Infrared holds key to plant stress

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Key Points

- Infrared sensors measure crop canopy temperatures that relates to water stress.
- Study: A plant operates most efficiently within a specific temperature range.
- Information from sensors can help make irrigation decisions.

EXAMINING the very narrow temperature range in which plants thrive, researchers have amassed years of knowledge and combined it with modern technology to ease decision-making for irrigators.

"It's been known for 30 years one of the reliable indicators that a plant doesn't have enough water is an elevation of the temperature of the [plant]canopy," says James Mahan, research plant physiologist at the USDA Agricultural Research Service's Cropping Systems Research Laboratory in Lubbock, Texas.

"People know you can detect plant stress by looking at temperature, but the question is, 'How elevated does it have to be?' " he notes.

Enter infrared thermometry, a technique that uses wireless infrared sensors in the field to measure crop canopy temperatures to correlate with water stress. The concept originated in Arizona in the 1960s, but has only developed recently with the mushrooming of computer capacity and technology. ARS scientists at Lubbock began investigating the technology in the 1980s and found it to be feasible.

The first challenge was to identify each specific crop's optimal temperature for flourishing plant growth and vigor. Researchers were surprised to find a plant operates most efficiently within a very specific temperature range, and these temperatures vary from species to species. For example, cotton has an optimal growth temperature of 82.4 degrees F, while spinach thrives at 57.6 degrees.

"If we could find the optimal temperature of the plant, we could use that temperature to indicate water stress," Mahan says. "We went to the lab and determined a good estimate of optimal temperatures for different species."

The technology stemming from the laboratory work on plants and the fieldwork with infrared sensors is known as Biological Identified Optimal Temperature Interactive Console, or BIOTIC. Infrared sensors measure crop canopy temperatures in the field, and can trigger recommendations for irrigation every time the temperature rises above a given threshold. Growers are able to receive such recommendations via text messages, e-mail, or through access to a Smartfield Web portal. The outcome allows growers to make irrigation decisions according to the specific needs of their plants.

A disadvantage of BIOTIC is that irrigation recommendations made through the system are limited somewhat to individual fields rather than a number of fields over multiple miles. For the most accuracy, most fields will need a separate system to monitor irrigation needs of a specific geographic area.

Works well with drip

Smartfield officials, makers of commercial products using BIOTIC, say the system works extremely well in drip-irrigated fields, where the immediacy of water application is easily met. In fields watered by sprinklers, however, a single water application may be days or hours away when the monitors sense stress in the crop canopy.

"If it's on pivot or furrow [system], it can't respond as easily, so you have to be able to keep track of how many minutes the temperature remained above the crop's threshold," Mahan says. "Then, when you decide to irrigate, you use the number of minutes the plants were stressed" to determine how much water to apply.

BIOTIC was patented in 1997 by USDA, but research continued for several years to refine the technology. The USDA and Mahan approached Lubbock's Accent Engineering, now Smartfield, in 2002 for design work.

"That took a few years to accomplish," says Tommy Martin, Smartfield's CEO. "After working several years together [with USDA] on BIOTIC, we obtained an exclusive license to the technology and renamed it SmartCrop for commercial applications."

Since then, the system has been improved with more sensors available to the remote computer system, increased radio frequency range and the use of weather stations for better correlation to local climatic conditions. Smartfield has developed products similar to SmartCrop that can monitor rain amounts and shut off irrigation systems, monitor flow and pressure for pivot and drip systems, and provide pivot status and location information with GPS tracking systems.

"The BIOTIC technology has the potential to be used on all crops, regardless of water status," says David Weathers, vice president for sales for Smartfield. "A SmartCrop system affords growers the ability to monitor their crops throughout the growing season, which allows them to make informed decisions."

For more, visit *www.smartfield.com.*

Brazil writes from Clermont, Fla.

TOP TECH: Infrared sensors, which measure the crop canopy's temperature based on plant transpiration rates, make watering decisions easier. The technology is site-specific and does not rely on evapotranspiration readings, which can vary among fields.