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Can plant-based moisture sensing improve irrigation scheduling?

By Gary Alcorn

A new technology using plant-based sensing could upgrade irrigated crop scheduling. Imagine sensors so sensitive they can measure how much a plant stem swells when it takes up soil moisture.

Last summer the National Centre for Engineering in Agriculture in Toowoomba started a project to investigate the use of commercially available plant-based sensors to improve cotton irrigation scheduling.

The project is being funded by Cotton Research & Development Corp and CRC for Irrigation Futures.

Researcher Simon White is building on his previous PhD project which studied the effects of regulated deficit irrigation and partial rootzone drying in cotton.

“Current systems for detecting actual

soil moisture levels cannot, alone, tell the researcher or producer how well a crop is responding to soil moisture availability.

“This is due in part to soil moisture availability and extraction by the plant’s root system being measured only at one point with no indication of growth rate measured,” he said.

A plant-based sensor can measure crop response directly, accounting for the availability of soil moisture (as well as other influencing factors, such as climatic conditions) for the whole root system.

“This is important when irrigation systems which may result in non-uniformity of soil moisture beneath a crop are being used,” he said.

“It seems reasonable to assume that a measurement device, which detects a crop’s response directly, may prove useful as an aid or alternative for improved irrigation management.

“One of the plant-based sensors we are evaluating is Phyttech’s stem micro-variation (diameter) sensor,” he said.

The stem diameter sensors (SDS) operate by using a linear variable displacement transducer connected to a logger which continually measures the change in stem diameter over time (Figure 1).

There are two methods by which a cotton crop’s response is measured. The first method is applied during cotton’s vegetative growth stage (up until flowering), where the daily increase in stem diameter (known as DSI — daily stem increment) is measured.

Because the SDS are highly sensitive (measuring in the micron range) they can measure not only increase in stem diameter as the plant grows, but also the diurnal change (over each day or 24 hour period) which occurs.

“During the day, as evaporative conditions increase, the plant is under increasing transpiration load which can result in a loss of plant water status and result in a narrowing or contraction in the stem diameter.

“Over night, this process is reversed and as the plant re-hydrates the stem swells with increased plant turgor,” Simon said.

This reduction in stem diameter due to evaporative conditions each day is re-

FIGURE 1: Stem micro-variation sensor in situ and the logger with antenna for remote download



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ferred to as the daily contractual amplitude (DCA). This DCA is the second crop response method and is used in cotton from flowering onwards.

The accompanying Phytech software, PhytoGraph enables a visual assessment of the crop's performance to be made over time in terms of DSI and DCA. It also enables the import of other data sources such as weather data and soil moisture data to enable a more comprehensive decision on when to irrigate to be made (Figure 2).

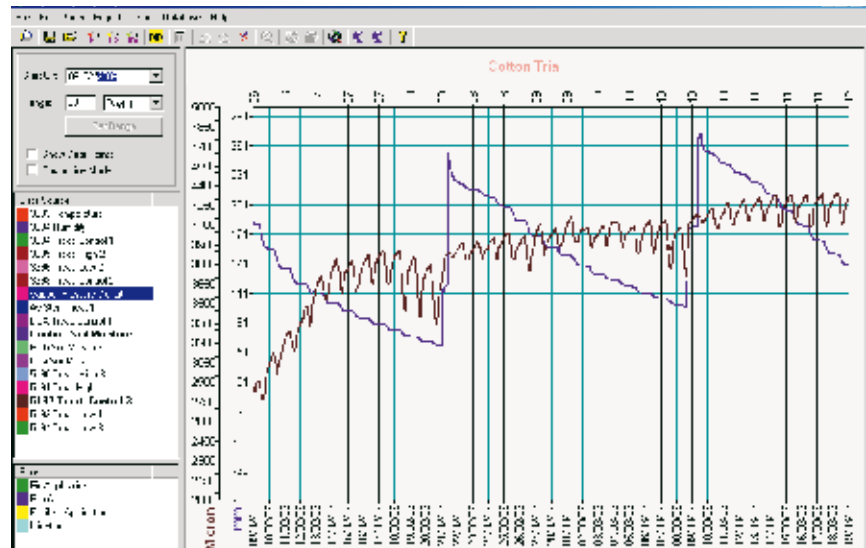
Last season NCEA, with assistance from Sam Plant of Isis Phytomonitoring (distributor of Phytech's products in Australia), installed stem micro-variation sensors in cotton under three different irrigation regimes beneath one span of a commercial lateral move irrigator.

"By doing this we could compare the response of the stem diameter sensors in terms of DSI and DCA under the same climatic conditions to a range of soil moisture conditions," Simon said.

These varied from severely stressed, to normal irrigation practices and low soil moisture deficit conditions.

"Our objective is, over a number of seasons to establish threshold values DSI and DCA for optimising irrigation in cotton. This will enable stem diameter sensors to

FIGURE 2: Phytech's PhytoGraph software showing stem diameter (black line) and soil moisture data imported from EnviroSCAN (blue)



As soil moisture becomes limited there is an increase in the daily contractual amplitude until the next irrigation. A change in climatic conditions will also influence the stem diameter value and can be accounted for by importing temperature and humidity or vapour pressure deficit (VPD) data. Climatic data which might have overloaded this chart is not shown.

be used as an aid to improve or possibly as an alternative tool for irrigation scheduling," he said.

Phytech's phytomonitoring sensor is already being used in a range of crop in-

dustries around the world including; horticulture, viticulture, flower production, tree crops and broadacre irrigated cropping.

Contact Simon White Ph: 07 4631 1354 or Sam Plant Ph: 0427 031 775.

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