Hot cotton: New system senses water stress

By Jim Core, US Agricultural Research Service Information Staff

Water stress in crops is caused by drought or poor irrigation. Traditional methods of identifying water stress use sensors to measure water pressure in individual, removed leaves, or the flow of sap through the plant stem. Monitoring soil moisture is also commonly used to determine crop water use and to schedule irrigations.

While these methods are reasonably reliable, they are time consuming and costly and give information only for the immediate area in which they are used.

“It can be very difficult to quantify the stress of the entire crop canopy,” says Gretchen Sassenrath-Cole, a plant physiologist at the Jamie Whitten Delta States Research Center in Stoneville, Mississippi.

“Using measurements from one leaf from the top of a plant to characterise the entire plant canopy could lead to a false conclusion.”

Many environmental factors influence plants’ loss of water. Sunlight, air temperature, humidity, and wind speed all affect plant temperature. Physiological factors affect a plant’s ability to transport water to cool its leaves through evapotranspiration.

Because inadequate water supply increases canopy temperature, scientists in the ARS Application and Production Technology Research Unit at the Stoneville centre, in collaboration with Lyle Pringle, a Mississippi State University scientist, are exploring canopy temperature change as a more reliable indicator of crop water status. They developed a movable field-tracking system that uses thermal sensors to capture images of the canopy and measure its temperature.

The system can be rapidly deployed and positioned at various levels above the canopy, measuring individual leaves or entire canopy elements. The sensors are located at the end of

US researchers have developed a system that measures the temperature of a cotton crop for better crop monitoring and irrigation scheduling.

a boom attached to a yoke that rotates 360 degrees in the horizontal plane. The entire pivoting system is attached to a tower mounted on the front rack of an all-terrain vehicle. The boom, engineered by Gretchen and technician Ray Adams, is positioned over the canopy by a hydraulic cylinder that raises and lowers it to the desired height, focusing the sensors on a specific canopy region.

Various remote-sensing devices can be attached to the boom, including infrared thermometers and spectroradiometers, which record reflected light wavelengths.

As incoming radiation and ambient air temperature are registered, the specific location is recorded with a geographic positioning system. The data is downloaded into an on-board computer, along with images from a video camera, allowing the operator to see the canopy element that's being measured.

"At this time, no standard method to monitor soil moisture or crop water stress for irrigation purposes has been adopted by producers in the Mississippi Delta," Gretchen says.

"Systems based on thermal detection have been used successfully in arid regions; but the humid conditions of the Mid-South limit a plant's ability to cool."

Researchers anticipate that managers could make better decisions about irrigation scheduling by using this technology. Gretchen says one day the system could evolve into a robotic device for continuous monitoring of crop canopies in a production setting. ARS is interested in cooperating with a commercial partner to further develop and commercialise this technology.

This research is part of Integrated Agricultural Systems, an ARS National Program described at http://www.nps.ars.usda.gov.

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