Canopy temperature – bringing the doctor to the field

By Dr Hiz Jamali[1], Dr Michael Bange[1] and Tom Dowling[2],

What is the research?

Cotton growers in Australia work hard to make the most of limited water available for irrigation. Optimised irrigation scheduling is one key to achieving high water productivity as both overwatering and water stress reduces yield. As canopy temperature is a direct response to plant's access to (or lack of) soil water (Figure 1), we used this understanding to develop an irrigation scheduling method based on continuous monitoring of canopy temperature and underpinning physiology.

Continuous monitoring of crops reflects crop conditions approaching the need for irrigation; this is the key to the methodology – avoiding plant stress. This decision making tool will help make an irrigation decision based on a crop's response to current soil water status rather than relying on a fixed soil water deficit. Being a plant-based approach, canopy temperature offers different but complementing information to soil and weather based approaches. Canopy temperature infrared sensors are affordable, easy to use and maintain, and will hopefully be a valuable addition to the suite of tools available to growers for making important irrigation decisions.

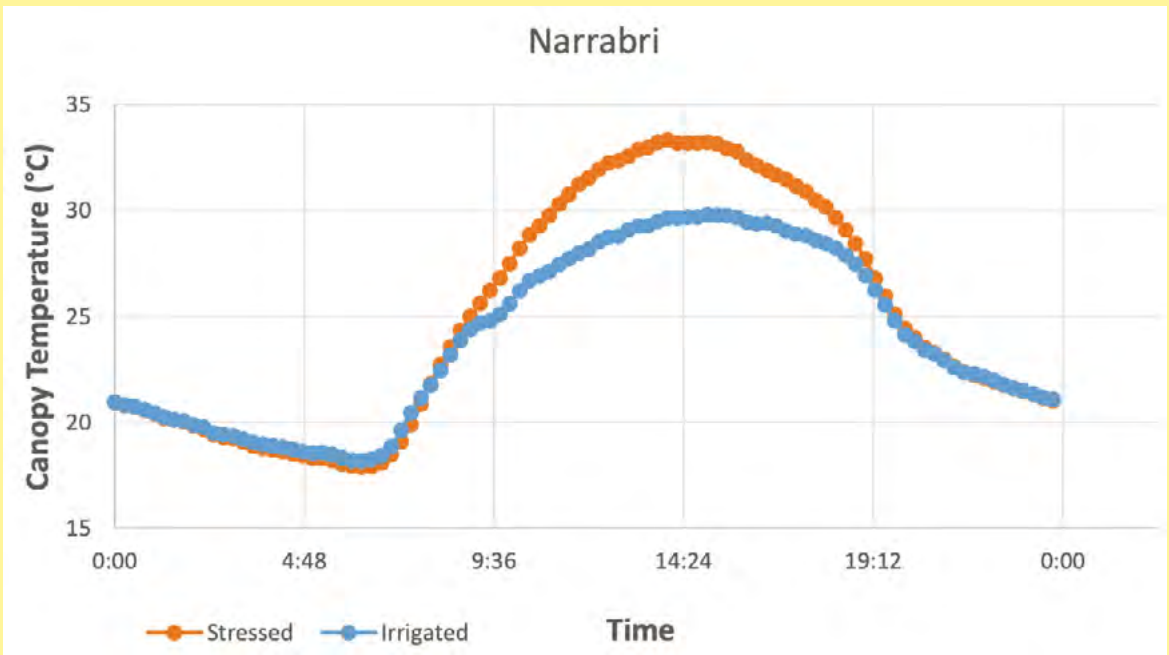
Left to right: Tom Dowling holding the Goanna Ag's new canopy temperature sensor next to CSIRO's sensor, Michael Bange (CSIRO), Victoria Smith (CSIRO) and Hiz Jamali (CSIRO).

How does it work in practice?

The canopy temperature approach is based on the understanding that all plants have an optimum temperature for physiological functioning, e.g. 28 °C for cotton – not unlike a person going to the doctor when the body temperature is higher than 37 °C. The times the cotton canopy temperature stays above 28 °C – and meeting some other criteria – are called 'deficit hours'. The crop needs an irrigation once the cumulative deficit hours reach a certain 'threshold' determined by CSIRO research supported by the Cotton Research and Development Corporation (CRDC).

Responding to grower feedback that they often need to plan ahead, we developed a model to predict canopy temperature few

FIGURE 1: The difference in canopy temperature of a well-watered (blue) and a water-stressed (orange) crop at CSIRO trials in Narrabri during the course of a day



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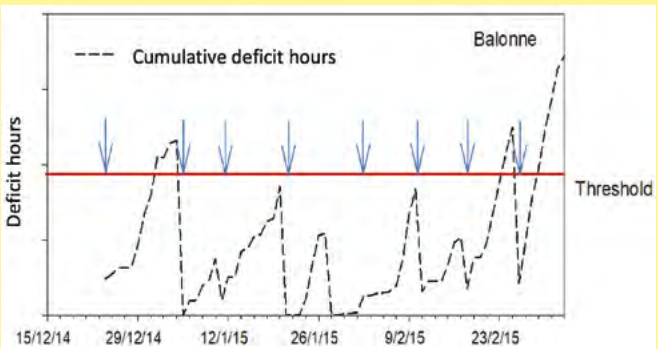
The canopy temperature sensor was used in a CSIRO trial on Glen Price's farm at St George.

days in advance using the forecasted weather conditions. This predictive capability will enable growers to plan their irrigations a few days in advance to allow flexibility in the system.

Why do I need to know about it?

We monitored the canopy temperature on farms in different valleys where growers used their own experience and/or fixed soil moisture deficits to make irrigation decisions. The continuous measurements of canopy temperature showed that many irrigations on some monitored farms did not match the recommended threshold. For example, Figure 2 shows one such farm where irrigations were mostly applied earlier, and in some cases, later than the recommended threshold. These observations highlight significant opportunities to increase water productivity through optimising irrigation scheduling.

FIGURE 2: Canopy temperature data of a farm in that was irrigated using farmer practice



Blue arrows show irrigations; irrigations applied when deficit hours are below the red line (threshold) are considered early and vice versa.

We also conducted trials at different farms where irrigation scheduling using canopy temperature was compared with the scheduling of some of the high yielding growers. The results were encouraging as yields of two treatments matched closely even though in some instances one less irrigation was applied in the canopy temperature treatment.

Trials were also conducted where growers integrated canopy temperature into their existing irrigation decision making process using soil moisture probes and their experience. The grower feedback provided important insights into how the technology might fit into their whole farming system and how it can be improved. Glen Price was one of the growers who used this technology for two cotton seasons at his farm at St. George.

Below are a few comments from Glen Price

"You have to integrate different types of information. You can't ask the plant.

"Who knows, it might reduce the number of irrigations. Or on the contrary, people might realise that they should be irrigating more often.

"Even if I start using canopy temperature all the time, I would still continue with soil moisture probes. I would still need to get used to the canopy temperature and be confident with it.

"Being able to have a line, considering soil moisture and canopy temperature to know when to irrigate would be very handy."

When the technology will be available to growers commercially?

The canopy temperature technology will be available to growers in the 2019–20 cotton season. CSIRO and CRDC have entered into a formal agreement with Goanna Ag to extend this technology out to growers. Tom Dowling and his team at Goanna Ag are currently working with CSIRO researchers to integrate the canopy temperature algorithms into their existing platforms being used by growers.

"Goanna Ag is excited to partner with the CSIRO and CRDC in bringing the canopy temperature sensor algorithm to the cotton industry this coming season," said Tom.

"Goanna believes the technology will fill the gap in our GoField product. With this technology we can monitor the plants' temperature in real time.

"It will be combined with our soil moisture probes monitoring what is happening underneath the soil and our GoSat analytics monitoring spatially what is happening at the field level.

"The wireless sensor will be released with LoRaWAN connectivity and a 'deploy anywhere satellite' option."

Future research

Trials are being conducted to optimise the canopy temperature approach for use in limited water situations. Future research will also include assessing spatial variability on larger farms to determine the optimum number of sensors required to capture the variability.

[1]CSIRO, Agriculture and Food, Narrabri, NSW.
[2]Goanna Ag, Goondiwindi, Queensland.

Contact:
Dr Hiz Jamali, CSIRO; Email: hiz.jamali@csiro.au
Tom Dowling, Goanna Ag; Email: tdowling@goannaag.com.au

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