt tolerance; and increased yield.

A Better Bean Is Goal

While increasing seed quality, increasing yield and disease resistance, Shannon said the real goal is to make the bean itself better.

"Soybeans are primarily grown for protein and oil. They're 40 percent protein and 20 percent oil by weight. However, soybeans aren't perfect inside, they need to be changed. We want to modify the protein to make it more digestible to an animal, and also make the oil better for use in more products."

One of the unique things already done with oil is modification of the fatty acid profile of the oil itself. This makes it more readily adaptable for more things.

"Soybeans are pretty low in saturates but we know we can get that cut in half," he continued. "We can lower saturates in soybeans from 15 percent, its present composition, to 7 percent. That's very good for health. Also, by increasing the oleic acid we can make them more heat stable. They have about 20 percent oleic acid, so you can't fry with them very long. Olive oil and some other oils are high in oleic acid and they are very heat stable, they're healthier. Actually biodiesel and lubricants are better with higher oleic acid because they are heat stable. There's just many more uses if we can increase the oleic acid levels.

"Pioneer has gone the transgenic route and they've developed a high oleic acid soybean," he said. "Pioneer has Plenish which is a high oleic soybean, but they did that with biotech, with transgenes. Here in Missouri what we've done with Dr. Kristin Bilyeu, a molecular geneticist with USDA-ARS at the University of Missouri-Columbia, and others, we were able to put two genes together to increase oleic acid content. We found one gene with relatively high oleic and another gene with relatively high oleic, we put these two genes together and the result was a seed oil that went all the way to 80 percent oleic.

"The two gene trait occurs naturally in nature so they're not genetically modified, and some countries just don't like genetically modified traits. I don't think there's anything wrong with them, but, through the funding of the United Soybean Board we've been able to increase oleic acid from about 20 percent to 80 percent. We and other breeders in this program with this funding hope to put the high oleic trait into every maturity group soybean in the United States – all the way from double zero to Group VIII.

"There are a lot of breeders working with this trait. I work closely with Dr. Kristen Bilyeu, and we actually found the trait here about two years ago. She did the genetics on it, located the genes. One of the lines that we used was unadapted, but we're now taking these high oleic traits and back crossing them into some high yielding soybeans. We think in three or four more years we'll have something."

In Missouri, researchers are working mainly in Groups III, IV and V; but other states to the south like Georgia and to the north like South Dakota, Michigan, and Iowa are putting it into maturity groups adapted to these areas.

So basically researchers are creating soybean oil similar in characteristics to olive oil.

"It's healthier, more functional, not only for food and fuels, but for use in the cosmetic and pharmaceutical industries" Shannon said. "When I say it is more functional, that means it's going to be used in more products. It'll be more heart healthy. It'll make soybeans more competitive with things like canola oil or sunflower oil. Soybean oil is good oil, it's just going to be better with these modifications." Δ

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