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Auto-guidance Technology Tested in Mechanically-cultivated Cotton

Goal is to improve weed control, reduce herbicide use and save money

By Cary Blake, Western Farm Press

Researchers Bill McCloskey, left, and Pedro Andrade are utilizing real-time kinematic global positioning system (RTK-GPS) technology to precisely guide a tractor in a cotton field, using an attached conventional cultivator to cultivate broadleaf weeds within 2.5 inches of the seed line.

The University of Arizona's Pedro Andrade and Bill McCloskey kicked off a precision cultivation research project last spring at the Maricopa Agricultural Center (MAC), Maricopa, Arizona. The duo are testing a real time kinematic global positioning system (RTK-GPS) auto guidance system—the Trimble AgGPS NavController II, in a Case IH Puma Series tractor—across a 2.5 acre cotton plot with implements for bed listing, seed planting, and cultivation of seedlings three times in the season.

RTK-GPS is an ultra-precise version of GPS that allows sub-inch accuracy levels in positioning measurement. Andrade, an agricultural engineer and precision agriculture specialist at MAC, says the technology combines two elements in positioning measurement.

First, in addition to a satellite link to the rover (tractor), there is a radio communication link between the rover and a ground base station. This communication carries positional correction data. Second, a patented algorithm solves the rover's position mathematically with time and phase delay information of the signal.

“During bed formation and seed planting, the RTK-GPS system guides the tractor in a straight, pre-determined path. Understanding the implement geometry allowed us to know exactly where the seed line is located,” says McCloskey, UA extension weed specialist in Tucson. “The cultivator is able to run closer to the seed line than traditional cultivation since the tractor knows within an inch the precise seed line location. This keeps the cultivator clear of the plants and enhances mechanical weed control efficacy.”

The Arizona researchers are determining if RTK-GPS-guided mechanical cultivation can remove more weeds with steel instead of herbicide to help farmers save money and to benefit the environment.

“The less herbicide we put out there then the less selection pressure there is for the development of herbicide-resistant weeds. What we don't know is what are the trade-offs,” McCloskey notes. “With the RTK-GPS system the farmer would reduce herbicide use yet increase diesel fuel use. We're anxious to get additional project funding to see how this shakes out.”

The test plot was planted with Deltapine 164 B2RF on April 8 and mechanically

cultivated with a four-row, 14-foot cultivator on May 15 (3 to 4 leaf stage), June 5 (about 10 leaves), and June 18 (20-22-inch-high cotton).

RTK-GPS systems cost in the \$30,000 range and can come pre-installed on new tractors. McCloskey says total costs include the equipment installed on the tractor plus access to the base station network that enables radio communication with tractors to achieve the sub-inch level of accuracy. The infrastructure of local towers has been built and funded by equipment dealers. In Arizona base station towers provide coverage to many locations including the Yuma, Safford, and Central Arizona valleys.

While RTK-GPS creates more accurate row listing, farmers want other perks including precise cultivation to reduce herbicide use, according to McCloskey.

“If you're spending \$25 per gallon for Roundup and broadcast spray one quart per acre, you're spending \$6.25 per acre for the herbicide,” McCloskey says. “If we're able to cultivate all but a four-inch band on the seed line, we could reduce the \$6.50 to one or two dollars per acre. If manufacturing costs of inputs are considered, I think precision cultivation

will save cotton farmers money over herbicide use," McCloskey says.

Andrade says cotton is conventionally cultivated with two types of six-row, 20-foot wide cultivators. Both systems cultivate 1.5 to 2 inches deep and within 4 to 5 inches of the seed line and utilize Alabama sweeps to move the soil back into place.

Some new cultivator systems on the market include electronic cameras or mechanical wands to gain closer seed line cultivation. McCloskey says those systems don't work well with cotton seedlings.

"I've worked with a mechanical wand-articulated electro-hydraulic quick-hitch guidance system and the system limitation is cotton needs to be about a foot tall with a woody stem for the mechanical wand to sense it. Otherwise the wand bends the seedling over," McCloskey says. "With the RTK-GPS system, we can safely cultivate seedling cotton."

The RTK-GPS guidance system is also essential for spraying narrow bands of herbicide topically (over-the-top) so that the spray band and the seed-line/uncultivated area are properly aligned.

The sky is the limit for RTK-GPS technology. Andrade says, "Enhanced

cultivation with RTK-GPS technology has the potential to work in any crop grown in a bed."

McCloskey's goal in the trials is saving money through decreased herbicide use while improving overall weed control.

"There is a saying 'Steel is non-selective.' Weeds cannot build a resistance to cultivation. Mechanical control is a simpler approach," Andrade says.

In the Western U.S. more tillage is required in cotton than other regions of the Cotton Belt since the crop is furrow irrigated. Two of the most common broadleaves in Arizona cotton fields are Palmer amaranth and annual morningglory.

Andrade and McCloskey are seeking funding for four more years of research including the expansion of test acreage into larger commercial farmer fields. This is where the energy savings can be calculated more accurately.

"Determining the actual costs of the RTK-GPS-equipped tractor and the actual fuel consumption to pull the implement across large fields is how to get a handle on accurate energy savings," Andrade says.

The researchers are requesting continuation funding from the USDA's

Arizona Cotton

While farmers across the Cotton Belt reduced cotton acreage in '08 due to higher grain prices, cotton remains the second largest acreage crop in Arizona. According to the National Agricultural Statistics Service's Arizona field office, about 141,000 acres of cotton were planted in 2008, compared to 170,500 cotton acres harvested in '07. Alfalfa ranks first with 260,000-acres producing alfalfa hay in '08, up 10,000 acres from '07.

Sustainable Agriculture Research Education (SARE) program. The UA is providing the first-year funding.

One of the justifications for SARE funding would be to take the project "on the road," McCloskey says. During year one and two the system details would be worked out and the technology readied for field-scale testing. Years three through five would include field tests to collect crop budget information to demonstrate cost benefits and seek work out answers to the concerns of the farmer cooperators.

Andrade and McCloskey are convinced that RTK-GPS technology can improve standard cultivation and farmers will embrace the system.

"We have a component of growers who are technologically innovative," McCloskey says. "I would hope after five years to have these early adopters buy into this technology; not only in cotton but every row crop grown in Arizona. Their success will prompt others to accept the technology."

The RTK-GPS technology requires a higher educated work force that over the long-term could reduce labor needs. Andrade says precision cultivation system works well in all soil types.

Cultivating so close to the seed line doesn't damage the plants if done properly, McCloskey says. The proof will come when cooperators harvest full-length strips of cotton. ☆

CONTACT

Pedro Andrade
(520) 568-2273
pandrade@ag.arizona.edu

William McCloskey
(520) 621-7613
wmclosk@ag.arizona.edu



Pedro Andrade says precision agriculture technology holds many financial and environmental benefits for farmers.



Closer mechanical cultivation to the cotton seed line reduces herbicide requirements with real time kinematic global positioning system (RTK-GPS) technology. Related research is underway at the University of Arizona's Maricopa Agricultural Center.