High-tech tools may help small grains breeders 'see' valuable plant traits faster

June 1 2012, By Kay Ledbetter

Sean Thompson, a doctoral student working on a Texas AgriLife Research project, is looking at the possibility of using a ground-penetrating radar in wheat breeding efforts. Credit: Kay Ledbetter

Two tools from industry are being applied to the small grains breeding program by a Texas AgriLife Research team to help identify valuable drought-resistance traits in wheat faster and less intrusively than with normal practices.

The team consists of Dr. Amir Ibrahim, AgriLife Research small grains breeding program leader; Dr. Dirk Hays, a cereal grain development professor in the Texas A&M University soil and crop sciences department; Dr. Robert Washington-Allen, a professor in the Texas A&M ecosystem science and management department; and Sean Thompson, a doctoral graduate student in plant breeding.

The study is looking at below- and above-ground traits using high-throughput phenotyping or characterization technologies, Ibrahim said. The goal is to differentiate types of plants with the aim of identifying traits that give the breeding line an advantage when it comes to drought resistance.

Thompson's project is using both ground-penetrating radar and terrestrial laser-scanning tools to look at traits "we have not been able to look at in the past," Ibrahim said.

"What we are trying to do is apply technology that allows us to see further into characteristic traits than we have been able to with the human eye," Thompson said.

Ground-penetrating radar was designed more or less for the construction industry to detect pipes, electrical lines or different densities of objects below ground, he said. This remote-sensing technologyhas been used to look at crop-water availability, but not to look directly at agricultural plant populations. The team believes they can adapt it so that for the first time, they will be able to look at the roots of wheat as it is growing in the field.

"It's important for us to be able to do this in a non-destructive manner," Thompson said. "In the past, people had to dig up the plant to measure root biomass. It was costly, time and labor intensive, and the plant would not survive."

The ground-penetrating radar can map the three-dimensional spatial distribution, estimate the biomass of roots below ground and may be able to discriminate between different root systems from different crops, he said. The ability to map roots at different depths allows detection of plants with deeper roots or roots that spread out further.

“We think these root systems will provide the plant with more water during a drought situation,” Thompson said. “Our idea is if we can identify those plants in a population or be able to characterize the roots below ground, we could adapt our varieties to make them more drought-resistant or drought-tolerant.”

The machine consists of a computer, the radar, a battery and an antenna that operates at different frequencies, he said. These frequencies are the same as some older cell phones operated on. The unit sends a radio signal into the ground and then receives it back within seconds and this allows a three-dimensional picture of the below-ground environment to be created on the computer.

A terrestrial laser scanner will give researchers, such as Sean Thompson, the ability to take rapid, accurate measurements in wheat fields. Credit: Texas AgriLife Research photo by Kay Ledbetter

“The frequency is able to detect roots since the amount of moisture is more concentrated within them than in the surrounding soil," Thompson said. "This same technology has been used to find tree roots, but obviously there is a big difference between tree roots and those of wheat."

The terrestrial laser scanner also creates very high resolution 3-D images, only it works above ground utilizing a small computer and a laser to shoot across a field as far as 300 meters with 4-millimeter accuracy, he said. To put that into perspective, it would be able to see the differences between two wheat plants from three football fields away.

"That's a much more accurate measurement than we've had in the past using a yardstick or ruler," Thompson said. "Typically we walk through our nurseries looking for characteristics or traits in a plant that give it an advantage over others. We take plant height measurements which can be related to yield or performance, or we take an overall agronomic score."

AgriLife Research has many nurseries across the state, he said, and as "we spend hours looking at the plants with a naked eye, we become biased to different traits we are scoring. The bottom line is you just can't see enough of the diversity between the plants or see the difference because they are so minuscule between the lines.

"This opens the doors for a technology that allows us to take data both rapidly and accurately," Thompson said. "That's where these tools come into play."

The terrestrial-laser scanner uses a green wavelength that is safe for anyone around it, he said. The laser captures two or three images from different sides of a plot to reduce shadows, which are then joined together in the computer to produce a 3-D point cloud.

This provides breeders with a whole new set of options, Thompson said.

A key option is not using the destructive methods that are typical of taking above-ground biomass measurements.

“We wind up killing the plant and damaging the population under traditional methods,” he said. “But the laser allows us to set up outside the field and take these measurements multiple times throughout the growing season so we can evaluate lines repeatedly and not have to remove them or destroy them in the process.”

Another option is to be able to look at larger populations, Thompson said.

“The more plants you can look at, the greater the chances you have to find something that is going to be very productive in the field for a farmer,” he said.

Provided by Texas A&M University